TELEVISION

THE FIRST TELEVISION JOURNAL IN THE WORLD

NEW SERIES

PUBLISHED BY THE PROPRIETORS OF "AMATEUR WIRELESS" AND "WIRELESS MAGAZINE"

JULY, 1934. No. 77

For the Beginner

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An Experimental Light Chopper

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No. 77 VOL. VII JULY, 1934.

TELEVISION

THE FIRST TELEVISION JOURNAL IN THE WORLD

In This Issue

TELEVISION

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COMMENT OF THE MONTH

An Opportunity for the Amateur.

A SUGGESTION that the amateur should enter the transmitting field which was made by a reader last month has evoked very keen interest and as a result we have already been in touch with a number of enthusiasts who are keenly desirous of seeing some such scheme put into operation. Almost at the same time comes the news that two northern amateurs have already formulated a scheme for amateur transmission and are making preparations to put it into execution. Readers will, we are sure, join with us in congratulating them upon their initiative.

At the time of writing it has not been possible to ascertain the status of the amateur as regards the transmission of pictures, but representations have been made to the Post Office authorities on the matter. It would appear that an amateur who holds a transmitting licence would be entitled to transmit picture signals under the present regulations, but this is a matter upon which we shall have more to say when we learn the exact position.

It will be quite clear that to put out amateur transmissions even on a small scale would require the co-operation of a number of people both on account of the cost and the work entailed; also it would only be possible to cover comparatively small areas. The first step taken by the two amateurs to whom we have already referred was to form an amateur society and this, we suggest, would be an excellent example to follow in various districts. Even apart from the matter of amateur transmission the time is now quite ripe for the formation of clubs and societies on the same lines as those which were so successful in the early days of broadcasting. The suggestion should interest members of the Constructors' Circle, and we shall be glad to hear from any amateurs who are desirous of participating. The first necessity would appear to be the co-operation of someone who holds or is able to obtain a transmitting licence.

For a start " stills " could be transmitted as the apparatus required for this would be of a very simple character; when experience was gained transmissions of a more ambitious character could be undertaken. By next month we hope that the position will be clarified and we will then be able to make more definite statements and to give some information on the construction and operation of simple transmitting apparatus. Meanwhile, will interested readers kindly let us have their views.

Rumour.

In the course of the past month the air has been full of rumour concerning imminent developments. These have embraced such departures as a television theatre in a leading northern seaside resort, transmissions from Athlone, sponsored transmissions from the Continent and some other minor developments. We have endeavoured to trace these rumours to their source but have not succeeded in getting confirmation in any case, but as there is no smoke without fire it appears quite probable that some ideas are being evolved which will later see the light. The possibilities of sponsored television programmes are not likely to have escaped the notice of advertising interests and we make the conjecture that it is probable that here is the source of the rumours.

FACTS AND FIGURES OF PUBLIC OPINION

A more complete analysis of the replies to the Questionnaire published in May discloses some further interesting facts. Though a good number of additional forms have been received since the first summary of the replies was published, these have not had much material effect on the general summing up then given.

A Retrograde Step

The percentage of those who consider that the curtailment of the 30-line television broadcasts will definitely adversely affect progress is still approximately ninety-eight per cent. A large proportion of those who have answered this question in the negative are of the opinion that progress can still be maintained by individual research and experiment. In very few cases is the plain answer " No " given.

With regard to the use of the present bi-weekly transmission, it is evident that most of those who state that they are able to use both these are engaged in the radio trade. The figure, however, is only a little over five per cent. of the total, and it is clear that to all intents and purposes the Friday morning transmissions are regarded as being practically valueless.

Opinions as to whether the duration of the transmissions is sufficient are quite definitely in the negative, and the point is emphasised that for experimental purposes such a short time is almost useless.

Six hours per week is the moderate demand for the total weekly television transmission time. The valuable suggestion is made in many letters that television could without difficulty be introduced as a subsidiary feature in many of the ordinary broadcasts such as talks, lectures and debates.

Low-definition Television Should Be Continued

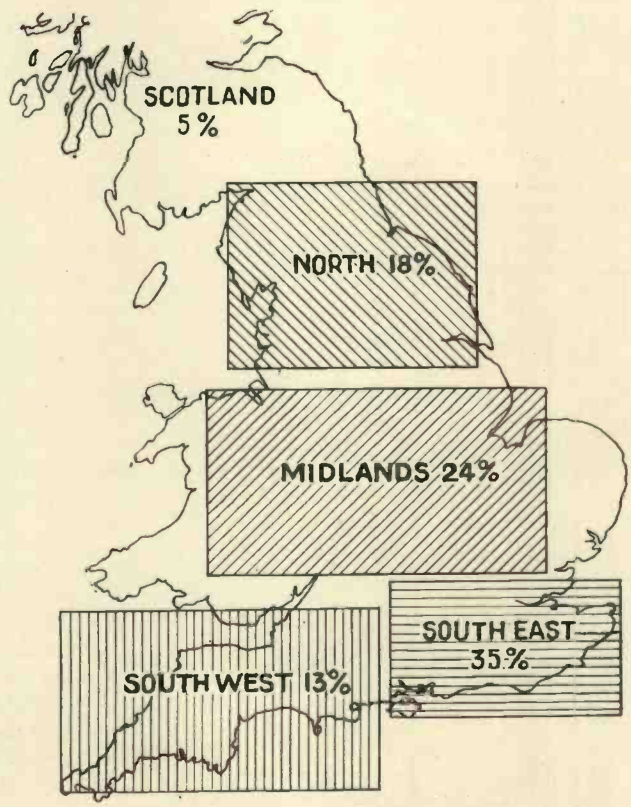
The opinion is very general that the low-definition system is proving of great value in the development of television, and also that it can provide a fair modicum of entertainment. In many cases it is pointed out that it is the only system that is likely to be available to the person of average means, and also to those who are not resident in or near London, for a very considerable time. The cessation of this, unless a similar system took its place, would, it is contended, debar a large proportion of the public from taking any active interest in television.

The estimate of the average amount of money spent by individuals on television given last month was rather on the low side. Twelve pounds was the figure stated, and this would be the figure if an average of all the replies received were taken. The writers of some of these, however, have not up to the present spent any money on apparatus, and if these be excluded the figure is slightly over sixteen pounds per person. This figure, as remarked last month, may seem somewhat high and convey the impression that television is a rather expensive hobby, but as was pointed out then quite a number of the replies received indicated that in many cases very considerable sums had been spent in intensive research. It is noteworthy that most of these, which are obviously from readers of considerable experience, advocate a continuance of the low-definition transmissions.

Interest in Different Parts of the Country

It was obviously desirable to ascertain the relative amounts of interest that were being taken in television in different parts of the country, so with this object the replies were roughly divided into six sections with areas as those shown by the map. That the highest figure should relate to the area nearest the London National transmitter was a foregone conclusion of course, but the figures serve to show the amount of interest there is in districts where reception must be carried out under certain difficulties due to distance. The figures are as follow, and the areas are indicated by the shading of the map :—South-eastern area, including London, thirty-five per cent. ; south-western area, thirteen per cent. ; midlands, twenty-four per cent. ; northern area, eighteen per cent. ; Scotland, five per cent. ; foreign, five per cent. It will be obvious that the above figures probably represent also the facility with which the broadcasts can be received in the different areas, and they indicate that the public interest is according to what facilities are available.

That the disadvantages of distance have been overcome by keen enthusiasts is proved by the replies from foreign sources which have been received. These include France, Holland, Spanish Morocco, Madeira, Germany and Italy, and in all cases these are from readers who are actually receiving the B.B.C. transmissions.



This map gives an idea of the distribution of people in this country who are taking an active interest in television and it clearly indicates that this is according to the facilities that are available.

An Experimental Light Chopper

By Robert Desmond

AS the origin of a television signal is fluctuating light falling on a photo-cell it is often necessary to produce fluctuations of light which are of a definite character and frequency; with this view in mind some simple apparatus was constructed by the writer. There are various ways in which light may be made to modulate. The most obvious to the television experimenter is to use a neon or similar lamp, or a Kerr cell and polarised light; unfortunately it is difficult to get a constant output from such devices over a wide band of frequencies and they also require very carefully designed and constructed sources of the modulating frequencies. In the "talkies" a form of light modulation, as most readers will know, is used in which an ordinary beam of light is varied in intensity by passing the film, on which there is a photographic image of the recorded sound (see Fig. 1), through the beam of light.

This is a description of an experimental apparatus for producing light fluctuations of a definite character and of any frequency. A fluctuating light will be found most useful for a number of purposes connected with television research.

Mechanical Modulation

Turning to Fig. 2, A is what might well be a portion of a "talkie" sound track, but is actually a drawing of three cycles of a sine wave. Now if one had this pattern on a "talkie" film one would get pure sine wave light modulation falling on the photo-cell at frequencies depending on the speed at which the film passed the light beam. It is also obvious that if one arranged it so that the film remained stationary, the beam of light travelling along the film, the result would be the same, though in the case of a cinema film it would be rather impracticable! However, as a light chopper is only required to reproduce certain definite wave forms at different frequencies it becomes quite practical to move the light beam. Suppose we arrange for a narrow beam of light to travel from a to d (Fig. 2A) and that the instant the light leaves d another beam follows from a, and so on. The result would be sine wave light pulsations at a frequency depending on the time taken by one beam of light travelling from a to d multiplied by 3, as there are three cycles drawn in that period.

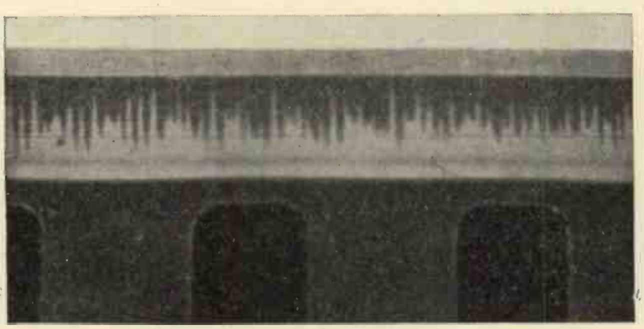


Fig. 1. A photograph of a piece of film with a sound record on it.

Such a method can be easily arranged. A disc D, Fig. 3, in which there are a number of slits, is rotated in front of a light source S while the lens L is arranged to project the image of the slits as they pass the lens's field of vision on to the pattern P. If the pattern is a painted design on, say, a piece of paper, the light reflected will vary according to the pattern, while if the pattern is a cut-out, a fluctuating light will pass on to the area left of P. All this seems simple, but there are practical difficulties which, however, with careful construction can be overcome.

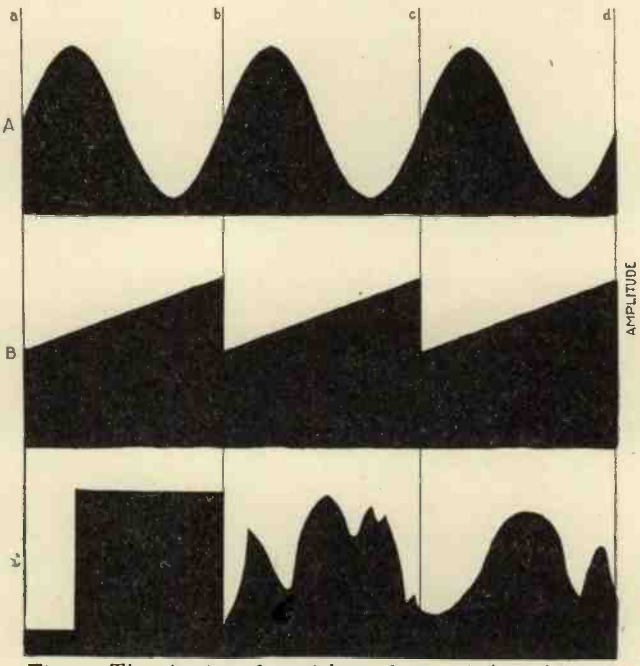


Fig. 2. Three drawings of recorded wave form. A shows three cycles of a sine wave, B three cycles of a saw tooth wave, and C a square topped and two irregular wave forms.

Making the Disc

In the simple apparatus about to be described, the first problem tackled was that of a slotted disc. At first an attempt was made to cut 180 slots in an aluminium disc of some 2 feet diameter, which was a failure owing to a few slits being uneven, which superimposed an undesired frequency of considerably lower period on the desired one, while over $\frac{1}{2}$ h.p. was required to drive the disc at the required rate. It was then decided that the smaller the disc the easier to drive while the increase in slits would require a slower running speed for a given frequency. Also the smaller the angular spacing the less the distortion due to curvature.

The writer had no means of producing such a disc in metal so it was decided to use photographic film as the material for the disc, and that the number of

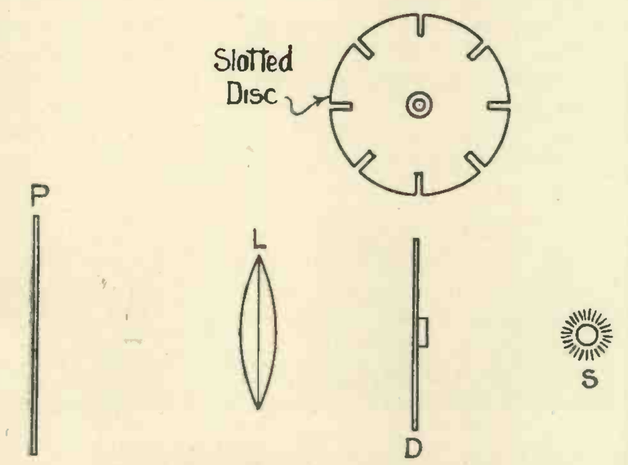


Fig. 3. A schematic diagram showing the layout of the light chopper.

the slits would be 360. The original idea was to draw such a disc on paper and photograph it, but on buying a circular transparent protractor for the purpose of making the drawing it was obviously easier to photograph the protractor direct. This was done on an

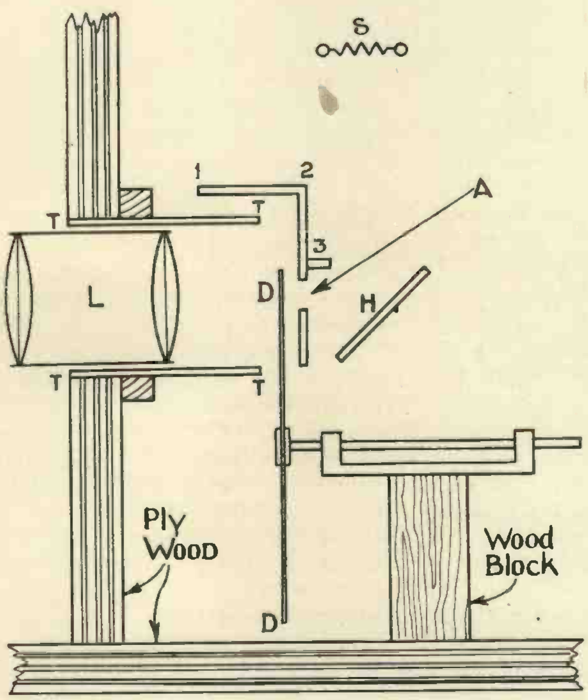


Fig. 5. This diagram shows the construction of the light chopper and the relative positions of the parts.

Eastman $\frac{1}{4}$ plate process cut film and the resulting negative in which a 5 in. diameter protractor was reduced to 3 inches, was used to make the disc.

Great care must be taken to ensure that the protractor is reproduced as a circle on the film, that the illumination is uniform and the sharpest focus is obtained. It should be mentioned that instead of passing a light slit across a pattern, a black one may be used but the " standing " light will be of a very high order

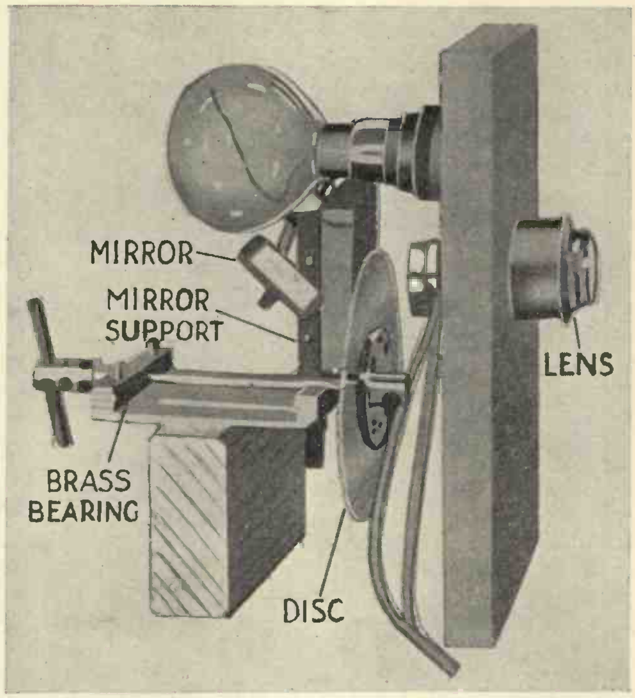


Fig. 4. A photograph of the actual chopper assembly. It will be seen that the mechanical construction is quite simple.

and in such cases the protractor itself could be used for a disc.

Mounting the Disc

The negative of the protractor was carefully trimmed and mounted between a Meccano " face-plate " on one side and aluminium disc and Meccano large crown wheel on the other, great care being taken to ensure that the disc and its fittings ran true in every way. The disc being mounted on a silver steel rod of .165 in. diameter, the bushes of the Meccano fittings had to be drilled out to a slightly larger size. The bearings were made of $\frac{1}{4}$ in. square brass rod, mounted on a piece of heavy gauge aluminium which in turn was mounted on to a block of wood on a baseboard, as shown in Fig. 4. In this figure it will also be noticed that the lamp and the projection lens are shown. The latter is out of a 5s. " Bing " toy cinema. It is not intended to give a detailed description of the construction, but a general outline.

The Assembly

Fig. 5 shows the theoretical layout. S is the filament of a 6-volt 36-watt motor headlamp; H a small mirror .75 in. square to reflect the light through the aperture A of .125 in. diameter; 1-2-3 is a metal mask containing an aperture A, the whole being made adjustable in vertical and horizontal directions. The little lip at 3 is to prevent light passing through the aperture obliquely. D is the disc already discussed, and L the projection lens which slides in a metal tube T T. Fig. 6 shows the disc, lamp, etc., enclosed in a plywood box, but with one side removed. The

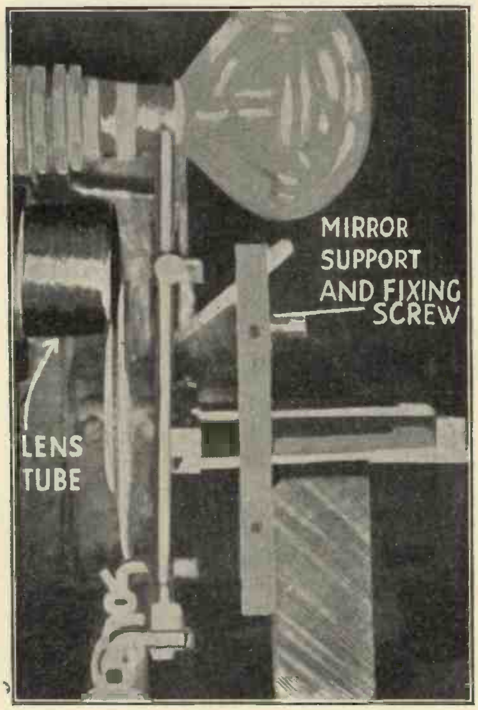


Fig. 6 (left). The entire chopper assembly is enclosed in a light-tight box and this photograph shows how provision is made for the horizontal movement of the mask.

Fig. 7. (right). This is a general view of the complete apparatus with the light tunnel and screen.

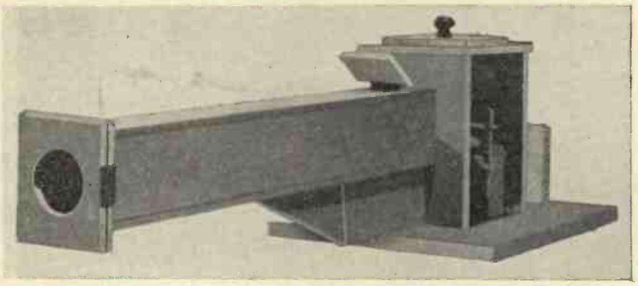
runner for the horizontal movement of the mask is made from the curtain fitting sold by Woolworths which with its own fittings makes very useful sliders for all sorts of purposes. The mirror was cut from a lady's vanity outfit and mounted on a piece of Meccano rod and supported by ¼ in. square brass post and locked into position by a locking screw which can be clearly seen.

Fig. 7 is a general view of the whole apparatus taken during construction. The chief thing to observe in this picture is the long rectangular arm projecting from the lantern box. This arm is 17 in. long, the inside dimensions being 2 ins. x 2 ins. The inside of this and also the lantern house are painted dead black. The arm or case is made of ply-wood and it encloses the projected beam; at the extreme end a sort of photographic printing frame is fitted, the only differences being that the hinged back which is in one piece, has a circular opening so as to allow the light to pass through. This end piece is fitted permanently with a piece of clear glass; it is also necessary to have available a few pieces of ground glass to fit in when required.

If one of these pieces of ground glass be fitted, an image of the edge of the protractor, after duly focusing the lens, should be seen on the screen as in Fig. 8. Here can be seen the spacing of five degrees bound by six white lines; also the half degree marks and a ten degree mark. Use is made only of single-degree markings. It must be mentioned that there is a small trap door in the long ply-wood case just above the lens so that the lens can be reached for focusing and removal; it is shown open in Fig. 7.

The Wave-Form Pattern

We now come to the all-important part of making the pattern of the wave-form, of which we wish to have our modulated light. Unless one is good at free-hand drawing on a small scale the camera must come to our aid. The special wave-form is drawn any convenient size except that the proportion of the time period to amplitude must be suitable; that is to say, having decided on a time period measurement do not select an amplitude that will cut into the half degree markings or go outside the length of the degree lines when the period distance has been reduced in the camera to the correct size. To make the last statement clearer, suppose we wish to have a sine wave pattern as A, Fig. 2, further, we decide to have two cycles per line of the disc. To do this we must photograph the two cycles a to c of A, Fig. 2, so that the time period fits exactly into the space between one degree line and the



similar edge of the next line of the projected image on the ground glass, while the amplitude as already mentioned must not extend into the half degree marks or outside the length of the degree lines. Film or plate can be used equally well for results, though in both cases the emulsion should be of the process type. For a start it is definitely best to have only one cycle which on the writer's machine will give from 10 to 60,000 cycles per second at constant output, while with a three-cycle pattern the range is from 30 to 180,000 cycles though the output is less than when only a one-cycle pattern is used.

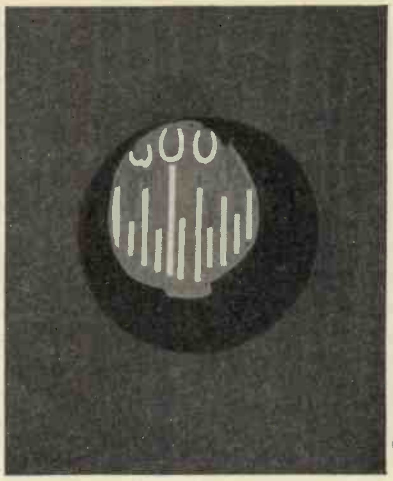


Fig. 8. A photograph of an image on the disc on the screen. Owing to halation effects a difficulty was experienced in getting a correct photograph of this.

So far, only sine wave light has been mentioned, but any wave-form can be produced by simply drawing what is required. Fig. 2B is that of an idea "saw-

(*Continued in 3rd column of next page*).

TELEVISION AND THE STAGE

The views of Sir Cedric Hardwicke are here given in an exclusive interview to Watson Lyle.

THE speed with which the profession of music, and the science of broadcasting sound developed a situation of involved interests as soon as the *modus operandi* of a public radio service was fixed, decided me to seek the views of Sir Cedric Hardwicke on the approaching contact of television and the stage when once the commission now sitting on the question of a public television service has completed its deliberations.

" So far as experimenters in television have been able to progress, within their existing field of operations, I believe reception is limited to the appearance of one, or two small size reproductions of figures, or objects transmitted," I remarked, " but I know nothing, technically, about television."

" Nor do I," replied Sir Cedric. " but depend upon it, improvements in transmission will be made enabling a whole stage production to be sent out."

" When that transpires, how do you think it will affect the art, and professional interests of the theatre?"

Television Actors

" The actors who act for television broadcasts will have to be exceedingly good, and thoroughly well taught. The stage is the only real school for the actor to learn his profession. Sooner or later the authorities—the B.B.C., or whatever body is set up to deal with a public television service—will have to realise that. A voice alone will not do. Even with existing radio broadcasts of plays there must be personality to put over as well, and personality will be more than ever necessary when television comes into use with the stage. Actors with faces as expressionless as a block of wood are useless for the stage or the talkies; and will be similarly valueless for service with this new daughter of the theatre—television. The films and television are like two rather bulky daughters of the stage. Only their mother can equip them for their service in these new developments of dramatic art. This has been amply demonstrated by practical experience with talkies, which have had to get back to the technique, and methods of the stage. For television, actors who can act with their toes, if need be, will be required.

"The B.B.C. will therefore have to depend upon the stage for its supplies of actors and actresses for television performances, and it would pay the authorities to subsidise all theatrical and operatic productions to the extent of twenty-five per cent. of the returns from broadcasting. In this way they will support the mother stage, and ensure for themselves supplies of the best equipped talent, as well as young talent, for use in television when the necessity arrives."

Publicity Value

" I think," I said, " from what I know of the small fees for broadcast performances paid to musicians, especially to the rank and file, on the grounds that the advertisement of the broadcast was in itself a fine remuneration, something should be done by the commission to make sure that actors, playwrights, and theatrical producers, are paid at least professional stage rates for their television performances."

Sir Cedric was ironically amused. " Advertisement!" he exclaimed, " why, the notion is ridiculous. The theatres and film companies might use that argument with as much (or as little) justification. As we know, they do nothing of the kind."

" And I have not yet had an editor suggest to me that I should accept a smaller fee because my name was published," I remarked, laughing.

" Actually," proceeded my host, " because of the thousands and thousands who hear a broadcast, anything of the stage broadcast loses interest for the public as soon as it is over. It would be very little use producing on the stage in the ordinary way a play, or sketch, that had been transmitted by television. Experience proves the public do not visit the theatre to see plays that have been broadcast. On the night of the last Royal Command Performance of variety from the Palladium there was a large falling off in attendances at other places of amusement. Yet the contribution of the B.B.C. to the funds of the charity, the Variety Artists' Federation, was a mere £500. A sum more in keeping with the value of the programme given, and the resultant shortage of receipts at theatres and cinemas, which of course hits the profession, would have been £5,000. This is a point that cannot be too strongly emphasised in the consideration of any policy concerned with television and the stage."—Watson Lyle.

"An Experimental Light Chopper"

(*Continued from preceding page*)

tooth " wave of half the modulation depth of A, while C from a to b is square topped and b to d made up from toying with a French curve. The little sharp points in C would be lost unless the light slit was considerably smaller in relation to the space between it and the following slit than would be obtained with an ordinary protractor previously described.

Rotating the Disc

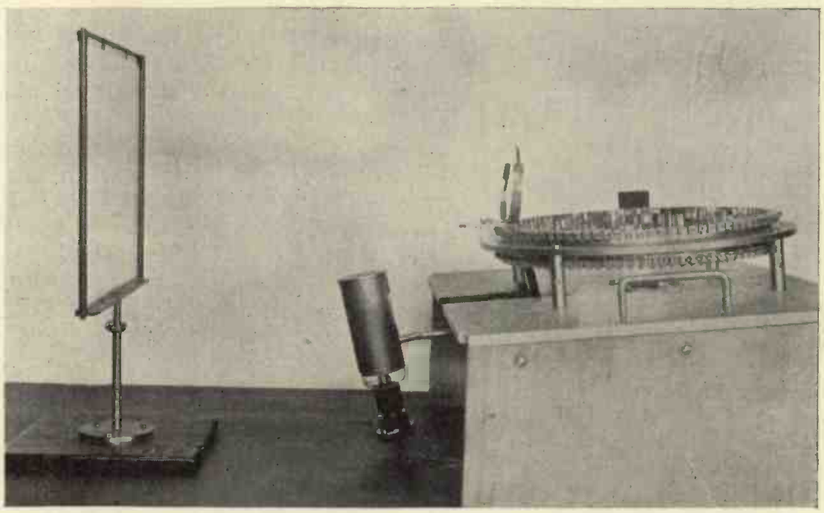
We now come to the mechanical rotation of the disc which must cover a range of from about 4 r.p.m. for 25 cycles per second to about 8,300 for 50,000 cycles. Two types of motor are used, electric and clockwork, the former for speeds below from 120 r.p.m. upward and the latter for speeds below 120 r.p.m. Details of these driving motors and the stroboscopic checking of their speed together with the various uses a light chopper can be put to will be given in a second article.

LOOKING IN WITH A STATIONARY MIRROR DRUM

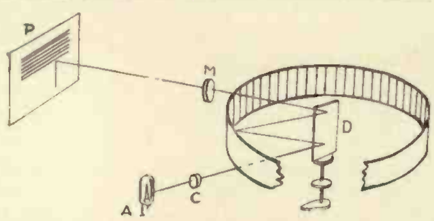
A TEST OF THE MIHALY APPARATUS

WHEN towards the latter part of last year the details of the Mihaly stationary mirror drum were published it created a considerable amount of interest, for it was such a departure from the ordinary practice in the construction of mechanical scanning devices. The principal feature from a mechanical point of view is the extremely small size and light weight of the only moving part and it was expected that this would do much towards the simplification of the problem of synchronisation.

For those of our readers who are not acquainted with the principle of the Mihaly receiver the diagram will make this clear. It will be seen that the essential parts of the receiver are the light source A, a lens C, a small double-sided plane mirror D, a stationary drum provided with a series of small mirrors in its internal surface and finally another lens M and the screen. The path of the modulated light beam is underneath the ring of stationary mirrors, on to the central plane mirror, from which it is reflected on to the stationary mirrors of the drum, and then again on to the central mirror from which it is finally reflected on to the screen. This path is clearly indicated in the diagram. Each of the stationary mirrors is, of course, slightly inclined with respect to the preceding one, just in the same way as are the mirrors of the ordinary type of mirror drum.



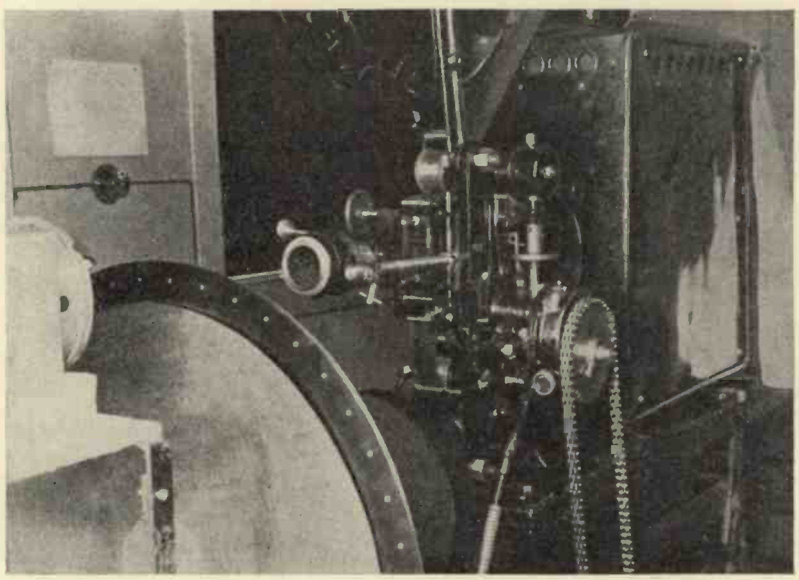
A general view of the Mihaly stationary mirror drum. In the receiver with which the demonstration was given an ordinary projection lamp was used, the light being modulated in a Kerr cell.



This diagram shows the working principle of the Mihaly stationary mirror-drum receiver.

Light Sources

Any of the usual sources of light can be used with this apparatus, but it has been found that the best results are obtained with an ordinary projection lamp, the light being modulated before its incidence upon the central revolving mirror. From a study of the apparatus it will be realised that the optical arrangements have much in common with the ordinary mirror drum and from this point of view the efficiency can be regarded as being practically the same. Mechanically, however, the receiver has two distinct differences. One of these, as mentioned before, is the extreme lightness of the only moving part—the central plane mirror—and the other the fact that by reason of weight or difficulties of construction there is no reasonable limit to the numbers of the mirrors which may be used on the stationary



The 90-line experimental transmitter used by the International Television Corporation for test purposes. The disc and film are driven by two separate synchronous motors.

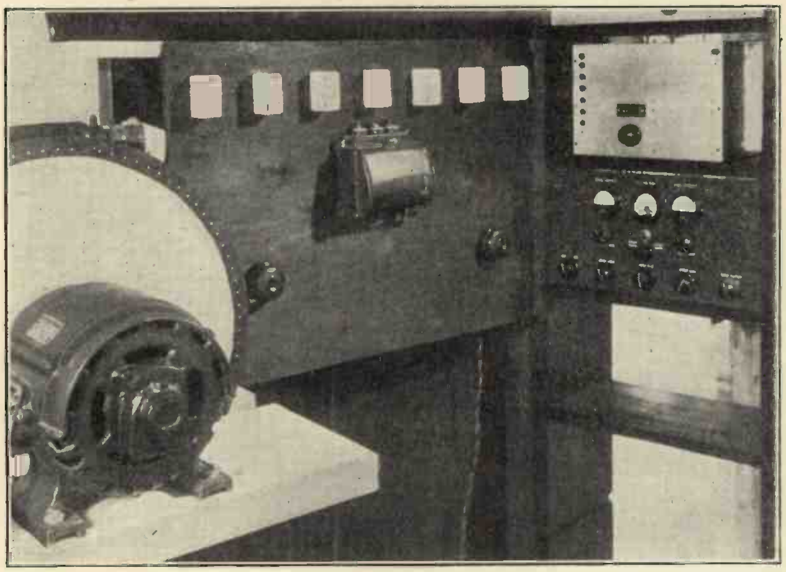
mirror drum so that the apparatus is easily adaptable for a large number of scanning lines. We understand that drums are under construction to produce as many as 180 lines though certain modifications are being made in the design for this high definition.

The Mihaly stationary mirror drum scanner is being developed in this country by the International Television Corporation, Ltd., of Conduit Street, London, W., and by the courtesy of this concern we were able to witness recently a demonstration, the first accorded to the Press. The demonstration was made with a 90-line scanner so on this account the transmission was by line from another part of the building. The picture ratio was 3 x 4, an endless film being used at the transmitter, with a modified standard film projector, scanning being accomplished by disc.

As both transmitter and the mirror drum receiver were driven by synchronous motors the question of synchronising did not enter into the demonstration, but it would appear that difficulties in this respect will be considerably reduced owing to the extremely light weight and perfect balance of the rotating mirror.

The size of the picture was approximately five-and-a-half inches by four-and-a-half, but this is by no means the limit, in fact picture size is easily adjustable provided that adequate illumination is available.

Ninety-lines gives a fairly good degree of definition and it means that there must be a considerable degree of accuracy in the setting of the mirrors unless defects in the picture are to be apparent; however, practically no trace of irregular spacing of the scanning lines was visible which is proof that accuracy with this type of apparatus, even when a large number of mirrors are used, is quite possible. We understand that when some definite policy with regard to television broadcasts is arrived at the Mihaly stationary mirror drum will be put on the market .



A simple 90-hole disc receiver is used as a check for the output of the transmissions.

TELEVISION—
THEORY AND PRACTICE

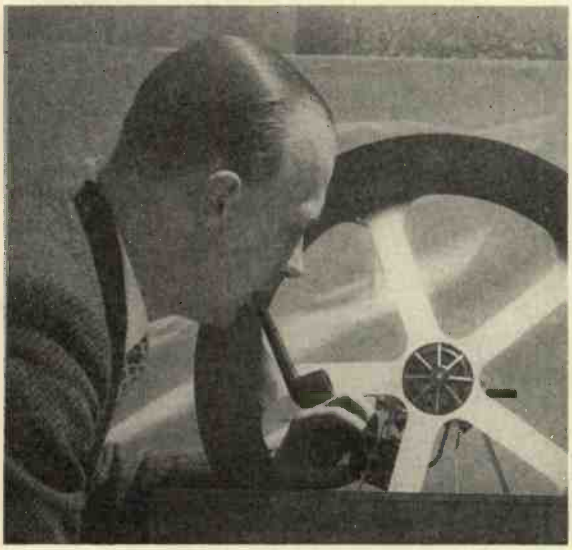
"TELEVISION—Theory and Practice," is the title of a new book by J. H. Reyner, B.Sc., and published by Messrs. Chapman and Hall, Ltd. The author's object has been to explain the principles of the different systems and in each case follow with a resumé of the developments that have taken place. It differs from most books that have been published hitherto in that no attempt has been made to show the historical development of television. The first chapter deals with general principles and the requirements of the production of a televised image, and this is followed by a simple explanation of the operation of the disc type receivers and some notes on synchronising. The physical characteristics of the eye and their relation to the production of a television image are dealt with at some length.

The chapter on optical systems includes a brief explanation of the operation of the mirror drum and light modulation and these are followed by operating instructions of the mirror drum and disc type receivers. Chapter V is devoted to photo-cells, and data relating to the more commonly used types are given. Forty pages are occupied by a consideration of the cathode-ray tube and the cathode-ray system and this is probably the most complete survey of this branch of the subject so far published in any book dealing with all aspects of television. Receiver and time-base circuits and explanations are given which should enable anyone to gain a good insight of this most recent side of television.

The wireless receiver is, of course, an important part of any receiving system and the necessary characteristics for this have been gone into very fully. The remainder of the book is occupied with descriptions of special systems and includes some of those developed on the Continent and in the United States. There are one or two errors in the diagrams and in some instances these are not very clear, but they do not detract seriously from the value of the book which will be found to provide a useful guide to present-day developments and an exposition of television theory and practice. The price is 12s. 6d.

Mixed Layer Photo-Cells

[R. Fleischer and P. Gorlich, Dresden Institute of Technology.] The improvement observed in the sensitivity of cesium—cesium oxide (thick layer) on silver cells when cesium and other metals, silver in particular, are forced in a finely divided state into the salt or oxide layer to form a so-called mixed layer, is confirmed (*Zeits. f. Phys.*, 74: 604-623, 1932. *Physics*, 2: 12, 1932). The foreign metal facilitates the replacement of the electrons furnished by the sensitive layer. The cesium particles may be forced into the layer by keeping the completed cell for a quarter of an hour at a temperature of 160° C., or by using a glow discharge through cesium vapor followed by short heating. The sensitivity begins to increase as soon as an invisible film of the inactive metal is laid down upon the cesium-cesium oxide mass and grows rapidly as the silver diffuses. —*Phys. Zeits.*, 35; 289-292, 1934.



Using your ordinary set with a disc machine

By KENNETH JOWERS

Practically all ordinary wireless receivers can be used with a disc machine to receive the television broadcasts. A little modification is necessary as a rule, but this is of a simple character, as will be clear from the explanations given in this article which has particular reference to some well-known commercial sets.

TELEVISION to the average radio fan seems to present innumerable difficulties. That it is the easiest thing in the world to get started has not yet sunk in! Television and all that the word means is still talked about with a too respectful air. Why is it? A disc turers putting out cheap components television has gone ahead in an amazing manner.

When I think how many radio receivers there are and compare this figure with the number of television sets in use I wondered just why it is that there are so few, comparatively speaking. I made a special point of finding out, and after a while it was quite obvious that one of the snags was that large numbers of people have commercial sets where it is not an easy matter to get at the works so that the neon lamp can be coupled in the anode circuit of the last valve. They may be keen television fans, but all the time they must bear in mind the fact that any alteration to the commercial receiver renders the guarantee useless.

It is for these readers that I have gathered together some of the more popular commercial sets and tried them out to see whether or not they are suitable—without breaking the guarantee—for television.

Of course, it is not possible to try them all at once so I am going to check up three or four each month. Correspondence indicates quite clearly the sets that are in most demand so if you own a set that is not mentioned very shortly, please drop me a line, and I will see what can be done about it.

In most of the battery sets an additional 60- or even 100-volt battery

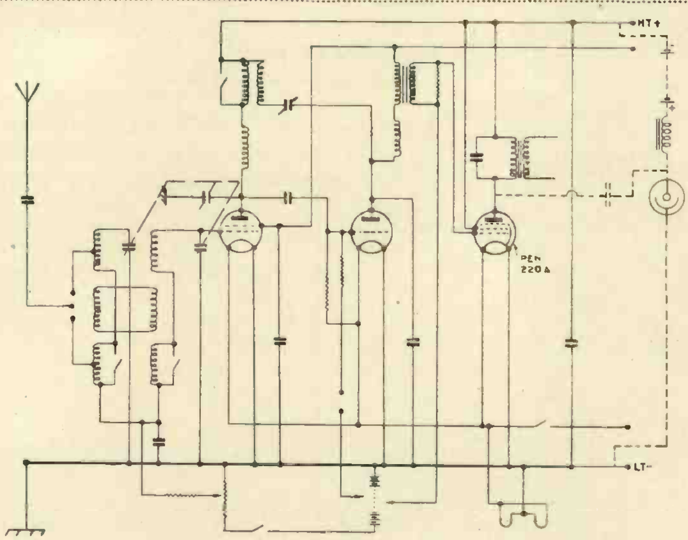
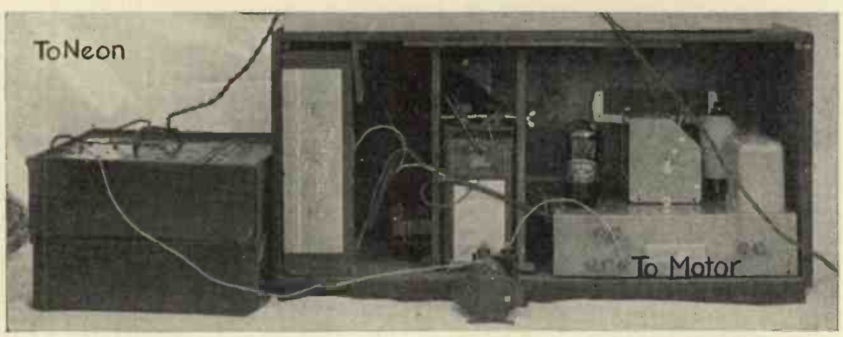


Fig. 1. — The Halcyon three-valve battery set with pentode output. With a large pentode the output is sufficient to modulate the neon.

receiver is so easy to make.

The trouble with the majority of home constructors appears to be that they have, for one reason or another, still retained the idea that television will be too difficult for them and they would rather wait until more is known about it.

Until this erroneous idea is wiped out many readers will miss all the fun that goes hand in hand with the home construction of television gear. New ideas always suffer from this drawback, but thanks to manufac-



A back view of the Halcyon Battery Three connected to a disc receiver; the output choke and condenser can be seen in the foreground.

will be required so as to boost up the voltage to the 187 required to cause the neon lamp to strike or glow.

This is an additional expense, but as the neon is not used very extensively the battery will last quite a long while. There are a lot of readers who use battery sets while having mains supply actually in the house.

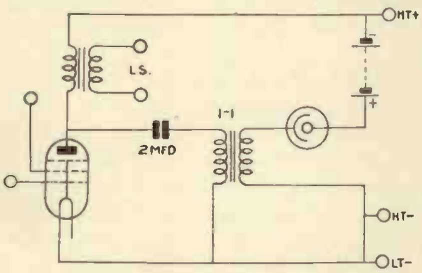


Fig. 2.—Method of connecting the neon to a commercial receiver through a 1—1 isolating transformer.

For such readers a separate exciter unit can be built up to feed the neon lamp. This makes it entirely independent of dry batteries.

As there is not a battery set on the market that uses a battery with a voltage above 179, we must assume in almost every case that the neon lamp will want a booster dry battery.

The Halcyon Battery Three is a typical example of up-to-date radio design, but all these remarks about it can be applied to other commercial receivers which—as far as television is concerned—are fundamentally similar. I refer to such sets as the Ekco B54, the Kolster-Brandes model 333—in fact any of this type of battery set. Then there are the Cossor Melody Makers which, with a good 1,100 milliwatt output pentode will do quite well.

Fig. 1 shows the circuit of the Halcyon model 301 and dotted in are the new connections for the neon lamp. Please don't worry about having to alter the set in any way. The makers have provided terminals for additional loud-speakers which come in very useful.

Obtain a low-frequency choke of fairly low resistance—such as would normally be used for smoothing, or in the choke filter output stage—and a two- or four-microfarad fixed condenser.

Take a lead from the terminal that connects internally to the anode of the output valve which is marked negative.

This terminal is connected to one side of the fixed condenser, and the other side of the condenser to one side of a neon lamp. This side of the lamp is then joined to one side of the low-frequency choke.

The spare side of the neon lamp is taken directly to the earth terminal on the radio set or to an equivalent point. It can go to the metal receiver chassis or to low-tension or high-tension negative on the actual batteries.

That leaves us with two more connections to make. First take the spare terminal on the low-frequency choke to the positive socket of the high-tension battery that you have in addition to the one in the receiver. The negative side of this battery is then joined up to the positive of the battery in the radio receiver.

There are not any more connections to make so no one could call that difficult—could they?

Now for one or two points which must be watched. If you find that the neon only gives a small concentrated glow, reverse the connections to it, that will do the trick. A more troublesome snag that sometimes crops up is reversed pictures. This can be overcome by reversing the primary or secondary of the intervalve transformer or by changing the method of detection. Although both of these methods are quite useful to the user of a home-constructed set they won't work with commercial sets. For even if you can get at the works the guarantee is broken directly you make any alteration.

The only remedy is to interpose a 1/1 ratio output transformer between the output from the receiver and the neon as shown in Fig. 2. This is quite easy to do and, at the same time, it does not affect the radio set.

One more snag that may crop up

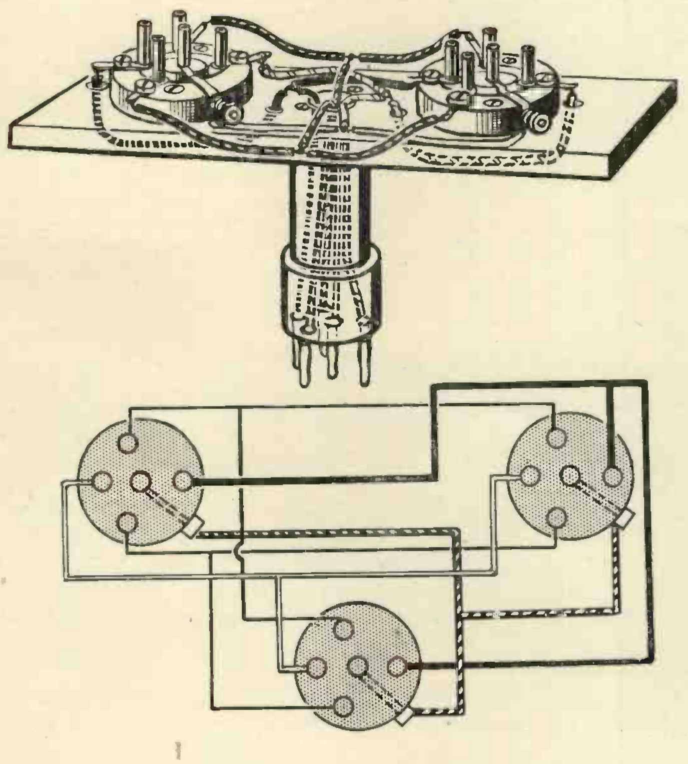
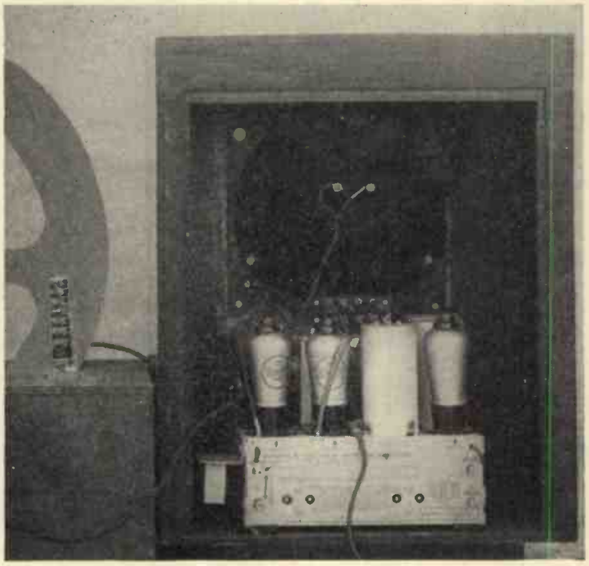


Fig. 3 (left) A useful gadget for use with battery sets; the output can be doubled without altering the receiver.

(Below) A typical commercial set—the Ferranti Arcadia—being used with a disc receiver.



is too little output. It can be taken for granted that a power valve, no matter what kind it is, run from a dry battery will not give enough output to modulate the neon lamp.

A pentode valve must be used with a minimum of 150 volts high-tension and then the volume will be just about enough. Of course, when I say a pentode valve, I do not mean one of the economy type that takes about 5 milliamperes. It must be one of the power type such as the Mazda Pen 220A which gives, under the conditions mentioned, about 1,100 milliwatts.

You can, if you wish, make or buy an adaptor with a five-pin base and two more valve holders wired in parallel on top of it. That will enable you to use two output valves and so increase the volume without upsetting the receiver. Fig. 3 shows just how this is done if you cannot follow it from this description.

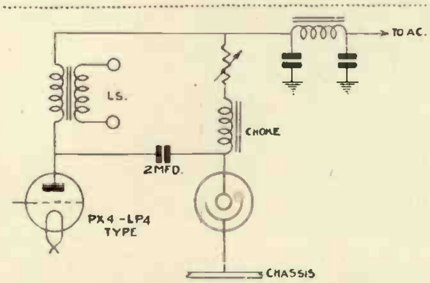


Fig. 4.—The connections for an A.C. mains receiver which are applicable to most commercial receivers.

Of course battery sets are all very well but they are very complicated as compared with a mains-driven set. Take the Ferranti Arcadia super-het as a shining example. This set uses 250 volts and at the same time the power valve gives about 2,600-milliwatts which is just what is wanted for modulating a television neon lamp.

The connections for the disc receiver to this type of set are simple and alterations less expensive than with a battery set, for an additional battery is not required. At the same time there is not any need to worry about the output being too low.

Take a look at Fig. 4. This shows the simple connections for a four-valve A.C. mains super-het of the Ferranti Arcadia class. They are also applicable to receivers such as the Ekco 74 and 64, the Cossor 635, Kolster-Brandes 444, 666 and 888 models, Marconi 262, H.M.V. 440 and the 540 radiograms.

The points from which the connections are taken may differ very slightly, but the circuit is the same. Here again the idea is to feed the A.C. output from the last valve into the neon lamp and to light the lamp from the high-tension supply.

It cannot be connected into the anode circuit of the last valve even though this valve has 250 volts applied to it, for the voltage drop across the neon would be so great that the output from the power valve would be insufficient to modulate the neon lamp.

Before this arrangement can be used the mains high-tension unit must give an output of at least 300 volts with a 200-volt power valve in circuit. This will prove a much too expensive idea so try this arrangement instead. It works well and is quite cheap.

A low-frequency transformer and a two-microfarad fixed condenser will again be wanted. Tap one side of the condenser on to the anode of the power valve and the other side of it to one side of the neon lamp. Then take the contact on the neon lamp that you have just used to one side of the low-frequency choke. The remaining side of the choke is connected to the maximum high-tension output from the power pack.

This leaves you with one connection to make—from the remaining side of the neon lamp. Take this contact to the earth terminal on the radio set, or to the metal chassis, for this is always earthed.

There are again some snags, but this time two only, both of which can be overcome if a little commonsense is used. The snags are to find the anode point and the spot where the maximum high-tension can be tapped off. On the Ferranti set the anode lead is taken up to the primary of the input transformer where it is quite an easy matter to make connection. The high-tension connection is also get-at-able. On the primary of the transformer mounted on the loud-speaker chassis are four connections in a row. This point by the way applies to almost every set. At one end the connection goes to the anode and the opposite end to high-tension. Simply join the negative side of a voltmeter to the receiver chassis and the other side to either of the connections on the transformer and the one that gives the lower reading will be the anode, the other, of course, being the high-tension tapping.

The same points apply to a mains driven set as to a battery set as regards the reversed pictures; interpose the 1/1 output transformer as in Fig. 2.

To make this article comprehensive I must deal with D.C. mains and push-pull output. Being rather lucky I can kill two birds with one stone and show how the new Pye Cambridge super-het can be used. This receiver is for D.C. mains and has push-pull output.

For once the choke and condenser need not be used. In place of these components an output transformer is wanted to connect across the two output terminals. Actually all you have to do is to take two connections from the primary of the output transformer in the receiver which is mounted on the loud-speaker chassis and connect them to the two terminals of the primary of the external transformer. One pole of the neon lamp is then joined to one side of the secondary of the external transformer. Two pieces of flex are then wanted; join one length to the remaining pole of the neon lamp and the other to the spare terminal on the secondary of the transformer.

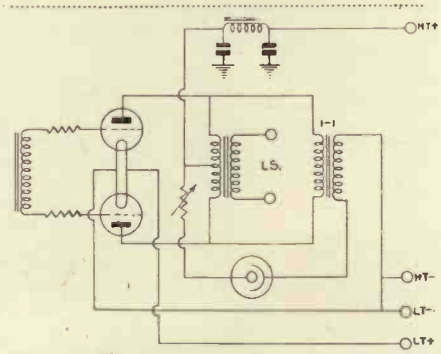


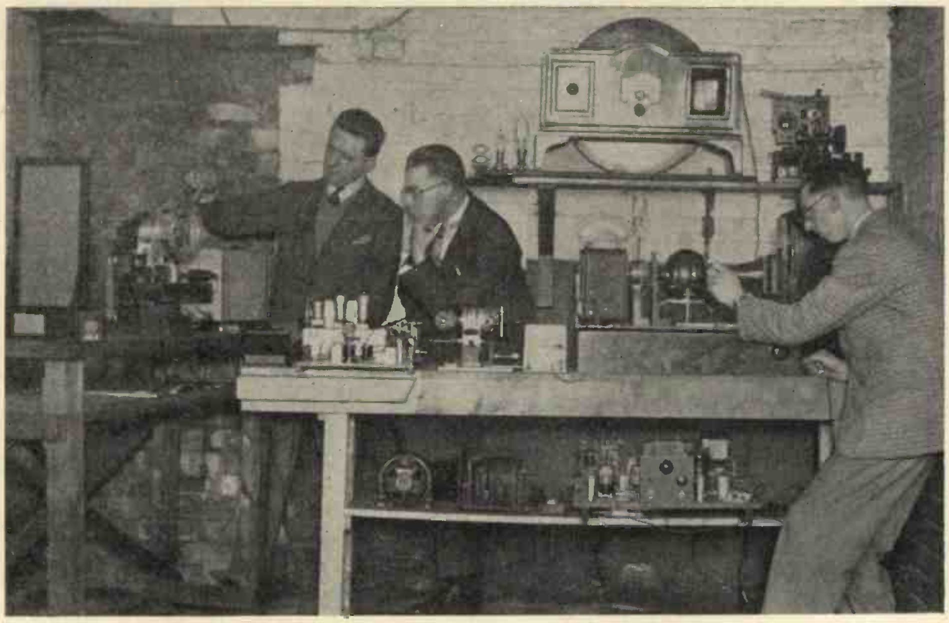
Fig. 5.—Showing the connections when the receiver has push-pull output.

These two leads should be about a yard long and the other spare ends should be taken to the radio receiver where they are tapped on to the high-tension. One of the leads can be joined directly to the metal chassis to form the negative connection. (In cases where for reasons of safety the chassis is isolated from earth by a condenser, connection will have to be made directly to H.T.—) The other or the positive wire is taken to either side of the smoothing choke in the receiver.

If you have a spare power point or a double holder it will be as quick to take these two leads directly to the mains providing the mains are of the correct voltage or the neon lamp has a resistance in series with it.

Fig. 5 shows how the Pye receiver is connected.

AMATEUR TRANSMISSION IN LANCASHIRE



Mr. J. L. R. Jensen (extreme left) and Mr. R. C. Base (extreme right), of Wallasey, demonstrating their television transmitter and receivers which they have constructed. In co-operation with other radio amateurs, several of whom are licensed transmitters, they have formulated a scheme, subject to receiving public support and official permission, for providing south-west Lancashire and Cheshire with amateur television broadcasts.

WILL Merseyside be the home of the first television transmitter in the North? An ambitious scheme formulated by several Merseyside and Cheshire radio amateurs, three or four of whom are licensed transmitters, is projected. The secretary pro tem. is Mr. R. C. Base, of 223 Seaview Road, Wallasey, and at his invitation our Liverpool correspondent called upon him and saw a demonstration of a transmitter and various types of receivers.

"Mr. J. L. R. Jensen and myself," said Mr. Base, "have been experimenting with television ever since the B.B.C. started five years ago. Along with other amateurs on Merseyside and in Cheshire we have struggled with the television transmissions from the London National station after eleven o'clock at night, but only the most sensitive receiver will provide adequate signal strength for the purpose. We have had very encouraging results, however, despite our great distance from London.

"We have petitioned the B.B.C. to transmit from the Regional stations without avail, and now to crown it all, the broadcasts from the London National have been cut down to two half hours a week.

"A few of our number are licensed radio transmitters, and, therefore, we cannot see why we should not be allowed to extend our activities within our own wave bands into the television field. So we have got together to consider the possibility of constructing a reasonable sized television transmitter of our own, and of forming an organisation of all those who are interested in television—and who is not? The idea is to pool all existing transmitting apparatus, and then by subscriptions from the members of the organisation we could supplement it until we had a machine capable of supplying south-west Lancashire and Cheshire with television broadcasts. The actual receiving apparatus could then be of a comparatively simple nature within the reach of a very moderate purse.

"We would, of course, have to obtain a licence, and this might be difficult at first, but we are investigating the legal position and we feel that if the B.B.C. are not prepared to give transmissions from the Regional stations, then we should be permitted to give them, because we are catering for a demand which we will prove exists. But we cannot do this thing alone. We must have public support, and so we hope those who are interested will communicate with us. A meeting place will then be arranged at an address most suitable to the majority, when the project will be fully discussed.

"This apparatus is of a fairly simple nature inasmuch as still pictures only are transmitted, but it is a comparatively simple matter to substitute the slide lantern from a cinema projector so that films can be televised.

"I think you will agree that television is past the mere experimental stage, and that it only requires frequent transmissions to make it as popular as the ordinary broadcasts."

Description of Apparatus

"The television transmitter is of the scanning-disc type, and uses an ordinary lantern slide projector. The lenses of this are altered in order to focus the picture on the slide to a smaller size, instead of larger as is usual. The picture is thrown on to the face of the scanning disc, but before reaching there passes through a special mask which shuts off the light for a brief interval between each scanning strip, in order to produce the necessary synchronising impulse.

"The light, after passing through the holes of the disc, as this revolves, is collected by another lens and focused on to a photo-electric cell. The cell is mounted in a metal box together with a three stage R.C.C. amplifier. This is called the 'A' amplifier, and is battery driven.

"The output of this is then connected, via a low-capacity screened cable to the 'B' amplifier, which consists of four R.C.C. stages to-

(*Continued on page* 296)

REVIEWS OF THE PROGRAMMES AND RECEPTION REPORTS

DESPITE the curtailment of hours, programmes have shown no decline in quality or variety. While others in his position might have been disheartened by the reduction in programme time, Eustace Robb, the producer, has never relaxed his efforts to secure the best available talent for the television studio. Of course, there are disappointments, and it is, perhaps, as well that "lookers" are not conscious of the treats which they have missed. Enjoyment of a striking picture would not be enhanced by the knowledge that a programme already good would have been better if a certain famous artist had been allowed to appear.

A case occurred the other day when La Argentina, one of the greatest Spanish dancers of our time, was in London for a short season. The producer was anxious to present her in the studio and negotiations were opened. The dancer was not unwilling, but a clause in her contract with a film company expressly excluded any performance for television. Constance Bennett was prevented from appearing for the same reason.

While it is encouraging to find that the cinema business already regards the new science as a competitor, it will be damaging to both interests if rivalry is allowed to develop in the visual entertainment field. In the early days broadcasting had to meet the opposition of concert promoters and others, the recording companies had difficulty with musicians and it seems that television will not escape the same kind of trouble. The instinct of self-preservation is pretty strong in any healthy industry and the friction which occurs on the introduction of new methods is usually due to fear of financial consequences.

After a period of adjustment, the old and the new learn to live together and mutual benefit often results. Far from harming the business, television is likely to help the cinema industry by reducing distribution costs. A single set of reels televised and transmitted from a central point could serve all the cinemas within a twelve mile radius if ultra-short waves were used.

* * *

The Cocktail Club was the success which it promised to be. Eve Becke with her piquant expression makes a good picture; Patrick Waddington has an informal air, and Sarah Allgood wrote afterwards saying that she had never before enjoyed a broadcast or television performance so much. She caught the spirit of the affair.

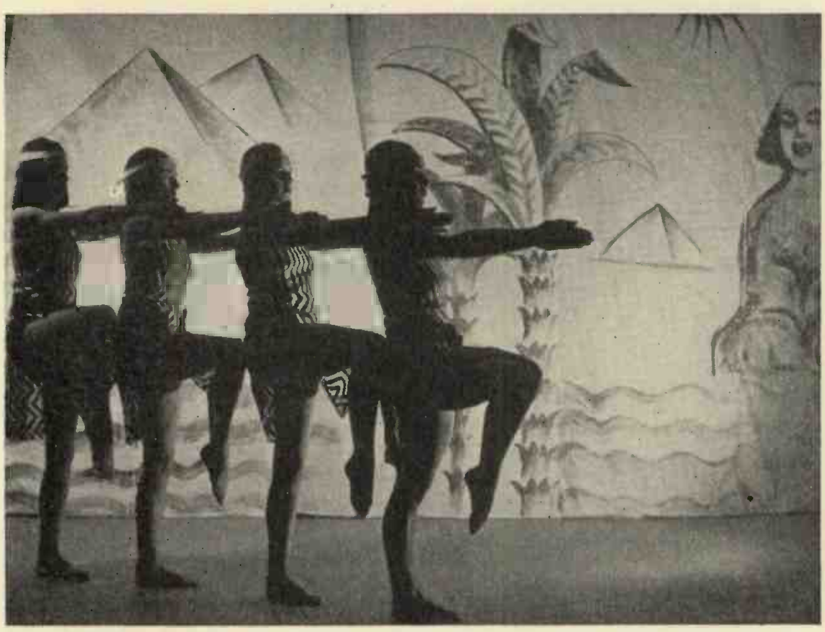
Smoking was allowed at the bar and business with cigarettes gave a realistic touch to the scene. Tom Webster, another guest, faced the scanner for the first time and, though his patter was witty, it was a pity to destroy the illlusion of a party. His talk of "make-up" and "phony" cocktails was out of place because it brought us back to earth.

The programme ended on a novel note to the cry of "Time, gentlemen, please," with the producer in the guise of secretary bidding his guests farewell. That club deserves our patronage.

* * *

The reaction of an older generation to a new art is sometimes enlightening and I was interested to hear a grandmother describing her first experience as a "looker." It was so much easier to listen now that she could see the lips moving, she said, after watching Doris Hare singing in close-up. She saw the programme through and her attention never wandered, though she was easily distracted when listening to the radio.

Sutherland Felce, who compèred this programme, acted as a visual announcer and afterwards gave his



Corps de Ballet in La Danse des Egyptiennes from Cleopatra. It is interesting to note the large amount of contrast provided by this setting.

Brigitta Paquerette-Ballet and Ballerina.

own act. Max Kirby, in the same bill, sang exactly like Jack Buchanan, whose parts he has played on tour. His voice would be mistaken for the original, but the picture told another story. He has not the Buchanan figure.

* * *

In the case of Sherkov, an excellent act, I began to tire of the distant shots through lack of detail. Five dances followed in extended focus, which demands considerable concentration. To effect a balance, the producer had arranged for the other artists, Jean Colin and Wilfred Burmand, to sing in close-up, but the programme would have been improved for me if the dances had been divided with songs in close-up between. Wilfred Burmand made several quick changes for his character studies, which helped to hold my interest.

* * *

The piano accompaniment was still audible after Jack Stanford had stepped out of the picture at the end of his dance, and " shut up " bawled from the shadows at the side of the studio was clearly heard as he threw his hat at the pianist. The music stopped abruptly as the hat caught the musician on the head.

Jack Stanford was appearing as the direct result of a letter to the producer. A " looker " who had seen the dancer at the Alhambra wrote recommending the act for television. Eustace Robb went to see the show and booked the artist. Suggestions from " lookers " are often helpful.

Ronald Frankau was in the programme on the same evening. He is an example of a regular broadcasting artist who takes the trouble to adapt his usual act for television and I was amused when he removed an enormous hat from his bald head with a gag about an ostrich egg.

Dates for " lookers' " diaries:

June 29, *in the morning*: The second Cocktail Club programme, when the members present will be: Roy Royston, broadcasting and televising for the first time in Britain; Charles Heslop; and Hilda Mareno, with a husky Spanish voice, who has reached town from Cuba by way of New York. She has not been heard or seen here by radio before.

July 3, *at night*: John Hendrik, Bertha Willmott, both old friends, and Doris Sonne and John Byron, in a graceful dance of the crinoline period.

July 6: Sarah Fischer, the distinguished singer, for the first time in the studio.

Later in the month we should see and hear Eve Becke again, and Mary and Erik in a truly astonishing roller skating act.

The Interference Problem in Germany

In view of the well-known fact that on ultra-short waves interference from electrical apparatus and motor cars can spoil the entire reception, especially in cases where the field strength of the transmitter is somewhat low, it is interesting to note that the German Post Office has now included in its courses of instruction for technical service, information on how to locate, and remove, sources of interference.

Although it has not been made absolutely compulsory, in Baden-Baden attempts have been made on a large scale to remove all sources of interference, and it is surprising to note that 80 per cent. has been located and removed; in many cases the usual condenser circuits have been sufficient. This experiment clearly emphasises one point; that it is only possible to go into this matter of interference provided a force of trained mechanics, with a special knowledge of the subject, is available.

It is interesting to reveal that the largest number of interferences emanated from vacuum cleaners and electrically-heated cushions. Private telephone installations showed the smallest number of interferences, the number being only 18, as compared with 1,468 from vacuum cleaners.

" Amateur Transmission in Lancashire "

(*Continued from page* 294)

gether with an additional transformer coupled stage to actuate the synchronising coils of the receiver. The transformer used here has a peaked frequency response of 375 cycles. The " B " amplifier is entirely mains driven and works with a H.T. voltage of 700. The output of the amplifier may then be fed either direct to the receiver or through a suitable radio transmitter via the ether.

" For our own experiments, of course, it is fed direct, and the receiver is of the mirror-drum Kerr cell type. This projects a picture on a screen up to two feet high, although we generally use a screen about 9 to 12 inches high.

" This apparatus is of a fairly simple nature inasmuch as still pictures only are transmitted, but it is a comparatively simple matter to substitute a cinema projector for the slide lantern so that moving pictures can be transmitted. The apparatus can also be easily modified to enable living artists to be used, al that is necessary being to use a larger lamp for the projector and more sensitive photo-electric cells and amplifiers.

"Also a mirror-drum can be used in place of the scanning disc to advantage. All these batters can be carried out with the necessary support of a number of amateurs. I think it would be advisable to restrict our transmissions to 30-lines at first as a large number of amateurs already possess 30-line receivers. If the members agreed, 60-lines or more could be used, although this would involve extra expense at both ends."

The Frequency Band Problem in Television

By E. L. Gardiner, B.Sc.

IN many respects a stage has been reached to-day in the design of television equipment in which the terminal apparatus, the actual transmitters and receivers themselves, can be made better than is of any practical utility; by this paradoxical statement I refer to the fact that television signals can be produced (from film particularly) and can be well received, which are of so wide a frequency band that no amplifiers or radio apparatus has yet been designed which will handle this range of frequencies without introducing losses and distortions considerably greater than those introduced by the television equipment itself.

The wide range of frequencies occupied by a good-quality television signal, necessitating also as it does the handling of very high maximum frequencies, has always represented a fundamental problem. It is also in this respect that television technique differs radically from that of sound broadcasting. Many of the methods evolved are entirely inapplicable to television. The importance of this problem is so great that no apology is needed for adding yet another viewpoint to the mass of published discussion on this topic.

For example, the leading exponents of cathode-ray systems can employ 180 or even 240 scanning lines with considerable success, which involve the transmission of side-band frequencies of 500 kc and over, about the maximum limit of ultra-short wave radio technique in the hands of most engineers at present. But we are told that the Ikonoscope can operate with comparative ease up to four or five hundred lines, which suggests that side-band frequencies of the order of 4,000 kc will have to be mastered sooner or later. Truly a formidable task for engineers who, a few years ago, regarded ten kilocycles as a very high figure at which to aim.

Workers on mechanical television systems also are not far behind in the matter of numbers of scanning lines, and although the majority of them are still content to rest at 120-line working, it must be remembered that the mechanical systems give in general a more perfect analysis of the image due to their more precise definition of the spot, and hence a better image in proportion to the number of lines employed.

So perfect can the best equipment of this type be made to-day, that very often the amplifiers introduce far the largest losses in definition, even at 120 lines; few, if any, demonstrations have ever been given over a radio link in which the received image was not noticably inferior to that given by the same television equipment when used over a very short land line.

The foregoing remarks serve to show that this question of width of frequency band is still a major problem, and is more likely to hold up the eventual progress of television than are the many problems in the design of terminal apparatus, scanning systems, and such like which normally occupy such an important place in our thoughts. It is not intended in this discussion to delve into the intricacies of amplifier or radio design, however, but rather to review broadly the various other avenues of attack on this problem which are constantly being proposed, and to investigate to what extent it may be possible to get round the difficulty indirectly.

Two Schools of Thought

This frequency problem rests on certain assumptions which are generally considered true, but which cannot be said to be proved beyond a shadow of doubt. The chief of these are, firstly, that a high-definition television image necessarily involves the production at the transmitter and the transmission of inconveniently high frequencies; and secondly, that such high frequencies, if produced, must necessarily involve the radiation by the radio transmitter, of equally high side-band frequencies. These two assumptions give the clue to the two kinds of improvements which have been brought forward by many workers, particularly during the last six years, with a view to obviating the frequency-band difficulty. The first school of thought seeks to evolve forms of scanning or image analysis, as it may preferably be called, in which a high definition image is not accompanied by so wide a band of frequencies as usual, or in which better use is made of the frequency band employed. They point out, I think quite rightly, that the systems of television to which we are most used to-day, and which employ a system of regular sequential scanning, are not by any means the only ones possible; and that maximum frequencies calculated on that assumption may be misleading.

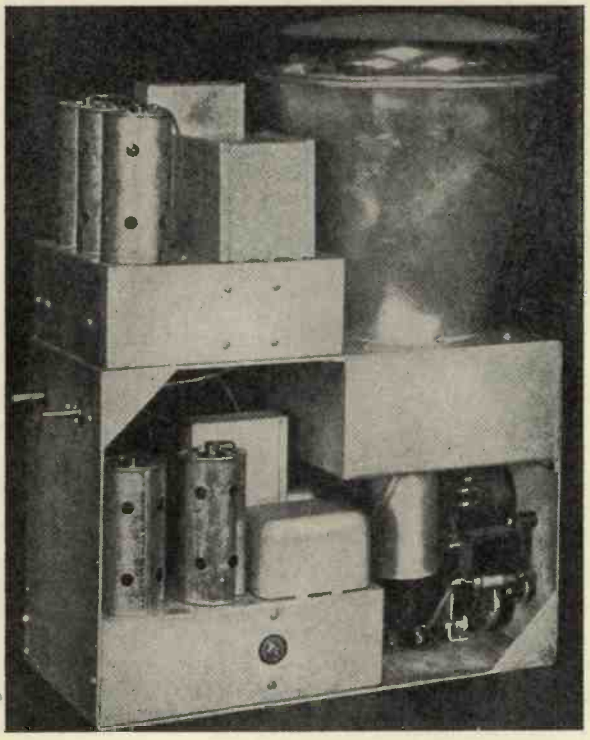
[*Photo.: Journal of the Franklin Institute*
A finished model of a television receiver incorporating the Zworykin Iconoscope.

The second school of thought pins its faith to improved methods of handling the wide frequency band produced by their television apparatus, and unorthodox methods of radio transmission which are believed to reduce or eliminate side-band effects, thereby assisting a particular radio station to transmit a wide frequency band without loss or causing intereference.

Of course there are systems which seek to effect both kinds of improvement at once. It is nearly always possible, however, to separate the two parts of the problem, and I think that it will be found far easier to grasp the possibilities of any particular arrangement if this mental separation be carried out whenever possible.

A Triple-spiral System

Let us now consider these two methods of attack in more detail, beginning with the first. Perhaps a simple and well-known example of such a system which has met with decided success in America will help to make clear the kind of thing which can be done. The system used by the Western Television Corporation, of Chicago, about three years ago, the invention of Sanabria, employed a scanning disc in the usual way with which we are all familiar, having 45 holes, but arranged in three interleaved spirals. This system has been described in this journal in the past, and I need only recall that it differs from the single-spiral system in use here, in that whereas the scanning spot traverses the image field 45 times during each image transmitted, as usual for a 45-line system, it does so in a different order, passing from side to side across the field three times for each image, and of course at three times the rate.



[*Photo: Journal of the Franklin Institute*

An internal view of the Zworykin receiver showing the Iconoscope.

This process will be found to have two advantages over the more usual single spiral; one of them obviously being that of reduced flicker for a particular number of images transmitted per second; the second and less obvious advantage, but one which can very easily be visualised after a little consideration of the operation of the scan, is that of a different distribution of signal energy throughout the frequency spectrum. Whereas the maximum frequency involved is the same in this system as in a single-spiral one of equivalent definition, there is a greater concentration in the medium-frequency portion of the band, accompanied by less signal energy at the very high and very low frequencies.

This gives a signal more readily amplified without distortion, and one in which the loss of some of the highest frequencies in transmission causes a less serious degradation of the image quality. Whereas the improvements just mentioned are not, of course, very considerable, the fact of obtaining any marked improvement at all by such a simple modification of the apparatus very aptly illustrates that the conventional systems are capable of very real improvement without going to extremes.

Having seen that improvement is possible by the use of new methods of image analysis, it is interesting to consider how far it is theoretically possible to carry this, not with regard to any particular method of achieving it, but on fundamental grounds. Is there an irreducible minimum of frequency band fundamentally inseparable from a particular degree of image quality?

The Question of Flicker

In one respect a great deal is clearly possible. It is obviously a clumsy expedient to transmit 25 or even 12½ images per second simply to prevent flicker on the receiving screen, when a smaller number of images would suffice to give the effect of continuous motion fairly well, if other means could be evolved to reduce flicker. It is clearly bad from the frequency band point of view to widen this unnecessarily merely to reduce flicker; this problem may well be capable of solution by improvements in the receiving apparatus only. As an indication of what I mean, the suitable choice of fluorescent screen material in a receiving cathode-ray tube can be made to assist materially in the reduction of flicker owing to the persistence of afterglow effects, although this method has other drawbacks.

The idea of transmitting a definite number of finite images during every second is in itself an adaptation of technique from the cinema, and may not be the best method of obtaining either continuous motion or flickerless reproduction in television. It is a discontinuous process, and it may well be that a continuous process of doing the same thing in a way better suited to television and with the production of a narrower frequency band, can exist; much work at any rate is being done at present on these lines. Even if we should decide to retain the sequence of separate images as used at present, about eight of these transmitted per second can give satisfactory continuous motion of all but very fast moving objects; and this would reduce the frequency band required for any given definition by about one-third of its present value.

(*Continued on page* 326)

RECENT DEVELOPMENTS

A RECORD OF PATENTS AND PROGRESS
Specially Compiled for this Journal

Fluorescent Screens

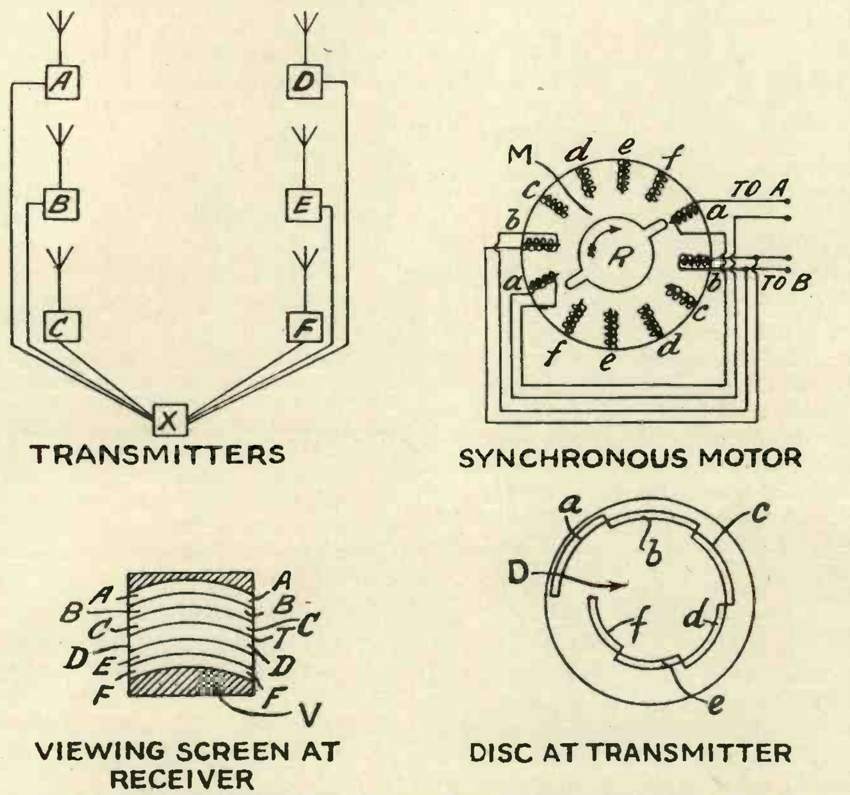
(Patent No. 407,540.)

Screens made of ordinary or commercial zinc-sulphide possess a certain "after-glow" over and above the true fluorescent effect which should be practically instantaneous. If chemically-pure zinc is used, this undesirable persistence disappears, and the screen can be used to record very high-speed movement. In addition it gives a bright blue light instead of a greenish one. The inventor secures the same effect as that obtained from chemically-pure zinc sulphide by subjecting "commercial" or impure zinc sulphide to a prolonged bombardment with cathode-rays, which gradually throws out the foreign particles to which the "after-glow" and greenish light are both due. The method is considerably less expensive than the usual chemical purifying process.—(*Telefunken Co.*)

Televising Outdoor Events

(Patent No. 407,739.)

A portable equipment is used to record an outdoor scene on an ultra-short wavelength, and the modulated signals are transmitted as a "beam" of energy towards a distant high-powered broadcasting station, where they are picked up and re-radiated on a medium wavelength. The portable "beam" aerial consists of a short dipole aerial mounted at the focal point of a parabolic reflector.—(*C. Lorenz.*)



Four diagrams showing the principle of the Marconi apparatus for indicating bearings at sea in visible form. The purpose is to obviate the necessity of any special knowledge on the part of the navigator. Patent No. 408015.

Semi-television Signals

(Patent No. 408,015.)

The idea is to simplify the operation of taking wireless bearings at sea, by reproducing in visible form the actual name, or call sign, of the wireless beacon station from which signals are being received. This makes it unnecessary for the navigating officer to be able to understand and read the Morse code signals which are ordinarily used.

Six differently-placed beacon stations, marked A—F are linked up by wire to a central control station X. Here a synchronous motor M (shown separately) sends out periodic impulses to each of the transmitters in turn, where they are made to control a similar motor driving a slotted disc D (see separate Figure) in front of a photo-electric cell. Eact slot A—C covers only one-sixth of the total circle and each is set back from the others, so that the slot *a* is operative only at the transmitter A, and so on!

At the receiving end a similar motor and disc are driven by a common synchronising signal, and are used in conjunction with a neon lamp. When the receiving aerial is pointing towards a particular beacon station, the arrangement is such that the neon lamp only lights up that band or zone A to E on a viewing screen V which shows the name of the particular beacon transmitter in question.—(*Marconi's Wireless Telegraph Co., Ltd.; H. M. Dowsett; R. Cadzow.*)

Line and Picture Synchronising

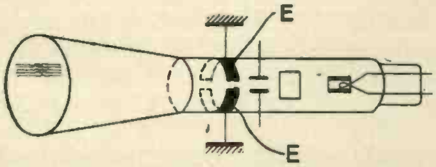
(Patent No. 407,823.)

In a cathode-ray television receiver, the synchronising impulses for controlling the line frequency and the pictures are usually transmitted through the ether at different amplitudes and are separated and applied to similar deflecting electrodes at the receiving end. In this invention both synchronising signals are sent out at equal amplitude, but the two pairs of deflecting electrodes on the receiving tubes are varied either in size or spacing, or in their position relative to the electron stream, so as to compensate for the difference between the length and breadth of the picture. For instance, the spacing of one pair of electrodes may be 5 mm., whilst that of the other pair may be 8 mm., to give the usual rectangular picture.—(*M. von Ardenne.*)

Cathode-ray Tubes

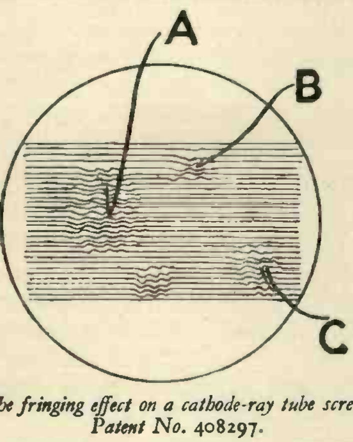
(Patent No. 408,297.)

When using high-powered cathode-ray tubes with anode voltages of the order of 1,000 or more for television, peculiar distortion effects have been observed, which by their regular appearance are supposed to be caused by oscillatory movements of the ions formed between the screen and the deflecting electrodes. In some cases they give rise to fringing, i.e., undulatory movements on the screen perpendicular to the track of the beam, as shown at A, B, C. in Fig. 1. At other times they appear as small nodules on the surface of the screen.



A special construction of cathode-ray tubes to prevent distortion effects in the picture due to movements of the ions formed between the screen and the deflecting electrodes. Patent No. 408297.

In order to remove these undesirable effects, steps are taken to neutralise the charges due to free ions, either by giving them a leakage path to earth, or by "binding" them electrostatically to an additional electrode placed on the glass wall between the deflecting electrodes and the fluorescent screen.



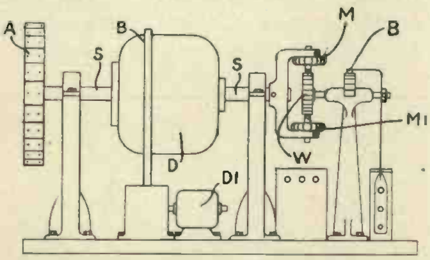
The fringing effect on a cathode-ray tube screen. Patent No. 408297.

As shown in Fig. 2, the extra electrode E takes the form of two annular metal plates placed on the inside or outside of the glass wall, and connected to earth.—(*K. Schlesinger.*)

Synchronising Motors

(Patent No. 408,332.)

The scanning drum A is synchronised by means of an auxiliary motor D1 geared by a band or chain B to the stator of the main driving-motor D. The main driving shaft is geared to a phonic wheel W, the electromagnets M, M1 of which are supplied with synchronising impulses from the amplifier. When the signals are out of phase, the phonic wheel W rotates and moves a brush B over its commutator, thereby varying a resistance in the circuit of the auxiliary motor D1. This results in driving or reversing the motor D1 which, in turn, adjusts the stator of the main motor D, until the latter falls accurately into step. The image is framed by means of a differential gear inserted between the scanning drum A and the motor D.—(*J. L. Baird and Baird Television, Ltd.*)



A method of synchronising employing a separate motor to revolve the carcase of the main driving motor. Patent No. 408332.

Multiple Scanning

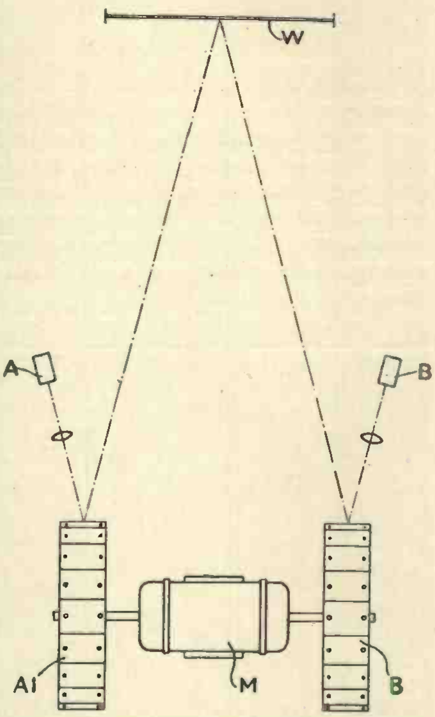
(Patent No. 408,596.)

The modulated light-rays from a pair of neon lamps A, B—or from similar light-sources comprising an arc lamp and a Kerr cell—are reflected from a pair of mirror-drums A1, B1 so that they substantially coincide on the viewing-screen W. The two scanning drums are driven from the same motor M. To minimise overlap, the best adjustment is that which gives precise concidence of the incident rays at the centre of the viewing-screen. The arrangement may also be used for scanning at the transmitting end. The object in both cases is to increase the intensity of illumination.—(*J. L. Baird and Baird Television, Ltd.*)

A Summary of Other Television Patents

(Patent No. 407,587.)

Shock-proof mounting for a cathode-ray tube, including means for shielding the tube from external electrical disturbances.—(*Marconi's Wireless Telegraph Co., Ltd.*)



A method of employing two light sources for projection on to one screen in order to increase the lighting intensity. Patent No. 408596.

(Patent No. 407,755.)

Improvements in the construction of photo-electric cells and of light-filters for use with such cells.—(*C. Zeiss.*)

(Patent No. 407,857.)

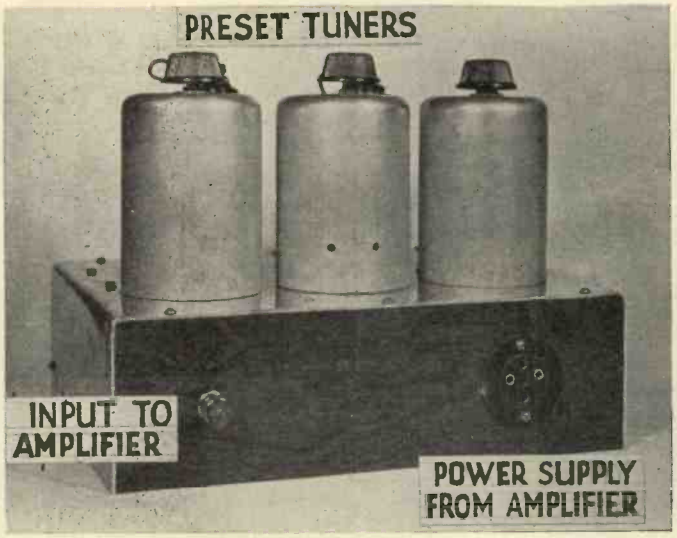
Cathode-ray receiver for television, operated from the mains and provided with special screening and filtering devices.—(*Radio A. G. Loewe and Schlesinger K.*)

(Patent No. 407,951.)

Television system in which a single carrier-wave is used to transmit (t) picture signals, (b) speech signals, and (c) synchronising signals.—(*A. H. Buckley.*)

(Patent No. 408,128.)

Improvements in arrangements for producing moving-picture effects from banks of electric lamps, which are switched on and off under the control of photo-electric cells.—(*H. Rosenberg.*)



A photopraph of the complete receiver.

A receiver for screen projection

The receiver described in this article is intended for use in conjunction with an amplifier such as that described last month and provides the radio signal for modulating a Kerr cell.

IN last month's issue we gave details of an amplifier capable of giving very high output and with a fidelity characteristic suitable for modulating the Kerr cell of a mirror drum visor. This consisted of three stages of resistance-capacity coupled amplification ending in a D024 output valve, capable of giving when fully loaded about 4 watts, which is more than sufficient for modulation purposes.

Owing to the fact that frequency response was considered before amplification, the overall amplification provided was not very high, and, as was explained last month, quite a large radio input was necessary fully to load the output valve.

With these considerations in view we set out to design a radio frequency amplifier and rectifier capable of giving the necessary high output from the London National programme suitable for use with this amplifier, anywhere within the service area of the National transmitter.

In order to provide adequate high-frequency amplification it was decided to employ two stages, and for considerations of stability the new indirectly heated high-frequency pentode valves have been used.

Westinghouse Rectifier

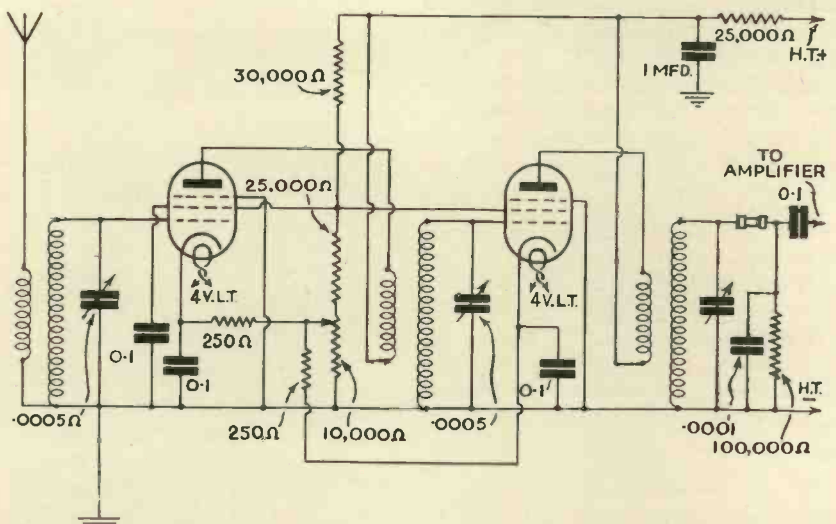
This combination gives quite a high magnification and enables us to use diode rectification. As is well known, this is excellent for television reception because its linear rectification characteristic, which prevents distortion on high input. The new Westinghouse dry rectifier, type WX6, is admirably suitable, owing to its small size and adaptability.

The original Westector was unsuitable for use at high radio frequencies, owing to the excessively high damping that it imposed on the coil preceding it. The new WH6 type of Westector, however, has been designed with a much lower self-capacity than the original model and in consequence it imposes negligible loading on the preceding tuned circuit, even at the higher radio frequencies. Therefore it could be used on the present set without fear of inefficiency. This, then, is the general scheme of the high-freqeuncy amplifier—two high-frequency pentodes followed by a Westector.

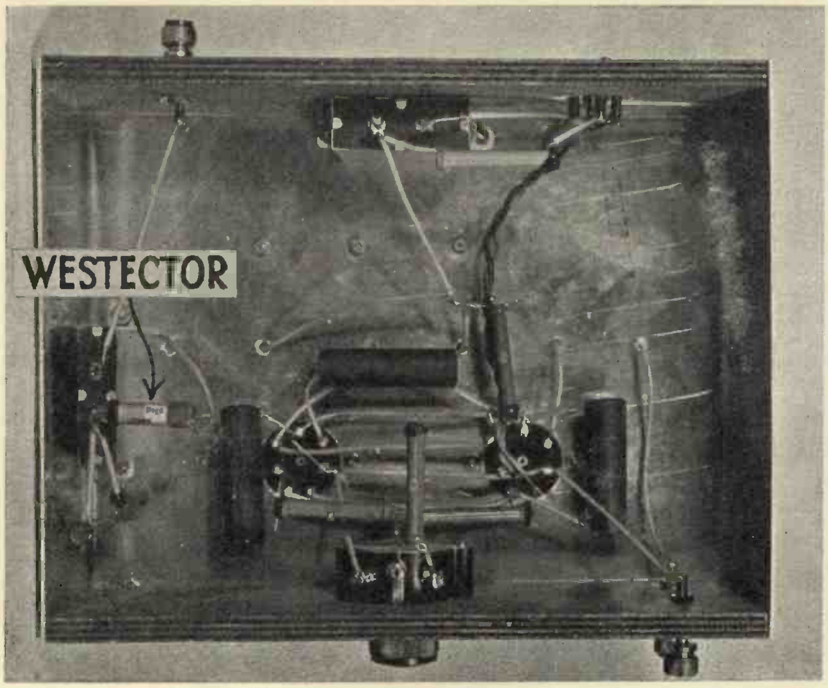
Volume Control

In order to give a distortionless control of volume, and to prevent distortion due to rectification in the high-frequency stages, valves of the variable-mu type are used, in this case Mazda AC/VPI's. These have the property of a slope which is variable with bias, and therefore the magnification of the stage can be varied by simply altering the grid bias as it is applied to the valve.

The various voltages which are required for the screening grid and bias arrangement are supplied from a potentiometer network across the main high-tension supply.



Circuit diagram of the receiver. Two variable-mu H.F. pentode stages are used followed by diode detection.



This view of the underside of the chassis should be studied in conjunction with the circuit diagram.

The screening grids of both valves are fed off the same tapping which gives them approximately 100 volts high-tension. In order to avoid interaction between two stages, however, the two cathodes to which the variable bias is applied are separately decoupled by a resistance of 250 ohms and a .1-microfarad condenser to earth, before they are connected to the variable tapping on the potentiometer.

Although a fair amount of selectivity is desirable, it is not advisable to have high-frequency circuits too sharply tuned for television purposes, as otherwise attenuation of the higher frequencies, due to sideband cutting, will result. Moreover, as the high-frequency pentode has a very high impedance, it is advisable to employ transformer coupling for the tuned circuits.

High-frequency transformers are therefore used, having a step-up ratio of approximately 1 to 3. As the set is only required to tune to one station it seemed absurd to go to the expense of purchasing a complete set of coils and a triple gang condenser. Small preset tuners have therefore been made, each of which consists of a high-frequency transformer, tuned by a small bakelite condenser, the whole being enclosed in an aluminium screening box.

Tuning Controls

In order to facilitate adjustment to the tuning condenser, the control has been brought out to the top of the can and a small bakelite knob provided for tuning purposes. The leads are brought out from small holes in the bottom of the screening can. The construction of the coils is simple. The secondary consists of 100 turns of 28 gauge silk-covered wire on a 1¼ in. former and tuned by a small .0005-microfarad variable condenser. The primary is overwound on this in the same direction and insulated from the secondary winding by a layer of wax paper. It consists of 30 turns of a similar gauge of wire. Three of such coils are required, one for an aerial transformer and the other two as high-frequency transformers.

In the case of the aerial transformer, one end of the primary is taken to aerial and the other end is connected to the low potential end of the secondary winding, both of which are connected to earth via the moving plates of the tuning condenser and the screening can.

(*Continued on page* 328.)

LIST OF COMPONENTS

CHASSIS.
1—Peto-Scott aluminium and wood to specification, 10 in. by 8 in. by 3 in.

COILS.
3—Peto-Scott preset screened, to specification.

CONDENSERS, FIXED.
4—T.M.C. Hydra, type tubular, values: .0001-, .1-microfarad (3).
2—T.M.C. Hydra, type 25, values: .1-, 1-microfarad.

HOLDERS, VALVE.
3—Clix, type chassis mounting, four-pin, seven-pin (2).

RECTIFIER.
1—Westector, type WX6.

RESISTANCES, FIXED.
6—Erie, type 1-watt, values: 250- (2), 25,000- (2), 30,000, 100,000-ohm.

RESISTANCES, VARIABLE.
1—Bulgin 10,000-ohm, type VC32.

SUNDRIES.
Connecting wire and sleeving.
2 yd. thin flex.

TERMINALS.
3—Belling Lee, type M, marked: red (2), black.

VALVES.
2—Mazda AC/VP1.

Only the valves and coils are on the upper part of the chassis: all the wiring is below.

SETTING UP A MIRROR SCREW

MANY readers who have constructed mirror-screw receivers have had difficulty in adjusting the mirrors so that correct scanning can be obtained. One of the principal difficulties appears to have been the determination of the proper arrangement of the mirrors necessary to produce the proper scanning direction which is, of course, from the bottom right-hand corner of the field of vision and upwards; then the spot is displaced one spot width to the left and again travels upwards, this being repeated until the whole thirty lines have been scanned when the cycle is repeated.

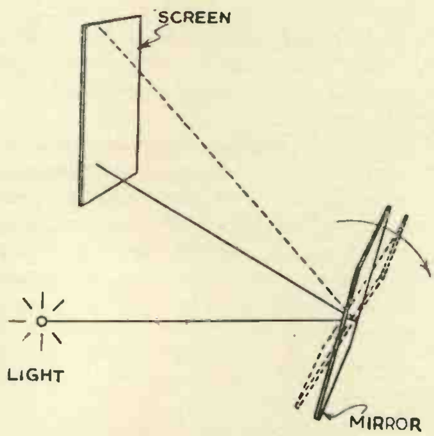


Fig. 1. A simple experiment to determine the correct arrangement of the mirrors of the screw.

Scanning Direction

Obviously, one factor that determines scanning direction is the direction of rotation and it is necessary to be quite clear regarding this in the first place. Having settled this it is an easy matter to visualise how the mirrors should be arranged. Each one can be considered as a plane mirror and an experiment with a small piece of mirror will soon settle the question. If a piece of plane mirror be held as shown in Fig. 1 and be tilted slightly, it is clear that a reflected spot of light will be caused to travel upwards as the mirror is tilted backwards. It is obvious, therefore, that a second mirror necessary to produce a second spot of light must be so placed that its bottom edge is a little behind the first. But it must be remembered that the image in the case of a mirror-screw is viewed subjectively and therefore in practice exactly the opposite conditions must obtain; so that if the screw is in front of the observer and revolving in a direction towards him, the pitch of the screw must be right-handed.

A little experiment on these lines will settle once for all the arrangement of the mirrors and prevent the error of setting up all the mirrors and then finding that the direction of scan is incorrect.

Setting the Mirrors

The mirrors require to be very accurately set, for it must be remembered that there is considerable optical leverage and any slight error in the angular positioning will make itself very apparent in the picture. It becomes necessary, therefore, to improvise some device by means of which this degree of accuracy can be obtained.

A scheme of a suitable arrangemen is shown below (Fig. 2). It will be seen that the mirror-screw assembly is mounted upon a vertical spindle so that it can revolve, and attached to it is a length of brass strip with a point at one end. This strip is merely to act as a pointer and a piece of wood will answer quite well, but a piece of brass can be attached easily to the central boss with a spot of solder.

The whole assembly is placed upon a board upon which a circle is drawn and which is divided into thirty parts. The larger this circle the better the prospect of securing accuracy, for it will be clear that its purpose is to indicate when the mirror-screw assembly has been moved twelve-and-half degrees.

We now require to project a spot of light upon the mirrors and arrange some means of picking this up so that the correct setting can be determined with accuracy. It is more convenient to use a line of light as this will answer for all the mirrors. For this a lamp of the tubular variety can be used with all the bulb masked out with the exception of a narrow slit. After reflection from the mirrors of the screw, arrangements are made for the light to pass through a slit in a metal plate and fall upon a definite line on a screen.

It will now be clear that if two succeeding mirrors are so positioned that the spot of light falls upon the point on the screen with the indicating pointer on two succeeding divisions of the scale, then these two mirrors will be correctly set. The procedure then is to set the pointer on one of the scale divisions and adjust the first mirror until the light is on the line on the scale; this mirror should then be secured to the end boss with a touch of Durofix cement. This will

(*Continued on page* 306)

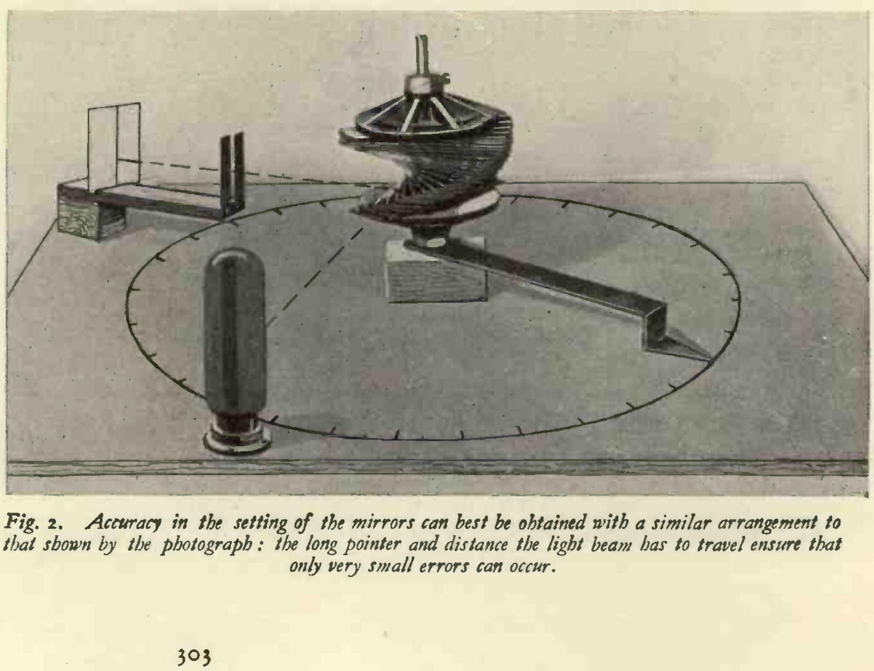


Fig. 2. Accuracy in the setting of the mirrors can best be obtained with a similar arrangement to that shown by the photograph: the long pointer and distance the light beam has to travel ensure that only very small errors can occur.

NEON — In Theory and in Use

AN interesting article, by S. D. Moyse, appears in the latest issue of the *Marconiphone Mail,* on the theory and use of neon. Primarily it deals with the use of neon lamps for advertising purposes, but there are many facts which are of direct interest to the television enthusiast which we have abstracted and give below.

Neon—the writer says—is a name given to one of a group of inert gases by Sir William Ramsay, and many so-called neon tubes contain no neon whatsoever. The name, however, has passed into current usage, and we cannot really expect the public to change to the correct title—cold cathode luminous discharge tubes. In this article, therefore, the term "neon lighting" will be used to cover all similar forms.

Five Inert Gases

The group of five gases just referred to are Argon, constituting nearly 1 per cent. of the air we breathe; Helium, one part in 250,000 of air; Neon, Krypton, and Xenon, together constituting but one part in 140,000. These five gases are inert; commercially they are a by-product of the manufacture of liquid air.

The neon tube is a hollow air-tight glass vessel, with an electrode at each end which communicates with an external source of electric current by lead-in wires sealed in the glass. The tube is exhausted of air, and a small quantity of the rare gas is admitted.

We are accustomed to think of air as an insulator—which it is for all ordinary purposes—but as far back as 1887 Sir Arthur Schuster discovered that he could make it a conductor by sparking it in a rarified state. In other words, ionised air (or other gas) becomes an electrolytic conductor.

Now ionisation on a very minute scale is continually taking place in gases. In the 400 million millions of atoms that make up a cubic inch of air, some 100 ions are formed every second from external causes which are still somewhat obscure, and into which it would be quite out of place to enter here. Minute as is this proportion, it suffices, when there is a state of electrical tension between the electrodes, to set flowing an infinitesimal current.

If the voltage applied to the electrodes is very low, there will not be sufficient movement of the ions to cause any luminosity; but if the voltage gradient is increased, the speed of the ions increases also. The ions on their passage towards the cathode collide with the atoms of gas and make new ions, and the process goes snowballing on until the current passing between the electrodes becomes appreciable. If the voltage gradient is made still steeper, every time an ion hits an atom both will rebound; on a very steep voltage gradient both will have gained energy between the moment of impact and the moment of return; there is an excess of energy, which takes the form of luminous radiation.

Some of the difficulties that the manufacturer of neon tubes has to face will immediately become apparent. In the first place, the degree of vacuum has to be studied scientifically. If the degree of vacuum is not high enough, there will be so many atoms of gas present that the moving irons will never obtain sufficient speed to cause the luminous discharge, as their passage will constantly be interrupted by low speed collisions with further atoms. On the other hand, if we reduce the density of the atoms, we decrease also the voltage necessary to produce a discharge. There comes a point where there are too few atoms left for the ions to collide with on their passage, so that the tube will not strike.

Life of the Tube

A further complication arises on the question of voltage; the life of the tube is largely limited by what is known as "sputtering." The positively charged ions at high speed, impinging on the surface of the cathode, disintegrate its constituent atoms. Every time an atom of metal flies off the electrode it adheres to the glass wall of the tube and entraps with it an atom of gas. In other words, the gas content gradually gets lower and lower, the tube becomes hard and eventually refuses to strike.

We have, therefore, always a question of compromise between the voltage at which it would be best to run the tube for efficiency and the length of life of the tube as a source of illumination; between the best pressure at which the gas should be in the tube and the voltage that that pressure calls for. The gas content, the tube diameter, and the tube length, all in turn have their effect upon our calculations.

So far we have spoken of voltage as being a consistent feature, whereas, of course, it varies through every half cycle of alternating current. A very high initial voltage is needed to

(*Continued on page* 306.)

A recent photograph of Manfred von Ardenne, the well-known television research worker.

HOW TO OPERATE THE KERR CELL FOR BEST RESULTS

By H. A. Hankey

An example of an efficient grid cell—the Baird.

IT is not essential to possess any profound knowledge of the theory of the Kerr cell in order to operate it to the best advantage. Two simple expressions, however, should be borne in mind when the cell is to be designed to work off a given voltage. The cell really requires two voltages for its operation, the first is the bias voltage and the second is the signal voltage. In what follows we shall consider the simplest method of ascertaining both these voltages. The first of the expressions mentioned above is the Kerr equation which gives the retardation R when the cell is stressed with a voltage V, when the light path through the cell is l and the distance between the electrodes is d, then

$$R=\frac{cV^2l}{d^2}$$

It must be remembered that V is expressed in volts, l in cms. and d in cms.; then the retardation is given in Angstrom units. c is the well known Kerr constant and for nitrobenzene we can take this as being about 20.10-². This value for nitrobenzene varies enormously in accordance with the purity of the liquid, but in the ideal case where the liquid is distilled straight into the cell the value can be taken as quoted above.

If the intensity of the light emerging from the analyser of the Kerr cell is to be compared with the voltage applied to the cell, then we have to write down the second formula which tells us the intensity of the light for a given retardation, this expression, slightly transposed to suit our present purpose, is

$$I=I_m \sin^2\frac{\pi R}{\lambda}$$

Substituting for R we have

$$I=I_m \sin^2\frac{\pi c l V^2}{\lambda d^2}$$

and putting

$$k=\frac{\pi c l}{\lambda d^2}$$

we obtain

$$I=I_m \sin^2 kV^2.$$

Now for the greatest intensity the coefficient of Im must be unity so that

$$\sin^2 kV_m^2=1$$

which gives

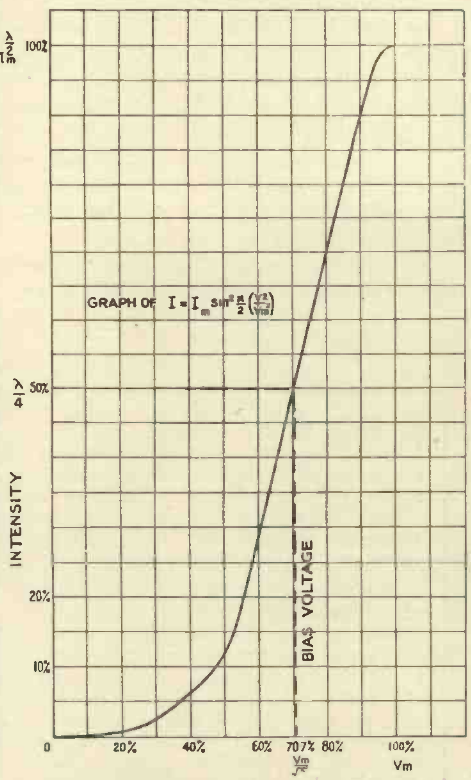
$$kV_m^2=\pi/2$$

$$k=\frac{\pi}{2}\frac{1}{V_m^2}$$

Substituting for k in the above expression we have finally

$$I=I_m \sin^2\frac{\pi}{2}\frac{V^2}{V_m^2}$$

Now the first thing to do is to draw a graph of this expression taking, say, 100 units on the abscissa for the maximum voltage and 100 units along the ordinate for the intensity. All that is now needed is one single value of volts against intensity in order to be able to read off the curve the voltage corresponding to the intensity throughout the range of operation of the cell.



A voltage-intensity graph of a Kerr cell.

Voltage and Intensity

The voltage giving the maximum intensity will be the easiest to determine, and there are a number of ways of determining this maximum voltage. The simplest of all is to stress the cell between crossed Nicols until the faintest trace of brown appears in the field. Just before the brown makes its appearance the retardation is half a wave-length and the voltage is thus a maximum. This gives the value of Vm for Im and hence one point of the curve is determined and the values of voltage and intensity can be read off accordingly. We need not trouble accurately to measure the actual intensity for the half-wave retardation; we may be satisfied that this is the maximum amount of light that the cell is capable of giving. We can take the other intensities as a percentage of the maximum intensity. Also the voltages can now be read off as a percentage of the maximum voltage.

A variation of this simple method is to make up a half-wave plate of mica (this can be done for a few pence) then, with crossed Nicols and unstressed nitrobenzene, introduce the half-wave plate into the polariscope so that the fast direction of the half-wave plate coincides with the slow direction of the stressed nitrobenzene. The slow direction of the stressed nitrobenzene is parallel to the plates of the cell and thus normal to the direction of the stress. When the half-wave plate has been correctly adjusted in its position, the cell and the mica will be in the subtractive position in the polariscope.

In this case the field will be fully illuminated when the liquid is un-

(Continued on next page.)

"How to Operate The Kerr Cell For Best Results."

(*Continued from preceding page.*)

stressed and the cell must now be stressed until the field is completely extinguished. The voltage at which this occurs will be the maximum for half-wave retardation; that is, Vm.

It may happen that the cell has been designed to work on low voltages, in which case a breakdown is likely to occur if the liquid is stressed to half-wave retardation. Such being the case we can easily determine $1/\sqrt{2}$ of the maximum voltage by employing a quarter-wave plate in exactly the same manner as that in which the half-wave plate was used above. That is, the quarter-wave plate must be introduced into the polariscope in the subtractive position and then the liquid has to be stressed until extinction has taken place. The voltage for which this occurs will be $Vm/\sqrt{2}$.

In this very simple manner complete optical and electrical information of the cell characteristic can be obtained. The bias voltage can be chosen from the curve which is shown in the accompanying graph. The bias voltage is usually taken half-way up the straight part of the curve. The voltage can be taken as that which gives quarter-wave retardation; that is $Vm/\sqrt{2}$, or 0.707 Vm. The working voltage is that voltage swing from the picture signal which at its peak gives the half-wave retardation, and thus the greatest intensity.

Capacity of Cell

When a Karolus multi-plate cell has been designed to operate on low voltages, then care must be taken in the design owing to the abnormally high capacity of condensers having nitrobenzene as the dielectric. If we take A as the area of one plate of the condenser in cms², and d the distance between the plates in cms., then the capacity of the nitrobenzene cell, the liquid having a high dielectric constant of 36, will be

$$\frac{36A}{4\pi d} \times 1.11 \text{ micro-microfarads.}$$

The introduction of the coefficient 1.11 is necessary in order to reduce the electrostatic units to micro-microfarads. We can therefore put

Capacity of Karolus multi-plate cell

$$3.17\frac{AN}{d} \text{ micro-microfarads}$$

where N is the number of "compartments" of the cell.

Now as the retardation is inversely proportional to the square of the distance between the electrodes and as the capacity is inversely proportional to this distance, then, obviously, in order to give great retardation compatible with small capacity, it is better to decrease the distance between the electrodes rather than to increase the length of the light path l in the cell.

FLICKER

FLICKER is often confused with the effect known as visual persistence. If a television image is completely repeated in less than one-twelfth of a second, the eye remembers the preceding image while the next one is being built up, and the effect of continuous motion is obtained.

Flicker is an effect produced by alternate periods of dark and light. An electric lamp switched on and off, or operated from an alternating-current supply will show flicker until the frequency of the current variations reaches thirty or forty per second. With the customary 50-cycle supply no flicker is observable.

In cinematography the light is definitely cut off between each picture and with the usual projection speeds of sixteen or twenty-four pictures per second flicker is very noticeable, particularly as the illumination increases. To overcome this two and three bladed shutters are used, which not only cut off the light in between the pictures, but also while the picture is on the screen. This increases the frequency of the flicker until it becomes barely noticeable.

With a television image the light is never definitely cut off for any appreciable time so that the same arguments do not apply, and hence a speed of twelve-and-a-half pictures per second gives quite tolerable results. It is even questionable whether there is any need to go to a larger number of pictures per second, except when dealing with rapidly moving objects which are in any case unsatisfactory for television at present.

A possible line for experiment, however, is suggested by the foregoing. It would be comparatively simple to interpose a small two-bladed shutter at a suitable point in the optical system, e.g., just in front of the Kerr cell. This would be driven from the motor by a small belt at a speed sufficient to give, say, thirty-six interruptions per second. This should give an appreciable reduction in the flicker.

—J.H.R.

IN the B.B.C. television studio a small picture receiver serves to check the quality of the transmission as it leaves the control room, and by a change-over switch the transmission from Brookman's Park can be received on radio and compared with the original.

An interesting phenomenon which occurs on throwing over the switch from land-line to radio reception is the displacement of the picture in the frame, caused by the time taken for the signal to travel to the transmitting station and back via the ether. If this only occupies 1/1000th sec., it will correspond to ½ the travel of the vertical scanning line, and the picture will drop by a corresponding amount.

"Setting Up a Mirror Screw"

(*Continued from page 303.*)

dry after a few minutes and then the next mirror can be positioned in the same manner, the pointer, of course, having been moved one division.

Only a very small amount of cement should be used until the whole assembly is complete and has been tested, as otherwise it will be found difficult to free the plates for correction if this is found necessary; when all are in order the black lacquer should be scraped off where the cement is to be applied.

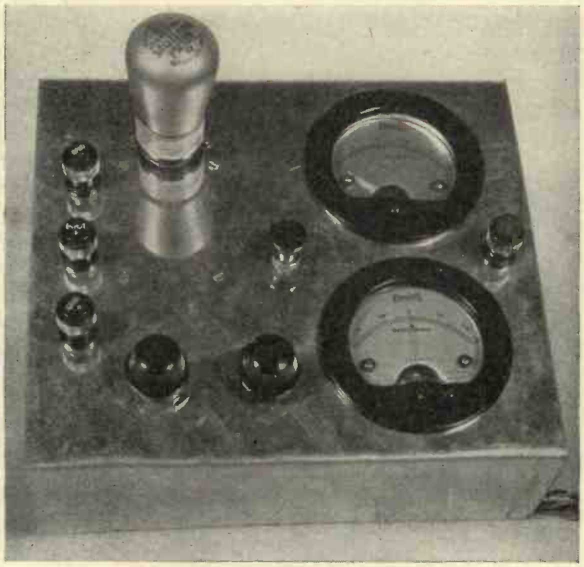
"Neon—In Theory and In Use"

(*Continued from page 304.*)

make the tube strike, but once the resistance of the tube is reduced by the flow of current explained above, a much lower voltage is amply sufficient to keep the tube alight. Indeed, if the full voltage originally applied were continued, with the resistance of the tube reduced to a fraction of its normal state, the result would be catastrophic, as the current would continue to rise.

Different gases and glasses give a considerable range of colour through the reds, blues, and greens, to white and gold.

It has only been possible to deal very summarily with all the questions involved on the technical side of neon, and the explanations given have been made as simple as possible, probably to the detriment of their very exact scientific accuracy.



The valve voltmeter ready for use.

EXPERIMENTS IN MY LAB.

MAKING A VALVE VOLTMETER

In this article details are given of a straightforward valve voltmeter which needs no preliminary calibration. Owing to its wide frequency characteristic such an instrument is ideal for measuring stage gain in television amplifiers, etc.

By S. Rutherford Wilkins

OWING to the exacting demands made on a television receiver it is really necessary to have a more accurate knowledge of such things as stage gain and frequency response than is usual with the ordinary wireless receiver.

A few decibels drop in the upper part of the response characteristic of an amplifier would in all probability be unnoticeable on music reproduction. Such a fault, however, could make quite an appreciable difference to the definition of pictures obtained were a similar amplifier used with a visor.

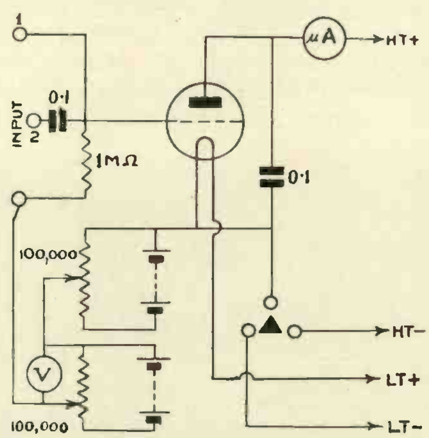
Uses of the Meter

It is therefore really desirable to have some means of determining signal voltage stage by stage and also of measuring the overall voltage response of the amplifier.

Clearly an ordinary direct current voltmeter would be useless and an alternating current voltmeter would be of very little use except in the output stage because of its relatively low impedance. This would have the effect of seriously loading the resistance or inter-valve transformer winding across which it was connected and thus producing an incorrect reading.

Moreover, unless you are prepared to pay heavily for a special output meter you will find very few alternating current meters which have anywhere near a constant frequency impedance characteristic. It is general for them to fall off at the higher frequencies owing to their relatively large self-capacity. Even a good output meter is rarely of use at frequencies in the neighbourhood of 15,000 cycles.

What is really necessary is some form of voltage measuring device which has an almost infinite frequency characteristic and whose input impedance is extremely high compared with the impedance across which the voltage is to be measured.



Circuit of the simple slide-back valve voltmeter described in the text. Owing to its extreme flexibility it should find many uses in the experimenters' laboratory.

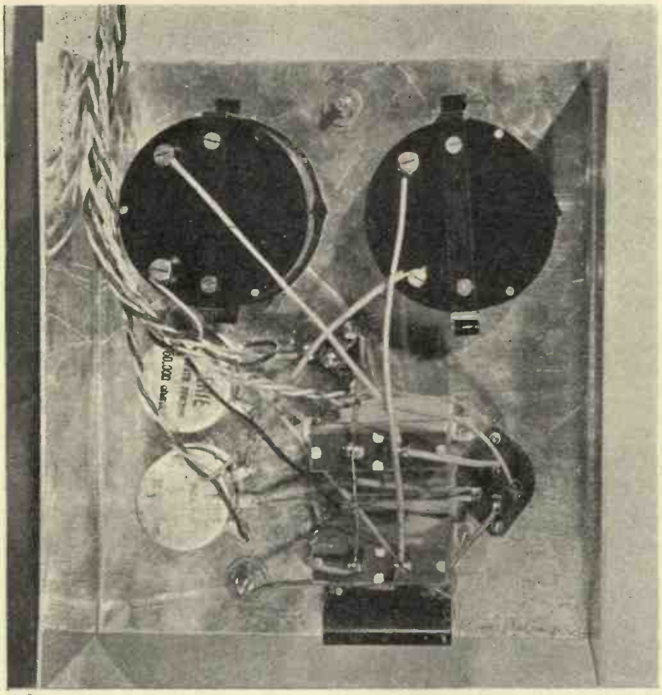
Moreover, the instrument should have a widely variable full-scale deflection. No ordinary A.C. instrument will satisfy these exacting requirements.

Fortunately, a valve rectifier with an indicating meter in its anode circuit can be used. Such an instrument is known as a valve voltmeter, and when correctly designed its frequency response can be made linear from a few cycles a second up to frequencies of the nature of 1,000 kilocycles. This frequency range can be extended still further if very special precautions are taken to remove all extraneous capacities such as the self-capacity of valve holders and that produced by long parallel wires.

Two Types

Valve voltmeters, speaking generally, are of two types. The slide-back type and the direct indicating rectifier type. In this article we are dealing mainly with the slide-back type of valve voltmeter which gives a measure of peak voltages. Such voltmeters make use of the fact that the plate current in an overbiased valve rectifier rises when an A.C. voltage is applied to the grid. (This, of course, is the principle of anode-bend rectification.) If then we bias a valve in a rectifier circuit so as to give it zero, or practically zero plate current and then apply an alternating voltage between its grid and filament terminals, the anode current will rise to a value depending on the square of the value of the applied A.C. voltage. By applying an external D.C. voltage to the grid of the valve, which tends to make the grid more negative, the plate current will begin to fall. Should this voltage be increased until the negative D.C. voltage applied is equal to the peak value of the alternating current input no current will be shown in the anode circuit of the valve, other than the standing current before the alternating voltage was applied.

This then gives a ready means of measuring A.C. voltages. The valve



This photograph shows the underside of the chassis; the wiring of the instrument is very simple and will be clear from a study of this picture and the circuit diagram.

with a sensitive microammeter in its anode circuit is originally biased until its standing anode current is of a very low order. The A.C. voltage is now applied and the anode current of the valve will rise. A further D.C. negative bias is then applied until the original value of the standing anode current is shown on the anode meter. The additional bias applied is now a measure of the peak voltage of the unknown input. This voltage can be easily measured with an ordinary direct current voltmeter.

Sensitivity

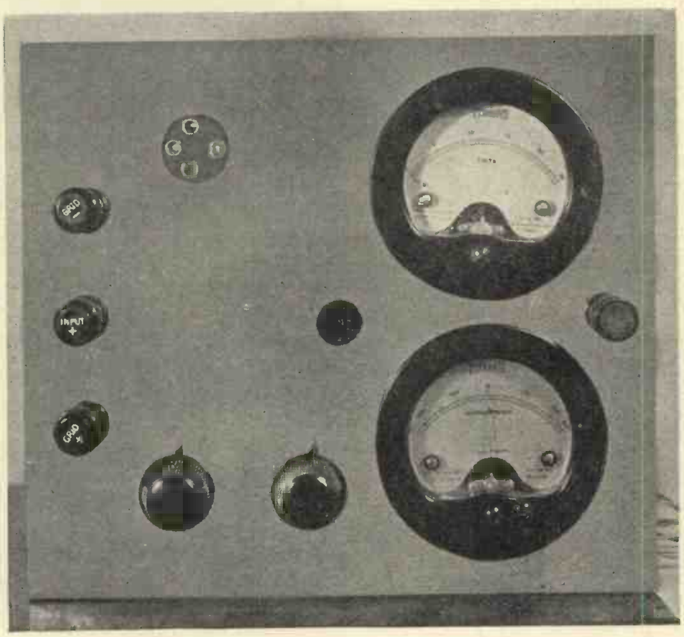
The sensitivity of such a slide-back valve voltmeter is determined by the valve characteristics, the anode voltage applied, and the sensitivity of the meter in the anode circuit. If necessary, a diode valve could be used in a similar circuit but its sensitivity would be low. If we use a fairly high slope triode, however, fed with a reasonably high anode voltage, it is quite possible to get an accurate measure of voltages of the order of ½ to 1 volt A.C. No anode load is included in the plate circuit of the valve other than the D.C. resistance of the measuring instrument, because any resistance in this part of the circuit tends to decrease the sensitivity of the instrument. To prevent any unrectified alternating current appearing in the anode circuit of a valve and causing instability, a large condenser of the order of .1 to 1 microfarad is used as a by-pass condenser directly between the anode of the valve and filament negative.

The impedance of such an instrument is determined by the input impedance of the valve. Between grid and filament, however, a high resistance is usually included, not low enough to affect seriously the input impedance of the valve voltmeter, but simply to provide a direct current path between the grid of the valve and the bias battery when there is no load across the input terminals of the valve voltmeter. Without such a resistance no bias would be applied to the valve unless it were connected across a load, and the anode current would rise to such an extent as to damage the sensitive instrument in its anode circuit.

The Circuit

The diagram shows the circuit of a slide-back valve voltmeter on these lines which I had occasion to design recently for some experimental work in conjunction with a frequency response of a television amplifier for mirror-drum work. It is quite a simple little gadget but will respond quite readily to voltages of the order of one volt if only about 20 or 30 volts high tension are used. Originally I used a 60-volt high-tension battery, and this gave all the sensitivity that was required for low-frequency work and since if necessary with a little care input voltages of the order of a half a volt could be measured, the instrument has since proved quite useful for measurements on high frequency amplifiers. In order to give a fairly sensitive instrument, but at the same time to keep the cost within reasonable limits, the anode current meter is a standard 500-0-500

(Continued on page 328.)



Here is a plan view of the complete instrument: note that all wiring is carried out underneath the chassis.

Correspondence

Correspondence is invited. The Editor does not necessarily agree with views expressed by readers which are published on this page.

Sunday Morning Broadcasts :: Amateur Transmission
Short-wave Work and the Amateur :: A Ready Market
The Public Does Want Television!

Sunday Morning Transmissions—A Suggestion

SIR,

With regard to the B.B.C.'s difficulty in finding suitable times to fit in their television broadcasts, I suggest they should radiate a 2-hour programme on Sunday mornings, say, from 10-12. I believe this time would be much more convenient to all "lookers" than either of the present times and would be long enough to make useful experiments in. There would then be no question of finding suitable transmitters as all would be available. We might even get a long-desired relay through North Regional or North National!

PETER FREEMAN (Sheffield).

* * *

SIR,

I should like to suggest a Sunday transmission of an hour or two hours duration. This I think would be the most suitable day for every amateur, and if between the hours of 9 a.m. and 12 midday, there could be no question of any B.B.C. difficulties either technical or in the suggestion that television transmissions are robbing the programme hours for those who do not possess televisors.

One item which I think conclusively proves the B.B.C.'s policy as foolish, is the fact that there is excellent apparatus on the market and also excellent information in the shape of your journal, whereas in the days of 2LO the transmissions were there, but the other items lacking.

C. H. C. SWAINE (Oxted, Surrey).

* * *

Amateur Transmissions

SIR,

In the June issue of TELEVISION I note in your correspondence page a suggestion for amateur transmissions on Sundays.

As a member of your Constructors' Circle I see no reason why your experimental department should not organise and run such a transmitter in conjunction with the members of the Constructors' Circle and firms interested from an advertisement point of view.

I for one would gladly welcome an annual subscription to maintain such a transmitter which would give a two-hour transmission on Sundays. Also I think such an idea would be well supported by a great number of members providing it was free from any B.B.C. control.

C. H. C. SWAINE (Oxted, Surrey).

* * *

Amateur Transmissions on the Ultra-short Waves

SIR,

In the June issue of TELEVISION, Mr. T. W. Humphreys suggests that amateur transmitters should collaborate to transmit television on the 160 metre band on Sunday mornings.

May I say that I heartily endorse this suggestion. In view, however, of the television possibilities in the ultra-short-wave spectrum I would suggest that amateurs also get busy on this band. A commencement could be made with 30-line transmissions on the ultra-shorts.

To carry the suggestion further, I think it would be an excellent idea if experimental Television Clubs were formed in all districts where sufficient support is forthcoming; such clubs could doubtless be affiliated with The Television Society, and would, therefore, supplement the good work which that Society is doing. For various reasons it is thought that two such clubs would be necessary for London—one north of the Thames, and one south of it.

The P.M.G.'s wireless transmitting licence would, of course, be necessary, but it is reasonable to suppose that this would be more readily granted to an organised body than to an individual.

May I add that I shall be happy to do what I can in support of this idea. Perhaps, therefore, any interested London readers living north of the Thames will kindly write to me as a preliminary move.

A. E. SEMPER (Fellow, Television Society).

* * *

A Ready Market

SIR,

I could sell 100 sets to-morrow if two hours' television transmissions were made nightly. Wishing you luck in pressing this cause of a hold up to the trade.

B. A. GREASLEY (Leicester).

* * *

The Public Does Want Television!

SIR,

I would like to congratulate you on the steps you are taking to show the B.B.C. that the public does want television, and that its decision to curtail, and perhaps stop completely, the present programmes is most definitely a retrograde step. I would urge you, on behalf of the many wireless enthusiasts in this district who, to my own knowledge, are now beginning to take a really active interest in television, to press forward this campaign until, at the very least, the old hours are restored, and preferably until television at last takes its place within regular programme time. TELEVISION was instrumental in getting these transmissions in the first place. May it now be the means of keeping them!

In regard to times for transmissions, it seems to me that the most suitable would be the period 6.30 to 7.30, or part of it. This is the part of the evening which is probably least listened to, and yet a time when most experimenters could take advantage of the transmissions. In many cases, too, it would not be too late for dealers to demonstrate. The programmes are ready to hand. Talks, violin and piano recitals, songs, and such subjects are the usual fare at this time, and are eminently suitable for television. Even the Foundations of Music might be entertaining when televised!

E. H. WARE (Exeter).

Satisfied with 30-Line Scanning

SIR,

I am writing this at the request of my many friends. I have been a " looker-in " for the past ten months now and have made numerous others likewise. I am quite satisfied with 30-line scanning and can safely say if it were only available a little oftener and for longer periods, I should be able to guarantee another 50 members to our " Circle."

If all our members would promise this, we may hope for some alteration in the near future. As it is, I get some people interested, and when I tell them it is only for one night per week, their enthusiasm cools off at once. This, I think, is the position with all of us.

FRANCIS JOHN GALVIN (Liverpool).

* * *

The Zeesen Transmissions

SIR,

I have received the morning broadcasts from Zeeson, but I am unable to make anything out of the picture with the exception of some German word which is transmitted once at half time and again at the end of each morning broadcast. This word is either " SLUA " or " SZUA " or just " ZUA," There might be another letter at the end, but it has been too badly distorted to enable me to be certain.

I should be very interested to hear from anyone who has successfully received these transmissions in Great Britain.

L. THOMAS (Chester).

* * *

Photographing the Picture

SIR,

I was interested to see reproduced in your June issue, two photographs taken by Mr. Whitehead, of Bradford, of artistes, taken from his television set.

There are two points which I think should be made clear to the public when they see these reproductions, first that the artistes were not specially posed and were therefore in a state of movement; in consequence a certain amount of blurring was inevitable, and secondly, that the camera being more critical than the eye shows up faults which the eye does not see.

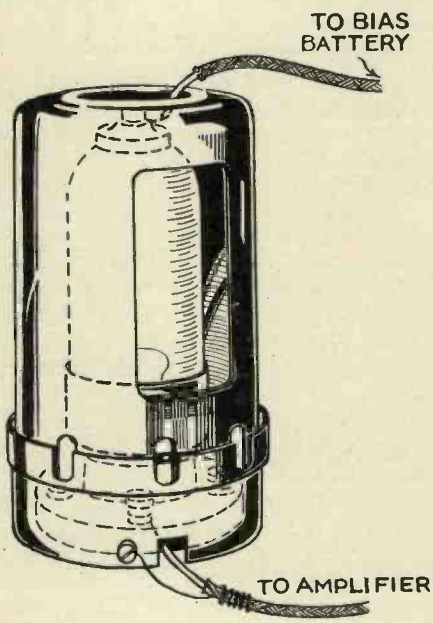
It also should not be forgotten that however perfect Mr. Whitehead's synchronisation may be, a certain amount of movement or " hunting " is inevitable, which will add blurr to the resulting photograph.

Therefore, excellent and interesting as these photographs are, it should not be thought that the impression given to a looker would be so lacking in detail, or blurred as is shown by these photographic reproductions of the televised artist.

EUSTACE ROBB (Television Production Director, Broadcasting House.)

Screening a Photo-cell

The sketch shows an improvised method of screening a photo-cell which is quite effective and easy to arrange. It will be seen that an old coil screening can is used; even if one of these is not available it can be bought quite cheaply. The valve holder to hold the photo-cell is screwed down inside the base of the can, the same screws being used to hold both valve holder and can base. An opening is cut in one side of the upper portion of the can through which the light can pass to the cell. This hole can best be cut with a metal-cutting fretsaw as this will leave the minimum of burr and not spoil the shape as would probably be the case if an attempt were made to use scissors.



A simple method of screening a photo-cell.

The Range of Wired Television

Herren F. Kirchstein and J. Lamb, of the German Post Office Laboratories, state that with the use of ultra-short waves, the quality of the pictures has been improved, but the reception of television is now limited to the local transmitter. To come back to real television, the programme must be relayed over wires, to different transmitters. The cables used must transmit a band between 0 and 500 kilocycles, the higher frequencies travelling 20 miles in about 0.1 millisec., the lower frequencies taking about 1 millisec. to travel this distance.

To prevent the distortion of frequencies, it is necessary to superimpose the whole band upon a carrier frequency of about 1,000 kilocycles. The attenuation of the radio frequency waves is proportional to the frequency amplitude, being reduced to about 0.5 after 1,000 metres at 1,000 kilocycles.

* * *

Checking the Time-Base

When receiving television on a cathode-ray receiver, it is often found that the discharging of the 375 cycles time-base produces a small amount of interference in the modulation circuit. The result is that a pair of telephones inserted in the output valve of the receiver will pick-up a note of 375 cycles similar to the familiar sing of television transmissions.

Provided this interference is not great, the effect causes no trouble during the actual reception, but it is useful in the preliminary adjustment of the apparatus, for it is only necessary to adjust the 375 cycle-base to give the same note as that being received from the transmitter to make sure that the frequencies are correct.

If gas-discharge tubes are being used, the apparatus should be allowed to warm up for five minutes before the programme starts. Then listen on a pair of telephones in the output circuit and adjust the 375-cycle circuit to give what you think is the correct frequency. As soon as the signal comes on from the transmitter it will swamp the pick-up from the time-base, but you will be able to tell at once whether the two notes are the same. If they are not, the time-base should be adjusted until they are identical. —J.H.R.

THE TELEVISION ENGINEER

PUZZLING PARADOXES IN TELEVISION

By J. C. Wilson

In this article, the third of a series of four, J. C. Wilson discusses another paradox in television which arises out of the determination of the frequency necessary for a correct reproduction of the original object scanned.

PROBABLY there are few problems in television transmission or reception of more fundamental importance, both to the theoretical and to the practical worker, than that of deciding what frequencies are necessary for the transmission of a substantially correct representation of the original object scanned. In the past, misconceptions of all kinds

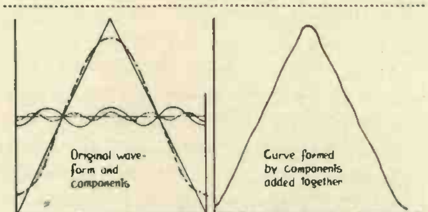


Fig. 1. The components of a triangular waveform and (left) the resulting figure.

have arisen, including controversy as to the so-called "real existence" of side-bands in radio transmission, the relative merits of different "systems of television," and the channel widths necessary with amplitude-modulation and frequency- or phase-modulation at a radio station.

Happily, most of these doubtful disputations, the effect of which was all too often to obscure rather than to elucidate the problems around which they centred, have now passed away; we can remember still the sense of thankfulness with which we first read Hartley's exposition of the problem of intelligence transference[1], which came at the right time, like a return to sanity after fever. But Hartley's analysis, though excellent in its close adherence to physics after a glut of nebulous "harmonics," "Fourier components," "side-frequencies," and the like, is not too convenient for the practical man who wants to design an amplifier, or analyse a waveform.

It is curious what a difference there has been between the problems of sound transmission and recording, and television; with sound, practically the whole of the essential groundwork had been covered by Helmholtz' original work. It was not a case of asking: "What frequencies exist in the tone of a violin string?" for, by means of a system of acoustic resonators, the necessary upper partials could be determined experimentally beforehand (even before the exact nature of the waveform, in the case of some instruments, was known).

With television, however, it was not until after commercial transmission had for some time been an accomplished fact that the importance of extremely high frequencies was conclusively demonstrated. With television, it is usually the waveform to be transmitted which is known, and the question: "How closely can this be represented with a limited band of frequencies?" is generally of great interest and importance.

Most readers will by now have become familiar with the expressions "Fourier analysis" and "Fourier's series" in connection with television problems of this kind, but not everyone, perhaps, is acquainted with the kind of results obtainable by the analysis of certain waveforms commonly encountered, or with the nature of the series representing them. To begin with, therefore, let us explain briefly what this process is.

While pursuing certain investigations in connection with the flow of heat in solids, Joseph Fourier discovered a property of curves in general (afterwards applied particularly to periodic curves, or "repeated waveforms"), in accordance with which they may be completely represented by adding together a number of purely sinusoidal curves differing in wavelength and amplitude, over a given range of their length. There are one or two exceptions, such as curves which become infinite, or have an infinite number of discontinuities, but in general this statement applies to any complicated curve, over a range, or to any periodic curve throughout its length. To illustrate the process of analysis in a simple case, in Fig. 1 there is shown a triangular waveform, together with the

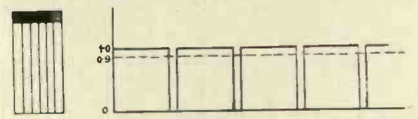


Fig. 2. Waveform corresponding to the scanning of a blank figure.

"components" into which it can be broken up (the first few components only are illustrated, for clarity).

Turning now to the application of this in television, let us take a waveform of very common occurrence: that shown in Fig. 2, which corresponds with a television signal yielded by scanning a blank field with an "underlap" of ten per cent. (that is, a gap between the scanning of successive lines equal to a tenth of the time taken to scan one line). Suppose that the number of strips scanned per second is 375, as in the

TABLE I.

n	*Corresponding Frequency.*	*Amplitude of Component.*
0	Zero (D.C. component)	0.9
1	375 cycles per second	0.197
2	750 „ „ „	0.188
3	1125 „ „ „	0.171
4	1500 „ „ „	0.151
5	1875 „ „ „	0.127
6	2250 „ „ „	0.101
7	2625 „ „ „	0.0736
8	3000 „ „ „	0.0468
9	3375 „ „ „	0.0219
10	3750 „ „ „	zero

case of the standard B.B.C. transmissions by the Baird process, then if n is the order of Fourier " term," we can make a table of the following kind, showing the various frequencies present in the transmission, and the amplitude of each. The total signal amplitude is taken as unity, for convenience (see Table 1).

Of course, these are not all the frequencies present: there are still higher harmonics, of amplitude constantly diminishing and alternately positive and negative in successive decades of n; for example, the frequency of 9,375 c.p.s. has an amplitude of 0.0255, and corresponds with the twenty-fifth Fourier term (i.e., $n = 25$). But sufficient terms are given in Table 1 to add up to a fair approximation of the original waveform.

Consider now the kind of " low-frequency test-card " shown in Fig. 3. If this is scanned, stripwise as indicated, in thirty lines at twelve and a half pictures per second, we shall have the frequencies present which are given in Table 2.

In this case, there exist frequencies lower than the strip-frequency (at the picture-frequency, and multiples of it); only the components at and above the strip-frequency are given, however, and the last component in the table corresponds with about half the first zero-frequency of the square scanning spot which is supposed to traverse the card.

Now, we could go on choosing waveforms for analysis, and tabulate the frequencies present, for a very large number of different signals, but this way of representation is very clumsy. A better way is to write down a formula for the amplitude of the *nth* component so that the presence or absence of any frequency in a waveform may be determined by simply giving n the correct value in the formula. This is a kind of mathematical shorthand, instead of tabulation. Take the waveforms shown in Fig. 4: the first, shown at (a), is an ordinary rectified sine-wave, such as might be supposed to emanate from a full-wave high-tension rectifier. The formula in this case would be:

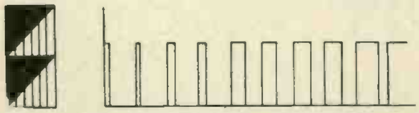


Fig. 3. The result of scanning a low-frequency test card shown in this figure is given in Table II.

$$A_n = \frac{4}{\pi(n^2-1)} \text{ in which:—}$$

A_n is the amplitude of the *nth* component.

n is the number of the Fourier term.

This formula is so arranged that the term $n = 1$ shall correspond with the frequency of the original unrectified wave; in this case, only *even* values must be given to n, for the frequencies corresponding with n = 1, 3, 5, 7, etc., are not present at all.

Next, take the waveform shown in Fig. 4 at (b); this consists of a few cycles (m is the number) of pure sine-wave, occupying a time T, followed by zero current for a time $(k-1)T$, where k is any integral number.

In this waveform, assuming it to be repeated over and over again (as in the case of a television signal in which all the lines are blank except one, which is " speckled "), it might be thought at first that the only frequency present is that of the series of sine-waves. Nothing, however, could be farther from the truth. Many frequencies are present, some lower, and theoretically an infinite number higher than that particular one; in fact the component which has the same frequency as that of the sine-waves has an amplitude of $1/k$ of that of the sine-waves, so that if the period of zero current is long compared with the wave-group (that is, $k-1$ is large compared with T), the amplitude of this component will be very small. The formula for the amplitudes of all the components is too complicated to be of much interest here.

Finally, let us take the waveform of Fig. 4 (c), which consists of two equal groups of sine-waves put end to end and repeated; the only thing unusual about them is that their amplitude changes from positive to negative after every group of cycles (that is, there is a periodic phase shift of 180°). It might, on the face of it, be thought that this waveform consists principally of an alternating current of sine-wave form and of frequency the same as that of the individual wave-groups. Paradoxically, this particular frequency is *not present at all*. The waveform comprises an infinite series of components, of higher and higher frequency to an indefinite limit (that is, covering an infinitely wide frequency-band) but the frequency of the original sine waves is not amongst them.

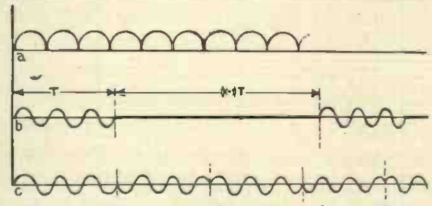


Fig. 4. Three types of waveform for analysis.

This kind of example shows how careful one must be in speaking of " frequency " in periodic waveforms other than purely sinusoidal ones. And it shows, too, how " chopped carrier " systems (such as some of the early photo-telegraphic systems), do not overcome the side-band difficulty, but, rather, mightily increase it.

The effect of phase-distortion in transmitting waveforms of various kinds has already been simply dealt with from a television point of view by Fayard, and the reader is referred to an article[2] by him if he wishes to pursue this aspect.

TABLE II.

n	*Corresponding Frequency.*	*Amplitude of Component.*
30	375 cycles per second	1.2490
60	750 ,, ,, ,,	0.1530
90	1125 ,, ,, ,,	0.0466
120	1500 ,, ,, ,,	0.0184
150	1875 ,, ,, ,,	0.0095
180	2250 ,, ,, ,,	0.0050
.	. ,, ,, ,,	.
.	. ,, ,, ,,	.
.	. ,, ,, ,,	.
1110	13875 ,, ,, ,,	0.000121

References:

[1] " Transmission of Information "; R. V. L. Hartley, Bell System Technical Journal, Vol. VII, p. 535, 1928.

[2] " On the Determination of the Highest Frequencies to be Transmitted, and the Influence of Phase Distortion in Television"; G. Fayard, " L'Onde Electrique," Vol. 12, No. 133, Jan., 1933, pp. 53-60.

THE TELEVISION ENGINEER

Trichromatic reproduction in television—II

By J. C. Wilson (of the Baird Laboratories)

This is the second and concluding instalment of the abstract of a paper read by J. C. Wilson before the Royal Society of Arts on May 2 on the problem of television in natural colours. This part deals with the amplifiers and receiver.

THE amplifier system employed is extremely straightforward. The first three stages comprise valves of the DEL 610 class, having a magnification factor of 15, and an internal impedance of 7,500 ohms. With anode-resistances of 20,000 ohms, a dynamic magnification of about 11 per stage (the grid-resistances are high compared with 20,000 ohms) is obtained, and the overall magnification is about 1,300 times at medium frequencies. In this connection it must be remembered that a substantially flat frequency-characteristic from 10 cycles to about 13,500 cycles per second is desirable to accommodate the component frequencies of the television signal up to the "first zero-frequency" of the scanning-device used. Naturally, this range would be considerably extended in the case of a commercial colour-television system of proper revolving-power instead of the comparatively crude experimental apparatus described here to illustrate the principles, but in the case of a radio-transmission channel it is not necessary to go to the "zero-frequency."

Now although the phase-frequency and amplitude-frequency characteristics of resistance-coupled amplifiers can be made considerably better, especially at the lower frequencies, than those of transformer-coupled valves, it is necessary, even with moderate band-widths as in the present case, to take precautions against high-frequency attenuation. This attenuation is due primarily to small shunt capacities, such as the inherent capacity of the photo-cells, the working capacity of the grid circuits of the valves, and the line-capacity; the working capacity of a triode, it should be remembered, is much higher than its static capacity.

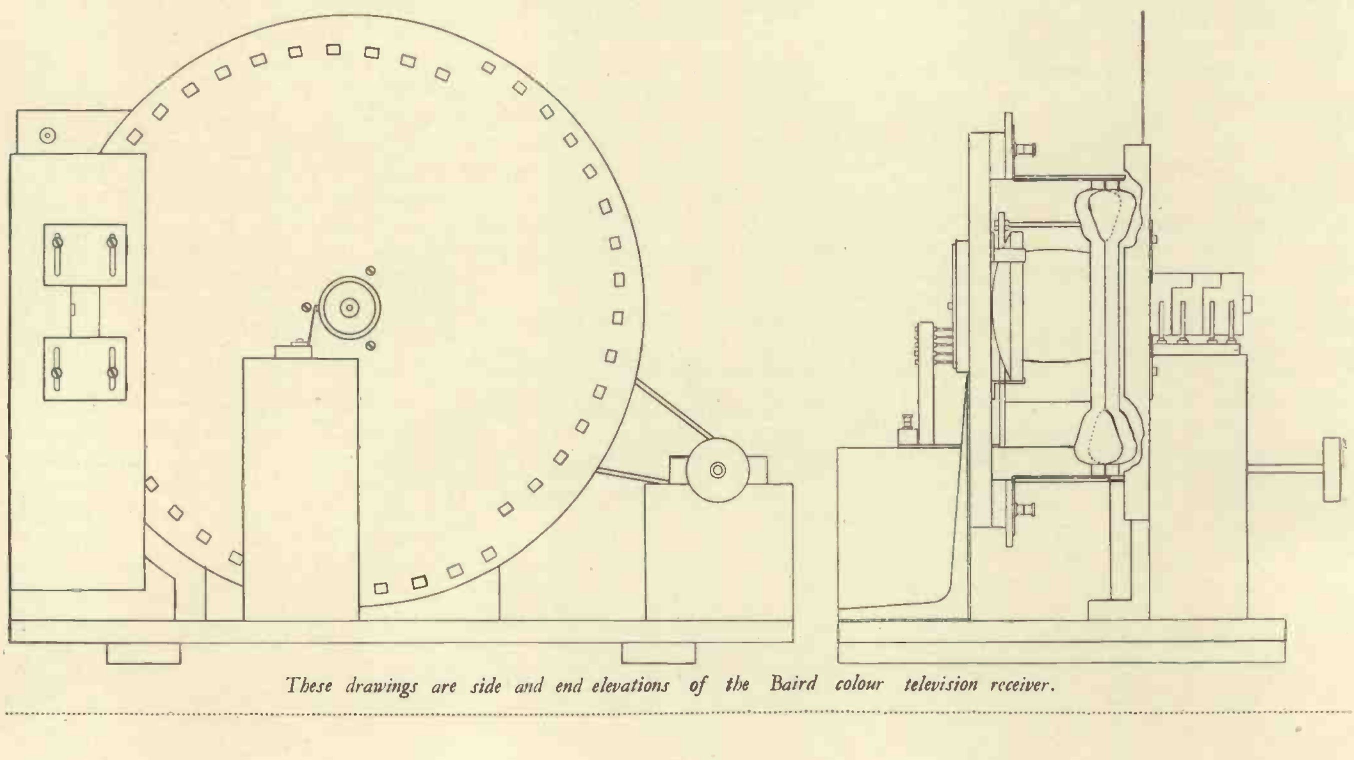
It will thus be seen that it is advantageous to keep the anode-resistances low, in spite of a reduction in gain, in order to keep the total effect of this capacity small.

The second section of the amplifier comprises two series of three stages each in parallel; in each series the first valve is an LS 5B, the second an LS 5, and the final either two T 250 valves in parallel, or, with an appropriately lower high-tension voltage, one DA 60. The amplification is arranged to bring the overall magnification of the system up to about 68 decibels.

The Receiver

At the receiver the source of light is not a radiator supplying a continuous spectrum with filters to transmit certain bands; the two gas-discharge tubes emit a composite line-spectrum, from which, in the case of

(Continued on page 326)



These drawings are side and end elevations of the Baird colour television receiver.

ANSWERS to QUERIES

Alteration of Motor Direction

I have an electric motor which I propose to use for driving a mirror drum, but upon investigation I find that the direction of rotation is wrong. Can this be altered so that the motor runs in an anti-clockwise direction ?—F. A. (Newcastle-on-Tyne).

Reversing the direction of rotation of a motor is usually quite a simple matter. Small motors as a rule are series wound—that is, the current first passes round the field coils and then to one of the brushes, round the armature and back to the mains from the other brush. The direction of rotation depends upon the relative direction of current flow in the field coils and the armature, so all that is necessary to alter it is to reverse the armature connections to the fields—in other words the field coils should be connected to the other brush, the brush which formerly was connected to the field being connected to the mains. It may be found that with the altered connections a certain amount of sparking takes place at the brushes and if this is the case it can only be remedied by making a slight alteration in the brush position or, what amounts to the same thing, moving the commutator round slightly on its shaft if this is practicable.

Threshold Effect

What is "threshold effect" in a C.R. tube and how does it affect the picture ?—D. M. (Windsor).

"Threshold effect" or "origin distortion" is peculiar to low voltage C.R. tubes which contain traces of gas and is due to non-linear travel of the beam, at low potentials on the deflectors. In effect the beam "slows down" when the deflecting potential falls below about ten volts, and this causes a line of brighter fluorescence to appear across the television screen. The bright line can be moved to one side or other of the frame by applying a bias to the deflector plate or by using magnetic coils to deflect the beam. See the article in the January issue, page 9.

Cathode Rays and Projection

Can I project the image at the end of the C.R. tube on to a screen by a lens system ?—F. D. (Manchester).

The image *can* be projected by lenses, but we fear that the intensity is too low to produce a satisfactory picture, owing to absorption by the fluorescent screen itself. The intensity could be increased by raising the anode voltage of the tube, but this would shorten its life. For photographic work, of course, you can use an ordinary short-focus camera—about two seconds exposure with H. and D. 1,200 plates should be tried for a start.

Connecting to Marconi Receiver

Will you tell me how to connect the "Daily Express" disc receiver to a Marconiphone four-valve A.C. superhet ? I have used an output transformer of one-to-one ratio, but the neon only lights up very dimly.—G. R. (Grimsby).

Unless you wish to excite the neon lamp externally, there is no need to use an output transformer between a Marconi super-het and the disc receiver. Obtain a Bulgin split-anode adaptor, of the five-pin type, plug this in place of the output valve, with the valve in the top of it. The two connections from the adaptor should then be taken to the neon tube.

It is quite easy to tell if the connections to the neon tube are correct for when it is the right way round the glow will be diffused, whereas when it is connected the reverse way the glow is centred around the bottom of the anode.

> **ANSWERS TO QUERIES**
>
> An expert service is available to assist readers who experience difficulties in the construction, operation and maintenance of television apparatus or associated wireless receivers and amplifiers.
>
> The following rules should be observed:
>
> Please write clearly giving all essential particulars.
>
> A stamped, addressed envelope and also the coupon on the last page must accompany all queries. Not more than two questions should be sent at any time.
>
> Reply will be made by post.
>
> Queries should be addressed to the Query Department, TELEVISION, 58-61, Fetter Lane, London, E.C.4.

Using with McMichael Set

How do I use the "Daily Express" disc receiver with the McMichael four-valve portable ? I have connected it up as recommended by a friend and used the split-anode adaptor but all I can get is a faint glow which varies with the strength of the signal.—J. P. (Liverpool).

The voltage of the high-tension battery in the McMichael portable is insufficient to cause the neon lamp to strike, so that your method of connecting is incorrect. The faint glow that you obtain is simply the A.C. output of the receiver and is not caused by the D.C. voltage from the dry battery.

With this receiver you should energise the neon lamp by means of an external battery or exciter unit and couple to the loudspeaker terminals of the receiver, by means of a one to one transformer.

A suitable exciter unit was described in the April issue.

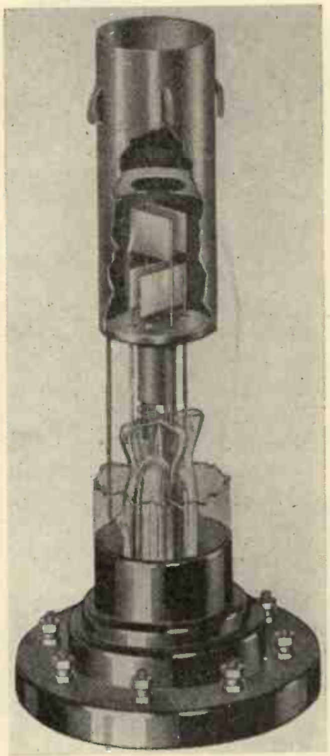
Synchronising the "Daily Express" Receiver

I have built up the "Daily Express" disc receiver, but cannot get the stroboscope to have any effect. I have mounted a lamp in front of the disc but no matter how I vary the speed of the motor I cannot tell when it is synchronised.—W. R. B. (Brighton).

It seems that you are running your receiver from D.C. mains in which case the stroboscope will not have any effect. The simplest way to tell when the motor is running at 750 revolutions is to hold a visiting card up against the phonic wheel. When the motor is running at 750 revolutions the hum from the card against the wheel will be almost the same pitch as that of the note transmitted through the London National station.

OPERATING THE COSSOR CATHODE-RAY OSCILLOGRAPH

The information contained in this article relates particularly to the Cossor cathode-ray tube, and it has been supplied by Messrs. A. C. Cossor, Ltd. The instructions on the operation are, however, general and thus applicable to any apparatus of this type.



A cut-away view of the Cossor cathode-ray tube showing the arrangement of the electrodes.

THE Cossor cathode-ray tube is of the hot-cathode, gas-focused variety, and its action is briefly as follows. Electrons emitted from a small oxide coated filament are drawn through a "gun" at a convenient positive potential (300-3,000 volts); the electron beam passes between two pairs of deflecting plates, these pairs being mutually perpendicular, and finally, after a relatively long travel, impinges on a fluorescent screen.

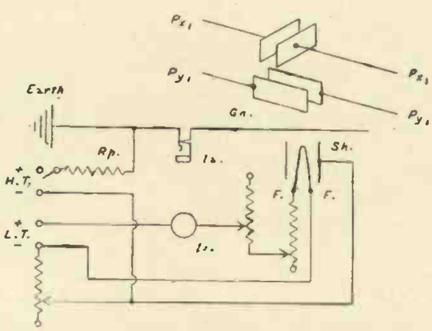


Fig. 1.—The general circuit for the oscillograph.

The bulb is filled to a low pressure of inert gas which allows the beam to be brought to a sharp focus on the screen, this focusing being carried out by adjustment of the filament current and of the negative bias on a focusing shield which surrounds the filament. When a potential difference is applied between two opposite plates the electron beam is bent towards the positive plate and the spot of light on the fluorescent screen is displaced accordingly.

It is not always necessary to operate the tube in a dark box at 500 volts and above, though, generally speaking, a dark room or dark box is an advantage because it allows operation at lower voltage.

An 8-pin low-capacity base is fitted which fits into a triple bayonet socket. The latter has four mounting holes spaced at 90° round a circle, and the basing is so arranged that these mounting holes lie on the axes of *x* and *y*; the hole between the terminals marked *Gn* and *Px* lies on the *y* axis (plates nearest the gun).

The tube must be kept as far away as possible from magnetic fields, either continuous or alternating. Even the earth's magnetic field gives an appreciable deflection, which, however, can be minimised by orienting the tube with its axis parallel to the direction of the field. Where trouble is experienced through the existence of external fields it may be minimised by using higher gun voltages.

The General Circuit

The general circuit for the oscillograph is shown by Fig. 1. Note that the *gun is grounded,* and therefore the filament and shield circuits are live to ground and must be appropriately insulated.

A two-volt acumulator is adequate for the filament provided that a smooth and delicate adjustment of current is obtainable on the rheostat. The use of two rheostats in series is recommended, the first of about 4 ohms resistance, acting as coarse adjustment and switch, and the second about 1 ohm, acting as fine adjustment. A filament ammeter, shown in the diagram, should be included when possible.

The shield bias may take the form of an "automatic bias" off the return space current as shown, for which purpose a smooth potentiometer of about 2 megohms resistance is needed. Alternatively a low resistance potentiometer of about 50,000 ohms and a biasing battery may be employed.

Either batteries or an eliminator may be used for the H.T. supply. The current drain, being minute, allows the use of a very simple eliminator with resistance smoothing. Fig. 2 gives a circuit for such an eliminator. One precaution is necessary in the case of an eliminator, and that is to keep the oscillograph clear of the magnetic field of the transformer.

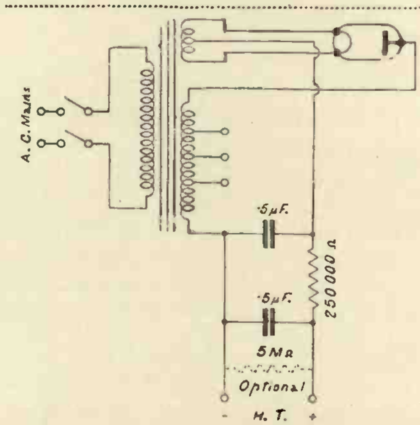


Fig. 2.—A circuit of a simple eliminator with resistance smoothing for the high-tension supply.

It is desirable, though not essential, to insert a protective resistance of about 10,000 ohms (*Rp* in Fig. 1) in the positive H.T. lead, especially if batteries are used for the H.T. supply.

The only general rule that can be given regarding the deflector plate circuits is that all deflector plates should have metallic connection to gun. Plates which are idle should be short-circuited to gun, or connected through a biasing battery to gun if it is desired to shift the picture. The live plates may be driven directly or through condensers as the circumstances demand, but in the latter case the metallic connection to gun must be provided by grid leaks of, say, .5 to 2 megohms. If the voltages under examination are balanced with regard to earth, push-pull working will be advantageous.

Focusing

The spot is focused as follows:—Light filament at the current marked on the tube, set the shield bias to its maximum negative value, and switch on the H.T. Then reduce the negative bias until a roughly focused spot appears on the screen, and finally manipulate both shield and filament controls until optimum focus is obtained. Note that various combinations are possible; do not focus too carefully on the spot, because a readjustment of focus is usually needed for a *figure*.

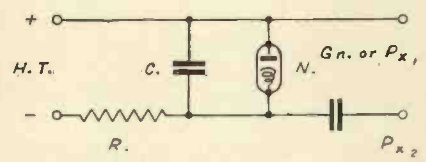


Fig. 4.—A simple time base circuit using a neon lamp.

The following theoretical considerations will be helpful in focusing. With a given gun voltage, the electrostatic field between gun and filament can be varied by manipulation of the shield voltage. If the shield is too positive the nett field between gun and filament is a spread affair; a large proportion of the gun current flows directly to the gun instead of passing through the hole, and is thus wasted, whilst that portion which does pass through the hole gives a rather widely divergent beam.

By making the shield more negative we increase the useful proportion of the gun current, and decrease the initial divergence; but at the same time we decrease the total gun current by the "grid control" effect of the shield, and this puts a limit to the negative bias that is permissible.

In no case does it seem possible to obtain a beam with zero initial divergence, and for this reason, and to

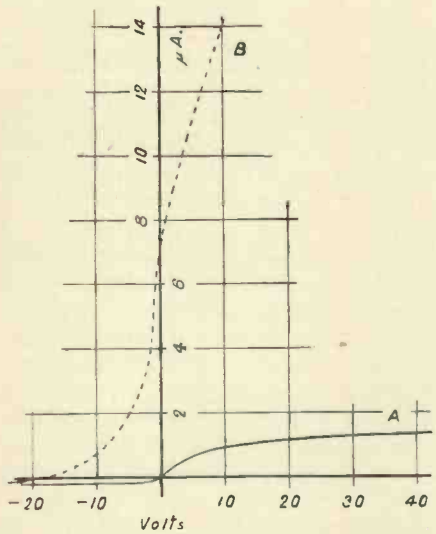


Fig. 3.—Typical current/voltage curve for a deflector plate, the other three plates being strapped on to the gun. Deflector Plate Current at 50μA Gun Current. Curve A: Shielded Structure. Curve B: Similar structure without Shield.

counteract the spreading of the beam due to the mutual repulsion of the electrons, a low pressure gas filling is provided, which allows the beam to be re-concentrated in the following manner: a certain proportion of the electrons in their transit from gun to fluorescent screen strike the gas molecules and ionise them; these ions, being relatively slow moving, remain for an appreciable time within the beam and so constitute a columun of positive charge along it; this has the effect of drawing the outermost electrons in towards the centre of the beam. For any given

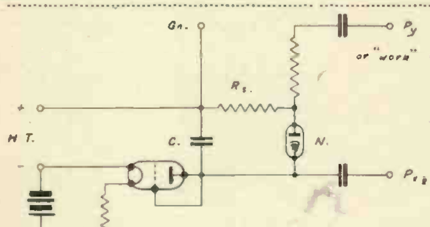


Fig. 6.—This diagram shows the addition of a synchronising circuit to the time base of Fig. 5.

beam current and initial divergence (within reason) it is possible to adjust the gas pressure so that the beam converges to its minimum diameter on the fluorescent screen.

The user's problem is rather the converse of this, the gas pressure having been fixed by the manufacturer; it is, then, with a given gas pressure to adjust the beam current and divergence so as to bring the beam to its minimum diameter on the screen. It is a remarkable fact, which emerges very plainly from the theory, that the beam current itself affects the focusing. It is for this reason that the adjustment of the filament temperature has to be included in the focusing operation. The shield voltage has a double effect; it controls simultaneously the beam current and the beam divergence. The filament temperature, provided that it is below saturation (as it should be), controls the beam current only.

A small secondary effect is associated with this gas focusing which for some purposes it is important to take into account, and this is a departure from linearity of the displacement-voltage curve at the point where the electric field between the plates changes sign; for about 1-3 volts each side of this point the sensitivity is reduced. The effect diminishes with reduced beam current, but is never completely absent. In cases when it is objectionable, it is a simple

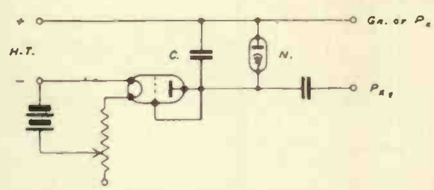


Fig. 5.—A time base incorporating a saturated diode to provide a more linear effect.

matter to bias the plates so as to avoid working over the distortion point.

Input Impedance

For the majority of investigations the input impedance of the tube may safely be left out of account—that is to say, taken as infinite; but in certain cases its finite, though high, value must be allowed for. For this purpose Fig. 3 gives a typical current/voltage curve for a deflector plate, the other three plates being strapped to gun. Note the striking improvement brought about by the shield.

Time Base Circuits

Figs. 4, 5 and 6 show some convenient time base circuits, in which a neon tube forms the trigger element. In Fig. 4 the condenser C is charged from an H.T. source through a resistance R. When the voltage across the condenser reaches the striking voltage of the neon lamp a discharge occurs, and, if the resistance R is not too small, the condenser will discharge to the breaking voltage of the lamp; it will then immediately start to recharge to the striking voltage, and so the process continues. These two voltages are usually in the neighbourhood of 200 volts and are separated by about 30 volts; the latter represents a convenient amplitude for a time base voltage, and may be applied directly to one pair of deflector plates. For the time base H.T. supply it is convenient to use the same battery or eliminator that supplies the gun, and this is intended in the circuits of Figs. 4, 5 and 6.

The circuit of Fig. 4 does not give a truly linear time base, because a condenser charging through a resistance does so exponentially and not linearly. But, if only a small portion of the exponential charging curve is used, the departure from linearity is not serious; in other words, it is advantageous from this point of view to make the time base H.T. supply as high as possible.

The period of this time base is:

$$CR \frac{V_n}{V_b - V_m} \text{ where}$$

V_m is the H.T. voltage.

V_b is the mean voltage on the neon lamp.

V_n is the difference between the striking and breaking voltages.

(The units are Farads, Ohms, Volts and Seconds.)

If a more exactly linear time base is required than is provided by the circuit of Fig. 4, the latter can be modified by the substitution for the resistance R of a constant current device, such as a saturated diode (Fig. 5). The period of this time base is $C\frac{V_n}{I_s}$ where I_s is the saturated current (amps.) supplied by the diode. For the latter it is convenient to use a triode with plate and grid strapped. A bright emitter (Cossor P1 or P2) is to be preferred, or failing this, a thoriated tungsten valve. The circuit arrangement of Fig. 5 permits the use of the same H.T. and L.T. supplies as for the oscillograph, if the values are suitable.

To either of the last two circuits we may add a refinement of the greatest importance, namely, a device for synchronising the time base to the "work." Fig. 6 shows this device applied to the circuit of Fig. 5. Between the condenser and the neon lamp is placed a resistance R_s, the synchronising resistance; this should generally be made as high as possible without unduly slowing down the "flyback" of the spot. On to the junction of the lamp and the synchronising resistance is fed a small proportion of the work voltage; thus the tripping point of the time base traverse is, as it were, adjusted by the work voltage, and so, if the period of the time base is reasonably near to a multiple of the work period, synchronisation results and a standing figure is obtained.

Summarised Operating Data

Filament current, 0.7 to 1.1 amps.
Filament voltage, 0.4 to 0.8.
Gun voltage 300 to 3,000 } relative to
Shield voltage, 0 to —200 } filament.
Gun current, 10 to 200 microamps.
Capacities (inclusive of socket):—
Each deflector plate to gun, 6.0 $\mu\mu$ F. approx.
Each deflector plate to opposite plate 1.5 $\mu\mu$ F. approx.
Electric sensitivity $\frac{350}{V}$ mms. per volt, approx.
Magnetic sensitivity $\frac{8l}{\sqrt{V}}$ mms. per gauss, approx.
Electromagnetic sensitivity $\frac{25}{\sqrt{V}}$ mms. per ampere turn.

At the higher gun voltages (2,000-3,000) the fluorescent screen is liable to be damaged by a stationary spot.

The Postmaster General's Committee

No Reports of the Meetings to be Published.

The first meeting of the Postmaster General's Committee, formed to decide the future policy of television in this country, was held on Tuesday, May 29, when the decision was made that the meetings should be held in private and no reports of the proceedings should be published. A few days later the Committee visited the television studio at Broadcasting House and witnessed a demonstration of 30-line television by the Baird system. The programme given was a repetition of the broadcast which was made a few days earlier. Mr. Baird and Capt. West, of Baird Television, Ltd., were present and explained the working principles of the transmission to the members of the Committee.

It has been announced that persons desirous of giving evidence before the Committee should inform the secretary, Mr. J. Varley Roberts, of the Telegraph and Telephone Department, General Post Office, of their intention, not later than June 30.

Standard Terms and Definitions

Photo-electric Cells.

The Research Committee of the Television Society has defined Photo-electric (light-sensitive) Cells in the following way:—

1. A LIGHT-SENSITIVE Cell is any device if modification of its electrical properties occurs on illumination.
2. A PHOTO-CONDUCTING CELL is one whose electrical resistance varies with the illumination incident upon the cell.
3. A PHOTO-ELECTRIC CELL is one in which electrons are emitted from a metallic surface under illumination.
4. A PHOTO-ELECTROLYTIC CELL is one which depends primarily for its action upon the Becquerel effect.
5. A PHOTO-VOLTAIC CELL is one in which a difference of potential is developed across the rectifying contact between the surfaces of a semi-conductor and a metal under the influence of illumination; this potential difference gives rise to a current in an external circuit.

FLUORESCENCE—What It Is

With the rapidly increasing use of the cathode-ray tube the phenomenon of fluorescence has assumed considerable importance and much research is being carried out to determine the most suitable material for the screen. This article explains how fluorescence is produced and details the coatings at present used for the screens.

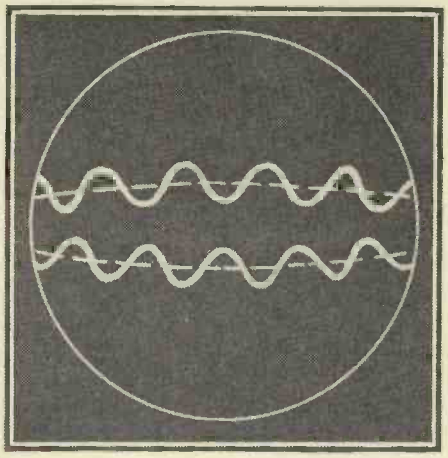
WHEN we view the image on the white screen of a cathode-ray tube, we are observing the path of the electrons projected through the anode. It is interesting to investigate how, and under what conditions, this image is produced.

A bullet as it leaves the muzzle of a gun possesses a very high velocity. By virtue of its mass and this velocity, it also possesses energy of motion, or kinetic energy. If the bullet is suddenly stopped by a steel plate, it no longer has kinetic energy. But a fundamental law of nature states that energy cannot be destroyed, therefore, the bullet's energy must either be transferred to the target, or if the target is immovable, must be dissipated in some other form such as heat or light.

Electrons in a cathode-ray tube

An experimental cathode-ray tube made up by the Ediswan Co. for comparing the effects of various screen coatings; the six sections can be clearly seen.

behave in a similar manner to bullets. Travelling at terrific velocities, due to the accelerating voltage applied, they hit their target, which, in this case, consists of the atoms of the screen.



How Fluorescence is Produced

Consider now the bombardment of an atom by an electron. The atom consists of a central nucleus which has a positive charge (see Fig. 1). This nucleus is surrounded by a series of electrons, all revolving round it, just as the planets Earth, Mars, Saturn, revolve round the Sun. The electrons are attached to the atom by electrical attraction, and considerable force is required to remove them from their positions. Also, once removed, they return to that position as soon as possible, giving out energy as they do so. The reason for this is, that to remove the electron from the influence of the positive nucleus, energy must be put into it. As it returns to its normal position, it gives out energy.

When a high speed electron hits an atom, it damages it to such an extent, that electrons are knocked off. This accounts for the well-known occurrence of secondary emission in valves. With the atoms of certain substances, they are not only denuded of electrons, but, in due course, these electrons return to their native atoms and on their return give out energy in the form of light. This light is the fluorescence of the cathode-ray tube.

It is perhaps difficult to realise that light is a form of energy, but it will be clearly seen that an electric lamp is an example of the transference of electrical energy into light energy.

Electrical Power (watts) → Candle-power.

The light given out by electric signs such as the red neon sign or the blue mercury-vapour tube is another example of energy given out by electrons returning to their atoms.

It will be seen that fluorescence is the after-effect of a bombardment of electrons, not the actual bombardment. The bullet electrons flying through the tube, from the cathode, and speeded by the anode, knock electrons out of the atoms of the screen, and these electrons give out light as they return.

The problem of the most suitable screen for cathode-ray tubes is therefore that of finding what substances will give out the best light when bombarded by a stream of electrons.

The most important characteristic of a fluorescent material is called its brilliance of initial response. This is measured by the effect of the light emitted on the retina or screen of the eye. The retina is not equally sensitive to all colours. It is therefore essential, for visual cathode-ray work, to have a screen material which will fluoresce in the region of the highest retinal sensitivity. For photographic work, a screen material with its fluorescence in the ultra-violet part of the spectrum is desirable, since that part of the spectrum has the highest actinic value.

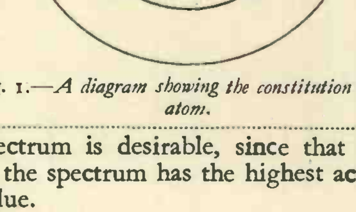


Fig. 1.—A diagram showing the constitution of the atom.

Fluorescent Materials

The best substance yet discovered for brilliance of response for visual

(Continued at foot of next page.)

PROGRESS IN U.S.A.

Light Sources

Mr. H. J. Brown, in an article on "The Behaviour of Gaseous Discharge Television Lamps at High Frequencies," when discussing various questions such as frequency discrimination, phase shift, harmonic distortion, etc., comes to the following conclusions:—

> . . . that a crater lamp of conventional design will be found completely satisfactory for television systems employing 120 lines per frame, and 25 pictures per second. It is quite likely that they will be found useful for systems requiring even greater detail than this. Since no theoretical basis has been evolved to rationalise the results here reported, it is not possible to make any estimate of the limit response of the behaviour of a lamp of other characteristics. Further, in view of the fact that the interesting characteristics herein reported were found in a lamp which had been built without any attempt at design and without any understanding of the features involved in the high frequency characteristics, it is believed that glow lamps can be developed that will provide satisfactory performance in an otherwise practical television system.

New Fluorescent Screen

Improvements in technique have enabled the Allen B. Du Mont Laboratories to overcome the blackening of the fluorescent screen when the electron beam is allowed to remain stationary, on all cathode-ray tubes having high intensity screens developed previously by these laboratories. This means that the life of the tube is materially increased, as the darkening causes deterioration of the fluorescent screen. Because of this defect in cathode-ray tubes, it has not previously been practical to use them for certain purposes, such as sound recording, or indicating meters, where a spot or line might remain stationary for a considerable period of time.

At the Convention of the Institute of Radio Engineers, which was held in Franklin, Philadelphia, from May 28 to 30 television was discussed in a series of papers read by Camden Engineers, and the position of the ultra-short waves was thoroughly examined. The responsibilities of the radio engineer from broadcasting transmitter to the listeners' receiver, were carefully discussed. The following papers were read:—

"The Theory of the Electron Gun for Cathode-ray Tubes," read by I. G. Maloff and D. W. Egstrom, R.A.C. Vintor Company, Incorporated, Camden, N.J.

"Cathode-ray Oscillograph Tubes, and their Applications," read by W. H. Painter and P. A. Richards, R.C.A. Radiotron Company, Incorporated, Harrison N.J.

"The Experimental Television System." Introduced by E. W. Egstrom.

"Transmission and Reception." Read by I. Wolff, E. C. Linder and R. A. Braden, R.C.A. Victor Company, Incorporated, Camden, N.J.

"Fluorescence—What It Is"

(*Continued from preceding page.*)

work is zinc silicate or willemite. This white substance is the most suitable all-round screen material, but its fluorescent value is largely determined by the nature of the impurities in its composition. Samples of willemite prepared in different ways, or obtained from different places, give widely different results when used as fluorescent screens. It has been determined that impurity of the order of one part in ten thousand can materially affect the brilliance of the screen.

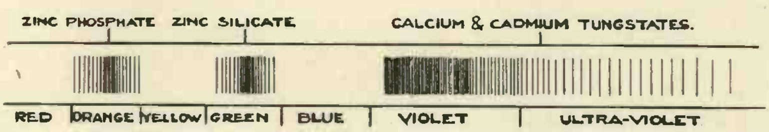


Fig. 2.—The positions in the spectrum of the colours produced by various screen materials.

After Glow

For photographic work, the most suitable materials are calcium tungstate and cadmium tungstate. These substances, compared with zinc silicate, require much higher accelerating voltages in the tube to produce the same brilliance of response. The position in the spectrum of the various screen materials is shown in Fig. 2.

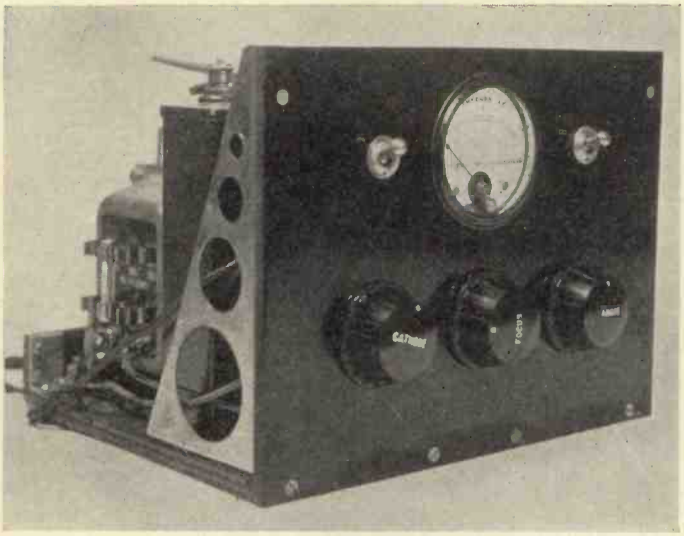
The phenomenon of fluorescence was known long before it was practically applied in the cathode-ray tube, and it was previously studied in conjunction with another effect called phosphorescence. The difference between the two is simple. Fluorescence takes place only when the agent causing the effect is present; in the case of the cathode-ray tube, light is only emitted when there is a stream of electrons in the tube. Phosphorescence on the other hand takes place after the activating agent is removed. It obtains its name from the well-known property of phosphorus, of shining in the dark. The luminous dials of clocks and watches is an example of phosphorescence.

Some substances possess the combined properties of fluorescence and phosphorescence. That is, after the electronic bombardment has ceased, there is a short afterglow. This becomes very important in cathode-ray tube work, and as the intensity of the afterglow varies with different substances, care must be taken to use the correct screen for particular work. For television, a certain amount of afterglow assists the continuity of vision, but excessive phosphorescence gives a blurred image. In high-speed work, afterglow is a positive nuisance, and if necessary, brilliance of response must be sacrificed to obtain the minimum of afterglow.

Zinc silicate and zinc phosphate have a sustained afterglow, calcium tungstate has a little and cadmium tungstate none.

For accelerating voltages of less than 500 volts, the only suitable screen material is zinc silicate. For higher voltages, zinc phosphate and zinc sulphide are suitable; the latter has only a small amount of afterglow. Less brilliance of response is obtained with calcium and cadmium tungstate with a corresponding reduction of the afterglow.

BUILDING THE CATHODE-RAY TUBE SUPPLY UNIT



A view of the completed supply unit for the cathode-ray tube.

This article, by G. Parr, describes the construction of the cathode-ray tube supply unit, preliminary details of which were given in last month's issue.

THE front panel of the H.T. supply unit for the cathode-ray tube corresponds in dimensions with that of the time-base unit, and the two baseboards can thus be housed in the same cabinet if desired.

The front panel drilling dimensions are given in Fig. 1, the controls, reading from left to right, being cathode current, focusing, and anode potential. On the right and left sides of the meter are the Bulgin switches for the cathode supply and the mains supply to the transformer primary. Incidentally, it is always advisable to switch on the cathode a few seconds before the H.T. in order to avoid overloading the condensers and to make sure that the auto-bias resistance is brought into action as soon as the anode supply is on. In the particular circuit used for this supply unit the latter point is not of importance, as there is a shunt resistance across the H.T. which ensures a flow of current through the bias resistance irrespective of the tube current.

The baseboard is cut from a piece of 5-ply wood ⅜ in. thick, measuring 7 in. by 8 in. The panel dimensions are 6 in. by 8 in. and it is secured to the baseboard by four screws along the lower edge, and by two angle brackets.

The Layout

Fig. 2 shows the layout of the components, and in fastening them down the condensers should be left out temporarily to allow access to the connections of the switches and resistances at the back of the panel.

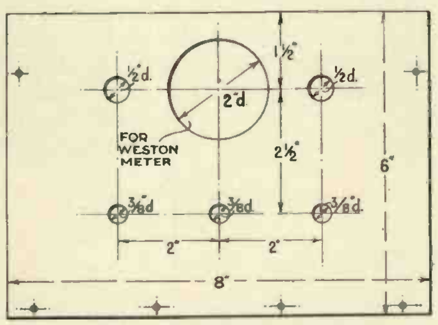


Fig. 1.—The drilling diagram of the front panel.

Fig. 3 is the terminal strip at the back of the baseboard, the terminals being L.T.+ and −, anode and modulation. The modulation terminals are in the shield circuit of the tube, and *must be kept short-circuited except when the tube is being used for television.*

Commence by fixing the resistances and switches on the panel. The ammeter can be wired in circuit straight away, one terminal going to the right-hand switch (front of panel view) and the other terminal to the cathode resistance. Now fasten down the Dubilier 2-mfd. condenser, and join its terminals to the tap and one end of the focus resistance in the centre of the panel.

The rectifier filament and anode can now be wired up to the transformer, the anode control resistance being connected in series with one filament lead. This lead should be kept well over to the right to clear the condensers. The tube cathode wiring may now be completed, and the main smoothing condensers fitted into place.

The last of the wiring is seen on the top of the photograph. Two terminals on the condensers are connected together and to the H.T. winding on the transformer, while the other two terminals are joined through a 200,000-ohm Erie resistance. One condenser terminal is then taken to rectifier filament centre tap, and the other to the anode terminal at the back of the panel. This lead is seen running over the transformer to the left. The shunt resistance across the H.T.+ and L.T.− was made up of two 5 meg. Eries, but a single 10 meg. will be equally satisfactory.

There finally remains the connecting cable for the tube. This is a four-core length about 3 ft. long. If any difficulty is experienced in getting suitable four-core cable, a neat job can be made of two lengths of twisted twin flex. In any case the connections are as follows:

One to cathode resistance on panel.

One to L.T.− on terminal strip.

(It is advisable to reinforce the insulation of this with a length of stout systoflex, since the cathode accumulator is "live" to shield and anode.)

One to terminal "A."

One to the free "modulation" terminal.

(The other modulation terminal will have been connected to H.T.−.)

The other end of the flex should be soldered to the sockets on a four-pin valve holder for the Ediswan tube, or taken to the appropriate terminals on a special cathode-ray tube socket.

Checking the Connections

Now check the connections carefully, paying particular attention to the following points:

Focus resistance is connected to L.T.– and to H.T.–, which is the end of the H.T. winding on the transformer.

Terminal A is connected on the " smoothed " side of the condensers, and not direct to rectifier filament centre.

All wires at high potential do not touch low-potential ones unless they are substantially insulated. It is always as well to put a double thickness of systoflex over the wire in doubtful cases, as mysterious sparkings may occur if the insulation is poor.

Examine the Erie resistances and make sure that they will not accidentally touch each other or the condensers.

Having again checked the connections to the tube, the unit can be tested out as follows; the instructions apply more particularly to the Ediswan tube, which was used in the apparatus described, but the user can adapt them to other cases with little difficulty. All cathode-ray tubes are fundamentally similar in their action and the slight differences encountered are those of cathode current, focusing potential and sensitivity. Needless to say, this H.T. unit should not be used on special tubes whose anode voltage must not exceed 3-400 without taking care that the rectifier filament is sufficiently dim to lower the voltage to that value.

The pre-set resistance should be "all-in" and the cathode resistance the same. Connect a two-volt cell to the L.T. terminals and switch on the L.T. alone. Watching the ammeter, adjust the pre-set resistance to a value which gives a nice range of control on the panel resistance. *Make sure that the " Modulation " terminals on the strip at the back of the baseboard are short-circuited.*

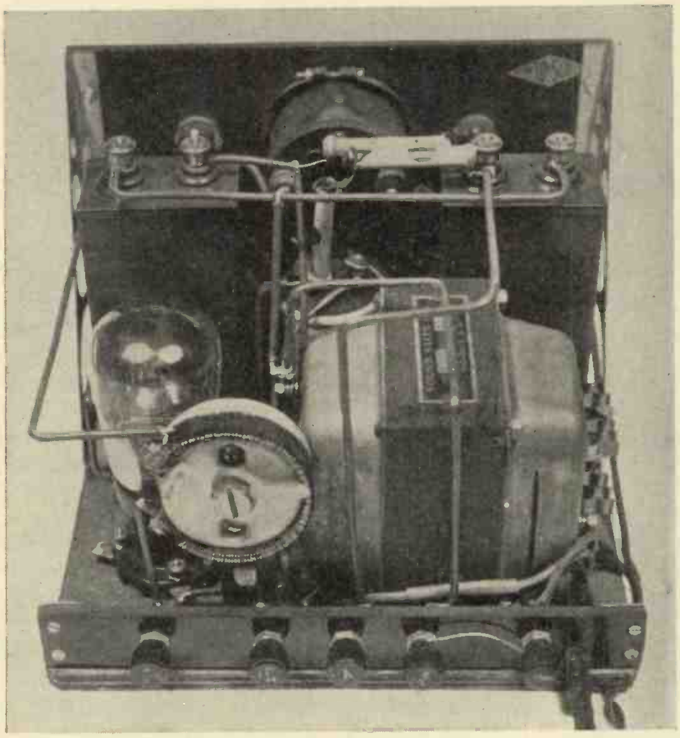


Fig. 2. — This plan view shows the arrangement of the components behind the panel, and it will be easily possible to identify these by reference to the adjoining list of components and the circuit diagram which was given in last month's issue.

Now join all the deflector plates of the tube together and to the terminal " A." Turn the anode H.T. resistance " all-in " and switch on the transformer. The focus resistance should be about half-way. Cautiously turn up the filament of the rectifier and move the focus resistance to see if the spot is forming at the end of the tube. The anode voltage may be too low, and the rectifier can be brightened up until a splash of fluorescence appears on the screen. This should quite easily focus to a spot with suitable adjustment of the focus control. The correct focusing position is one which occurs just before the spot is completely cut off by an increase of bias.

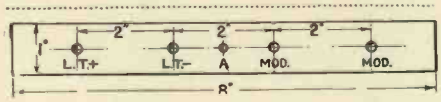


Fig. 3.—Dimensions of terminal strip.

Operating the Tube

If the tube refuses to focus sharply it is probable that the cathode is too cold, and the accuracy of the cathode ammeter should be suspected. Too high a cathode current will, on the other hand, produce a halo round the spot, and it should at once be reduced. The life of the tube depends largely on the cathode temperature, and it is always a good plan to reduce the cathode current to as low a value as possible consistent with sharp focus. It may be found that after a long run the cathode current may be appreciably reduced without impairing the quality of the fluorescent spot.

COMPONENTS FOR TUBE H.T. SUPPLY UNIT.

- Transformer: 1,500 volts, 2.0 volts C.T. (Sound Sales).
- 2 1 mfd. 1,000 v. condensers (Dubilier).
- 1 1 ohm. fixed resistance.
- 1 ½ ohm variable resistance (Reliance Mfg.).
- 1 2 megohm potentiometer (Reliance Mfg.).
- 1 200,000 ohm. resistance (Erie).
- 1 100,000 ohm. resistance (Erie).
- 1 2 ohm variable resistance (Reliance Mfg.).
- 1 4-pin valve-holder (Bulgin).
- 1 Ediswan C.R.2 rectifier.
- 1 2 mfd. fixed condenser (Dubilier).

Another cause of halo round the spot is too high an anode voltage accompanied with insufficient bias. In this case the whole of the screen is usually covered with a greenish glow which disappears as the anode voltage is reduced. Do not forget that the appearance of a spot is different to that of a line when the television screen is formed on the end of the tube, and that in most cases it will be necessary to raise the anode voltage and re-focus when the scanning lines are put on.

Possible Faults

If no spot appears at all when the H.T. is switched on it may be off the screen and somewhere on the walls of the tube. Careful inspection in the dark may show the spot

(*Continued on page 324.*)

The Stixograph and Scophony

By the Inventor, G. W. Walton.

This is the fifth of a series of articles on the Stixograph and Scophony system and it explains how the principle of the Stixograph can be applied to television. It is shown that the principle differs from all other television scanning systems. The details are exclusive to this journal.

IT is particularly interesting to portray graphically the effects of persistence of vision when viewing the reproduced picture of Fig. 28D. The retina of the human eye (and perhaps nerves and brain cells connected therewith) when excited by a flash of light of short duration continues to experience the sensation of light for an appreciable length of time after the cessation of the flash, the effect dying away with time, probably logarithmically.

Supposing Fig. 28D to be the reproduction of a stationary picture, it would be repeated in exactly the same form by each complete scanning. Two such repetitions are shown in Fig. 29 which also shows persistence of vision effects, as continuations of each detail in time at gradually decreasing intensities. In order that flicker in the picture should not be pronounced, the apparent decrease of light intensity of a detail due to one scanning should not exceed 10 per cent. before it is repeated by the next scanning.

Fig. 29 shows also why, when flicker is apparent, it takes the form of light and dark bands apparently moving at scanning speed over the field of view, for what is visually appreciated at one instant of time is in a plane parallel to *I—O—D*. It will also be appreciated that flicker is more pronounced with a bright picture than with a dull picture, for the apparent brightness of a detail, decreasing logarithmically, falls off more rapidly when it is of high intensity to start with than when it is low.

Scanning Characteristics

In Figs. 27, 28 and 29 the scanning characteristic is rectilinear. This is something which is seldom obtained in practice. For instance, a mirror drum rotating at a uniform speed has uniform angular velocity but it scans a picture in a plane, consequently its scanning characteristic is part of a tangent curve or rather a combination of two such curves. This can be shown graphically by taking *T* and *D* co-ordinates only as in Fig. 21 (May issue). Fig. 30A shows a mirror-drum characteristic and Fig. 30B that of a Nipkow disc. Fig. 30C shows the characteristics of double oscillating mirror scanning. In Fig. 30 the motion of the scanning aperture is shown in relation to a perfectly regular Stixograph distributed along *O—D*. The scanning characteristic, though not of much importance with low-definition pictures, must always be taken into account with high-definition pictures, for if the difference between the characteristic of a transmitter and that of a receiver is marked, serious distortion of the reproduced picture will occur.

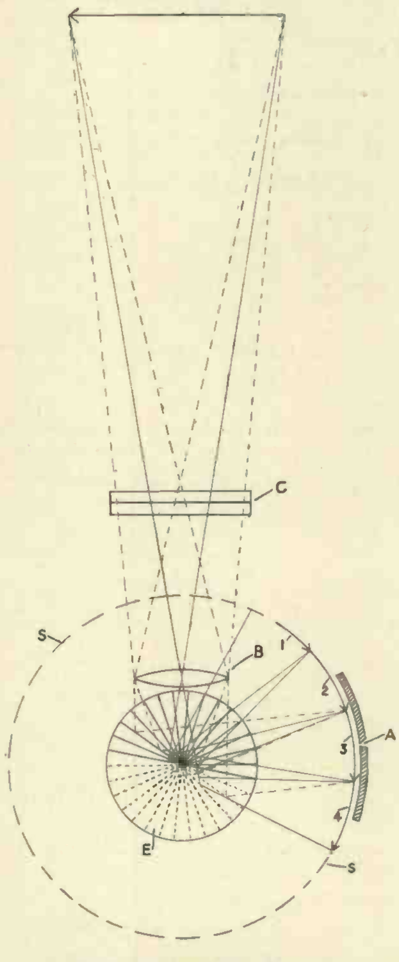


Fig. 33. Reflecting angularly displaced rotating echelon for television.

The Stixograph and Motion

From the previous articles dealing with the Stixograph, it must be evident to all that the Stixograph is not special to television, any more than an ordinary optical image is, nor are the optical systems confined to television only, any more than a lens is. Primarily the Stixograph and its apparatus are optical and can be used wherever normal optical images and apparatus are used. Whether the Stixograph is used or not in a particular application depends on the advantages obtained. There is obviously no sense in using complicated optical apparatus and unintelligible pictures unless advantages are secured which are unobtainable in other ways.

To use the Stixograph instead of normal still pictures for general purposes is ridiculous. *No advantages are obtainable through the use of the Stixograph until motion is in some way introduced*, either in the picture itself or connected with some process of dealing with pictures. Obviously the Stixograph comes in a special branch of optics, which, for want of a better term, may be called *motional optics*, and in that branch the superiority of the Stixograph is most marked.

The Stixograph and Television

The essential processes in television are concerned with obtaining electrical signals from a picture at the transmitter and reproducing a picture from those signals at the receiver. A *system* of television is therefore something which particularises the type of signals obtained from a picture rather than the apparatus (optical, mechanical and electrical) used to obtain those signals. The relative merits of different types of apparatus employing the same system of television are measured in terms of light, strength and accuracy of signals, bulk and weight of apparatus (particularly of moving parts), ease of accurate manufacture, amount of power required to drive and synchronise, and

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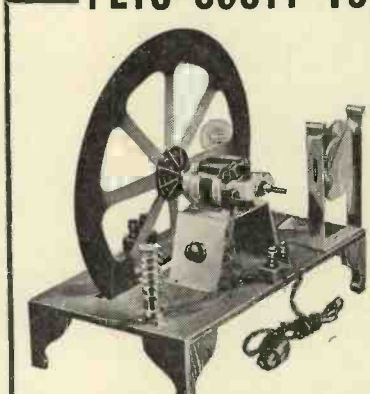

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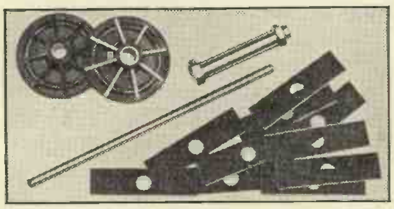

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Moulded Bakelite end plates, 8 ribbed and with heavy brass insert, 9" long ... ... per pair	4	6
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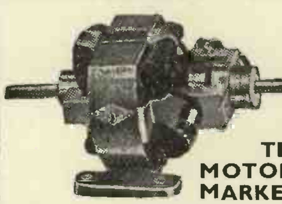

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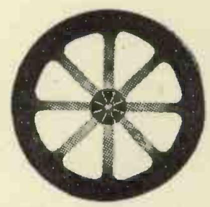

EACH disc is of light gauge aluminium, dull black one side, and centres cut out to reduce weight. The centre boss is an 8-ribbed black bakelite moulding. Each rib being faced white to give true stroboscopic effect, and thereby visual speed indication. A heavy brass bush insert with Grub screw provide simple and accurate fixing for ¼" motor spindles. Scanning holes perfectly punched to secure uniform scanning without preventable lines.
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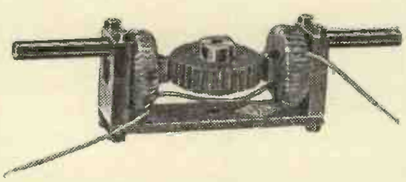

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requires relative motion between an aperture and the picture, and this is true whether the picture is normal or a Stixograph. Generally a stationary aperture is best and therefore a picture image must be swept over it. This can be done by forming first a stationary Stixograph image by apparatus such as Fig. 8 (March issue) and a second moving image of this obtained by any of the usual moving optical devices such as oscillating mirrors, rotating polygon mirrors, lens discs or drums, etc. This method has some constructional advantages for great precision can be obtained, and certain particular arrangements give a good light.

The advantages are more marked, however, with other systems of television; for instance, zone and simultaneous methods. A stationary echelon can be used with cathode-ray scanning though there is no practical advantage obtained.

Instead of using a second moving optical part, the echelon itself can be set in motion, and obviously the Stixograph formed will also move. For instance in picture telegraphy, where very high definition is required, an echelon of the type shown in Fig. 5 (March issue) which can be made with very precise displacement of the laminations, can be traversed past a stationary lens forming an image on a scanning aperture as in Fig. 31. The echelon *E* moves in the direction of the arrow, consequently the Stixograph *S* that it forms moves with it. The rest of the Stixograph optical system is omitted. The lens *L* viewing the moving details of the Stixograph forms an enlarged image, which moves also, on the scanning slit *A*. The lens *L* could be omitted and *A* placed in the plane of *S*, but in picture telegraphy a detail of *S* might be so small that there would be difficulty in obtaining a fine enough slit.

Scanning Speeds

In television the scanning speed would be high and the picture has to be scanned repeatedly, consequently the echelon must be of a form that can be moved at high speed, together with its mounting. Fig. 32 shows such a type, the echelon mount being a drum *E* which may be rotated or oscillated, the Stixograph *S* moving with it over the scanning aperture *A*. The scanning aperture with Stixograph apparatus is usually a slit. The echelon in Fig. 32 has its laminations with angular displacement, as well as a linear displacement. Angular displacement, though more difficult to obtain with precision, makes a very compact echelon, a useful feature when it has to move at high speed.

The echelon as mentioned previously may take many different forms, and besides the refracting lens type shown in Figs. 31 and 32 it is possible to use plane refractive displacement, prismatic, mirror or any combination of lens prism and mirror types. *They all have the features of being stepped (i.e., staircase form), displaced of course by the thickness of the steps in one direction, and displaced angularly or linearly in a direction at right angles to the thickness.*

Fig. 33 shows a reflecting type having angular displacement. The reflecting surfaces are shown plane and therefore a cylindrical lens *B* having its axis of curvature parallel to the thickness of the laminations is necessary to form the Stixograph. The object lens *C* focuses a cylindrical image of the object in a plane approximately that of the mirror surfaces of the laminations, as described in connection with Fig. 6 (March issue) whilst the lens *B* focuses images of strips of the object at some point after reflection by the mirror surfaces to form a Stixograph *S* which is curved around the axis about which the laminations of the echelon are angularly displaced. When the echelon *E* is in motion the Stixograph *S* moves over the scanning aperture *A*. It should be noted that so far as the formation of the Stixograph is concerned it makes *no difference whether the echelon is in motion or not*, the motion is only required for scanning, i.e., to obtain relative motion between picture and scanning aperture. The aperture *A* together with photocell could readily be rotated relative to the echelon *E*, or both *E* and *A* may be rotated in opposite directions or even in the same direction at different speeds.

In receiving a television picture, the arrangement of Fig. 33 would operate reversed, i.e., the slit *A* would be illuminated with light controlled by the received signals and a reproduced picture would be projected on to a screen. Scanning at the receiver may also be by moving the echelon, aperture, or both. The lens *B* in a receiver may be between *A* and *E*.

Instead of the lens *B*, the echelon laminations may be given a curvature, as concave cylindrical mirrors or as mirror lenses. This method is generally preferable as it reduces the number of separate optical bodies, and therefore the losses. A field lens may be placed between *C* and *E* so that light incident and reflected from all laminations has approximately the same angles in a direction normal to the laminations. A condenser lens between *A* and *E* is also useful.

Motion not Required

In Fig. 33 the arrangement is intended for television using scanning, and as only a small part of the picture, and therefore of the Stixograph, can be active at any time, it is sufficient if two or three lamination images, such as 1, 2, 3 and 4, about the scanning aperture *A* are clearly defined. Obviously with movement of *E* the lamination images, which are clearly defined, will change so that only sharp images fall on *A*.

The feature of "static rearrangement" of a picture, as described in the previous article (March and April issues) is always present. *Motion is not required* to reassemble the strips of the picture in a receiver, or to deploy the strips of a picture at the transmitter, but is only required to form a Stixograph image *from impulses distributed in time* in a receiver, or to *distribute in time impulses representing a picture* at a transmitter.

"Building the Cathode-ray Tube Supply Unit"

(*Continued from page 321.*)

up, but a magnet held near the tube and moved about will usually bring the spot on the screen. If one of the deflector plates has been left disconnected the spot nearly always drifts off to one side, and these points should therefore be checked before examining the H.T. circuit for a possible break.

The tube is susceptible to external fields, and no magnetic material should be near it when it is mounted for test. After the spot has been focused it should not be left on the screen too long, particularly if the anode voltage is high, as there is a liability of burning the screen at one point. For further experiments in handling the tube an A.C. voltage of 30-50 can be applied to one pair of deflectors, and the behaviour of a line examined. Any irregularity in the line produced may be due to external interferences, and this can be traced at the outset.

If the user has access to an electrostatic voltmeter reading to 1,000 volts or more, it is convenient to roughly calibrate the H.T. unit by marking the H.T. voltage against the knob of the filament rheostat.

"The Frequency Band Problem in Television"

(*Continued from page 298*)

To carry this argument a stage further it is necessary to look at the television image from the most fundamental view-point, namely, as an example of the "transmission of intelligence" or of information from place to place by electrical means, just as is done in the telegraph, telephone and radio for spoken or written information. We want to transmit an image having certain detail, and it seems quite a valid argument to define the degree of detail as being proportional to the number of "picture points" in the image; but to do this we should define a picture point as the smallest detail which can be distinguished in the stationary image, and not with any reference to the size of the scanning spot itself, which may or may not be the same.

This definition of a "picture point" gets round all the arguments of those who point out that the idea of image quality should be considered as a continuous process, and not as a succession of "dots," that the apparent definition of the image is improved by the effects of motion, or that it is possible with highly corrected amplifiers to see details smaller than the actual scanning spot itself. (I use the expression "scanning spot" because of its familiarity to readers, rather than some more exact expression such as "minimum area of analysis"; but it must be understood that motional or sequential scanning is not necessarily implied; scanning is used here to mean any form of analysis of the image.) We merely say that the definition of the image is proportional, not equal, to the number of "picture points" which gives us a simple and valid measure of the goodness of the image.

Now let us assume that we have improved our apparatus to the limit, and are handling only a stationary image transmitted only once per second, because no motion or flicker effects are to be considered. It is axiomatic in communication engineering that you cannot transmit by present-day radio technique any "unit of information" smaller or briefer than one cycle of the carrier wave employed (I will return to this later; it will be assumed true for the moment). It therefore follows that there must be at least one cycle of our frequency band for each "picture point," and that the maximum frequency involved in the transmission must be at least equal to the number of points in use. This means than an image of, say, 100,000 "picture points" (of the kind defined here) must necessarily imply a frequency band of 100 kc minimum width, no matter what apparatus is used to carry out the analysis of scanning, and the subsequent reception.

Effect of Motion

This argument is easiest to grasp for sequentially scanned systems, but I maintain that it applies equally to non-motionally analysed systems, although the proof of this is necessarily mathematical, and beyond the scope of this article. The addition of motion to the image implies a transmission of still more "information," and hence an increase in the frequency band from that arrived at above; or, in other words, since motion occurs in less than one second at any part of the image, we must transmit the equivalent of more than one image per second. This might increase the band to perhaps 800 kc for the 100,000 point image under discussion.

This is a much narrower band than would be used under average present-day systems for a similar image, and indicates that improvement in the technique of image analysis is both possible and desirable, but that there is a limit difficult to fix exactly beyond which progress no longer depends on the apparatus. It is for those better versed in advanced mathematics than the writer to arrive, if possible, at a definite figure for this limit.

The latter part of this discussion has become a little involved because it encroaches on to the territory of the second school of thought originally detailed, namely, those who pin their faith on improved methods of "modulation," or of impressing the television signal on to its carrier wave in such a way as to reduce frequency-band width, or side-band effects.

(*To be continued.*)

"Trichromatic Reproduction in Television"

(*Continued from page 313*)

the blue and green traversals, the blue-violet and green lines of the mercury spectrum are isolated, and in the case of the red traversal, a bunch of red-orange lines, together with the fainter red mercury lines, are selected. The light-filters used do not need, therefore, to be entirely mutually exclusive. It is true that there is considerable energy radiated in the form of a continuous spectrum by mercury-vapour, but in the green and blue this energy is small compared with that radiated at the characteristic wavelengths.

It will be seen from this that the neon radiation preponderates considerably, not only in number but in intensity of the effective spectral lines. This is due to the lack of infra-red emission from neon, nearly all the lines being within the visible spectrum. The total candles per watt of the mercury tube is about 0.4, while that of the neon is 1.6 approximately; in order to obtain a proper colour-balance it is therefore necessary to cut down the mean current passing through the neon tube by adjustment of the negative bias upon the grid of the power-stage feeding it, and so to adjust the amplitude-controls C^1 and C^2 that the brightness variations of the two tubes correspond properly over the working range.

To increase the brilliance of the picture, a spherical reflector is placed behind the tubes, which are crossed behind the picture-area of the receiving disc. Colour-filters are affixed over the apertures of the disc, as at the transmitter, but, in addition, the receiving apertures are covered with a light-diffusive medium (frosted gelatine is found very suitable) in order to increase the angle in front of the disc over which the image may be seen.

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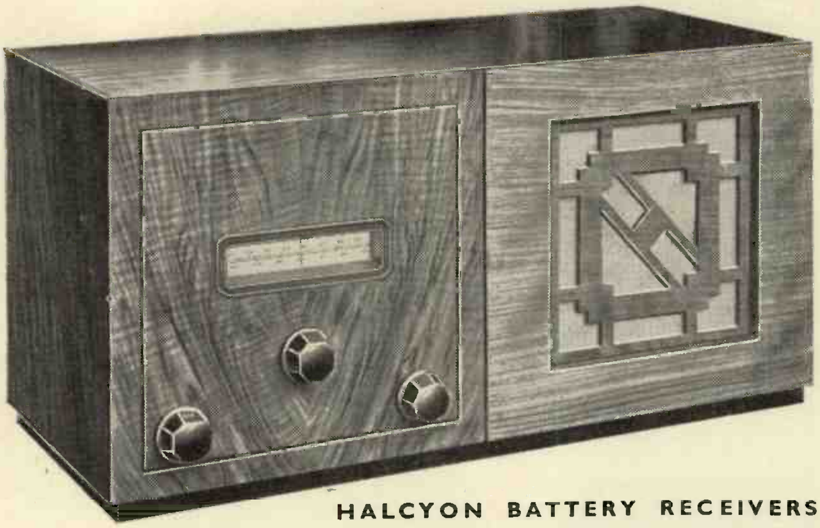

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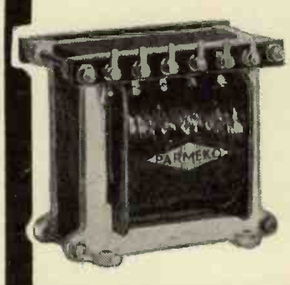

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It helps us if you mention "Television"

"Making a Valve Voltmeter"

(Continued from page 308.)

Ferranti microammeter. A central zero instrument has been employed so as to make it easy to read the low standing anode current. When I used the meter my procedure was to bias the valve until it gave some 20 or 30 microamps reading to the right hand side of the central zero, I then rotated the zero adjusting screw until the pointer gave zero indication. Zero on the instrument now stood for a reading of 30 microamps. This arrangement was very satisfactory because when the valve voltmeter was in use it was merely necessary to increase the value of bias voltage until the pointer returned to zero before reading off the value of peak voltage on the direct current voltmeter.

The actual valve used was a fairly high slope medium-impedance valve —A Mullard P.M.2.DX—as the instrument was required mainly for low-frequency use, the direct current voltmeter had a full scale deflection of 15 volts. Should it be necessary to use this instrument on higher or lower voltage ranges it will merely be necessary to chose a voltmeter of a full-scale deflection suitable to the range of alternating voltage to be measured.

It will be seen from the diagram that there are two separate input terminals provided on the grid side of the valve input. One of these has a fixed condenser interposed between the grid of the valve and the alternating current voltage to be measured. This should be used when it is intended to measure the alternating current component across a load which is also carrying direct current. The fixed condenser is to prevent the direct voltage from affecting the working of the instrument whilst providing a path of negligible impedance to the alternating voltage.

Two Bias Controls

Two potentiometers are provided to control the bias on the grid of the valve, each one having its own separate bias battery. These are so arranged that the voltages produced across each potentiometer are in series between the grid of the valve and earth. The first potentiometer across which there is no indicating voltmeter, is used to control the standing bias on the valve, which is necessary to produce the low initial value of anode current. The value of battery across this will naturally be dependent on the high-tension voltage applied to the valve. Using between 30 and 60 volts high-tension and a valve of the P.M.2.DX type, 4½ volts grid bias will usually be found sufficient in this position. Once this control is set to the required standing value of anode current, it should not be necessary to alter it again during the taking of any set of readings.

The other bias control across which the indicating voltmeter is connected is for varying the additional bias supplied to suit the value of alternating voltage to be measured. The size of this battery will naturally depend on the range of voltage to be measured.

As will be seen from the photographs, the unit has been neatly assembled on a metal chassis with all the wiring carried out underneath. Unless it is required to use this valve voltmeter on widely varying inputs the unit can be mounted in a wooden cabinet complete with all the necessary batteries. It then forms a portable instrument of great utility.

A Very Flexible Instrument

The great advantage of the slide-back type of valve voltmeter is its extreme flexibility. It requires no calibration, and provided that suitable ranges of battery voltage are used to cope with the alternating voltage to be measured, one may use one's own discretion about the actual batteries used.

An instrument of this description is easiest to use when the voltages to be measured are greater than one volt, and for this reason the slide-back valve voltmeter is more commonly used for low-frequency than for high-frequency measurements.

In my laboratory notes next month I shall describe a slightly more complicated instrument of greater sensitivity which will be of use mainly for high-frequency work.

The uses I have already described for such an instrument as is detailed above are but two of the many to which it can be put. Some time ago I wrote a short article on the checking of synchronisation by means of a local oscillator. A slide-back valve voltmeter would be excellent for checking up the synchronising voltage in various parts of the amplifier and provided that it was given a suitable range could really be left in position across the synchronising coils without affecting the operation of the scanner.

"A Receiver for Screen Projection"

(Continued from page 302.)

The primary windings of the high-frequency transformers have one end connected to the anode of the preceding valve and the other end to high-tension positive. The valve anode connections consist of flexible leads coming out through the holes in the top of the screening can and going out directly to the anode of the valve.

The Metal Chassis

A similar method of construction is employed to the amplifier that we described last month and a metal chassis is used having a similar depth to the amplifier chassis. The two chassis can thus be mounted side by side in a cabinet if necessary. The high-tension supply is obtained directly from the amplifier, and is connected to the high-frequency portion by means of a plug and socket arrangement.

A chassis mounting valve holder is used as a power socket and connection is made to the main amplifier, via a four-pin plug. The low tension winding is connected to the two filament pins of the plug and high tension positive to the anode pins. High tension negative connection is made to the grid pin.

The volume control and the various connections are mounted on small wooden sidepieces and consist of an aerial and earth terminal and the variable-mu volume control on one side and the power plug and output connection on the other.

As 400-volts high-tension is provided on the amplifier it is necessary to drop this voltage to the 200 volts high-tension necessary for the variable-mu valve. This is done by means of a 25,000-ohm resistance which is by-passed to earth by a 1-microfarad fixed condenser.

The operation of this little unit is simplicity itself. The correct tuning of the National programme can be ascertained by switching over to the speaker provided on the amplifier and tuning until loudest results are obtained. It is then merely necessary to switch back to the Kerr cell when television programmes commence and adjust the volume control until the correct depth of modulation is obtained.

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