TELEVISION

THE FIRST TELEVISION JOURNAL IN THE WORLD

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

AUGUST, 1934. No. 78

Adjusting and Operating Cathode-ray Receiver

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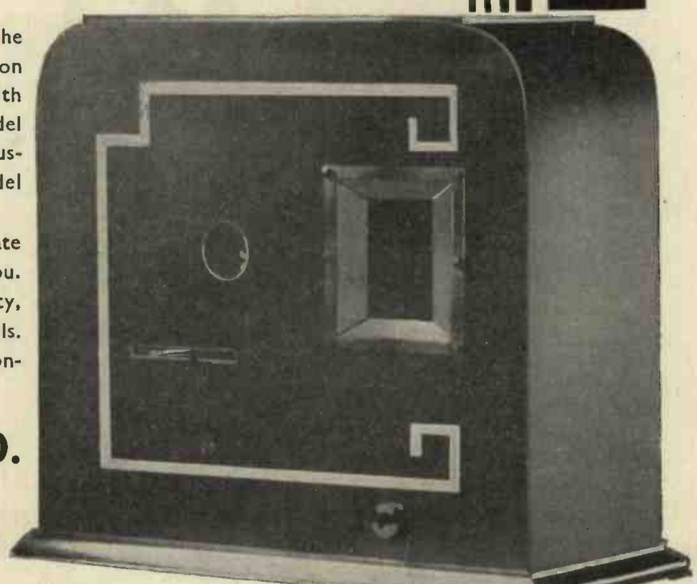

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In This Issue

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COMMENT OF THE MONTH

The P.M.G. and the Amateur Transmitter.

AT first sight the conditions imposed by the Postmaster-General on the amateur who wishes to transmit television do not appear too happy—for the amateur. Many experimenters had hoped that they would have been able to supply their district with television programmes which would in some measure have filled the gap left open by the B.B.C. The ruling says, however, that " subject matter of entertainment value shall not be transmitted. Transmission shall be limited to test objects such as geometrical designs and diagrams or three dimensional objects. In addition a test length of film occupying not more than two minutes in transmission may be used. Only one such film may be transmitted during the course of a day although this film may be repeated." Obviously it is not intended that the amateur transmitter shall provide entertainment, but in our opinion he can do some very useful work and keep well within the conditions laid down. Transmissions of a test nature have been a long-felt want and here is the opportunity to provide them and earn the thanks of thousands of experimenters.

The conditions further state that " sending will be limited to the band 28,035-32,000 kilocycles per second (10.70 to 9.375 metres) and that the band 30,000 to 32,000 (10.00 to 9.375) only shall be used for vision." Here again is an opportunity to provide what every serious experimenter has been desiring for serious practical work upon the ultra-short waves where the ultimate solution of television lies. Some of the other conditions which are printed on another page in this issue appear rather unnecessary, but we venture to say that they are not of a nature to deter the real enthusiast.

Reference to our correspondence columns shows that there are a number of amateur transmitters who express their willingness to take up this new branch of transmission which offers such a wonderful field for experiment and there are doubtless many more who have the necessary qualifications. Obviously co-operation is necessary and we therefore ask all those who are interested in the matter and are of opinion that they can help this new movement in a practical manner to communicate with us in order that some scheme can be evolved. We should also like to take this opportunity of suggesting that the time has now come when members of the Constructors' Circle, which now number nearly a thousand, could co-operate with the idea of forming local clubs and societies as was done in the early days of broadcasting. Such co-operation would permit of apparatus being available which in many cases would be beyond the means of individuals. In this matter also we shall be glad to hear from readers who are prepared to develop schemes of this nature.

SCOPHONY PROJECTED PICTURE

120 Lines, Adequate for the Home.

UNTIL comparatively recently, that is, since it has been possible to give demonstrations of television which could be classed as high-definition it was argued that the number of scanning lines used must be much higher than any figure which there seemed any immediate possibility of using because of the many technical difficulties which a high number of scanning lines entailed. Scanning frequencies of from two hundred and forty to four hundred were freely mentioned as being desirable. Practice, however, has shown that excellent definition is obtainable with a much smaller number of scanning lines providing that the system used is suitable.

No Noticeable Scanning

Ample proof of this was afforded to us a few days ago at a special demonstration of the Scophony 120-line system. The size of the picture in this case was approximately 14 in. by 18 in. and the shape therefore was practically that of the cinema picture. Standard film was used in the transmitter and it included every type of picture, including crowd scenes. Viewed from a distance of about twelve feet every movement was clearly discernible and the entire action of the film could be followed easily.

Transmission was, of course, by line but the standard apparatus was used which it will be possible to place upon the market when a decision is reached as to the future of television in this country. One hundred and twenty lines is by no means the limit of the Scophony system for it is clear that it is perhaps the most adaptable of any mechanical system in this respect and we understand that apparatus is now in course of construction with a much greater scanning frequency.

One important feature of the Scophony system is the absence of noticeable scanning lines on the screen, either with thirty or a hundred-and-twenty line scanning. Only close observation reveals that scanning lines exist and the effect is to blend the picture into a homogenous whole. The Scophony scanning device, by the way, is remarkably small, that used in this demonstration being a matter of a couple of inches in diameter and less than three inches in length. The most remarkable point about the Scophony system is that the picture demonstrated was truly projected. This is apparently something which no other system in the world can give. A design of apparatus giving a picture 7 ft. × 6 ft. is completed.

The Stixograph and the Cinema

No less interesting was a demonstration of the Stixograph principle as applied to cinema use. It is amazing to see a picture reproduced on the screen from a film which only close observation shows is moving, so slow is the speed. Actually the speed is one millimetre per second which is less than the seconds hand of a clock and a programme of four minutes duration only occupies a piece of film about a couple of inches in length; in fact, a short programme can be accommodated quite well on an ordinary quarter plate negative. Other features of this system are that the film can be stopped at any instant and the picture remains and also there is no stroboscopic effect whatever.

No serious attempt has yet been made to develop the Stixograph principle for cinema work but it would appear to have very considerable possibilities for home use, the saving to the amateur in films would be tremendous.

Thirty-line Transmissions to Continue

The decision has been reached by the B.B.C. to continue the 30-line transmissions until such time as there is a better system available which will give as good a service with comparatively simple apparatus and be suitable for home reception and meet the needs of experimenters. There is a proviso, of course, that this will be subject to the findings of the Postmaster-General's Committee and its recommendations, but it would appear that this decision has been made with the view that the Committee would not be likely to disturb it. It is to be hoped that the next news will be an announcement of an extension of present facilities.

German Prohibitions

The German Ministry has prohibited the following, from May 15, 1934, to December 31, 1936:—

1. The opening of new factories where are manufactured:—
   (a) Wireless receivers,
   (b) Amplifiers,
   (c) loud-speakers,
   (d) wireless valves.
2. For existing works to start manufacturing, or to open new branches for the purpose of manufacturing, any of the articles mentioned under (1).
3. Should any of these articles be already in production, no further production is to be commenced.

The Radio Corporation of America are in negotiation with the Chinese Ministry of Transport, with regard to the erection of Broadcasting Stations in South China. The R.C.A. is prepared to give long term credits to the Chinese Government in connection with the financing of the building of radio stations. The R.C.A. have many interests in television in America, and it now seems that the development of the science in the Far East will also be partly controlled by them.

The German Radio Exhibition for 1934 is to be held from August 17 to 26 and will be under the control of Dr. Goebbels. The Exhibition will be conducted under the slogan: "Dein Rundfunk bei der Arbeit," which, translated literally, means: "Thy Broadcasting Working."

A SPECIAL SECTION FOR THE BEGINNER

How a Television Image is Broadcast

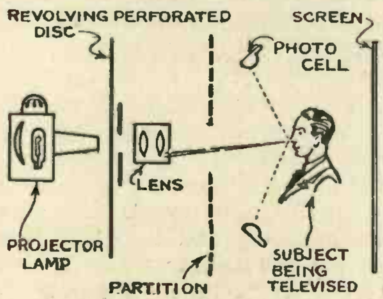
AT the present time there is only one method of broadcasting an image so that it can be reproduced at a distance, and this is to divide the image into a number of units, convert the light values of these into electricity of corresponding values and transmit these in correct sequence. At the receiving end the reverse process is gone through, the electrical values are converted into correspond-

Scanning commences at the bottom right-hand corner and covers the whole image in a series of lines.

ing light values and distributed in the same sequence on the screen as the original image. It will be clear that though the televised picture has much in common with the cinematograph picture there is the fundamental difference that with the latter the picture is thrown on to the screen as a whole, whereas in television it is built up of a series of units. This, incidentally, increases the difficulties very considerably.

Scanning

The division of the image into a number of units is accomplished by what is termed scanning. At the transmitter an intensely bright spot of light is focused upon the image and then by means of a mechanical

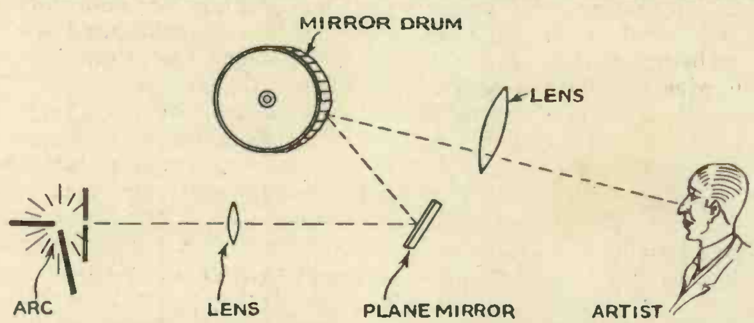


The simplest scanning device is the disc with a series of holes in it arranged in spiral formation. It is shown above in section.

arrangement, which usually consists of a disc with a series of holes in it or a drum upon which are mounted a number of plane mirrors, the spot of light is caused to travel over the image in a series of lines. The practice with the present B.B.C. transmissions is for the light spot to start its travel at the bottom right-hand of the image, travel upwards, and then move one spot width to the left and again travel upwards and so on until the whole image has been covered, when the sequence starts again. This scanning system will be clear from the diagrams of both disc and mirror-drum scanning. It is important to remember that at any given instant only one unit area of the image is illuminated by the light spot. The actual mechanical devices employed for scanning will be described later in this section.

The Electrical Reproduction of the Image

It will be clear that as the light spot travels over the image the amount of light reflected from it will be constantly varying; for instance it will be a maximum when passing over a white surface, such as a collar, and a minimum when passing over a black surface, such as a black coat, and there will, of course, be many intermediate values. The next purpose is to convert these varying light values into electricity and this can be done by arranging photo-electric cells so that the reflected light falls upon them. For the sake of this explanation it may be said briefly that the photo-electric cell possesses the property of producing



How scanning is carried out with the mirror drum: this is the actual type of scanner used by the B.B.C. The photo-cells are placed in suitable positions facing the artist.

electric current of a value corresponding to the value of the light which is falling upon it. These currents are very feeble but they can be amplified and broadcast in the usual way.

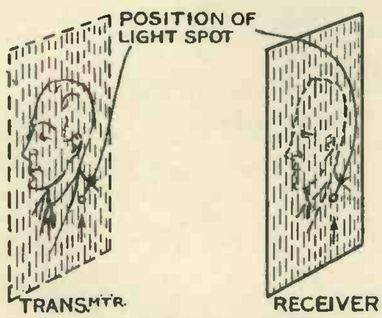
How the Image is Received

We can now picture what must happen at the receiving end if we wish to reproduce the transmitted image, assuming that we have a wireless receiver which is capable of picking the signals up. If a loudspeaker is connected to the wireless set a peculiar hum will be heard which may perhaps be most simply described as an aural reproduction of the transmitted image. This is merely mentioned as affording aural proof that a constantly varying sequence of signal impulses is being received.

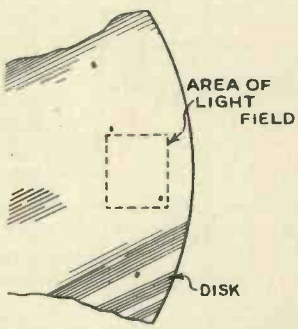
Building the Picture Up

It will be evident that in this varying signal we have all the essentials which went to compose the original image and the problem is to use them in such a way as to reproduce the original. Obviously, the first essential is to convert the signal impulses into corresponding values of light, and this we can do by various methods which do not immediately concern us for the purpose of this simple explanation. For the moment we will assume that we have turned the signal impulses into light and can focus this to a spot. If this spot of light be observed it will be seen to be constantly flickering; its rate of variation will be too rapid for the eye to follow exactly but it will be definitely noticeable that variations are taking place. Actually there will be periods when it is practically out though the variations occur with such rapidity that the eye cannot follow them and so at no time will it appear right out though this is the case.

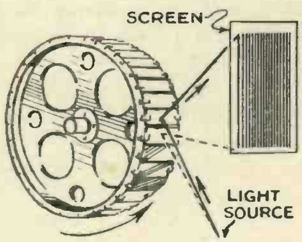
The next essential is the placing of the light spot so that at any given instant its position on the viewing screen corresponds exactly with the position of the spot at the transmitter. For example, supposing that the scanning spot at the transmitter is on the fifth scanning line from the right and is over the area of say a portion of a white collar, then it must be projected on to a corresponding part of the receiving screen. At this instant the equivalent light value of the received impulse will be white and we shall have obtained a correct interpretation of that particular part of the original image. This condition must, of course, obtain for any part of the picture.



The position of the light spot on the receiving screen must coincide exactly with the scanning spot on the image being transmitted.



With a disc receiver the whole area of the field of light is used and modulated.



How the mirror drum projects the picture on to a screen.

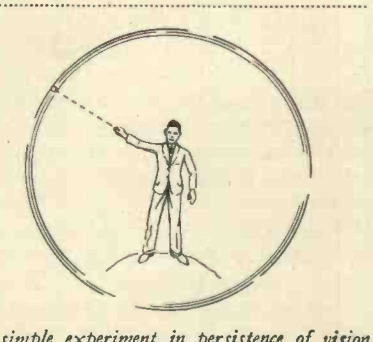
Scanning at the Receiving End

There are several methods of arranging for the correct placing of the light spot at the receiving end so that at any given instant it corresponds with that at the transmitter. The two most generally used are by the use of a disc with a series of small holes in it in spiral formation and the other with a drum upon which are mounted a number of mirrors set at different angles. A little digression is necessary here or some confusion will arise because of the slightly different principles involved with the two types of scanner.

Up to the present it has been assumed that a spot of light of varying intensity had been produced. We can, however, use the whole area of the light source for the vision field and at any given instant employ a certain part of this for the production of the spot. This means, in effect, that we have an illuminated screen and that at given instants we are able to select a unit part of it for the spot, the light value of the entire screen being caused to vary. This is what is actually done when a disc is used for scanning at the receiving end. Its merit is its simplicity, but it will be appreciated that only a small fraction of the total available modulated light is used and therefore the efficiency is poor.

The Continuous Picture

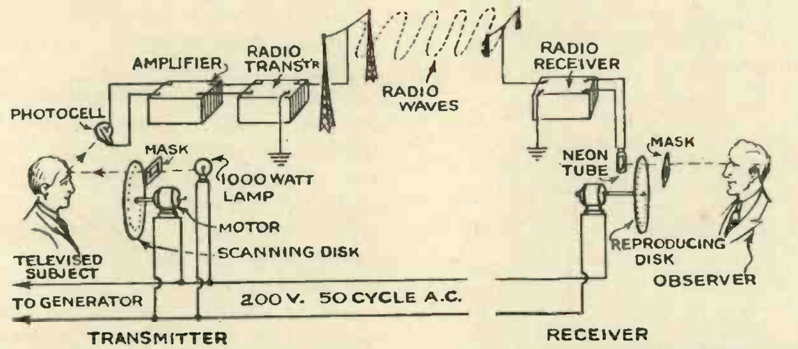
When a disc or other type of scanner is set running, at first the spot of light is clearly visible as a travelling point or spot of light; as the speed of the scanner increases, the spot owing to persistence of vision resolves itself into a line and as the speed increases still more the series of lines cover the whole field and the illumination is fairly even, though the demarcation produced by the lines is observable. The number of lines of which the



A simple experiment in persistence of vision effect.

screen is composed naturally governs the amount of detail that can be produced. The present B.B.C. transmissions are thirty lines but systems have been developed with as many as a hundred and eighty lines.

It will be clear that when one scan of the field of vision has been accomplished the proceeding must be repeated, and upon the number of times per second these repetitions take place will depend the flicker observable.



The general scheme of television transmission and reception. For the sake of simplicity it is assumed that both transmitter and receiver are connected to the same mains. In practice this is rarely the case.

In the cinema twenty-five pictures are thrown on the screen each second. Scanning with the present system as used by the B.B.C. is carried out twelve and a half times a second. This figure compared with cinema practice may seem rather low, but the conditions are not quite the same in both cases, and though flicker is observable at this rate it is not so pronounced as would be the case if this frequency were used for the cinema. The reason of this is that never at any instant of time is the screen devoid of light as is the case with the cinema. However, the desirability of increasing the picture frequency is appreciated and the high-definition systems that are being developed mostly use a twenty-five-per-second frequency.

Direction of Scanning

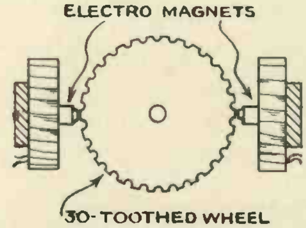
Scanning can take place either vertically or horizontally and in either direction, but of course the scanning direction of the receiver must correspond with that of the transmitter. Continental practice and that of the most recently developed high-definition systems is to use horizontal scanning.

The Mirror-drum Scanner

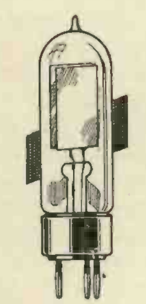
Mention was made earlier of the mirror-drum scanner. The mirror-drum consists of a metal drum around the periphery of which are a series of plane mirrors—thirty in the case of apparatus for reception of thirty-line transmissions. Each mirror is placed at a small angle with respect to the one preceding it and in the case of the thirty-line drum the total displacement between the first and the last mirror of the series is twelve and a half degrees. It will be clear that if a drum of this type be interposed in the path of a beam of light which is focused to a point or spot, the light will be reflected from the particular mirror upon which it falls and if the drum is caused to revolve the light will be picked up by each mirror in succession and be reflected so that if allowed to fall on to a screen the spot will travel over the screen in a series of lines.

Synchronising the Receiver with the Transmitter

In order that the light spot can be correctly positioned on the receiving screen relative to its position at the transmitting end, the receiving scanner must revolve at exactly the same speed as the transmitting scanner and also the two devices must be exactly in synchronism. That is, when a certain scanning hole in the disc, or mirror on the drum, of the transmitter is in a certain position, then the corresponding hole or mirror on the receiving scanner must be in exactly the same position. The two devices may be likened to two clocks which not only keep perfect time but also show always the same time. This is a problem which up to the present has not been completely solved, but it will suffice here to say that a fair degree of success has been obtained by making use of a special synchronising signal which is transmitted at the end of every line of scan and which is filtered out at the receiving end and fed to the coils of two electro-magnets which have their cores placed close to a small laminated iron wheel on which there are thirty teeth. If a pair of teeth are slightly lagging as the impulse comes along, the effect is that the magnets exert a slight pull and correct the position of the scanner. The simpler types of visors are not fitted with this device, speed control being obtained either by a mechanical friction brake or control of the motor by means of a variable resistance.



This diagram shows the device used for utilising the synchronising signal so that both transmitter and receiver are kept in synchronism.


A neon lamp of the flat-plate type.

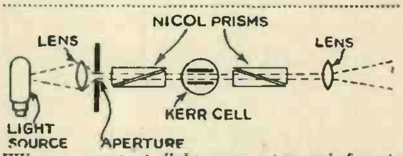
Varying the Light Intensity

The most important function in a television receiver is the production of a light which can be caused to vary in accordance with the values of the received signals. These variations may be of the order of twelve or fourteen thousand per second and very much higher where greater definition is to be obtained, so it is clear that no ordinary lamp can produce modulated light at these frequencies. Fortunately there are several lamps of special types which are capable of modulation at very high frequencies. The simplest of all is the neon lamp which is *very familiar in the type used for advertising purposes. The current requirements of this lamp are very small and it is possible to operate it directly from the output of a reasonably powerful wireless receiver. In a similar class are the mercury vapour lamps as used for sound recording and which are readily adaptable for television purposes.*

The objections to the use of the neon lamp is that the light that it is capable of producing is not very bright and the colour is rather objectionable for television purposes. It is, however, capable of modulation at extremely high frequencies, its operating voltage is reasonably low and it is cheap.

The neon lamp of the ordinary flat-plate and beehive types are ordinarily used in conjunction with the disc scanner and the whole of the light field is employed, this providing practically the area of the picture as was explained earlier.

When screen projection is required, the source of light must be almost a point. It is out of the question to obtain this with an ordinary neon lamp, so use can be made of a special type, which is termed the crater point, which provides a highly concentrated source of light capable of modulation in the same manner as the flat-plate type. The amount of light which this lamp is capable of producing is limited and it is therefore only suitable for projection on to comparatively small screens.



When a constant light source is used for the scanner the light is modulated by passing it through a special light valve shown diagrammatically above.

In cases where more intense illumination is required, or it is required to cover a larger screen, it is necessary to employ an ordinary source of light and modulate this after it is produced, a method which is distinctly different to direct modulation. Briefly, the light in its passage to the screen is passed through a special light valve consisting of an assembly of two Iceland spar prisms and a series of small metal plates immersed in nitrobenzine. The signal potential is applied to the plates and the amount of light that passes through depends upon the applied potential. This light valve is termed a Kerr cell. It is necessary to apply a potential of from 400 to 500 volts to the plates of the cell and an output of about 4 watts must be available from the amplifier.

THE ABC OF CATHODE-RAY TELEVISION

A Series of Questions and Answers Easy to Understand

What is cathode-ray television?

It is a system of receiving television images on a fluorescent screen deposited on the interior of an exhausted glass bulb, the source of light being produced and controlled entirely by electrical means.

What advantages are claimed for cathode-ray television?

Greater flexibility, absence of moving parts such as are found in mechanical systems, and increased sensitivity as regards the control of the moving light spot.

These advantages seem to place it ahead of the mirror-drum. Why does not every amateur change to it?

This is a little difficult to discuss. First there is the question of expense, as cathode-ray tubes are not as cheap as valves! Then a certain amount of auxiliary apparatus is required and the tube itself in its present stage requires a certain amount of care in handling and in adjustment. There is no doubt, however, that for high-definition television the cathode-ray tube will be used on a very wide scale, and its use will increase as soon as it is realised to what a variety of uses is can be put.

You say "auxiliary apparatus." How much apparatus, and of what does it consist?

The tube itself requires an H.T. supply like an ordinary power valve, only the H.T. voltage is higher—about 1,000 v. To produce the line screen two circuits, called "time-base circuits" are needed, which are connected to the tube. Then there is the ordinary receiver for producing the actual image, but this has the advantage over the one used with a neon lamp in that the power stage is quite a moderate one. In fact, cathode-ray tubes have been worked off portable sets.

And what is all this going to cost me?

How much are you prepared to make up yourself? If you are an amateur constructor, the making up of the "time-base" should present no difficulty and the cost of the components will be in the neighbourhood of £6. The tube costs about the same, and the H.T. unit for it about £5 5s. If you say £20 all told it will be a fair estimate, assuming you have no stock of components on which to draw.

Supposing I make all this up, how long is the tube going to last?

Under the present television regime, indefinitely! Joking apart, the life of the tube is a varying factor, since a lot of things influence it. If you take care of it and do not overrun the filament, and if you keep the anode voltage at a reasonable value and don't "turn up the wick" you should get at least 600 hours useful life, which, reckoned in television hours, is a very long time. Unfortunately no manufacturer could guarantee the life of a tube, since he has no control over the way it is operated after it has left his hands.

But aren't the rays from cathode-ray tubes harmful to the eyes?

Nothing of the kind. You are probably muddling them with X-rays. Any harmful energy that the cathode-ray may contain is completely dissipated long before it can affect the eye. The only harmful thing about a *cathode-ray tube is the high voltage applied to it and, of course, you would not be so foolish as to touch a high-voltage transformer when it is switched on. In any case the windings would be protected with a proper cover against an accidental contact.*

Well what are cathode rays?

You have heard of electrons? The little particles of electricity which are emitted from a hot filament when it is mounted in a valve bulb? Electrons are emitted from the filament of the cathode-ray tube in exactly the same way, only instead of forming the anode current as they do in an ordinary valve they are sent in a compact beam up the length of the tube until they hit the glass domed end. They travel at a very high speed due to the high voltage employed on the anode of the tube, and it is their compact beam-like formation which gives the name "ray" to the cathode-ray tube. A more accurate name would be "electron tube."

What happens when they hit the end of the tube?

The inside of the tube at the big end is coated with a special compound which fluoresces under electron impact. So where these electrons hit the end of the tube they make themselves visible by a little patch of greenish or blue fluorescent light. By suitably controlling the electron beam this patch of light can be narrowed down to a point finer than a pin's head. Then we have the first step towards television—the production of a tiny spot of light which can move over the screen and respond to impulses given to it from the outside.

How can the spot be made to reproduce an image?

First of all it must be given a scanning motion similar to that produced in the mechanical system, but in the case of the tube it is done by two electrical circuits connected to electrodes in the tube. These circuits cause the spot to travel across the fluorescent screen rapidly and uniformly to generate the scanning lines. While the spot is travelling across the screen the television signal alters its intensity to produce light and dark gradations in a similar manner to those caused in the neon lamp.

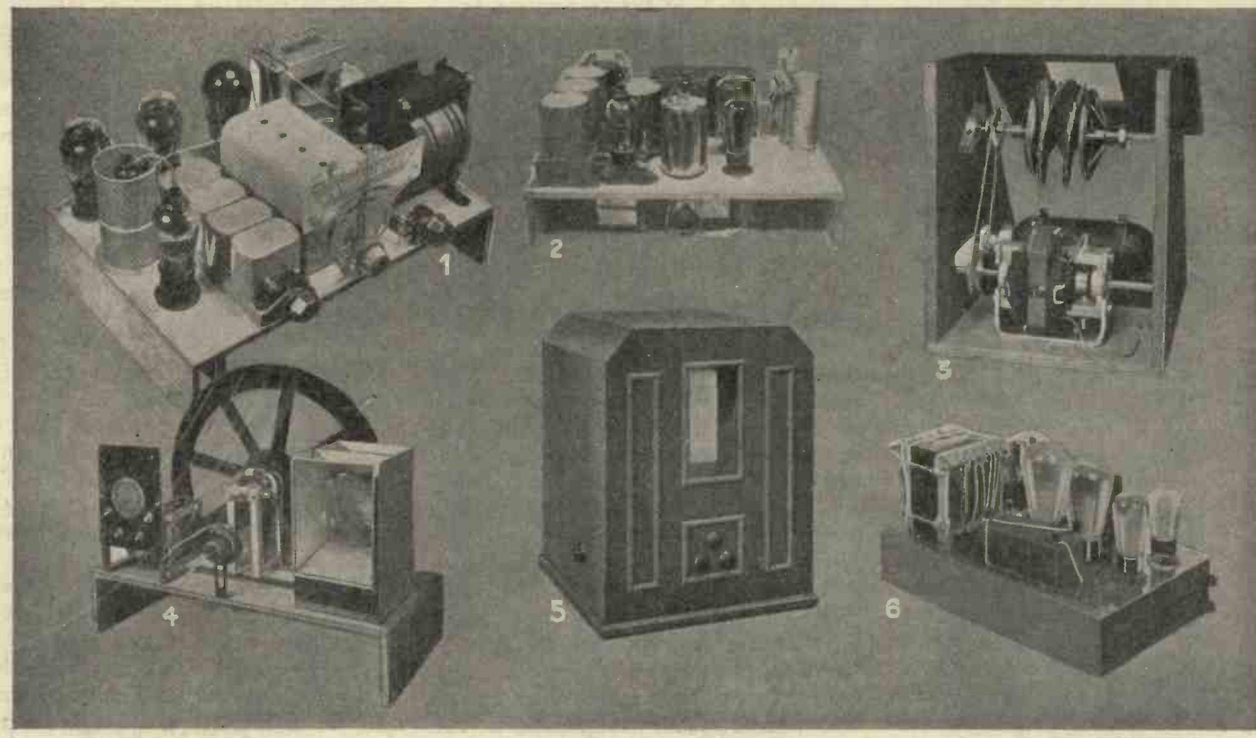
If there are no rotating parts, how is the tube synchronised to the signal?

By applying a portion of the signal voltage to the scanning circuit to lock it into step with the transmitter. Since there are no rotating parts, the energy required to keep the moving beam in step is negligible, and this means that the cathode-ray tube does not require a large power output stage in the receiver to which it is connected.

Will the tube receive any kind of television transmission?

It depends on what you mean by any kind of transmission. The systems depending on the Baird scanning spot can all be received on a cathode-ray tube with the minimum of trouble, but if the number of lines and the picture ratio is different, the circuits will have to be adjusted to take them. The main thing is that an alteration in speed or in the number of lines will not necessitate rebuilding the whole equipment.

TELEVISION RECEIVERS FOR THE CONSTRUCTOR



1—*The Standard television receiver* (*Details in February*, 1934, *issue*). 2—*A set for reception in any part of the Country* (*May*, 1934). 3—*A Mirror-screw receiver* (*January*, 1934). 4—*Beginner's disc receiver* (*March*, 1934). 5—*Mirror-drum receiver* (*July*, 1933). 6—*An amplifier for Mirror-drum* (*June*, 1934). *Copies of the above issues are available.*

THE HUGHES TELEVISION SYSTEM

By Our Special Commissioner.

TO expect that a 25-year-old amateur could have overcome all the television problems that have so far defied solution by the best engineering brains of the world was, of course, quite absurd. But there it was—news from Plymouth of a 100-line system of television!

So I called on the young experimenter in question—R. W. Hughes. I found him at work in the radio section of a large piano firm in the heart of the busiest part of Plymouth. To my surprise I was met with a Lancashire man—quite a contrast, I can assure you, to the soft-speaking West countrymen.

Mr. R. W. Hughes who has developed a television system using osscillating mirrors.

He was one of the pioneers, I discovered. Although so young, he remembered playing around with wireless before broadcasting began. Evidently he learned quickly, for he soon passed beyond the ordinary thrills of the average radio fan, graduating to an A.M.I.R.E. degree.

When Baird came along with his Nipkow disc and neon lamp, said Hughes, he was immensely interested. "Television seemed just round the corner," he remarked, "but, as the American said later, 'Oh, boy, what a corner!'"

"I very soon realised that the fault of the disc system was the terrific inertia of the moving parts," went on young Hughes.

"So I concentrated on the problem of cutting out moving discs and heavy electric motors. In my present system the moving parts don't weigh more than a fifteenth of an ounce.

"The apparatus is not driven from a motor at all, the drive comes from an oscillating valve. Of course, with such a circuit the frequency of oscillation is under complete control. It is just a matter of fixing your inductance and capacity values.

"I have got off discs absolutely. It seemed to me that the whole idea of a great revolving disc was wrong. Motors driving heavy discs or drums were too difficult to manipulate. Then there was the trouble of synchronising. As a matter of fact I got quite good pictures by developing a local synchronising frequency—but the variations in the mains often meant that I lost the picture from London National for as much as five minutes.

"That is why I have developed my oscillating valve drive, which as I say has practically no inertia and can be held perfectly steady. Across the inductance coil I have two condensers, one fixed and the other a small vernier. By suitable variation of the capacity I can easily adjust the circuit to give me the 30-line pictures from London National.

"For example, working on 30-line pictures I might have an oscillator drive current at 300 cycles—by splitting this I could get a tenth and so work on 30-line pictures. By altering the frequency of the drive I could make the apparatus suitable for 100 lines or anything else—there would be no other alteration needed."

At this point I asked if I could be given a full technical explanation of the Hughes' system. But that is at the moment impossible, as a large concern has the patents under its wing, and while negotiations are proceeding it has been thought unwise to disclose any of the "secrets."

All the same, Mr. Hughes was very obliging and did try his best to give me as much information as possible about the possibilities of his new system.

Talking of the definition, he said that with his own transmitter and receiver he had got pictures with a 100-line definition—pictures, he thought, of real entertainment value. Made by precision people he thought that the utmost limit of definition that could be obtained from his system would be about 500 lines.

"What about the light source?" I asked. "Well, as you know," said Mr. Hughes, "there has been no fundamental advance in the light source problem for many years. True, detailed improvement have been made in old ideas, such as the crater arc, for example.

"Personally, I have been using the well-known Nicol-prism and Kerr-cell system—but, of course, the light source problem still has to be fully solved."

"As you cannot say anything about your system, perhaps you can give us a hint as to how it would be put into practice," I ventured.

"Surely. It would have to be put out on ultra-shorts—the high definition would make it impossible on the ordinary broadcasting wavelengths. You see, I need at least a 50-kilocycle band width to take my pictures, even as they stand.

"Of course, I realise the big snag of ultra-shorts is their very limited service area. But as you know these very low wavelength transmitters are not very expensive—and only very low power is needed.

"I think that if the B.B.C. can face the enormous expense of high power stations like Droitwich it ought to be able to face putting up television stations of the ultra-short-wave type.

"The cost of the apparatus for reception? Yes, that is very important from a commercial point of view. I have worked it out that on a commercial scale my system could be marketed complete with valve oscillators for no more than £7. This would be without the radio set, of course."

Until such time as Mr. Hughes is himself able to reveal more details of his system we must, of course, reserve judgment. But any idea that helps to reduce the difficulty of scanning to a minimum must be considered something of an advance, even though we all realise that there are many other problems in television besides that of scanning.

ARE THE PROGRAMMES TOO AMBITIOUS ?

THERE has been a noticeable tendency of late to elaborate the programmes—very desirable from an artistic point of view, but it seems sometimes that presentation is outstripping reception technique and that elaboration is defeating its own object.

One great problem as all who possess any type of visor know is that of synchronisation and this difficulty is increased threefold when the picture contains a lot of quickly moving subjects. Here is a typical instance which occurred on the occasion of the broadcast of the ballet "The Gods Go A Begging." Whilst the caption cards and the curtain were being transmitted the picture remained rock steady. With the appearance of the close-up of Harold Stern, a slight swaying motion developed, but the picture became steady again provided that no excessive movements were made by the artist. A sudden tilting of the head or sideways movement caused the swaying motion to develop again and once this resulted in a quick succession of pictures floating past until a divided picture resulted. Correction of this, however, resulted once more in a practically steady picture which held almost steady again without touching the controls.

Now this was what might be termed reasonably good synchronisation; there have been occasions when the picture has held steady, with the exception of one break, for the whole duration of the programme, so obviously it was not the best actually possible.

Increased Synchronising Difficulties

But what a difference when later the screen was occupied by more than two dancers with their violently contrasting dresses. At no time could the picture be held for more than a minute and there was present the recurring additional difficulty of correctly centring the image; in fact during the whole of this time it was necessary to be at the controls. The apparatus used was a Baird mirror drum, which represents the best in mechanical scanners, and an amplifier fitted with a 375-cycle peaked transformer and control of synchronising output. It may be assumed that users of inferior apparatus would be working under greater difficulties still.

It could be contended that the fault is in our receiving technique which should be capable of coping with such conditions, but at the present time this would be an unreasonable attitude to take. The reception technique of even thirty-line transmission has by no means reached finality and synchronism is by no means the least of the problems waiting to be completely solved, and in this respect it would seem desirable to keep transmission or rather presentation technique just ahead of that of reception.

Too Much Detail

Comparatively easy synchronisation is only one side of the matter but it will do more to mar the enjoyment of a programme than any other difficulty, and it is very desirable that cognisance should be taken of it as a problem in the design of the programmes.

The amount of detail that is present from time to time in a transmission such as that mentioned above can be revealed moderately well with screen projection with a picture approximately nine inches by four, though it is to be admitted that a certain amount of eye strain is felt which is not experienced with more simple subjects. Users of disc machines must, however, find increased difficulty with such complication and these it must be remembered form the larger proportion of lookers.

This picture of a transmission from the old studio shows plenty of contrast without unnecessary confusing detail; note how the black and white squared pattern on the floor gives an idea of perspective without increasing the detail behind the artists.

Scenic Effects

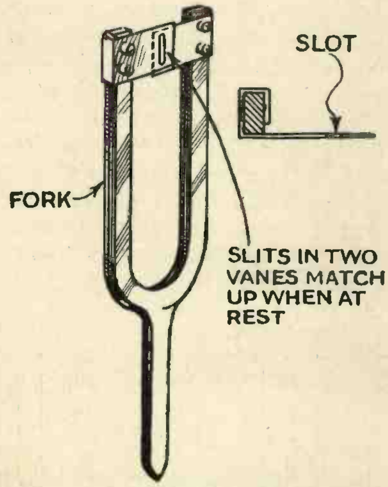
Increased complication has also been introduced by the increased use of decorative backgrounds. Opinions as to the desirability of these appear to differ but in the writer's opinion they definitely detract from the picture and to some extent they may increase some of the troubles which

(Continued at foot of next page.)

THE TUNING FORK AS A SPEED INDICATOR

Some suggestions for experiment in determining disc speed when A.C. mains are not available.

As is well known, an alternating current supply is of very great value in obtaining a correct estimation of the speed at which a scanning device is running by making use of the stroboscopic effect which a lamp lighted from such a source will produce. In this respect those who must of necessity operate the scanner from either D.C. mains or batteries are at a disadvantage, for unless some special means are employed the correct speed can only be secured by judgment and guesswork. Any mechanical speed indicator which imposes a load on the motor must be ruled out for the load will vary to a slight extent according to the speed. One idea, which is practicable to a certain extent, is to cause the scanning device) to produce a note and then to judge the speed by the pitch of the sound produced. This requires a sensitive ear but it is possible to obtain a very near approximation of the speed in this manner especially if another sound of the same pitch can be produced with which a comparison can be made.



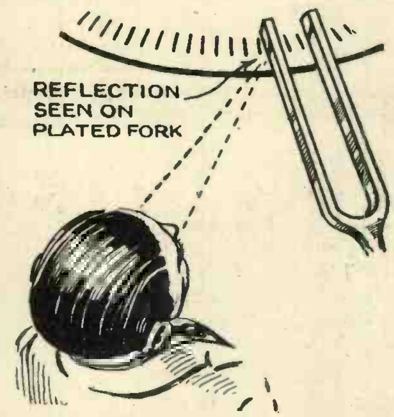
A tuning fork fitted with two light vanes which act as a shutter through which the indicating marks on the scanner can be viewed.

The suggestion has been made to employ a tuning fork to provide a visual indication of the speed and there is no reason why properly applied an exact record should not be obtained. One method would be to have two light vanes on the prongs of the fork with slits in them so that when the fork was at rest there would be an opening; this would be closed when the two prongs came nearer together. The indicating marks on the disc would be viewed through the slit and so when the correct relative speeds of fork and disc were attained the marks on the disc would appear to be stationary.

A better scheme would be to secure a light plane mirror to one of the fork prongs and view the reflections of the indicating marks on the disc in this; alternatively, one of the fork prongs could be highly polished and reflection obtained in this way.

The number of indicating marks on the scanner will, of course, depend upon the frequency of the fork and it is desirable to use as high a number as possible. Thus, with a tuning fork frequency of 128 per second and 128 marks on the disc, an image of the marks which appeared stationary would indicate a speed of one revolution per second. The determination of the number of indicating marks obviously will depend upon the frequency of the fork that is available, but this only involves a simple calculation.—A.D.

A further valve has just been added to the Osram 4-volt A.C. mains Catkin series. This is the V.M.P.4 variable-mu screen pentode. This valve, which may ultimately take the place of the glass valve, has the following characteristics:—Filament volts 4.0 A.C., filament current 1.0 amp., anode volts 250 max., screen volts 100 max., mutual conductance 2.5 ma/volt (measured at anode volts 200, screen volts 100, grid volts −1.0), mutual conductance .004 ma/volt approximately (measured at grid volts −30).



Another method of producing a stroboscopic effect by viewing the indicator marks by reflection from the end of the fork.

The valve will be fitted with a 7-pin base and will be supplied with the usual Catkin metal shield to which an earth connection can be made through the requisite pin in the base. The price of the valve is the same as the glass type, viz., 17s. 6d.

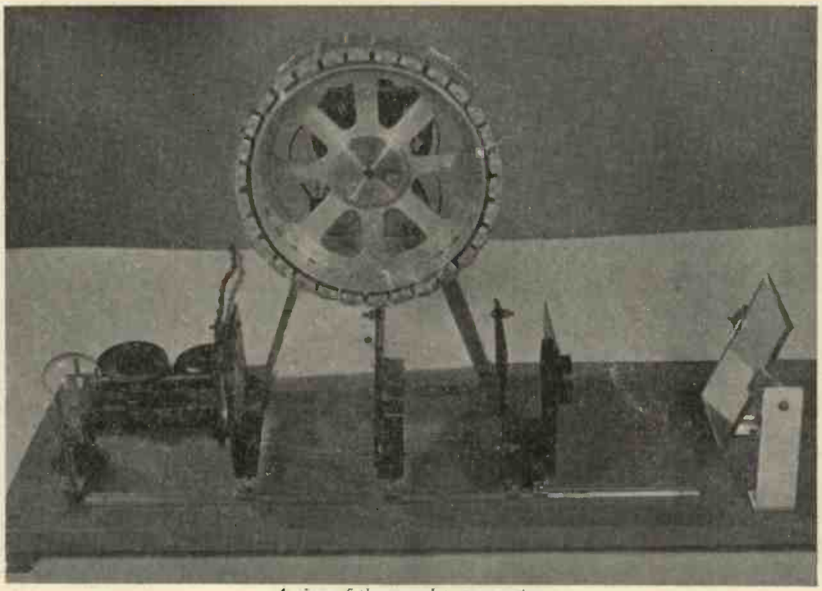
Are the Programmes too Ambitious?
(*Continued from preceding page.*)

have already been discussed. The black and white floor which was discarded when the new studio was opened was a valuable property and a real help in reception, for it always provided an unvariable indication of the sharpness of the picture which was being obtained, irrespective of the artist being televised, who might possibly be slightly out of focus. A no less valuable feature was the impression of perspective which it gave and which has not since been obtained either by properties or scenic backgrounds. Without this floor, demarcation of the background (when this is plain) and the floor is not very apparent and considerable effect is lost during the few seconds intervals when the stage is empty.

The foregoing conclusions are impressions, rather than criticism, of one who has looked-in almost consistently for a fairly long time now and has witnessed a steady improvement in the programmes. Entertainment value, it has been found, bears a distinct relation to technical matters and freedom from reception difficulties, and if these can be reduced by the method of presentation, so much the better. Close-ups have invariably provided the best pictures, but usually long-shots of dancers and acrobats, etc., the best entertainment, and the latter, provided that the costumes have been light and without any great contrasting effects, have appeared to eliminate synchronising troubles.—VISOR.

AN AMATEUR EXPERIMENTAL TRANSMITTER

The curtailment of the television broadcasts has had the effect of directing amateurs' attention to another branch of the subject—transmission. Already several enthusiasts have shown that with time and interest in the subject some very useful experimental work can be carried out—in fact, there seems no reason why the field of interest should not be expanded to outside transmissions. As a preliminary we are giving a description of a simple transmitter which any amateur can construct.



A view of the complete transmitter.

THE transmitter about to be described can be made comparatively cheaply, and while a certain amount of metal work is incorporated in the design, no difficulty should be experienced in doing it, even by those unused to working in aluminium.

A wooden baseboard is employed which should measure 2 ft. 6 in. × 9 in. if the dimensions shown in Fig. 1 are adhered to, though slight modifications in the mechanical design may be necessary in view of the difficulty of obtaining lenses of identical characteristics with those used in the original lay-out. Two 1 in. square battens are screwed to the two ends of the base to make the construction rigid and enable the small amount of wiring required to be accommodated beneath the baseboard. The finish of the wood is not important, though the screening box for the lamp can be simplified if the whole baseboard is finished in dull black before commencing assembly.

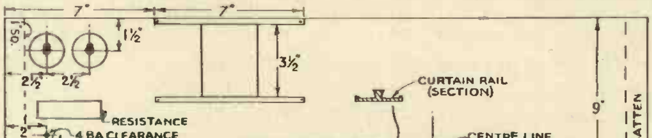


Fig. 1 (above).—Plan view of the transmitter showing general layout.

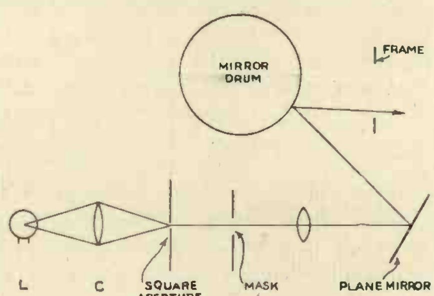


Fig. 2a (right top).—Details of optical arrangements.

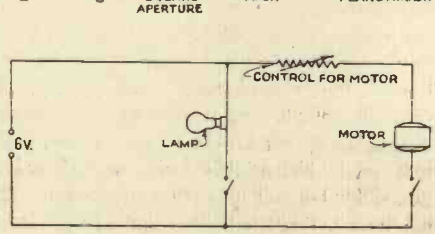


Fig. 2b.—Circuit arrangements of motor and iamp.

The Optical System

The general lay-out of the optical system can be seen from Fig. 2, and this figure in conjunction with the illustration should render the assembly quite straightforward. It was felt that in many cases the transmitter might be required where no mains supply is available, and accordingly both the lamp and motor have been chosen with a view to battery operation.

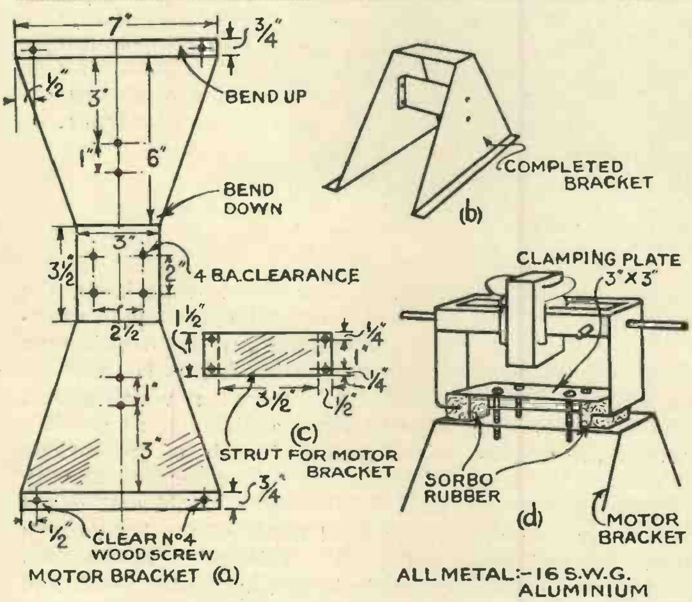
A 24-watt car lamp is employed, fitted with a small bayonet cap, and while a mains-driven motor can be used, it is not practicable to operate the lamp from A.C. mains as the amount of interference obtained is sufficient completely to mar the results. Using the 24-watt lamp, the maximum optical efficiency is desirable so that the largest possible area can be scanned. A lens is therefore included (C in Fig. 2) which should have as large a diameter as possible with a focal length of 3-4 inches. Whilst a large diameter lens of very short focal length would embrace a larger solid angle of the light given by the lamp, this gain is more than counterbalanced by the high cost and absorption.

A square spot of light is obtained by means of an adjustable square aperture, which is placed at the focus of the lens C. When using this class of optical system, difficulty is frequently experienced with "halos," but this trouble can be practically eliminated by the addition of a further square aperture some $\frac{1}{4}$ in. in size placed between the first aperture and the objective lens O.

The use of an achromatic lens as the objective is strongly recommended, and it should have a focal length of four to five inches at least.

The motor bracket together with the lens mounts and square apertures, are all constructed of 16 gauge sheet aluminium which is rigid yet comparatively easy to work. Fig. 3 shows the method of mounting the on the motor and the top plate of the main bracket, and two more strips of similar size are inserted between the flanges of the small brackets and the clamping plate, which measures 3 in. × 3 in. Four holes are drilled in the clamping plate to register with those on the main mounting bracket, and the motor is screwed down with 4 BA screws 1 in. in length. The actual method of mounting will be made more clear by examination of diagram D of Fig. 3. The completed motor assembly can now be screwed down to the baseboard as can two standard 5-amp. tumbler switches. The motor resistance can be mounted behind the switches, and if desired tive lens, and in order to render the whole equipment more flexible, both lenses and apertures have been mounted on sliders. The runner for these sliders is a piece of curtain rail 16 in. long, having the cross section shown inset in Fig. 1, which can be purchased from most multiple stores. Four sliders of the shape shown in diagram B of Fig. 4 are required on which to mount the lenses and apertures so that they can be adjusted on the runner.

Two lens mounts are required, one to accommodate the condenser lens and one for the objective. The objective in the writer's transmitter is the lens from an old camera, and, as



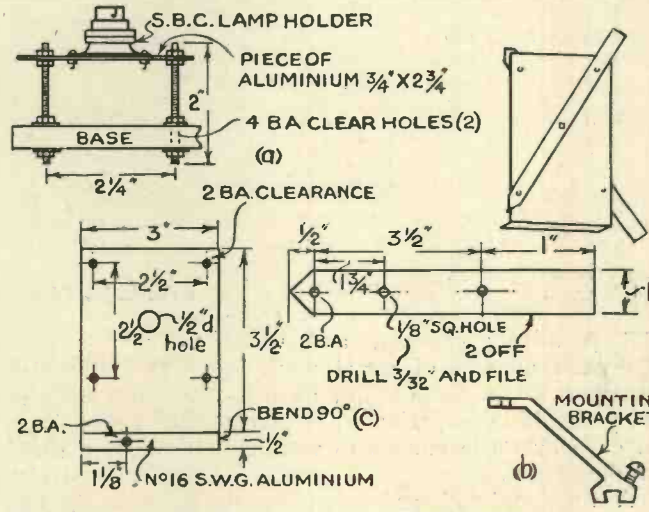


Fig. 3 (left).—Details showing method of mounting the motor.
Fig. 4a (above).—Details of lamp holder. Fig. 4b.—Detail of sliders for apertures and lenses. Fig. 4c.—Details of adjustable aperture.

motor. A piece of aluminium measuring 17 in. × 7 in. is required, and can be cut as shown in Fig. 3a. The two flanges for screwing the motor mounting to a wooden base are bent outwards to facilitate screwing down, and all holes should be drilled before bending up the metal. Greater strength is obtained by fitting the simple strut shown in diagram C of Fig. 3. This is fixed by means of four 4 BA round-head screws which need be no longer than $\frac{3}{8}$ in.

Mounting the Driving Motor

The motor used in the original transmitter is one manufactured by The Mervyn Sound and Vision Co., and has been fitted with two brackets so that it can be completely isolated from the mounting proper by sorbo rubber. Small strips of sorbo measuring $2\frac{1}{2}$ in. × $\frac{1}{2}$ in. × $\frac{1}{2}$ in. (relaxed) are placed between the small brackets practically all the wiring can be completed at this stage.

Considerable discrepancies are encountered in the sizes of different lamps of the same type, and it is recommended that the holder be fixed very much as in the original, so that adequate adjustment is available. Fig. 4 (diagram *a*) shows the type of bracket used. Two 4 BA clearance holes are drilled in the position shown on Fig. 1 and two short lengths of 4 BA studded rod fixed to the baseboard by means of a nut and washer above and below. The lamp holder proper is screwed to a small strip of aluminium which can be fixed in any desired position by means of a further pair of nuts and washers on the threaded rods.

Lens Adjustment

It is desirable to accommodate quite large movements of the objec- it was already fitted with a threaded housing and fixing ring, only the upright support shown in diagram *a* of Fig. 5 was required. If, however, an ordinary unmounted lens is used for this purpose, a plate similar to that shown in diagram *b* is required, so that the lens can be clamped between this plate and the main support.

The central hole to take the lens proper should be cut to have a diameter at least one-eighth inch less than that of the lens. The two plates can be fixed together by means of 6 BA or 4 BA screws $\frac{1}{2}$ in. in length. It is essential that the 2 BA hole on the flange of the mount, and the large hole to take the lens, are drilled accurately, as otherwise difficulty will be experienced in lining up the complete assembly.

With this transmitter, a comparatively small aperture is required, and the constructor cannot do better than utilise the design given on pages 238 and 250 in the June issue of this Journal. The aperture in use in the writer's equipment is shown in diagrammatic form in Fig. 4, and consists of two small strips of aluminium having $\frac{1}{8}$ in. square holes which are made by drilling out 3/32 in. holes and filing square with a small square file. Particular care should be taken to obtain sharp corners, and unless a very fine file is used, it may be necessary to trim out the corners with a small knife. When filing these holes, it should be remembered that the strips are mounted at an angle of 45° to the baseboard, and that the hole should therefore be filed with its sides 45° to the edge of the strip and not parallel with this edge.

The freedom of movement which is necessary to allow the size of aperture to be reduced, is obtained by drilling out the mounting holes for the strip and bracket sufficiently large to clear 2 BA screws and using 6 BA screws to actually hold the strips in place. Washers are, of course, necessary in order to prevent the heads of the screws dropping through the holes. If the constructor intends to use the aperture described in the June issue, the only alteration necessary is in the size of the main frame which must be adjusted to ensure the actual aperture being in the same relative position as that shown in Fig. 4.

As mentioned earlier, a second mask is required to avoid a halo being apparent when the spot is sharply focused on the object to be televised, and this is constructed on the lines of Fig. 6 (diagram A). The main mounting is identical with that of the adjustable aperture, with the exception that only two holes are required to fix the aperture. This is made in one piece of aluminium of similar size to those used for the the adjustable mask. The drilling dimensions for the strip will also be found in Fig. 6.

Before assembling either the masks or lens mounts, all the component parts should be finished in dull black enamel, and considerable care is necessary in the assembly to avoid scratching the enamel which has a rather soft surface. Difficulty may be experienced in obtaining dull black enamel, in which case a very successful substitute is available in the form of ordinary cellulose enamel which can be rubbed with fine emery cloth to remove the gloss. It is as well to carry out the rubbing down process before the enamel has set dead hard, and then leave the component parts to harden properly before tightening up the fixing screws.

Assembling the Optical System

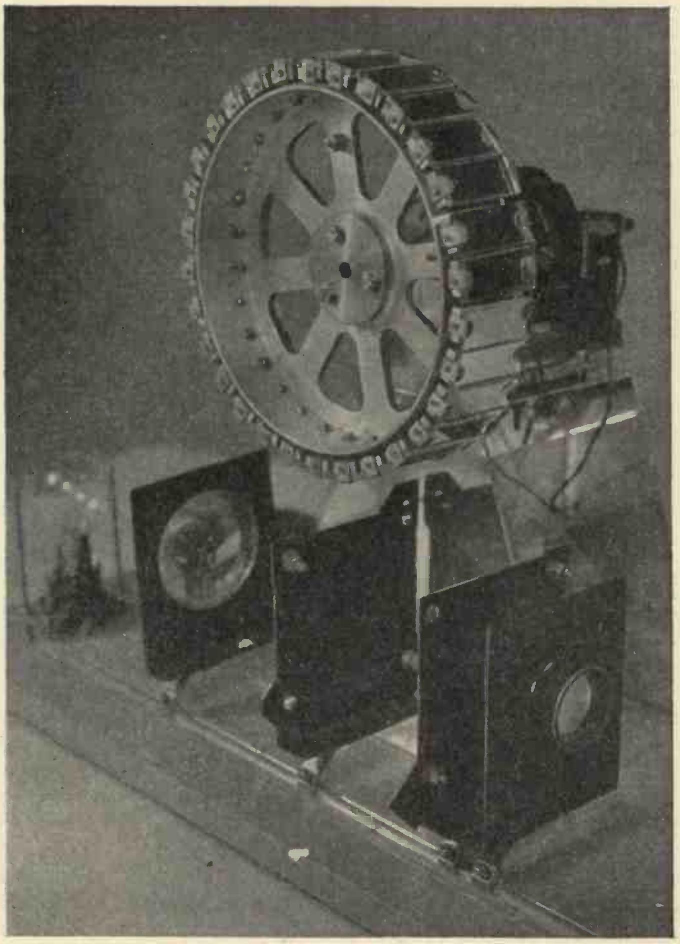
The completed optical system can now be assembled on the runner, and by placing a sheet of white paper some 2 ft. 6 in. from the objective lens, the optimum positions of the condenser and adjustable aperture can be found. It is, generally speaking, preferable to carry out the preliminary adjustments before putting the second mask on the runner, as if this is too near the objective, considerable loss of light will ensue.

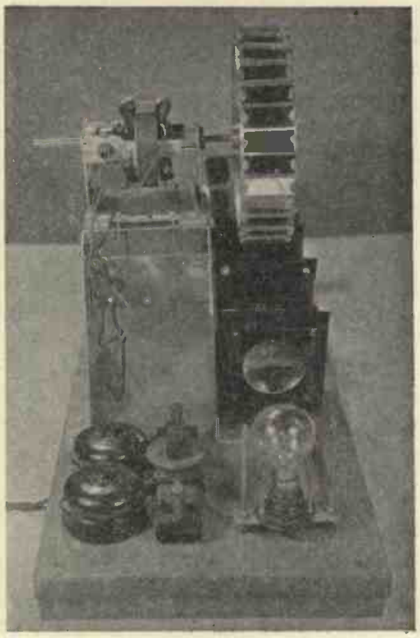
The optical system proper is now completed, except for a plane mirror for reflecting the beam on to the mirror drum, which can be screwed on to the motor shaft at this stage. The actual size of the mount for the mirror is dependent entirely on the size of mirror used, but some form such as that shown in Fig. 6 (diagram B) will be found suitable. The optical centre of the lens mounts is some 3 in. above the baseboard, and this point should be borne in mind when fixing the plane mirror.

Balancing the Drum

The mirror drum used in the original model was a Mervyn Unisphere kit which measures 6 in.

(*Continued on page* 376.)





The photograph on the left shows clearly the arrangement of the lamp lenses and aperture masks. Right—a photograph of the transmitter taken from above showing the layout.

A PERMANENT-MAGNET SYNCHRONISER

By C. M. De Silva Wijeraine, B.Sc., Eng.

This article gives details of a new type of synchroniser suitable for mechanical scanning devices which employs a permanent magnet toothed wheel

THE perfect synchronising of mechanical receivers is still a problem waiting to be solved and any contributions which are an improvement on present systems are of value. The following is a description of a modified arrangement which it is claimed is a step towards better results and gives more steady pictures than are obtainable with the usual device.

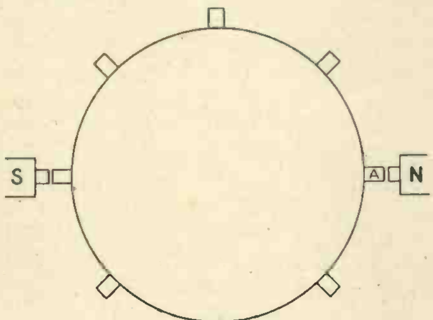


Fig 1. Sketch showing the ordinary toothed-wheel synchroniser.

In the usual tooth wheel synchronising device the magnet poles are diametrically opposite each other, as shown in Fig. 1. Now when a tooth, say, A passes the N pole the tooth A is magnetised to a polarity S by induction. When the wheel has turned 180° the tooth A is opposite the S pole and is magnetised to an opposite polarity N. There is, therefore, a reversal of magnetism of the teeth as the toothed wheel revolves. This reversal of magnetism results in a certain amount of eddy current loss, and the pull of the magnets on the teeth is weaker than would be the case if this reversal of magnetism were eliminated.

A Permanent-magnet Wheel

Fig. 2 shows an arrangement where the toothed wheel has twice as many teeth as the toothed wheel of Fig. 1. The magnet poles are not placed diametrically opposite, but one pole is displaced one tooth pitch from this position. By assigning a polarity to the teeth N, S, N, etc., the action of the synchroniser will be clear. It will be noticed that the N pole is over an S tooth, and the S pole over an N tooth. In action the N pole always pulls on an S tooth and the S pole on an N tooth. The N teeth pass the N pole when the pole is not energised, and therefore do not suffer any reversal of magnetism. There being twice as many teeth as in Fig. 1, one set of teeth pass the pole of similar polarity during the idle period.

As there is no reversal of magnetism and therefore no hysteresis, the toothed wheel may with advantage be made solid and of hardened steel so as to retain a high degree of permanent magnetism.

As an N pole always pulls on an S tooth the resulting pull is very powerful. The tendency to break away from synchronism is also greatly reduced. When an N tooth tries to break away from an S pole, the next tooth being an S tooth would tend to approach the S pole, but being of like polarity is repelled, thus tending to maintain synchronism, and prevent the scanner from getting out of step.

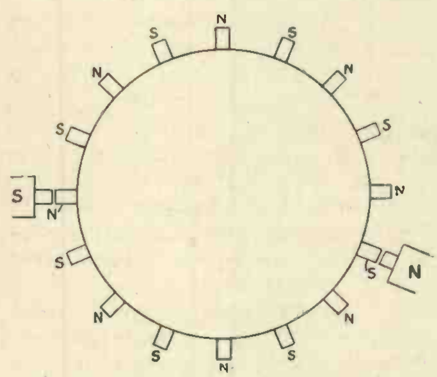


Fig. 2. The modified synchroniser employing a permanent-magnet toothed wheel.

As there is no sudden rise of flux density in the teeth of the wheel a measure of damping may be introduced by embedding copper in the toothed wheel. Any tendency to hunt will result in the generation of electric currents in the embedded copper thus expending the energy which would otherwise cause hunting.

Due to this tendency to hunt it has so far been the custom to adjust the synchronising signal strength until the picture remains fairly steady. It is, therefore, not possible with undamped wheels to use a high value of synchroniser signal input. This, of course, definitely limits the period of stable synchronism. With the damped wheel a large input may be fed into the synchroniser without causing a tendency to hunt and stable synchronism is obtained.

In practice with the present transmissions a 60-tooth hard steel wheel replaces the laminated 30-tooth wheel. The poles are not diametrically opposite but one pole is shifted one tooth pitch from the opposite position (Fig. 2).

Ultra-short Wave Research in Russia

Soviet engineers have not been idle during the past few months. Extensive experiments have been conducted on short waves by the Central Scientific Research Institute of Electro-communication, and the Moscow Institute of Food Specialists.

It is expected that ultra-short waves will find many practical applications in medicine, agriculture, and industry. According to interviews published in the Soviet periodical *Izvestia*, the Electro-communications Institute has been successful in establishing communication by ultra-short waves beyond the horizon, covering a distance of 72 miles. Clear pictures have been received on a screen 9 in. × 12 in. A 2-kilowatt telephone ultra-short wave station has been constructed, which can operate on a wavelength of 6.8 metres.

The Moscow Institute of Food Specialists has made several experiments employing ultra-short waves for the purpose of killing insects and germs. It is possible to kill all pests in infected grain by two seconds exposure to ultra-short waves.

ADJUSTING AND OPERATING A CATHODE-RAY RECEIVER

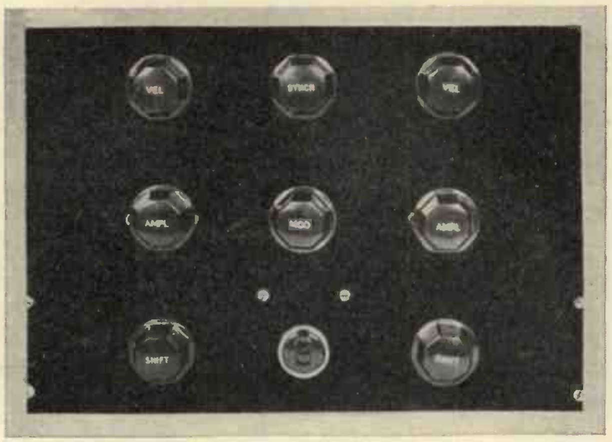
By G. Parr

This article applies particularly to the cathode-ray apparatus which has been described in preceding issues; the instructions, however, are general and provide information for the operation of any cathode-ray television receiver.

FOR the experimenter accustomed to mechanical systems of television reception, the cathode-ray system usually appears to require far more adjustment. This is certainly true if the number of knobs is taken into account, but actually, after the initial tuning up, the effort required to keep the picture in synchronism is negligible, and the majority of the controls need not be touched except to alter the scanning lines to suit another system of transmission.

The slight extra trouble at the initial stages of adjustment is caused by the fact that the time-base is capable of giving 30 lines (or any other fixed number required) in an infinity of ways. For example, 360 traverses per sec. vertically and 12 horizontally, or 300 and 10, or any other pair of ratios which yield 30 on division. The first step in setting the time-base is, therefore, to make sure that the horizontal scan is 12½ per sec., and the vertical speed can be established by counting the lines.

The time-base should always be allowed to run for a few minutes to allow steady conditions to be established. While the mercury relays are warming up, the temperature rise causes an alteration in the striking potential, and it is useless to attempt fine adjustments under these conditions. After the valves have settled down, therefore, the "Speed" knobs should be set to give approximately 30 lines, with the horizontal speed at 12½, as nearly as can be judged by the eye. An A.C. transformer brought near the tube will then give a number of black bands on the screen due to interference (see TELEVISION for January, 1934, p. 8) and when the horizontal speed is 12½ these will resolve themselves into four well-marked stationary lines—50 cycles ÷ 12½ = 4.



The controls of the double time base to which reference is made in the accompanying article.

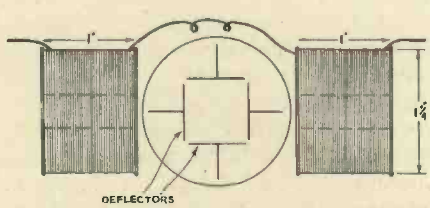
The vertical speed can then be altered until approximately 30 lines can be counted on the screen.

So far no attempt need be made to frame the picture or obtain the right picture ratio. On adjusting the grid bias of the relays to give the right proportion of picture, it will be noticed that the speed of the time-base is altered as well. This is unfortunate but inevitable, as an alteration of bias means an alteration in the potential at which the relays strike. This means that the point at which the condenser discharges is made either earlier or later depending on whether the striking voltage is raised or lowered. After one has got used to the "feel" of the controls, due allowance may be made for this effect, and, indeed, the "amplitude" knob may be used as a fine adjustment for speed in some cases.

The direction of scan is also a point to be watched before actual reception is tried, although when the picture is received a wrong connection in this respect is shown up immediately when lettering appears! The reversal of the scanning is only a matter of reversing the leads to either or both of the deflector plates, but if it is desired to have everything right at the start, the time-base can be slowed down by the insertion of extra resistance or by lowering the H.T. volts until the direction of travel of the beam can be seen with the eye.

If the scanning lines are irregularly spaced the linearity of the time-base may be at fault and the H.T. volts may be increased. The voltage specified (1,000) gives a wide margin in linearity of the base, but if the bias of the relays is too high, the condenser charging curve may depart from linearity before the relay strikes.

If the time-base length does not cover the full diameter of the tube, the sensitivity of the beam can be increased by reducing the tube anode voltage, but this usually results in loss of brightness and is not advisable on this account. In very obstinate cases of irregular time-base the presence of external fields may be the cause of the trouble, and the connection to the tube may be reversed, whilst at the same time the tube itself is turned through a right angle. There is generally an optimum position for the tube, and the effect of turning it should be tried when setting up.



The placing of two coils over the deflector plates in the tube will displace the origin distortion from the centre of the screen.

Modulating

If the tube supply has been built as a separate unit, the " modulation " terminals on the time-base should be connected to the terminals in the shield circuit of the tube, and a radio signal applied to the " input " terminals. The modulation of the beam by the sound signal should cause the scanning lines to become patchy in a sort of plaid effect, a sustained note causing a definite stationary pattern to appear on the screen. The depth of modulation can now be tested, an excessive value giving a curl to the ends of the lines on the screen, and producing a hard black and white effect. When receiving an actual picture it will be found preferable to slightly defocus the tube, since the effect produced is much more pleasing than a harder definition, and the space between the scanning lines is filled up. If the image is weak due to under-modulation, it can sometimes be improved by reducing the tube volts, but this leads to reduction in all-over intensity, as said above.

" Origin Distortion "

This has already been discussed (see TELEVISION for January, 1934, p. 9) and while the bright line across the picture does not appear so vivid when the image is actually on the screen, it is nevertheless objectionable. The best method of getting rid of the horizontal line is to push it down to the bottom of the line screen by applying a deflecting field to the tube. If a bias is applied to one of the deflectors the whole line screen will be displaced from the centre and the origin distortion effect will move with it. The problem is to leave the distortion behind and fetch the line screen back on the centre of the glass! To do this the bias is applied by means of a pair of magnetic deflecting coils mounted on the neck of the tube on level with the rear deflector plates. These coils can be conveniently wound on bobbins measuring 1 in. by 1¼ in. overall diameter, with, say, 3,000 turns of No. 38. They can then be clamped round the neck of the tube with their axes in the horizontal plane. Note that a horizontal deflecting field gives a vertical deflection of the beam! The coils are then connected in series and a D.C. current put through them from one or two accumulators in series with an adjustable resistance.

The whole line screen will then move to the bottom of the glass and can then be brought back to centrality by adjustment of the " Shift " knob on the time-base, leaving the origin distortion at the lower edge of the screen.

Tube Oscillation

It sometimes happens that a gas-filled tube has a tendency to oscillate at high frequency. This has the effect of giving little wriggles in the lines on the screen, and also tends to affect the uniformity of focus. A simple remedy for this is to wrap a sheet of tinfoil round the tube in the region of the deflector plates, holding it in place with rubber bands. The foil should be directly connected to the anode of the tube.

Should the time-base refuse to operate, or should it produce a very limited travel of the beam, it is possible that the bias battery may be run down. An open circuit in any of the deflector plate circuits will produce an erratic movement of the beam and it will not be possible to centre it successfully. The question of actually connecting the H.T. supply to the earth to eliminate interference is one which can be determined by experiment. In some cases of A.C. interference it will be found beneficial, but a great deal depends on the nature of the mains. The writer has even found it to depend on the state of the weather, owing to the effect of damp on flexible leads!

New Season's G.E.C. Radio Receivers.

THE new season's radio receivers produced by the G.E.C. are now on the market. There are two battery operated receivers. One of these is called the Compact 3, a powerful and well built 3-valve set in a handsome bakelite cabinet, which houses a moving-coil speaker as well as the accumulator and battery. It has single tuning control, an illuminated scale, separate selectivity and volume controls, and, in addition, facilities for an extension speaker and for a pick-up connection. Supplied complete for £5 17s. 6d. it offers remarkable value in view of its sterling appearance, absolute reliability, and quality of reproduction.

The other battery set, which has Class B output, is a four-valve with the power of a mains receiver, giving a wide range of stations with exceptional quality. Among its salient features are an illuminated metre-calibrated tuning scale, variable-mu volume control, sensitivity control, Gecalloy iron-cored tuning coils, moving-coil speaker and gramophone pick-up connections. Its price is £9 17s. 6d., which includes the batteries.

For listeners who have A.C. mains available, a super-het has been designed in three different forms—as a table model, a console, and a radiogram. The broadcast receiving circuit is practically identical in all three cases. Five valves are employed, and an almost unlimited number of stations can be tuned in at ample power and with a quality which should satisfy the most critical ear. The table model—with speaker and panel side by side—has a luminous station indicator of the vertical type with the controls neatly arranged below, and the actual tuning control is given additional flexibility on account of the sensitivity and tone controls which act as auxiliaries to it. The circuit incorporates delayed and amplified A.V.C. so that uniformity of output is ensured all around the tuning range. A large energised moving-coil speaker is fitted in the inlaid walnut cabinet, and a key can be employed to silence it if required when an extension speaker is used.

The same circuit figures in the console model, but instead of being at the front of the cabinet, the control panel is placed beneath the hinged lid.

For districts where D.C. mains form the means of potential supply the G.E.C. has devised two models of a widely differing type. One of these can actually be operated on either A.C. or D.C. mains, and as such should make a strong appeal to those who are resident in districts where conversion of the mains supply is impending or is probable at some future date. It incorporates three of the latest forms of Osram valves, providing thereby exceptional quality and power with reasonable range and has a built-in moving-coil speaker in its bakelite cabinet.

All these receivers are suitable for television reception with a little modification.

The Photo-electric Cell Simply Explained

By C. G. Lemon, F.Ph.Soc., A.M.I.R.E.

HERTZ, in 1887, during his classical experiments with an induction coil, observed that the passage of sparks between the two electrodes was accentuated if the spark gap was illuminated by the sparks from another induction coil.

With the increasing interest that is being shown in the development of the photo-electric cell and its ever-widening field which is being brought about by the experiments of amateurs and reseach workers, the information contained in this article will be of value in explaining its working principles in a simple manner.

A number of experiments were performed with a view to finding out just what caused this effect and finally Hertz concluded that ultra-violet radiation from one spark gap could make easier the passage of sparks across a second gap. He also demonstrated that ultra-violet light from other sources was just as effective as a spark.

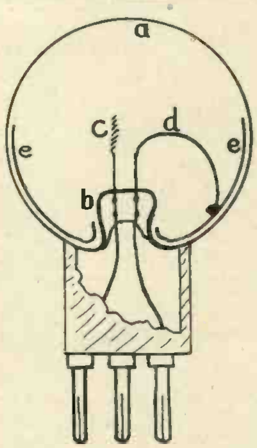


Fig. 1. This diagram shows the form and general design of the Burt type of photo-electric cell.

Hallwachs further developed the work of Hertz mainly to simplify the fundamental apparatus and in 1888 showed that a polished zinc sphere connected to a gold-leaf electroscope and charged negatively was discharged if the light from an arc lamp was allowed to shine on the sphere. If the sphere was charged positively no appreciable effect was noticed upon illuminating the sphere. Hallwachs concluded that " under the influence of ultra-violet radiation negative electricity leaves a body and follows electrostatic lines of force." This is referred to as Hallwachs effect.

In 1889, Elster and Geitel carrying this work further found that an amalgam of zinc worked better than zinc alone; following up this conclusion they thought that if they could use the alkali metals, particularly sodium and potassium, the photo-electric effect would be greater. In 1890 we find that this is accomplished and a description is given by Elster and Geitel on the manufacture of a sodium amalgam photo-electric cell entirely enclosed in glass and exhausted of air.

Photo-cell and Valve

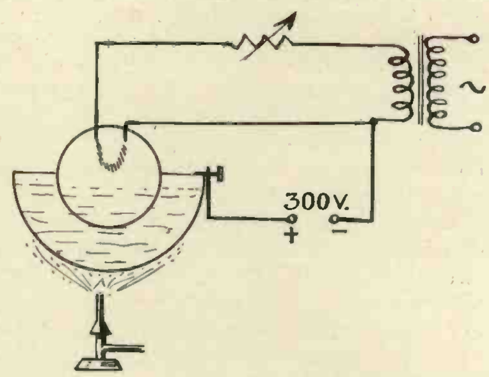
If one understands the working principles of the thermionic valve, the essential characteristics and similarities of the photo-electric cell are more easily followed. From a mechanical or constructional point of view, the only similarity lies in the fact that it has an anode and an electron-emitting cathode.

In the case of a valve, the electron-emitting cathode is, of course, the filament, and when this is heated by an accumulator or battery, electrons are emitted which then travel to the anode; the amount of current that is passed is dependent on the voltage that is applied to the grid; if this grid voltage varies, then the anode current will also vary, but on a magnified scale; the degree of magnification is dependent to a great extent on the valve's slope or mutual conductance, which is expressed in milliamps-per-volt.

Now, if we apply these remarks to the photo-cell, the initial emission of electrons is caused by a predetermined amount of light falling on the cathode, and if this light fluctuates in intensity the photo-electric current will also vary. The degree of variation is, in this case, dependent upon the sensitivity of the cell, and is expressed in micro-amps-per-lumen, the lumen being a unit of illumination.

The emission of electrons from metals when suitably illuminated is most marked in the case of sodium, potassium, rubidium, caesium, lithium, strontium and barium. The oxidisable nature of these metals makes it essential not only that they be enclosed in a sealed bulb, but they must be prepared in it; the metal cathode cannot be made in the air and then introduced into the cell.

Fig. 2. How sodium is introduced into the cell electrolytically.



The process which is most generally used to obtain a clean film of the metal in the cell is the introduction of the metal as a vapour, which is then condensed in the required position. In one form of photo-cell, evolved by R. C. Burt, the metal sodium is admitted into the bulb by electrolysis, whereby the sodium is deposited on the inside of the cell after it has travelled through the glass wall of the bulb.

A Burt type sodium photo-cell may possess the form and internal design shown in Fig. 1. The cell con-

HOW THE PHOTO-ELECTRIC CELL IS CONSTRUCTED

sists of a bulb (a) of spherical shape, made of glass absolutely free from lead, and a lamp stem, (b) carrying three electrodes and sealed to the bulb. Two electrodes support the filament (c); the third electrode (d) possesses an extension consisting of a piece of platinum coated wire which is bent sideways towards the wall of the glass bulb, and acts as a leading-in conductor from the cathode (e) which is formed by condensation at the point in question.

It will be noticed that in the case of this type of photo-cell, the anode and cathode leads are arranged

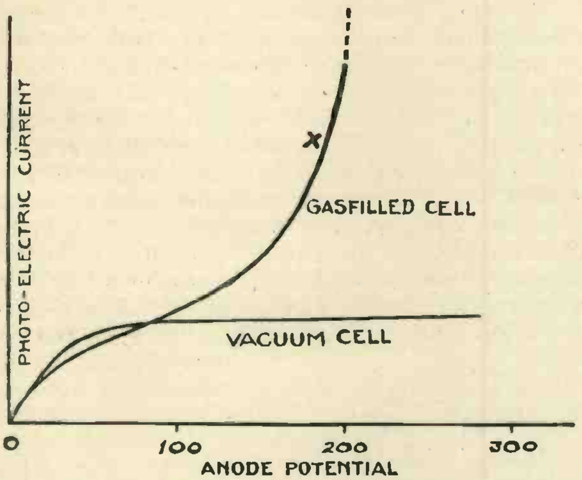


Fig. 3. The anode voltage-anode current characteristic curve of typical vacuum and gas-filled photo-electric cells.

in a common socket, also that the leads are molten into the same stem. One would at first think that this method could be improved upon as the insulation resistance cannot easily be kept at a higher figure than 10^{11}ohms. This means that with a cell operated at 100 volts a leakage current of 10^{-9} ampere is passed, the disturbing effects of which are readily felt in the case of very accurate galvanometric measurements, whilst rendering measurement by the electrometer altogether impossible.

These leakage currents, however, can be rendered entirely innocuous by using an alternating current voltage as the cell voltage.

In particular, the insulation resistance should be considered as being arranged as a shunt resistance between the anode and cathode of the cell. Now if an alternating voltage is applied to the cell and an ordinary galvanometer is connected in series with the A.C. supply, there will flow across the cell a pure alternating current, and the instrument will therefore remain at rest. If the cell is illuminated, it acts as a complete rectifier and the galvanometer will indicate only the direct current flowing through it. This simple scheme will be effective in the case of leakage currents, which in the case of a D.C. voltage would produce an indication of many scale divisions.

Electrolysis

Now the electrolytic introduction of sodium is most easily understood if we look at Fig. 2

This is a very interesting process and it consists of simply immersing a portion of the previously evacuated bulb into a molten mixture of salts (approximately equal proportions of sodium nitrate and sodium nitrite) at a temperature of about 300° C. Inside the bulb is suspended a thick filament, which when heated by an A.C. source, supplies the current necessary for the electrolysis. The current itself is maintained by means of a battery of 300 volts, the positive terminal of which is connected to the molten mixture of salts, whilst the negative terminal is connected to the filament. The intensity of the electrolysing current amounts to between 50 and 100 milliamps. The whole cycle of operations necessary for converting the bulb into a photo-electric cell takes about five minutes only, during which time such parts of the bulb as are intended to serve for the condensation of sodium on them are cooled by a strong current of air.

After a vigorous initial internal clean-up the electrolysis takes place very rapidly.

The sodium cathodes produced in the manner described are of a silvery white colour; they present a bright mirror-like surface on the glass side and a finely granulated dull surface on the inner side. The correct surface condition of the sodium deposit is decisive for the amount of sensitiveness, whilst its spectral distribution remains the same. (Spectral distribution is explained later on.) The correctness of this assertion can be proved most conclusively by carefully increasing the temperature of the cell until the sodium deposit begins to melt; the surface of the latter becomes mirror-like by this process, and the sensitiveness is reduced to practically zero.

The surface condition of the sodium deposit—whether mirror-like or of a finely granulated dull description—depends not only on the degree of vacuum and on some other circumstances difficult to define, but also in a decisive manner on the temperature and on the surface condition of the glass wall on which the deposit condenses.

Apart from the method of producing photo-electric cells by electrolysis, the sensitive metal may be introduced into the glass bulb by several other methods. These may be classified thus: solution, distillation, disintegration.

Solution

This method is not now in common use, but consisted of dissolving the alkali metal in a volatile solvent, and applying this solution to the part of the bulb to be sensitised. When the bulb is evacuated, the solvent evaporates, leaving a thin film of the metal on the wall.

As an example, lithium may be dissolved in aethylamine and this solution applied to the inside of a glass bulb upon which a conductor is fixed in order to make electrical contact to the deposited metals.

Distillation

The introduction of light-sensitive metals into the glass bulb by distillation may be carried out by joining to the photo-cell bulb a further bulb or series of bulbs, the last one of which holds the metal to be distilled.

VACUUM AND GAS-FILLED PHOTO-CELLS

This arrangement is evacuated to a high degree and the bulb holding the metal is then heated so that the metal distils into the next bulb; this bulb is heated and the metal distils to the next and so on for the several bulbs, until finally the metal is allowed to distil into the photo-cell bulb and to condense directly upon the glass wall or else upon a conductive metal coating, such as silver, which has been previously deposited.

The process of distilling from bulb to bulb sounds very involved and unnecessary, but this process of re-distillation results in the metal becoming increasingly purer at each distillation, so that the metal finally deposited in the bulb is extremely pure.

Disintegration

Deposition by disintegration or decomposition may be very easily accomplished by heat treatment.

In one manner of producing a very sensitive photo-electric cell by this means a photo-cell bulb is constructed in which there is fitted internally a silvered plate which has been oxidised by heat treatment in oxygen. A metal structure is also fitted internally and of such a shape that it can hold a pellet of the material to be decomposed.

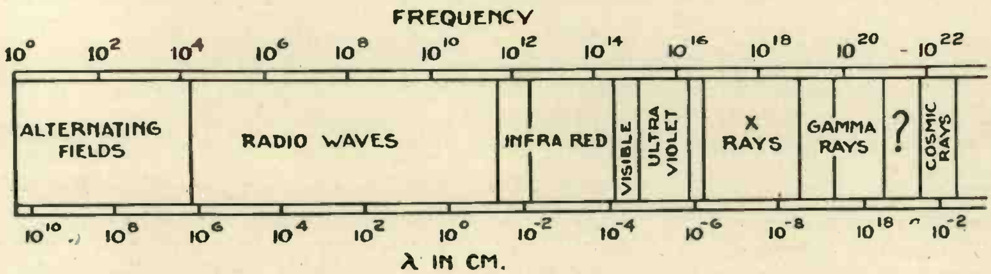


Fig. 4. A theoretical spectrum of the whole gamut of radiant energy.

The pellet may be made of a mixture of cæsium chloride and calcium, and when heated decomposes and condenses on the oxidised silver plate. On further baking in an oven a reaction takes place between the alkali metal and the oxygen on the plate, which ultimately results in the formation of oxides of cæsium with probably a monatomic layer of cæsium over the whole plate.

A cell of this type has a very high sensitivity and has a great response to artificial light.

Vacuum or Gas-filled Cells

From the point of view of characteristics and performance there are two distinct type of photo-cells: the vacuum and the gas-filled cells. The first, as its name implies, is highly evacuated, while the gas-filled type contains an inert gas (generally argon) at a pressure ranging between 20 to 150 microns.

The object of introducing gas into the cell is to magnify the initial photo-current through ionisation by collision.

A collision between an electron and a molecule of gas results in the molecule being broken if the electron is moving fast enough. This collision ejects an electron from the molecule, leaving the remainder, which is a positive ion. The electron which caused the impact and the detached electron both travel to the anode, while the remaining positive ion moves to the cathode. The increased number of electrons which travel to the anode, due to the collisions, constitute the magnified photo-current.

The energy required to detach an electron from a molecule, or to *ionise* it, is a property of the molecule, called the ionisation potential of the gas.

It can be seen that should the ionisation be of sufficient intensity, a great number of positive ions travel to the cathode and this positive ion bombardment is detrimental to the light sensitiveness of the metal in certain types of cells.

The main disadvantage of the gas-filled type of photo-electric cell is the definite potential that is required on the anode in order that it may give its greatest output. The most sensitive operating part of the curve shown in Fig. 3 is X. This is just below the ionisation potential of the cell. By keeping the anode potential constant and varying the illumination, or vice versa, a point is reached at which the cell is filled with a luminous glow. The current at this point rises suddenly to a very high value, due to ionisation, and if allowed to continue will reduce the sensitiveness of the cathode by positive ion bombardment.

The glow continues until the anode voltage is reduced to what is termed the "stopping potential." At this point the glow ceases and the current again determines itself in accordance with the degree of illumination from the light source. The limit to the emission with a given light source is, therefore, set by the glow potential, and for the greatest sensitivity and emission the voltage must be adjusted to a point just below this value.

The anode voltage-anode current characteristic curve of typical vacuum and gas-filled cells with a constant value of light flux incident on the cathode, is also shown in Fig. 3.

For scientific measurements, such as light photometry, the vacuum type is the best to use, as wide variations of anode potential above saturation voltage do not materially affect the output for any given degree of illumination. This saturation part of the curve is strictly proportional to the light intensity falling on the cathode, so long as the quality (or wavelength) remains unchanged.

HOW THE PHOTO-ELECTRIC CELL IS USED

Colour Sensitivity

The sensitivity of the light-sensitive cathode in any type of photo-electric cell varies with the wavelength or frequency of the incident radiation. Simply, a photo-electric cell may give its relative maximum output when a radiation having a wavelength of 700 millimicrons, which appears visually as red light, falls on the cathode; whereas a wavelength of 450

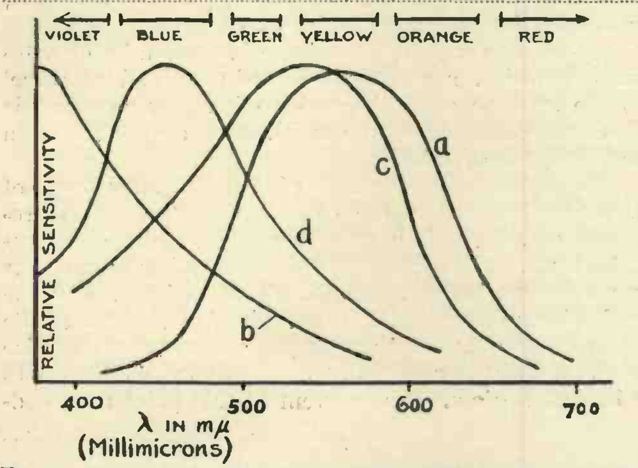


Fig. 5. Curves showing the colour sensitivity of different types of photo-electric cells.

millimicrons, that is, blue light, may give a response which is only a fraction of that for red light.

As is well known, white light may be split up into its components by projecting it through a glass prism. The beam of white light then resolves itself into a band of coloured light, called a spectrum. At one end we have violet, then blue, blue-green, green, green-yellow, yellow, orange and red. The wavelengths of these coloured bands are approximately as follows:—

Violet	410	millimicrons
Blue	470	,,
Green	520	,,
Yellow	580	,,
Orange	600	,,
Red	650	,,

If we could devise a prism which would resolve into bands or octaves, the whole gamut of radiant energy, including visual light, the spectrum would appear as Fig. 4.

This classifies the spectrum of radiant energy according to frequency and its wavelength in centimetres. It is remarkable that the octave of frequencies which constitutes visibile light forms but the smallest fraction of the entire range. The visible range is, of course, limited by the sensibility of the human eye. A frequency of approximately 750 thousand billion vibrations per second produces the sensation of violet light, while a freqeuncy of half this produces the sensation of red light.

The human eye is most sensitive to radiation of a wavelength of 550 millimicrons, falling off almost symmetrically on both sides of this wavelength, the lower limit being about 400 millimicrons, and the upper limit about 730 millimicrons.

Photo-electric cells may be made similar in colour response to that of the human eye, although almost all metals used as light sensitive cathodes have their own peculiar and differing responses.

The colour sensitivity and range of the human eye (a), together with typical colour sensitivity curves of a vacuum type sodium-cathode cell (b), cæsium cell (c), and gas-filled rubidium cell (d), are given in Fig. 5.

Amplification

The current which is passed by the photo-cell is so small that only very delicate instruments can successfully measure it, but by magnifying this current by means of a valve amplifier, quite large current changes are available. The simplest single valve photo-electric cell amplifier is shown in Fig. 6. This circuit gives an overall amplification of $10^6 - 10^7$ times and is eminently suitable as the basis of all photo-cell experiments and can be used for a variety of effects.

It will be seen that the photo-electric cell is in series with a high-voltage grid bias battery and the grid of the amplifying valve. If the cell is in darkness, however, it acts as an insulator and prevents this high negative grid bias from getting to the grid, and, therefore, the anode current has a value which is approximately that which occurs at zero bias. But, when we illuminate the cell, the grid bias is then conducted through and so reduces the anode current by an amount which is determined by the value of the effective negative bias, which in turn is determined by the brilliancy

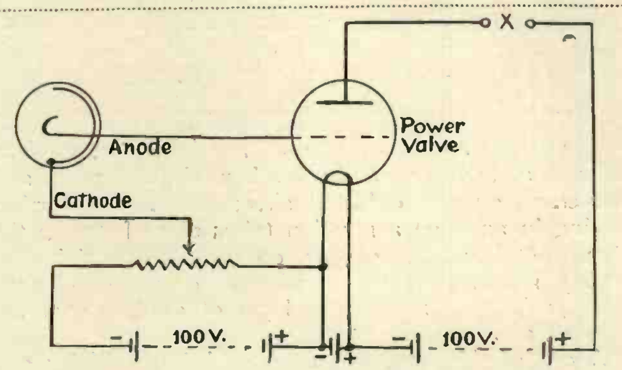


Fig. 6. A simple single-valve photo-electric cell amplifier.

of the illumination. In short, when the illumination is increased, the anode current is decreased by the increased negative bias, and when the cell is in darkness the anode current is at its maximum.

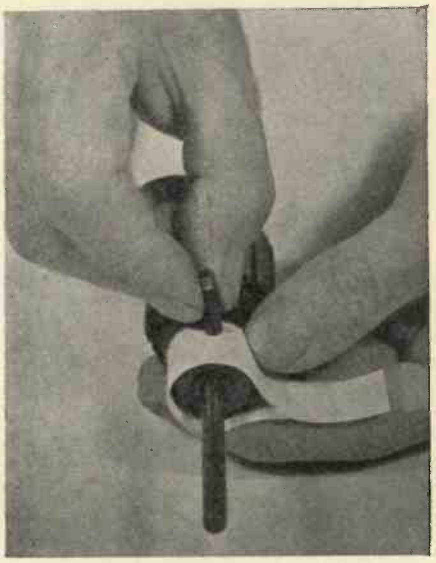
Apart from the construction of photo-electric cells utilising the alkali metals, there are several other forms of light sensitive cells which have been evolved.

Amongst the types of cells which have been developed may be mentioned the following: Photo-conductive cells, photo-voltaic cells. A description of these will be given in a later article.

THE TELEVISION MOTOR

HOW TO IMPROVE ITS RUNNING

WHETHER synchronising gear is employed with a mechanical scanner or not, much of the difficulty of holding the picture steady can as often as not be ascribed to minor defects in the motor and it will usually be found that if a little simple attention is



The running of the motor will be improved if the brushes are bedded down to fit the commutator; this photograph shows how the correct contour can be obtained by rubbing them on a piece of sandpaper held as shown.

given to this much of the trouble will disappear. It might be thought that with a motor that has had comparatively little use no defects would be present, but the writer's experience is that defects of a minor character are more likely to be present in a new motor than in one that has had some use.

Everyone who has used a mechanical scanner will have appreciated how sensitive is the device to the smallest amount of friction from external sources, as, for instance, when the finger is pressed on the spindle; and it will be realised that if this friction is of an irregular character then the resulting trouble will be increased very greatly.

Elimination of friction, and particularly any that is likely to be of an irregular nature, therefore, is one line of attack, and the other is the elimination of the electrical equivalent produced by bad contacts.

The mechanical arrangements of a motor are the simplest possible, merely a revolving shaft upon which is mounted the commutator against which rubbing contact is made with carbon brushes. The bearings may be either plain or the ball type. Provided that the former type are kept well lubricated with a suitable oil it is doubtful whether one is better than the other and with proper attention the wear of plain bearings is comparatively insignificant. Steady running is, however, impossible if there is any looseness of the shaft in the bearings.

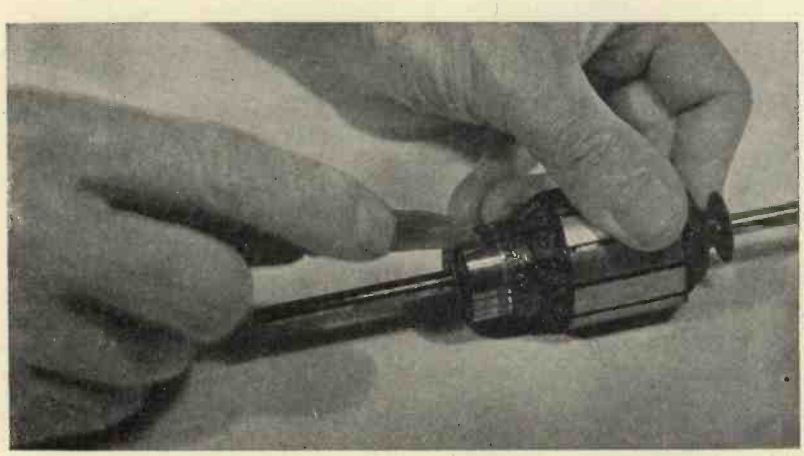
In the case of ball bearings there is one source of trouble which is very common and which is not due to any defect in manufacture. This is the presence of particles of grit in the bearing. Working tolerances are so small in the case of ball bearings that solid particles of a thousandth of an inch can upset the working and not infrequently these find their way in from the packing, etc.

The first care then should be to ascertain if the armature shaft is quite free and to do this it is absolutely essential to remove the scanning disc or drum and the commutator brushes. Then the spindle can be gently rotated with the fingers and note made of the slightest irregularity which may be felt. It will not be difficult to ascertain the cause of this if it is present. Grit or other matter will result in sudden light checks being felt and faulty alignment of the bearings will be indicated by some amount of stiffness at certain positions of the shaft.

The elimination of grit from small ball bearings is often a difficult matter usually necessitating repeated washings in paraffin or petrol. The latter is more effective as it will allow the bearing to be thoroughly dried out and then it is probable that the grit can be dislodged by means of a brush or a jet of air from a tyre pump.

Taking Up Slackness

Faulty alignment can often be remedied by slightly enlarging the holes in the end plates and moving these a little in one direction or another; care, however, must be taken to get the holding screws quite tight again upon assembly otherwise there is the possibility of the bearing moving. Slight wear in plain bearings may be taken up by tinning the insides with solder; this is a simple expedient and quite effective. Any oil present should be got rid of by heating and then the inside be made bright and sufficiently hot to melt the solder so that it will run over the inside when applied; any surplus should be shaken off and then a piece of rag drawn through whilst the bearing is still quite hot. This will leave a smoothly tinned surface which



Sparking is frequently due to high insulation between the commutator segments: this photograph shows how it can be reduced.

if kept properly lubricated will wear quite well, and it will be found that the internal size of the hole will have been reduced by two or three thousandths of an inch.

Of equal importance to the bearings is the correctness of the position of the armature in the field magnet tunnel; this must be quite central and it is a matter that should be checked up when a motor is purchased; a motor which has this fault (and it is not uncommon) should be returned to the makers.

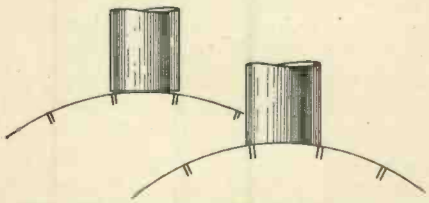
The Commutator and Brushes

Assurance having been made that the armature revolves quite truly and freely, attention should be given to the commutator and brushes. Motors are frequently sent out with the ends of the latter flat (see sketch) so that only a line contact is being made with the commutator segments, and therefore only one segment is in contact at any given time. Very much improved results will be obtained if the end of the brush is shaped so that it will fit the commutator and make contact with more than one segment at a time; not only will this make for steadier running but it will reduce sparking. To give the brush ends the correct curvature the armature should be removed from the machine and a piece of fine sandpaper wrapped round the commutator and the brush rocked gently backwards and forwards on this until it is rubbed away to the required shape. Care, of course, must be taken when refitting the brush to ensure that it is in the correct position.

One final point which concerns the brushes: make sure that they slide quite freely in their holders and also that the springs which hold them in position do not bind.

A motor should run with hardly perceptible sparking at the points of contact of the brushes; sparking is due to incorrect commutation and bad design generally, a worn commutator, high insulation between the commutator segments, incorrect brush pressure and improper contact between brushes and commutator. A badly worn commutator will require to be skimmed up in a lathe, but in the case of small motors usually a little treatment with fine glass paper will suffice. In some cases it will be possible to hold the sandpaper against the commutator whilst the machine is running; if this is not possible then a strip of the paper should be taken and lapped over and worked backwards and forwards.

A more usual cause of sparking is high insulation between the commutator segments; the insulation between each bar should be definitely lower than the metal. The method used to ensure this is to cut the insulation away with a fine saw, such as a piece of broken hacksaw blade, the undercutting being made to a depth of about 1/64th of an inch below the surface of the metal. The importance of this undercutting cannot be too strongly stressed for the best running conditions cannot be obtained even if insulation and metal are exactly level.



Two diagrams illustrating the incorrect and correct shape of the brushes.

The pressure of the brushes also has an important bearing on the running of the motor. If this is too heavy, then in the case of a small motor a considerable load will be imposed and the motor may tend to get hot or be incapable of performing its work; if on the other hand the pressure is too light, then poor contact will result and probably sparking take place. It is an easy matter to alter the brush pressure within limits either by cutting one or two coils off the spring (to reduce the pressure) or stretching it slightly if an increase is required. As a rule it will be found that the pressure is rather in excess of what is actually required.

Finally, a few words regarding the best running conditions. It is always best to have a motor of which the power is very little in excess of that required for driving the disc at the correct speed as this makes critical control more easy than if a fairly large amount of power has to be controlled. See that the commutator is kept quite free from oil and if it shows signs of blackening or becoming burnt the reason should be ascertained and the trouble rectified. Sparking should not be tolerated at any cost; once it starts it will rapidly become worse and apart from the interference which will result, the motor will be spoilt.

SYNCHRONISING BY A.C. MAINS

POSSIBILITIES of simple methods of synchronising may lie in the use of 50-cycle A.C. mains to control scanning movements at transmitter and receiver. Unless both are on the same actual supply, of course, such synchronisation is impossible because different A.C. supplies of the same nominal frequency may differ from instant to instant.

Even on the *same* A.C. supply a phase-control would most probably be necessary at the receiver as a means of framing, but this would represent no great difficulty.

As a matter of fact in view of the limited range of a 7-metre transmitter to a small locality, it seems not at all improbable that the whole district might reasonably be on the same A.C. supply—at least when the present spread of A.C. supply is fully matured. The district of London is possibly one of the worst left in the country, on account of the number of supply authorities, but even in this case a surprising majority of consumers are on the same actual frequency of supply.

Fifty-cycle supply can easily be used to control framing and scanning saw-tooth sources in cathode-ray systems at sub multiples and multiples of the 50-cycle frequency. —G.S.

Using the Experimental Light Chopper

By Robert Desmond

LAST month we came to the point of how we are to rotate the disc of the chopper at the required speeds. As pointed out the range required is high—roughly from .069 to 139 revolutions per second to produce light fluctuations of from 25 to 50,000.

Last month constructional details of a light chopper were given, an apparatus of which many television phenomena can be studied. This article explains how the apparatus is used.

Originally one electric motor was used, the armature-shaft being coupled direct for speeds above 2 r.p.s., while complicated gearing was used for the lower speeds. This method was, however, found not entirely satisfactory and it was decided to use a clockwork motor for the lower speeds. Figs. 1 and 2 show the driving mechanism.

Driving Motors

The electric motor was bought at a junk shop for 8s. 6d. and having a small armature, 1.125 inch in diameter runs at the speed of 1,100 revolutions per minute without load. It is of the type used in hairdressing apparatus, suitable for A.C. or D.C., being series wound.

The clockwork-motor is a Swiss gramophone motor which cost 3s. 6d. second-hand. The rest is made from Meccano parts, the general construction being best seen from the illustrations. It was found that for the governor of the gramophone motor to be really effective the driving spindle speed should not be less than 17 r.p.m. and as 25 cycles or light pulses is only equal to about 4 r.p.m. the speed must be reduced by some sort of gearing. This was done by driving a 3 in. diameter pulley on the driving shaft by a .5 in. pulley on the gramophone motor spindle which gives a reduction of 5.43 and not 6 as would be expected; this is due to the grooves of the pulleys.

The fastest speed at which the gramophone motor will run easily is a spindle speed of 100, which is a frequency of 110. Two more pulleys are used, a 2 in. driving 1.5 in. which gives a step-up in speed of 1.33 on the gramophone motor. The special shaft for running a stroboscope pattern is driven off the driving shaft by a worm working into .5 in. pinion; this gives a reduction of 19 to 1. The driving belt is of string, which was found best after trying Meccano's special product and also rubber bands, both of which were too springy. The string used is relatively thick. The same belt can be used for both sets of pulleys and is slipped right off when the electric motor is in use.

It will be seen from one of the pictures that the motor is on sliders, this is only to enable it to be easily removed and used for other purposes. The connecting link between the electric motor and the driving shaft is a rubber band looped through a Meccano "flange-wheel" and hooked on to an assembly made of two bolts and a "face-plate," details of which can be seen in Fig. 3. The electric motor is, of course, mechanically disconnected when the clockwork motor is in use.

The electric motor is driven off the A.C. mains via an auto-transformer which gives a selection of voltages from 25 to 250 volts, with a 100-ohm resistance for fine control. The connecting link between the driving shaft and the disc spindle, is a round piece of rubber about .125 in. diameter taken from the lid of a potted meat jar. This flexible link was found necessary as the parts of the apparatus were built separately, and difficulty was found in lining up the two shafts accurately.

Checking the Speed

The next problem is that of checking the speed of rotation and thereby knowing the frequency of the light interruptions or pulses.

Two stroboscopic methods will be given. No explanation of this effect will be given as Television readers will be fully acquainted with the principles of the stroboscope.

The wide range of speeds required has been some-

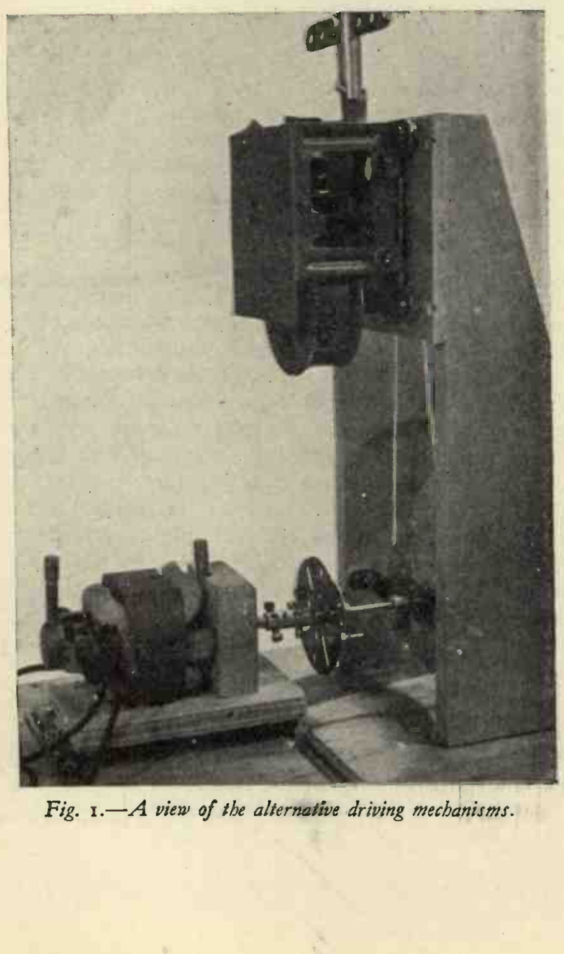


Fig. 1.—A view of the alternative driving mechanisms.

what reduced by the various gearing already described, at least where it can be measured. It will be noted that there are three points where a stroboscope pattern can be attached. (1) On the gramophone spindle, (2) on the main driving shaft; (3) on the special shaft for the pattern. All three are used in both methods. If we use constant light interruptions a separate pattern will be required for every frequency, which of course could not be considered. Even if only the octaves were required 12 patterns would be required for the 11 octaves between 25 and 51,200 cycles. One can use one pattern for, say, 100 cycles, and bear in mind that it will appear stationary every time the frequency doubles itself.

Making a stroboscope pattern of more than 180 spokes in small sizes is not too easy unless reduced from a large drawing photographically. In the case in question 263 spokes are required to indicate 25 pulses per second even when mounted on the gramophone spindle. Fig. 4 is a table of patterns for 50-cycle A.C. mains which is 100 flashes per second. They are correct to the nearest whole number; the position where to mount them is also given. Even with the system of one pattern being used to indicate more than one speed, at least two dozen patterns would be required, for any sort of useful range.

An alternative method is to have the pattern fixed and vary the light flashes on the stroboscope, but this requires a calibrated flashing light source to check a similar light source! This seems ridiculous, but as already pointed out it is most difficult to get a flashing light source of constant output suitable for making measurements by; though for observing a stroboscopic pattern it is a relatively simple matter.

The relaxed oscillating neon is well known to readers. Theoretically it is capable of a wide range of frequencies up to those described as radio. The simple circuit is shown in Fig. 5. The period of the current pulses T is equal to C R A:—

Where C = capacity in farads.

R = resistance in ohms.

$$A = \frac{V_1}{V_2 - V_3}$$

Where V_1 = difference of striking and breaking voltages.

V_2 = H.T. voltage.

V_3 = mean voltage on neon.

For our requirements the neon should flash from 50 to about 3,000 times per second. As it is generally necessary to have R of the order of a megohm and as it is so difficult to obtain variable resistances of a reliable kind of even .5 megohm it was decided to vary the capacity and the circuit; Fig. 6 was wired up.

The eight groups of condensers were all individually measured for their capacity. The variable condensers being two old straight-line capacity type, rated at 1,000 $\mu\mu$f each but actually over 1,400 $\mu\mu$f. The seven fixed condensers must each be less than the maximum of the two variable ones. The rather high minimum of 261 $\mu\mu$f in the writer's apparatus was chiefly due to the capacity of the leads to the neon lamp which, of course, must be calibrated with the variable condensers. The transformer is used to check the frequency by connecting the secondary to a pair of headphones and is of the ordinary telephone type. The neon is a small indicating type. The potentiometer is used to adjust V_2 in the factor A.

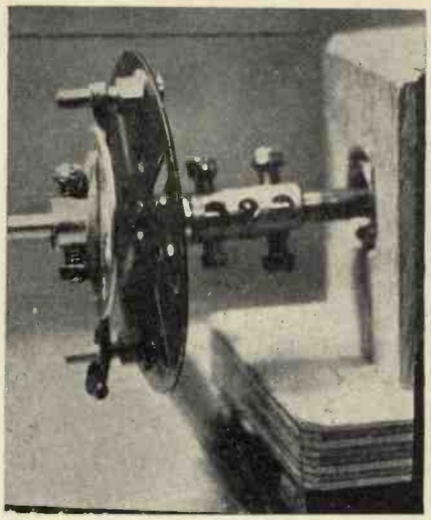


Fig. 3.—Details of the face-plate coupling device.

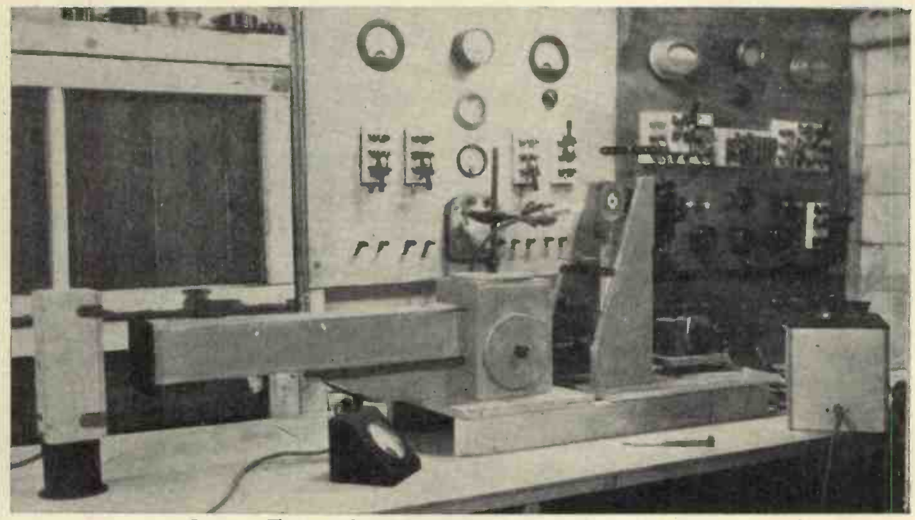


Fig. 7.—The complete light chopper in the author's laboratory.

Calibration is relatively simple. The capacity of all the condensers being known, one has only to adjust the potentiometer, with the capacities all in or nearly so, till the note in the 'phones is 50 cycles compared with a 50-cycle A.C. mains. Now halve the capacity for 100 cycle and halve again for 200, and so on. Plot the frequency against capacity and one, of course, gets a straight line curve. As R and A are fixed to commence with and provided the same H.T. is applied, the calibration will hold for a given neon.

Only three patterns are required. One 180-spoked pattern on the larger gramophone driving pulley, which when appearing stationary will give light pulses of $\frac{2}{5.43} \times T$, where T is the number of flashes of the neon per second. The above is for the pair of pulleys gearing down. For gearing up the pair $2 \times 1.33 \times T$ gives the required pulses. The second pattern of 48 spokes on the main shaft when stationary equals $7.5 \times T$ pulses. And finally 90 spokes stationary on the special stroboscope shaft equals $4 \times 19 \times T$ pulses.

Fig. 7 shows the apparatus complete in the writer's laboratory. The neon stroboscope lamp can be seen held in position by a retort stand; also the pattern on the gramophone spindle. On the left is a plywood metal-lined box in which is a photo-cell, which has just been tested. On the right is the neon tone source for indicating the speed.

In conclusion, let us briefly say what a light chopper is used for in a television laboratory. It is the only apparatus that can " squeak " a television amplifier properly. Ordinary oscillators are of no use for the purpose as the signal cannot be injected in the proper way, through the photo-cell. In the generation of a television signal it is no use having a perfect amplifier if the input arrangements of the photo-cell or the cell characteristics are not up to the job required of them. So the " squeak " must be in the form of light varying in frequency, but at a constant strength. Phase distortion can be studied by generating a signal of a wave-form known to require definite harmonics for its reproduction. After passing such a signal, through the photo-cell and amplifier it can be inspected on a cathode-ray tube and the output results compared with that of the input. As a tone source of any wave-form with photo-cell and amplifier that may be required its uses are endless. To the musically minded who may wish to hear the sounds of any note that they may choose to draw it also has possibilities.

Light Pulses per Second.	Number of Spokes in Pattern.	On Gramophone Spindle.	On Driving Shaft.	On Special Pattern Shaft.	Times Stationary.	
25	263	+			1st	To 120 v., clockwork geared down
50	263	+			2nd	
100	263	+			3rd	120-790 v., clockwork geared up
200	180		+		1st	
400	180		+		2nd	750 upwards. Electric
800	180		+		3rd	
1,600	180		+		4th	
3,200	180		+		5th	
6,400	107			+	1st	
12,800	107			+	2nd	
25,600	107			+	3rd	
51,200	107			+	4th	

Fig. 4.—Table of patterns for 50-cycle A.C. mains.

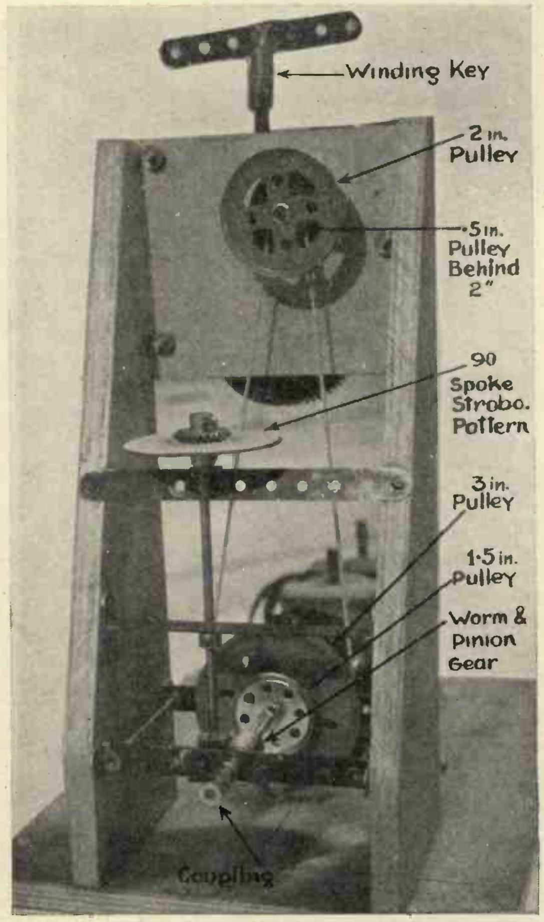


Fig. 2.—Another view of the driving arrangements giving details of the gears.

Thermionic Emission, by Arnold J. Reimann, B.Sc., Ph.D., F.Inst.P. Chapman and Hall, Ltd., price 21s.

This book is an advanced and comprehensive survey of thermionic phenomena. Early history and a summary of the new science are given in the first chapter and chapters II, III, and IV deal with electron emission from clean metals, contaminated metals, and oxide cathodes respectively. The modern theory of electron emission is dealt with at length in chapter V, and the emission of ions in the final chapter. The author is a member of the research staff of the General Electric Co., Ltd., and the book is probably the most authoritative work on this comparatively new subject.

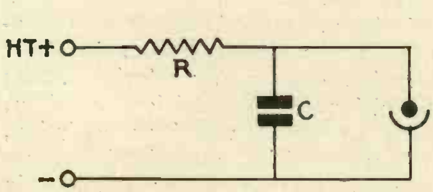


Fig. 5 (above).—The simple oscillating neon circuit.

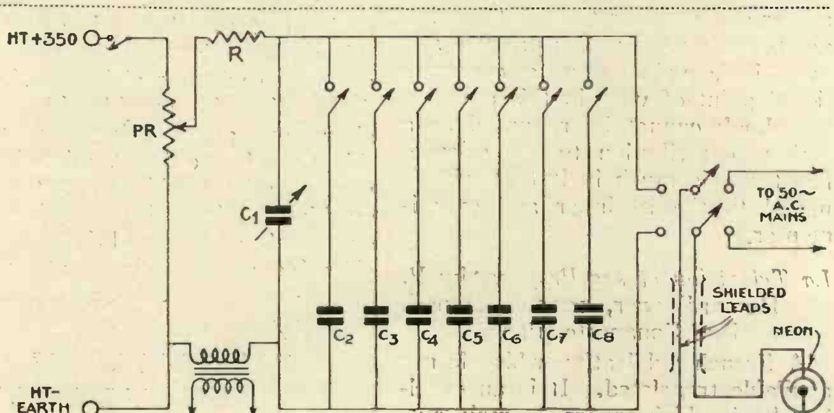


Fig. 6 (right).—Diagram showing the neon circuit used.

PR, 25 *megohm potentiometer.* R, 4 *megohm.* C1, 2,800 *uuf.* C2 *to* C8, *over* 2,000, *but under* 2,800 *each.*

THE LITERATURE OF TELEVISION

Television—To-day and To-morrow, by Sydney A. Moseley and H. J. Barton Chapple. Fourth edition, 1934. Sir Isaac Pitman & Sons, Ltd. 7s. 6d.

This book is largely concerned with the historical development of the Baird system and gives accounts of the various demonstrations that have been made from time to time. Most of the technical matter is also devoted to Baird apparatus and other information is very general. Chapters are devoted to synchronism, photo-cells and neons and the wireless receiver for television. Noctovision and phonovision occupy two chapters and in the latest edition some information is given on ultra-short waves possibilities and the cathode-ray tube. Television in other countries is very briefly dealt with in a matter of a dozen pages. The book is written in a popular style and is easily understandable, but its scope is rather limited.

Experimental Television, by A. Frederick Collins. First edition, 1933. Sir Isaac Pitman & Sons, Ltd. 10s. 6d.

The author of this publication is an American. Actually the book consists of a collection of electrical and optical experiments, which are related to television, though many of them are somewhat redundant. No pretence is made of great scientific accuracy or detail, but to those who are unacquainted with the fundamental problems in television it will provide an easy introduction. The contents include experiments with light, vision, scanning discs, photo-electric cells, amplifiers, neon lamps, electric waves, synchronism and cathode-rays. Two chapters are devoted to the construction of a transmitter and receiver though these are not based upon English practice and have little value from a constructional point of view in this country. The book cannot be regarded as a serious contribution to the science, but there is much in it that will be useful to the beginner and experimenter.

La Television et ses Progres, by P. Hemardinquer, 1933. Dunod, 92 Rue Bonaparte, Paris.

A French publication which is not available translated. It is an excellent book which covers the main outlines of the subject fairly thoroughly in the following sequence: history and principles, optical and electrical problems, practical applications of known principles, transmission and reception, amateur television and cathode-ray principles. It is a practical book and to those acquainted with French will be easy to understand.

A large number of requests have been received from readers for particulars of books dealing with the subject of television. It will be understood that as the subject is comparatively new there is not a very extensive bibliography in book form but no doubt the following information will be helpful to those who wish to take up the study of the subject. In making a choice some regard should be had to the date of publication as it will be understood that in some cases considerable development has taken place since. It is not claimed that the list is complete for only those publications have been included which are readily available.

The A B C of Television, by R. F. Yates, 1929. Chapman and Hall, Ltd. 10s. 6d.

This book treats the subject in a rather cursory manner and a large part of it is occupied with descriptions of picture telegraphy systems. It is of American origin and, of course, is now rather out of date.

Television for the Amateur Constructor, by H. J. Barton Chapple, 1933. Sir Isaac Pitman & Sons, Ltd. 12s. 6d.

The main theme in this book is the construction of television receivers of the disc type and the associated wireless vision receiver. A general exposition of the theory is given, but this mostly relates to the disc scanner. The wireless vision receiver is dealt with in considerable detail, about 120 pages being devoted to this though the information in this respect relates chiefly to the disc machine. Mirror-drum receivers are only dealt with very briefly. Considerable progress in amateur construction has taken place since the book was written, but it will be useful to those who wish to become thoroughly acquainted with the construction and operation of the disc-type receiver.

First Principles of Television, by A. Dinsdale, 1932. Chapman and Hall, Ltd.

This is probably the best book that has been published on the subject, though of course considerable development has taken place since 1932, its date of publication. It provides a complete survey of television and is practical without being too technical. The contents include elementary considerations, a survey of light-sensitive devices, details of early experiments, descriptions of most of the successful systems, methods of synchronising, an analysis of image structure, a discussion on transmission channels and the present (1932) state of the art in Great Britain, Germany, and America. Even though the book is now somewhat out of date, inasmuch as it cannot, of course, deal with the latest progress that has been made, it is a publication that will be found extremely useful to either the beginner or the advanced student.

Practical Television, by E. T. Larner, 1928. Ernest Benn, Ltd.

This book also is out of date and the treatment of the subject is very general. It includes historical matter, pictures by wire systems, and fundamental principles.

Television—Theory and Practice, by J. H. Reyner, 1934. Chapman and Hall, Ltd. 12s. 6d.

This is the most recent publication and a review appeared in the July issue of this Journal. The contents include the art in practice, the eye in television, optical systems, photo-cells, the cathode-ray tube, time-base circuits, cathode-ray television, film television, the television receiver, special systems, velocity modulation, colour television and foreign practice. It differs from most books in that no attempt is made to provide a historical survey of the subject. A few unfortunate errors appear in the text and illustrations, but the book will provide the student with a good insight into the subject.

(*Continued in 3rd column of page 358.*)

REVIEWS OF THE PROGRAMMES AND RECEPTION REPORTS

THE radio receiver used in the transmitter room behind the studio is now mains synchronised, and results during the transmission of *Carmen*, when it was first used, show that it provides a reliable check. A separate radio check was added to a line check when the studio was transferred to Portland Place and, since March, pictures on two screens have been visible from the control desk. It is essential for engineers at the transmitting end to know beyond possibility of doubt what sort of image is being broadcast, and this result is now achieved. Previously one receiver was radio synchronised and, owing to severe mains fluctuations, the picture was unsteady. These fluctuations in the mains are a local condition caused by the heavy and varying loads imposed by the electrical equipment at Broadcasting House nearby and one curious effect was that engineers were receiving better pictures in their homes some miles away than could be got by radio on the spot.

The six-valve receiver in use was designed by D. C. Birkinshaw, research engineer, and consists of an H.F. amplifier (in which great precautions have been taken to prevent sideband cutting), a diode rectifier, a special amplifying stage developed by the B.B.C. research engineers, and three standard resistance-coupled amplifying stages. The job is designed to give the best possible results on a radio picture, and now that automatic mains synchronisation is employed, a better picture is obtained than I have seen before on the screen behind the scanner.

The scenery used during the past month has not been an unqualified success. Though the backcloth looks crude when viewed in the studio, the drawings in black and white become natural when seen by television, I am all in favour of painting the scene in this way. The effect is to clothe the studio, normally rather bare, and I like to see as many changes as possible in the course of a programme. This may be a matter of taste, but there is a positive advantage from the use of scenery in the sense of speed obtained by seeing artists moving in front of a stationary object or design. There is also no doubt that "props" are an aid to perspective in the picture.

A scene from the ballet "The Gods Go A-begging" with Lydia Sokolova and Stanislas Idzikowski.

Susie Salaman has been responsible for the scenic effects in several recent programmes: *Cleopatra, The Gods Go A-Begging* ballet, and *Carmen*. Her bold style suits the medium and her settings for *Cleopatra* and the opera made splendid pictures on the screen. In *The Gods Go A-Begging*, the scene was overcharged and the figures seemed to me to lose definition against a backcloth laden with paint. One looker complained to me that his images were blurred, which may have been due to his apparatus. But the producer is wise enough to consider the effect of his productions in visors which are crude, judged by 1934 standards, and the backcloth will be less elaborate in future.

Nine big photo-electric cells are now in use and, as each new cell is four times as powerful as the old, thirty-six small cells would be needed to produce the same result. Equipment at Broadcasting House comprised only sixteen small cells, and pictures are certainly better lighted by the new arrangement.

A third microphone of the condenser type is now fitted in a stand round the angle of the studio wall for use by the announcer. In this position he will be out of sight where the beam from the scanner cannot reach him and the dim light of his reading lamp will not affect the transmission. It is intended to keep the microphone permanently in this place so that it can be discovered when needed in the darkness. The orchestral microphone is more or less a fixture behind the black curtain which shields the music lamps used by the band, but the artists' microphone must always be mobile to suit the action of the programmes. In the twilight of the studio it is enough to have one length of cable trailing across the floor.

If correspondence is any guide there is less looking, as there is less listening, during the summer months, and the producer for July reports that he is receiving comparatively few letters about programmes. So a telegram of congratulation from Mr. O. H. Relly, of Eastbourne, was all the more welcome after the second Cocktail Club programme. This correspondent considered that the transmission was the best technically that he had seen and the show had amused him more than any other. His reception was so good that he could see the rims of glasses standing on the bar. How tantalising!

Roy Royston was broadcasting for the first time in this programme and is now engaged for his original part in the radio production of *The Girl Friend*. Another case of an artist introduced to the microphone in the television studio and afterwards booked for a broadcasting show. This Cocktail Club is a bright and spontaneous effort, calculated to raise the spirits in the forenoon.

Charles Heslop was a guest that morning and so was Signor Vittorio Podrecca, whose extended season at the Fortune Theatre enabled him to appear again during the month. Marionettes usually fail to move me, but these little people have wit and charm. Lack of detail in the picture hides their imperfections, and was possible to forget that they were dolls. Nearly every emotion is within their range.

In transmission they occupied the whole screen so lookers were not conscious of their size. Before the scanner their diminutive stature gives them an advantage over human artists because they are able to move and dance close to the lens in a focus which would taken only the head and shoulders of an actor. There were moments when their movements became uncannily perfect.

The dolls are operated by long strings, and scaffolding with planks at the top was raised to the ceiling to enable the operators to work from above. Though the ceiling is lofty, there was barely room.

Carmen of all operas needs to be seen as well as heard and was, therefore, a good choice for an experiment in television. Drastic cuts were necessary in the score which had to be compressed to forty minutes and still it was easy to follow the plot. It was a realistic scene when Carmen (Sarah Fischer) was stabbed by Don Jose (Heddle Nash) and behind the curtain there was the usual rush to get changed in time, which was not always achieved. Heddle Nash was delighted with the role and resolved to sing it on the operatic stage.

One of Signor Podrecca's marionettes; the marionettes were "visiting members" in the Cocktail Club programme, and the picture shows a marionette imitating Josephine Baker.

Another exquisite performance was given by Sokolova, this time with Idzikowski in *The Gods Go A-Begging*. Pupils from her school took part in the ballet and it is good for the new art that ballerinas of the future should be trained from youth in the technique and routine of television.

Future programmes for the diary:

Friday, July 27th (in the morning):

First appearance of Wendy Toye, the young dancer from *The Golden Toy* and *Ballerina*. I was charmed by her performance at audition and recommend this transmission, which also includes our friends, Gavin Gordon and Leonie Zifado.

July 31st (at night):

George Sanders, returning to the studio after his success in *Conversation Piece*; and Hilda Mareno, who will sing in Spanish to blend with Reuben Garcia, a newcomer in dances with castenets.

August 3rd (at 11 a.m.):

Leslie French in songs, and Nini Theilade in dances, from *A Midsummer Night's Dream*; both are playing in the open air theatre.

"The Literature of Television"

(*Continued from page 356.*)

Television: Its Methods and Uses, by E. Felix. McGraw-Hill, 1931. 15s.

This book is of interest as presenting the American point of view on some of the problems connected with television. The author discusses in detail the difficulties encountered and the obstacles which still remain to be overcome. It is a pity, however, that he does not give due weight to the work done by British pioneers in the field.

The standard of performance required and the limitations of television equipment are dealt with very fully.

Items of Interest

Television Enthusiasts at Olympia

The Edison Swan Co. are showing an improved type of cathode-ray tube in which the distortion due to "threshold effect" has been overcome. The performance of the tube will be demonstrated on the stand and full circuit details of the scanning and modulation will be available. The price of the new tube has been provisionally fixed at £8 8s. od. but gas-filled tubes operating at slightly lower anode voltage will still be available at £6 6s. od. The company's television engineer, Mr. Price, will be available during part of the time to discuss problems with engineers.

Sound Sales, Ltd., of Highgate, are showing a new range of high-voltage transformers for use with cathode-ray equipment. The apparatus on their stand will include a mains-operated double time-base and H.T. supply unit for the tube. We are informed that the complete equipment can be supplied to customer's specification and that inquiries for power transformers and high-voltage transformers are welcomed.

This company are also marketing 1:1 ratio isolating transformers for neon lamps and 12 V. secondary transformers for projector lamps.

THE TELEVISION ENGINEER

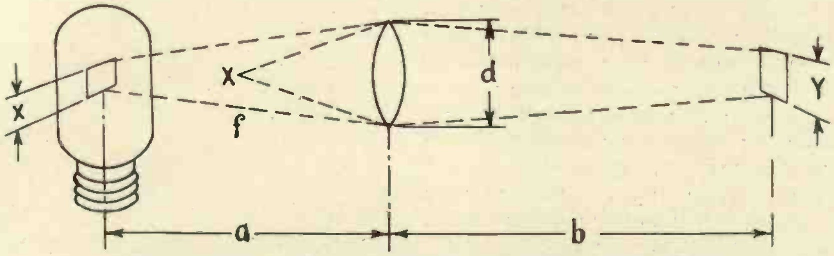
AN OPTICAL PARADOX

This is the fourth article of a series, by J. C. Wilson, on the paradoxes of television. It deals with some misconceptions of optical efficiency.

WHAT *IS* LIGHT EFFICIENCY?

IT is strange how curious little "local flaws" develop and stick in the sets of rules and precepts which form the empirical framework of various branches of technical knowledge. Scarcely any subject is free from rule-of-thumb methods of one sort or another, and few rules-of-thumb cover all cases. Occasionally a rule-of-thumb arises which covers no case, and is simply untrue: a result of a slip of memory or a piece of inaccuracy on someone's part. One is reminded of Wells' description of the kind of thing that sometimes happens in elementary schools even to-day: in "Joan and Peter," Miss Mills, the teacher of arithmetic, had one or two foggy places in her equipment. She was not clear about seven sevens or eight eights, but had a confused, irregular tendency to think that they might amount in either case to fifty-six.

"But," as Wells put it, "there was a guiding light in Peter's little head that made him grip at last upon the conviction that . . . when this haunting fifty-six flapped about in the sums, it was because Miss Mills, grown-up teacher though she was, was wrong."



A diagram explaining the argument in the text relating to optical efficiency.

What IS Optical Efficiency?

Now, in optics there are one or two vague spots which have not, perhaps, been given the attention they deserve. For instance, there is an idea extant that may be put succinctly in the following terms:

"In a simple lens system, the *maximum optical efficiency is obtained* when the image formed is equal in size to the object." At first sight, this seems quite a useful, unostentatious sort of rule, of special value in lens condensing systems for Kerr cell and other optical systems in which light from a small source is concentrated upon a small aperture. On closer examination, however, it leads to the inquiry: "What *is* optical efficiency?" and this leads to trouble at once.

If by maximum optical efficiency is meant the greatest amount of light in the image (assuming the object to be a luminous source), then the proposition is obviously untrue, for we have only to move the lens nearer and nearer to the source (forming, at the same time, a larger and larger image of it beyond the lens) to catch more and more light and so reach a definite maximum when the source is at the focus of the lens and the image is indefinitely far off, and indefinitely large.

If, on the other hand, by maximum optical efficiency is meant the greatest amount of light per unit area of the image, or the *greatest intrinsic brilliancy* of it, then verification (or disproof) becomes a little more difficult. Suppose a square, flat, even source, of edge x (see diagram) yields, with a lens of focal length f, an image of edge y, and that the distances of source and image from the lens-centre are a and b respectively, the diameter of the lens being d, then the total light caught by the lens is:

$$L_{lens} = \frac{B\,x^2 d^2 \pi}{4\,a^2} \text{ Lumens}$$

where B is the intrinsic brightness of the source in candles per unit area.

The intrinsic brightness of the image is obtained by dividing this amount of light by the area of the image (assuming negligible loss by absorption and reflections at the lens), i.e.:

$$I_{image} = \frac{B\,x^2 d^2 \pi}{4\,a^2 y^2} \text{ lumens per sq. unit.}$$

But by ordinary lens-optics, $x/y = a/b$ if the image is in focus properly. Hence:

$$I = \frac{\pi}{4} \cdot \frac{d^2}{b^2} \cdot B$$

Using the well-known formula $1/a + 1/b = 1/f$ we have:

$$b = fa/(a-f)$$

so that

$$I = \frac{\pi}{4} \cdot \frac{1}{P^2} \cdot (1-f/a)^2 . B$$

where P is a new quantity termed the *photographic aperture* of the lens, defined as f/d.

This formula for I shows at once several interesting things, for instance: since P is fixed (for any given lens) and so is f, then making a larger will make $(1-f/a)^2$ more nearly unity (its largest value) and so tend to make I a maximum. But increasing a indefinitely means a smaller and smaller image, until it becomes a pin-point and has a brightness equal to

$$\frac{\pi}{4\,P^2} . B$$

To make this equal the original brightness of the source B, we must

(*Continued on page* 373.)

Correspondence

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

Flicker :: The Zeesen Transmissions :: Amateur Transmission—An Enthusiast's Offer.

Flicker

SIR,

On reading TELEVISION for July, I noticed on page 306 an article on " Flicker " by a contributor J.H.R. He first of all says that " flicker is often confused with the effect known as visual persistence." Aren't they both the same? He then goes on to compare the cinema with television, because, I suppose, both of these project a picture on to a screen; and he tries to apply the " flicker wheel " of the cinema to television. In a cinema picture, the picture is stationary on the screen for a small period of time, whereas with television, at no time is the picture stationary with the usual form of scanned pictures. Interrupting the light of a cinema picture has no effect. Has the author ever seen a 100 cycle frequency on a 30-line picture with a number of lines moving across the picture? Obviously he has not, but he suggests that a flicker wheel giving 36 interruptions per second should be placed in front of the Kerr cell to do a similar thing. I suggest he tries this and considers why he sees three black lines moving across the picture.

J. SIEGER (London, S.W.).

* * *

SIR,

Mr. Sieger has fallen into the very error which my brief note was intended to clear up. Visual persistence lasts for anything from 1/10th sec. upwards and becomes longer as the intensity increases. Flicker, on the other hand, depends on the number of repetitions per second. At weak intensities a repetition rate of 12 per second is tolerable, but as the brilliancy increases, the frequency has to be increased to 30 or 40 per second before flicker disappears. (See Walsh on Photometry).

With reference to the latter part of the letter, Mr. Sieger is, of course, correct in pointing out that the image is never truly stationary as it is with a cinema projection, but he is confusing a periodic interruption of the source of illumination with a masking of the whole image. In the former case the light is blacked out at a particular point on the picture, every repetition giving a black band. My suggestion was that the whole image should be covered up momentarily which would give an entirely different result.

J.H.R. (Elstree).

* * *

The Zeesen Transmissions

SIR,

I have read Mr. Reyner's article on the reception of television from Zeesen, but my experience of results obtainable differ in some degree from those described.

I find that the system of detection used by the B.B.C. gives me a negative picture and that it is necessary to add an extra L.F. stage to correct this. I also find that to read the words Pause and Ende it is necessary to observe them with a mirror to bring them the correct way round. Although I am using a Baird 30-line mirror drum and in consequence the picture is a little distorted it is not sufficient to be at all objectionable, in fact the matter broadcast and the results obtained are well worth the trouble entailed; no alteration is made to the mirror drum except to turn the whole machine over on its side with the control knobs underneath; this, in my case, brings the picture the right way up. The duration of the programme, nearly an hour, permits adjustments being made and during the transmissions on the morning of Tuesday, June 19, the following items were clearly seen.

(1) Two ladies' heads, one fair and one dark, talking to each other, excitedly, after which they kissed and then left the screen.
(2) Tent, with dogs running out.
(3) Close-up of white dog, which could be easily observed—barked whilst being televised.
(4) Heads, lady and gentleman, who afterwards danced together.
(5) Two ladies, one with bandeaux in hair, who several times whispered into the other's ear some remark which they both appeared to have thoroughly enjoyed.

In your columns recently you referred to reception of the B.B.C. television transmission over here and it rather suggested that it was of a freak nature; but I can assure you the results obtained are very satisfactory. So much so that we cannot accommodate the people who wish to see the Friday morning transmission and at the present time people are having to reserve their places a month ahead, it being the usual experience to have to refuse admission, owing to lack of room, to considerable numbers of people who wish to see the demonstrations. Those who see them express surprise at the good results now obtainable on the 30-line, the only television system likely to give any result whatever in these islands for a considerable number of years with the present knowledge of the subject, it being very unlikely that an ultra-short wave television transmitter would be put up to serve here. And even if this was practicable a further difficulty would be the necessary cable connection with the mainland unless a television studio was erected here. This being the case the artists' expenses of getting here would then be a considerable item, which makes out a strong case for a low-definition system for outlying districts such as this.

F. T. BENNETT (Guernsey).

* * *

Amateur Transmission—An Enthusiast's Offer

SIR,

As an active amateur transmitter, and a reader of TELEVISION since March, 1928, I was interested to read your Editorial, and the correspondence contained in the July, 1934, issue.

In common with many other transmitting amateurs, I have been debarred from entering seriously into the television field of research on account both of expense and lack of co-operation.

A certain amount of surprise has been shown in some circles that amateur transmitters have not up to the present done more towards the development of television. I would like to make it clear that the task of maintaining a modern high-efficiency

An Opportunity for the Amateur :: Co-operation Wanted :: The Multi-spiral Scanning Disc Amateur Transmissions—The Official Attitude :: The Postmaster General's Conditions

C.W. transmitting station is no light one. Unless possessing unlimited spare time it is impossible for the amateur, single handed, to install and operate television apparatus in addition.

I am very pleased to see that an effort is now being made by television enthusiasts to gain co-operation with the amateur transmitter.

I would like to inform any television amateurs residing in my area that my station is open for television transmission at any time. Provided *adequate co-operation is afforded me,* and the G.P.O. permit it, I am prepared to run experimental television broadcasts at once.

If anyone interested will communicate with me at the address below I shall be delighted to arrange an interview.

Wishing your excellent journal the success it deserves.

RICHARD K. SHEARFOLD,
M.R.S.C.B., G.C.R.S.
Reculver, Manor Lane,
Sunbury, Middlesex.
'Phone: Sunbury 397.

* * *

An Opportunity for the Amateur

SIR,

With reference to your Editorial in the current issue of TELEVISION, I note your remarks under the heading (An Opportunity for the Amateur), I would further suggest that perhaps some already well-organised radio society could be prevailed upon to undertake this scheme, either wholly or partly, they would have the benefit of an active body of workers, and I feel sure some measure of advance could be made in this way.

CHAS. C. MILES (Streatham, S.W.)

* * *

Co-operation Wanted

SIR,

I should like to get in touch with some keen amateurs in this district with a view to forming a local television constructors' circle, and the building of a television transmitter.

W. F. COTTON
(59 Sydney Road, West Ealing,
London, W.13).

* * *

The Multi-spiral Scanning Disc

SIR,

With reference to your issue for July, 1934, our attention has been directed to a statement in an article by Mr. Gardiner, appearing on page 298, to the effect that the multi-spiral scanning disc for television was invented and developed by U. A. Sanabria.

This is, of course, not the case.

The multi-spiral disc for use in ordinary television or television in colours was described in J. L. Baird's British Patent No. 321,389 (June 5, 1928): the use of partially overlapping scanning strips is described in the same specification. The multi-spiral disc for lenses or apertures is described in Mr. Baird's Specification No. 314,591 (January 4, 1928) and the principle was demonstrated at the Baird Laboratories in July, 1928, and later in the year at the meeting of the British Association in Glasgow.

Sanabria's first description of the same type of scanning and device for accomplishing it, is given in his U.S. Specification No. 1,805,848 (June 7, 1929), but his practical development was, of course, much later.

Your attention has already been directed to the Baird patents relating to multi-spiral scanning in a letter published in your journal for February, 1931, on pages 508-509.

BAIRD TELEVISION, LTD.
(London, S.W.1.)
[J. C. WILSON].

* * *

Amateur Transmissions—The Official Attitude

SIR,

We are very pleased to see that you published our article on Amateur Transmissions, and a photograph of our apparatus and selves, in the July issue of your magazine, and wish to tender our thanks.

Since writing this article we have received a reply from the Postmaster General to our query as to the legal position of amateur television transmissions. The reply states that the broadcasting of television programmes of entertainment value cannot be permitted. Experimental transmissions of designs and objects, and a short length of film are, however, permitted. We enclose herewith a copy of the special conditions, as sent to us.

For the benefit of amateurs, we should like to point out that the main considerations for the granting of an ordinary licence for wireless telegraphy and telephony transmissions, include that the operator shall be capable of sending and receiving morse at a speed of at least twelve words per minute, and shall possess adequate knowledge of his apparatus. He may be called upon to be examined for this purpose. There are also restrictions as to wavelengths to be used, size of aerial, etc.

You will see, therefore, that our hopes of providing Cheshire and S.W. Lancashire with television transmissions of an entertainment value are doomed to disappointment. We can, however, send out still pictures, designs of varying definition, and objects of general interest, and this will at least provide signals for amateurs to test their receiving apparatus with, and should prove of considerable value. Of course, short-wave receivers or adaptors will be necessary.

We suggest that if a close-up of a human face, or even a full length study was broadcast without any accompanying sound, it could hardly be termed of entertainment value.

We shall be pleased to keep you informed of our future progress in this direction and let you know what support we obtain from local amateurs.

Wishing your magazine every success.

ROBERT C. BASE
(Jenson & Base, Wallasey).

The Postmaster General's special condition applying to licences for experiments in television.

Facilities for television experiments are not granted under the terms of the licence for experiments in wireless telegraphy. The Postmaster General is willing to grant facilities for television experiments, as an extension to the terms of a licence for experiments in wireless telegraphy or as a separate licence, under the following conditions :

(1) *All conditions laid down under the terms of a licence for experiments in wireless telegraphy shall apply equally to licences for experiments in television.*

(2) *Sending will ordinarily be limited to the band* 28035—32000 *kilocycles per second* (10.70 *to* 9.375 *metres*). *The band* 30000 *to* 32000 *kcs.* (10.00 *to* 9.375) *only shall be used for vision and the band* 28035 *to* 29965 (10.70 *to* 10.01 *metres*) *for sound or control.*

(3) *The clause 7 of the conditions of the licence for experiments in wireless telegraphy shall be amplified as under.*

Subject matter of entertainment value

shall not be transmitted. Transmissions shall be limited to test objects such as geometrical designs and diagrams or three-dimensional objects. In addition a test length of film occupying not more than two minutes in transmission may be used. Only one such film may be transmitted during the course of a day a though this film may be repeated.

(4) *Radiating facilities will not be granted until the applicant has produced evidence to show that the system proposed or apparatus employed possesses technical features equal to or in advance of existing systems or that the experiments will be of scientific value.*

G.P.O.,
LONDON, *June,* 1934.

* * *

Television—Theory and Practice

SIR,

Our attention has been drawn to your review of a book entitled "Television—Theory and Practice," by Mr. J. H. Reyner.

We have ourselves seen an advance copy of this book, and we are surprised to find that such an authority as Mr. Reyner should include in his work such a totally misleading and inaccurate description of this company's system of television.

For the benefit of your readers we should like to point out that the diagrams published in the *Wireless World,* of September 15, 1933: *Wireless Magazine,* October, 1933; *Journal of the Television Society,* No. IX, December, 1933; and TELEVISION, July, 1934, represent correctly the basis of the Mihaly receiver.

As will be seen from the above list of publications, full details of this system were published already in the autumn of last year.

ERNEST H. TRAUB
(Research Manager, I.M.K. Syndicate, Ltd.).

* * *

Mirror Screw Construction

SIR,

I have read the article in the July issue on "Setting Up a Mirror Screw" and note that Durofix cement is recommended for fixing each of the mirrors in the correct relation to the others. This is unnecessarily tedious and messy and I abandoned it in favour of another much quicker and altogether more convenient method which I am sure will interest other constructors.

All that is required is a lighted candle and a stick of sealing wax. The mirror plates are positioned by the same method as described in the article but each one is fixed in place by merely allowing one drop of sealing wax to fall on the rear edge of each plate where it is displaced to show part of the top surface of the last preceding plate.

The advantages are obvious. The wax sets immediately and so greatly reduces the time involved in making the screw, and it can be chipped off quite easily with a penknife should it be necessary to reset the mirrors as a result of any inaccuracy. Provided due care is taken until the end plate is firmly screwed down there is little fear of displacing any of the mirrors already fixed when moving subsequent ones to their correct setting. Of course, once the screw is accurately made Durofix can be applied to the plate edges as a precaution against accidental cracking or breaking of the wax when the screw is in motion, but this is not essential.

HUGH J. MILLER (Linlithgow).

* * *

The Way to Popularite Television

SIR,

As you are aware, we have commenced manufacturing television sets for the public at our Croydon factory. Being interested in television, we naturally have taken a very considerable interest in your recent questionnaire, and the summarised results obtained therefrom.

Television is definitely, at the moment, in a precisely similar position to broadcast radio some fifteen or sixteen years ago. The developments of that form of entertainment, was through a series of steps each related to the previous one.

To-day, we have two broadcasts of television from the B.B.C., but, speaking in general terms, there has been no receiving apparatus suitable for wide-spread reception. The public, we believe, would like to take a practical interest in this science, but to a large extent they cannot do this because those interested are seeking for some advanced stage of perfection before marketing receiving apparatus.

At the moment, the television programmes are a thirty-line definition, and while it is admitted that this low definition transmission is not the ultimate end of television, nor is it claimed to be perfect, yet at the same time, it is the only means by which the great general public can commence to take practical interest—which is essential—if television is ever to reach the perfection of the ordinary radio.

We are, therefore, placing on the market a receiving apparatus designed to retail at prices ranging from ten to twenty-five guineas. We hold certain patents in connection with such important parts of the apparatus, as the synchronising and glow discharge lamp, but we definitely intend to use the scanning disc or drum rotated by an electric motor.

It is well known that high-definition transmission necessitates the use of ultra-short wavelengths. These wavelengths are extremely difficult to control and cannot be received on the ordinary, everyday radio receiver. This would, therefore, entail the purchase of a further wireless receiving apparatus. Then again, the effective field of the transmissions is limited to a few miles, the range being estimated at between ten and thirty miles. It will, therefore, be seen that, for this type of television to become available to the general public, it would involve the broadcasting authorities in an enormous expense in the erection of special new transmitting stations throughout the country.

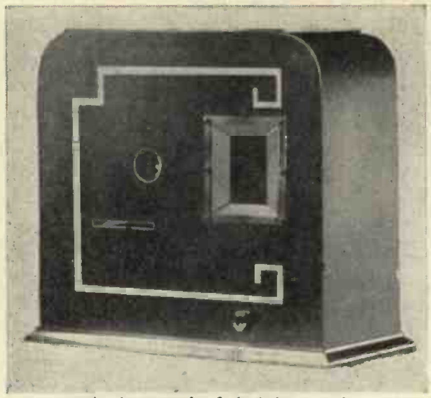
We should like to summarise the position by saying that perfection in television transmission and reception is doubtless upon high-definition lines on ultra-short waves, but cathode-ray principles cannot, at the moment, be adapted for popularised television reception, and—however much we may like to feel that we should run before we can walk—that, unfortunately, is not possible.

We must have our thirty-line transmission increased, to give the science a real lasting entertainment value. From thirty-line definition, we should go to sixty-line and the development to high-definition would follow automatically.

We cannot over emphasise the absolute necessity of apparatus being available for the general public at a low cost, and the equal importance, of as large an expansion as is possible on thirty-line transmissions of the entertainment broadcast.

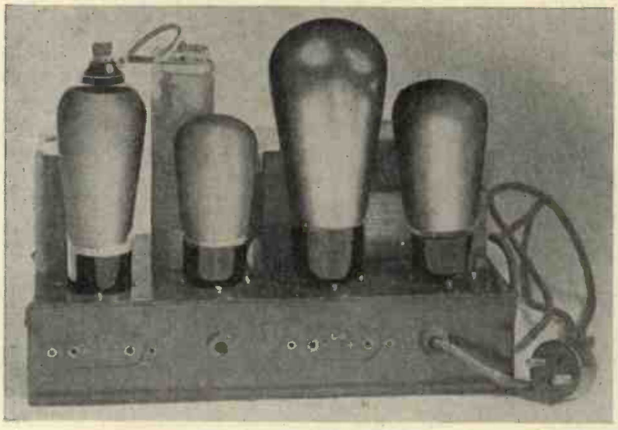
For PLEW TELEVISION, LTD.,
C. J. SHERMAN NORRIS.
Managing Director.

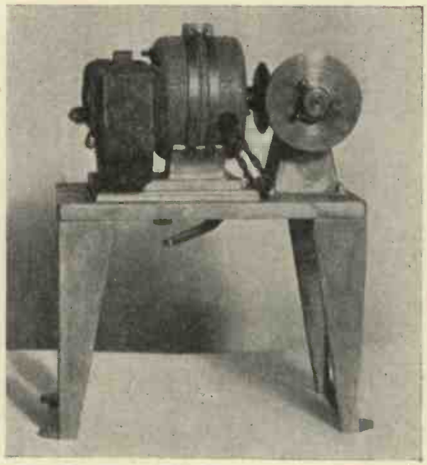
A MASS-PRODUCTION DISC RECEIVER OF NOVEL DESIGN



A photograph of the Plew receiver.

READERS will be interested to learn that a company has been formed and a large works equipped for the mass production of television receivers of a type that can be operated as easily as an ordinary wireless set. The company is the Plew Television Co., Ltd., and the premises, which are very extensive, are at Waddon near Croydon.





The three-valve Plew wireless set and (right) the motor, disc drive and synchroniser.

The intentions of this new concern are to manufacture complete receivers of a type that will meet the public demand. A start has been made with a disc receiver suitable for the present B.B.C. transmissions, which incorporates many novel ideas and is so easy to operate that it may be described as a "family" receiver. Three classes of this machine will be immediately available—one the motor and disc alone in a cabinet, so that it can be operated from an existing wireless set; another, the same type of motor and disc but incorporating a three-valve receiver consisting of an H.F., Det. and L.F. combination with, of course, a rectifying valve. The third machine incorporates a five-valve combination consisting of two H.F., Det. and power valves. A photograph of one of the receivers appears on this page and the whole assembly when in the cabinet is self-contained and remarkably compact.

The receivers are intended for A.C. operation only and advantage has been taken of this fact to include a novel type of synchroniser. An induction motor is used and on one end of the shaft there is a toothed wheel which revolves between two electro-magnets. These magnets are supplied with current from the mains independently of the motor and they therefore act as an external control. The motor is, therefore, mains synchronised and no use is made of the B.B.C. synchronising signal.

Another very novel feature of the drive for the disc is that it is frictional, the disc spindle being at right angles to the motor shaft. On the motor spindle there is a wheel provided with a rubber rim of special shape and this makes frictional contact with the face of a brass disc mounted on the spindle which carries the disc. Very accurate control of speed is obtained by sliding the motor one way or another so that the friction wheel can be in any position on the brass friction disc. Micrometer adjustment is provided, the operation being by means of a lever which projects through the front of the cabinet. A test showed that the device permits of very accurate and simple control, and it is quite silent.

The company is also carrying out experiments with recorded programmes and it is hoped to place on the market a series of records which will allow the machine to be used independently of transmissions. It has always been assumed that the very high frequencies necessary for television could not be recorded, but a record which was demonstrated proved that the Plew Company had secured a fair measure of success. Reproduction from an experimental record of a B.B.C. transmission appeared to be approximately seventy-five per cent. as good as the reproduction of the actual transmission.

A new type of neon lamp is also a feature of the Plew receiver. In appearance this is similar to the ordinary plate type neon but the electrode structure is different and the lamp gives a white light.

A photograph of the Plew Works at Waddon near Croydon.

? HOW MANY LINES ?

The question of the best number of lines for home television is one upon which opinions are divided, as so many other issues devolve upon it. The arguments put forward in this article are those of Ernest Traub, Research Manager of The International Television Corporation, Ltd., which is developing the Mihaly stationary mirror-drum receiver in this country.

HIGH-DEFINITION television has to-day reached a sufficiently advanced stage to merit serious practical consideration. This is borne out by the fact that H.M. Postmaster-General has considered it sufficiently important to appoint a committee to investigate on what basis a public service would be possible. The mere mention of the appointment of the P.M.G.'s Committee brings to mind a very important factor, namely, standardisation.

By this I mean standardisation of lines, picture repetition frequency, picture ratio, etc. Of these the standardisation of the number of scanning lines is by far the most important. Although the three factors have great bearing on *each other*, we may take it practically for granted that standardisation of picture frequency will be at 25 pictures per second on account of its proximity to the standard cinema frequency, and as only at that speed flicker of the image is reduced to a minimum level. As regards the picture ratio we must again look to the cinema for guidance as, no doubt, films will, for the first few years at any rate, play an important part in our high-definition television programmes. The standard film picture ratio is 5:6, so we can expect the same picture ratio to be standardised in television. This would mean a total picture ratio of about 3:4 including the synchronising strip.

Although our first two considerations are largely governed by cinema practice, the mistake should not be made in following the same considerations when considering the detail of the television image.

The detail of a television image is again bound up with several factors. These are:

(1) Number of scanning lines: n
(2) Number of picture elements: p.
(3) Picture size: (h=height, w=width).
(4) Viewing distance: D.
(5) Brightness of the image: e.

(Brightness is also connected with flicker and flicker is connected with picture frequency. Picture frequency is again to a certain extent connected with detail, especially at lower definition. An increase in the number of pictures per second causes an apparent improvement in the sharpness of the image, especially when this contains rapid movement.)

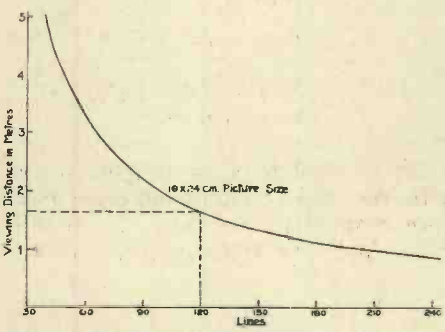


Fig. 1.—Relationship between viewing distance D and the number of lines n at a constant picture size 18 *by* 24 *cms.* ($7\frac{1}{2}$ *in. by* 10 *in.*).

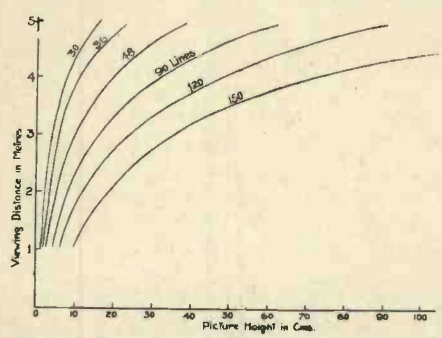


Fig. 2.—Relationship between viewing distance D and picture height h at various numbers of lines.

Let us now carefully examine the five factors that have a bearing on the definition of the image. The first two factors are governed by the transmitter, the other three by the receiver only.

Provided that we know the number of lines and the picture ratio we can work out the number of picture elements. This is $n^2 \times$ picture ratio. Thus if we know that a picture is divided into 120 lines and the picture ratio is 3:4, then

$$\frac{120^2 \times 4}{3} = 19{,}200 \text{ elements.}$$

This, of course, only holds good provided the picture spot is square.

Having dealt with the fundamentals we can now go on to consider the more practical side of the problem.

The writer has felt for some time that the question of the number of lines needed for satisfactory *home* television merited more serious consideration than was given to it in this country. He has therefore gone to the trouble of making very wide investigations on this subject from Continental and American sources. Perhaps the most important reports on this subject that have appeared are those by the German Post Office and a recent article by Thun.

The German Post Office produced special films by optical methods, each film representing pictures of different numbers of lines. These films were then scientifically observed by a number of people with different eyesight, the pictures being shown at different intensities, and viewed at various distances. The results are shown in a series of very important curves which are reproduced herewith. From these curves the following formula has been deduced:—

$$D = 750 \times \frac{h}{n} \times \sqrt[6]{e}$$

D being the viewing distance in metres, 750 a constant for all types of picture, h the height of the image in metres, n the number of lines, and e the image brightness in lux. This formula applies to all television images and gives one a proportion of the factors involved.

In order to apply this formula in practice we must decide on our requirements other than the number of lines.

Image Size

Image size is a very debateable point, and depends on the number of people that are to view the image simultaneously and the maximum angle of refraction of the viewing screen. The author has made a number of experiments in this direction in the laboratories of the International Television Corporation, Ltd., and has furthermore made inquiries among a number of people seriously interested in television, both professional and amateur. The result is that the *minimum* acceptable size seems to be 18 × 24 centimetres ($7\frac{1}{2}$ in. × 10 in.), preferably still bigger.

Viewing Distance

Viewing distance depends on the size of the room in which the receiver is to be housed and the grouping and number of spectators. Experiments and inquiries show that this lies somewhere between 4 ft. and 6 ft. Unfortunately most people are in the habit of stepping right up to the screen in the hope of seeing more detail. The contrary is, of course, usually the case. The image should, however, be so finely analysed that one can get fairly close without the distance between scanning lines forming an angle to the eye that is greater than 3 minutes.

Brightness

An image should be so bright that it can be viewed comfortably in a room with, say, two hundred-watt lamps as illumination. A fair amount of latitude is permissible here, depending on individual circumstances and tastes. At a rough guess one can say that a figure between 2 and 20 lux is an acceptable screen brightness.

Application of the Formula

Having decided on our minimum permissible factors we can substitute them in the formula and find the number of necessary lines.

Let the viewing distance be 5 ft. or 1.7 metres, the height of the image 0.18 metres (18 centimetres) and the illumination 10 lux, then if

$$1.7 = 750 \times \frac{.18}{n} \times \sqrt[6]{10}$$

then n = 118 lines approximately.

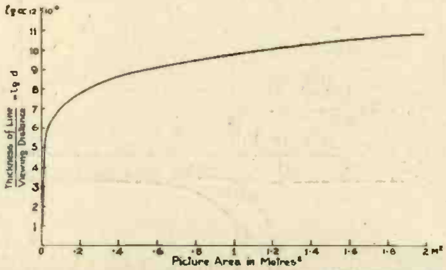


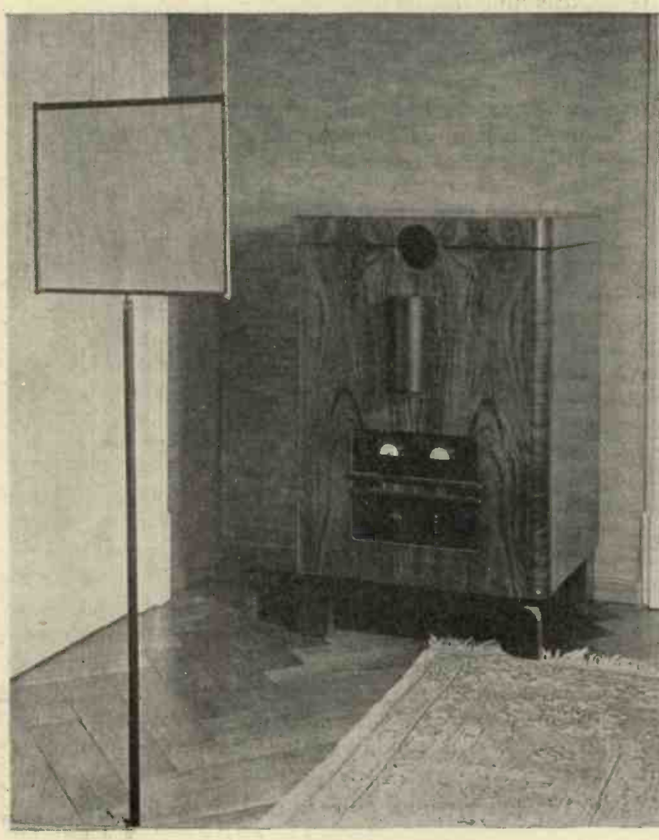
Fig. 3.—Relationship between $tgx = \frac{\text{thickness of line}}{\text{viewing distance}}$ *and the picture area.*

If we wish to view the image at 4 ft. we need 154 lines, all other factors remaining constant. If on the other hand we wish to increase the image size to 24 × 32 cms. (h=24) then we must increase the number of lines to almost 160, all other factors remaining constant. It should, however, be pointed out that the last two examples employ factors which are more stringent than those generally required. According to the calculation, therefore, we come to the conclusion that 120 *lines are sufficient* to give a good television image under the conditions which we at the beginning took to be in accordance with the majority of tastes and types of eyesight, although under certain *stringent conditions* 150 or even 160 lines might be of pictorial advantage.

Having arrived at a definite conclusion along this particular line of approach let us now look at the problem from a different angle. The Continental television expert Thun made a series of very interesting tests in this direction, using, however, a slightly different line of approach to that of the Post Office.

Thun examined a great number of reproductions in illustrated papers. For each picture the minimum viewing distance was found, that is the minimum distance at which the picture is still recognisable as such. If one now divides the picture height in millimetres by the viewing distance

A photograph of the Mihaly receiver with separate screen. This receiver utilises the stationary mirror drum and the picture is projected through the circular hole which can be seen at the top of the cabinet.



in metres, one finds the number of lines, provided that the thickness of one line subtends an angle of not more than 3.4 minutes to the eye. By process of elimination it was then found how many of the multitude of pictures that were examined could be easily recognised at various numbers of lines.

The result is produced in one of the curve diagrams, and shows that according to Thun at 120 lines 51 per cent. of all pictures can be recognised with sufficient ease, 71 per cent. at 150 lines, 84 per cent. at 180 lines, etc. It is interesting to note the figure of about 2 per cent. at 30 lines. This is obviously too low a figure, and this is where the number of picture elements come into consideration. The Germans in their 30-line pictures use only 1,200 elements whilst in England we use 2,100 elements, which corresponds to about 48 lines according to the Continental form of picture. For this figure about 5 per cent. is given as a factor of recognisability. This is still too low in the light of practical experience.

The reason why the curve throws a rather unfavourable light on the requirements of good television, is that the observed images were stationary. It is known that the movement of the picture and the continuous process of recomposition has a favourable effect on a television image. The improvement is of the order of 20 to 30 per cent., especially in the direction of scan. It is, therefore, fair to assume that we can shift the whole curve up 15 per cent. along the "percentage of recognisability" coordinate. This gives us a figure of 99 per cent. at 180 lines and 66 per cent. at 120 lines, which we know from practice to be correct.

Let us again examine the curve, and we find that just about 180 lines the curve flattens out, which means that any increase in lines above that figure gives us practically no improvement in picture, although the electrical transmitting and amplifying difficulties are enormously increased. In any case a 180-line picture requires a sideband of half a million cycles which already represents a maximum use of the 7-metre wave. To transmit a 240-line picture would require a sideband of one million cycles which could only be transmitted at 3 to 4 metres, again raising new difficulties due to loss of aerial transmitting power and therefore less field strength and reduced service area of the transmitter.

180 Lines the Maximum Necessary

We can, therefore, arrive at the conclusion, according to Thun, that *a 180-line picture is the absolute maximum* required for satisfactory home television. The transmission and reproduction of a 180-line picture still represents to-day a terrific technical effort, and it is doubtful whether 100 per cent. results have ever been achieved over a radio channel. The difficulties associated with still higher definition have been enumerated above, and both lines of approach to the question show that there is no necessity to go further than 180 lines.

The American theory of Engstrom is fallacious inasmuch as no consideration was taken of the brightness factor and also because the method of producing the test films by gratings in both directions across the picture is fundamentally wrong when applied to television. It is common knowledge that a television image has greater definition in the direction of scan than across it, as the position of the picture spot is not predetermined.

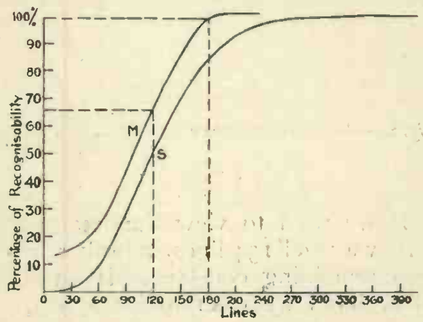


Fig. 4.—Percentage of recognisability against number of lines, A for moving television pictures, and B for artificially produced television images.

According to Thun's curve 180 lines would give 99 per cent. efficiency as far as recognisability is concerned, provided that the whole chain of equipment is perfect.

It is the writer's contention that a simpler solution to the problem would be to use a slightly lower number of lines at which 100 per cent. electrical and optical efficiency is more readily obtainable. For instance, *a really good 120-line picture is infinitely preferable to a mediocre 180-line picture.* Let us just for a moment compare the ratio of the problems associated with 120 and 180 lines. The available light at the higher figure is a quarter of the lower one. The frequency band is over twice as great. Thus, roughly, the amplification problem is nine times greater. The modulation of the transmitter becomes more difficult. The available light in every kind of receiver, even cathode-ray tubes, drops to a half, and in mechanical receivers to a quarter, all other things being equal. And even if all the equipment were perfect we only have an increase in recognisability from 66 per cent. to 99 per cent. The question arises *whether the increased technical difficulties are in any way commensurate with the slightly improved results,* assuming all the time that we are dealing with a perfect reproduction of a 180-line picture, the achievement of which remains doubtful.

In any case the formula deduced from the examination of the German Post Office films shows that 120 *lines is ample* for a satisfactory picture. The writer's view is that the recognisability factor of 99 per cent. at 180 lines is an *unnecessarily high* one. It is not essential to deal with every type of difficult subject for television transmission. Something can always be left to the imagination, and the special technique of the television producer would achieve wonders with 120 lines.

It should be stressed that these assumptions are not purely theoretical, but are substantiated by practical experience and observation of high-definition images of various numbers of lines.

During the experimental transmission from the Berlin Radio Tower, on the ultra-short wave transmitter installed by Telefunken, great difficulty was experienced with regard to the question of suitable transmitter valves; this difficulty increased rapidly with increased radiating power.

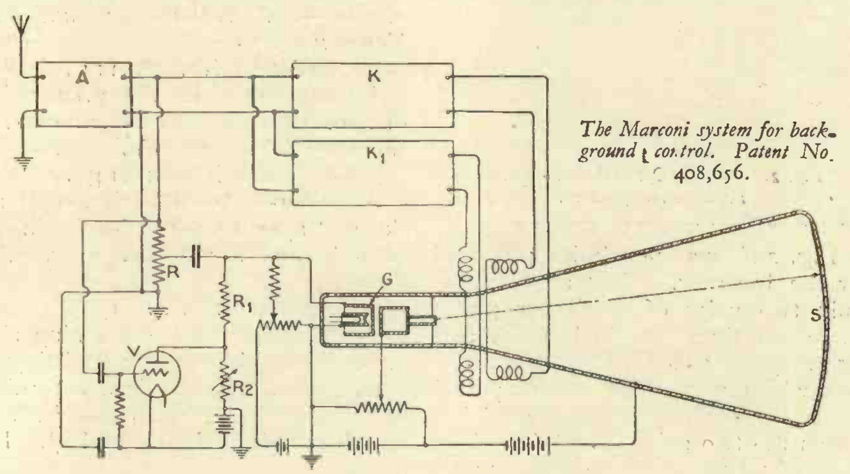
In the Year Book published by Forschungs Institut der Allgeinenen Electricitäts Gesellschaft (Vol. 3) there is some very valuable data dealing with cathode-ray applications. Also there is some very valuable information regarding the Kerr cell.

RECENT DEVELOPMENTS

A RECORD OF PATENTS AND PROGRESS
Specially Compiled for this Journal

Controlling "Background"
(Patent No. 408,656).

The background "brilliancy" of each picture is automatically regulated in accordance with variations in the intensity of the received signals. This object is attained by rectifying a part of the incoming signals, and applying the D.C. component to the control grid of the cathode-ray receiving tube. As shown, the picture signals, after amplification at A, are passed through a resistance R in the input circuit of a rectifying valve V, the rectified output voltage being applied through resistances R1, R2, to the control grid G of the cathode-ray tube.



The Marconi system for background control. Patent No. 408,656.

The initial grid-bias on the tube is such that when no signal is being received, the cathode-ray is cut off, and the screen S is black. As the intensity of signal increases in the "white" direction, the plate current through the rectifier V decreases, and the grid-biasing voltage falls off accordingly, to make the viewing screen brighter. On the other hand when the normal picture signal decreases in strength, the brilliancy of the background is automatically diminished. The usual synchronising frequencies are applied to the deflecting electrodes from two generators K, K1.—(*Marconi's Wireless Telegraph Co., Ltd.*)

"Facsimile" Television
(Patent No. 408,678).

The usual practice is to design an amplifier used for television reception so that it gives as nearly as possible a straight-line output, free from any distortion due to valve curvature. However, in television systems of the kind mentioned below (Patent No. R. 408,679) where the reproduced picture consists of a simple black and white design (e.g., the reproduction of a moving tape carrying a printed news bulletin) it is found to be an advantage to bias one of the valves so that it operates as an anode-bend detector.

In these circumstances only signal voltages above a certain minimum are passed through, all lesser voltages being suppressed. This does not produce any distortion, but on the contrary gives a more clearly-defined reproduction of the essential picture outlines. As the same time the bias tends to reduce "static" and similar interference, and also rules out the effect of small light-and-shade variations, such as are caused by differences in the "grain" of the paper on which the facsimile messages are written.—(*Marconi's Wireless Telegraph Co., Ltd.; R. J. Kemp; L. E. Q. Walker, and E. F. Goodenough.*)

Televising "News Items"
(Patent No. R. 408,679).

It has been proposed to use television apparatus for transmitting the facsimile of a moving tape on which news-bulletins or other messages of importance have first been written or printed. The apparatus necessary for this kind of work is relatively

Figs. 1, 1a, 2 and 2a. Diagrams illustrating the televising of news items. Patent No. R.408,679.

simple, since only pure black-and-white reproduction is required, without any half-tones or intermediate graduations of light and shade. At the same time certain rather special problems arise in scanning the continually-moving tape.

For instance, owing to the movement of the letters, shown in Fig. 1, in the direction of the arrow, they are liable to appear somewhat "blurred," as shown in Fig. 1A. In order to overcome this defect, the letters forming the message to be transmitted are originally printed on the tape so that the vertical parts are narrower than the horizontal portions, as indicated in Fig. 2. The result of scanning then restores these distorted shapes to the normal, so that they appear in the receiver as shown in Fig. 2A.

Another way of overcoming the difficulty is to use a neon lamp "trigger" as part of the receiving circuit, so that any received signal above a certain minimum value causes the neon lamp to break down and apply a sharply-defined impulse to the grid of the next valve. This serves to convert any blurred line into a clear-cut one of uniform thickness.—(*Marconi's Wireless Telegraph Co., Ltd.; H. M. Dowsett and L. E. Q. Walker.*)

Focusing the Ray

(Patent No. 409,221).

Fig. 1 shows a known arrangement of cathode-ray tube in which the beam from the cathode C, after passing through the central aperture in the anode A, is focused by an outside coil M, which causes the beam first to diverge and then to converge towards the screen, as indicated in dotted lines. The usual deflecting electrodes, for throwing the beam to and fro, and up and down the screen, are shown at E and E1, respectively. It will be seen that the pair of condenser plates E are set somewhat closer to the fluorescent screens than the pair E1.

Because of this the beam is rotated about a different centre when it moves vertically to when it moves horizontally across the screen, and, in consequence the spot of light is not equally focused over the whole picture, but tends to be blurred, particularly at the outside edges of the screen. It is possible to get over this difficulty by arranging both sets of condenser plates dead in line with each other, but then distortion may occur owing to interaction between the two fields of force. The same objection arises if one pair of condenser plates is replaced by a pair of magnet coils.

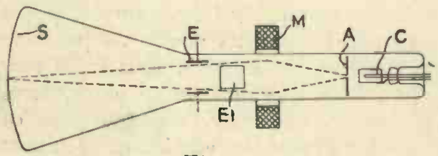


Fig. 1.

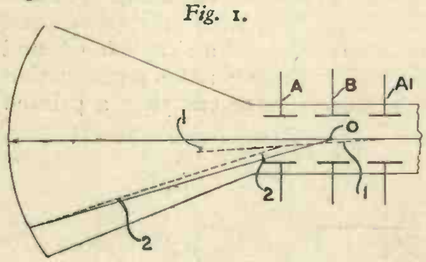


Fig. 2.

Fig. 2. Modification of cathode-ray tube. Patent No. 409,221.

Fig. 2 shows the solution proposed by the inventor. Instead of using only two pairs of condenser plates there are three, marked A, B, and A1 respectively. The control voltage which moves the beam up and down the screen is thus shared between the two pairs A and A1. The plates A1 first deflect the beam vertically into the line marked 1, and the plates A then increase the deflection still further into the direction marked 2. The middle pair of plates B are, of course, arranged at right-angles to the other two, though they are actually shown in the same plane for the sake of clearness. They serve to swing the beam in the lateral direction, about the point marked O, which is now the effective centre of radius of the up-and-down movement. The scanning spot of light is thereby correctly focused at all points on the screen.—(*Telefunken Co.*)

Summary of Other Patents

(Patent No. 409,367).

Apparatus for televising ball-games and other out-door events, or theatrical performances.—(*Electrical Research Products, Inc.*)

(Patent No. 409,970).

Reproducing television signals on the screen of a cathode-ray tube as a series of dots instead of as a series of lines in order to avoid striation effects.—(*T. Nakashima and K. Takayanagi.*)

(Patent No. 410,114).

Improvements in the preparation of fluorescent screens for cathode-ray tubes.—(*Telefunken Co.*)

(Patent No. 410,147).

Amplifier-coupling designed to reduce "aperture-distortion" in a cathode-ray tube.—(*M. Von Ardenne.*)

(Patent No. 410,159).

Fluorescent screen containing zinc or cadmium borate for emitting a blue, green, or white light according to composition.—(*Electric and Musical Industries, Ltd., and J. W. Strange.*)

(Patent No. 410,338).

Improvements in film systems of television.—(*Fernseh Akt.*)

PHASING AND FRAMING

TWO words "phasing" and "framing" are used in connection with the synchronising of the vision apparatus at the receiving end with the moving element at the transmitting end which are confused by many people. An image is said to be out of "phase" when corresponding disc holes or mirrors on a drum, although revolving at the same speed, are not strictly in step. For example, No. 1 hole at the transmitting end may be exploring the subject at the instant when, say, No. 15 hole of the disc at the receiving end is moving across the neon glow. Under these circumstances the image is split in the direction of scan.

To *phase* the image correctly the motor speed needs to be altered slightly to allow the image to drift at right angles to the direction of scanning and thus get it centred correctly. That is to say, in the case of vertical scanning, the image must be moved bodily to left or light, so that the centre of the subject scanned is seen on the vertical centre line of the viewing screen.

That may not be sufficient to give you everything you require, however, for if you have a toothed-wheel synchroniser it may be set on the shaft in an incorrect angular position, so that although the image is "phased" it is not "framed." In this case the top and bottom of the picture may appear interchanged, the division being horizontal. This can be rectified by moving round the motor carcase and synchronising mechanism bodily to raise or lower the image and bring it into frame. In the case of the Baird apparatus a framing knob brings this about through the medium of a pinion and toothed sprocket.

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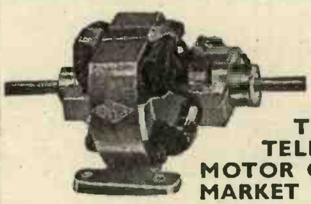

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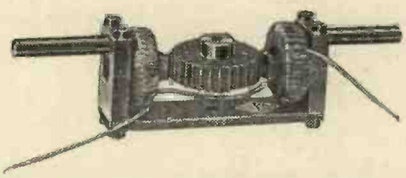

DESIGNED by one of the foremost Television Technicians and constructed of specially selected materials to ensure perfect synchronising, thereby reducing floating images to a minimum. Complete kit of parts comprises one Mild Steel frame with end bobbin supports. Slotted to permit of precise adjustment of pole pieces, 2 assembled laminated pole pieces, 2 ready wound bobbins, 2 ebonite handles for ease of control. Easily assembled at home, no skill required. Ready to mount on either end of Peto-Scott Universal Motor. Complete Kit Cash or C.O.D. Post free. **37/6**

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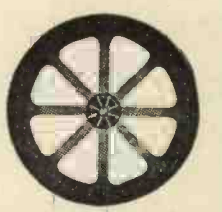

EACH disc is of light gauge aluminium, dull black one side, and centres cut out to reduce weight. The centre boss is an 8-ribbed black bakelite moulding. Each rib being faced white to give true stroboscopic effect, and thereby visual speed indication. A heavy brass bush insert with Grub screw provide simple and accurate fixing for ¼" motor spindles. Scanning holes perfectly punched to secure uniform scanning without preventable lines. Made in 2 sizes and ready for immediate use. 16" diam. **7/6** 20" diam. **12/6** (Postage 9d. extra).

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Described in last month's issue.

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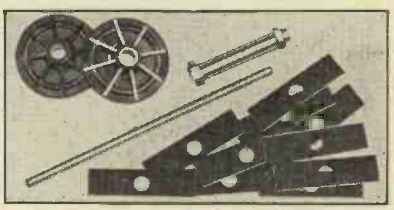

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Mirror edged plates, drilled finished dull black. each	1	0
Brass Centre Boss complete with locking nuts and bored for ¼" spindle ... ... each	2	6
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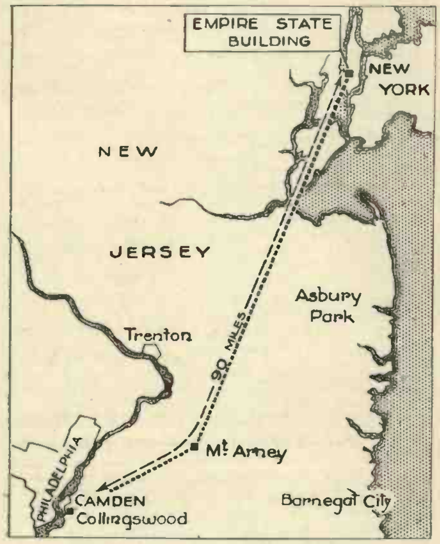
Rapid Progress in American Television

Considerable Headway Revealed at I.R.E. Convention.

AMERICAN radio manufacturers, as a general rule, are very keen to advertise any new ideas they may develop.

If the same remarks apply to the television manufacturers, we in this country would be able to learn a considerable amount about the proposed arrangements for television broadcasting that are now being made over there.



Map showing the area over which the transmissions were made.

The average man in the street does not realise that technically speaking television is an accomplished fact and providing that certain transmitting but economic troubles are overcome it will be quite common to see combined radio and vision apparatus.

The only snags are the cost and the lack of a definite policy. To prove that this state of affairs is not confined to this country it is interesting to note what the television engineers of America think about it and the opinions they voiced at the recent I.R.E. Convention at Philadelphia, where the brains of the radio industry congregated.

Remember that America, as far as television is concerned, is on a level with us and so what is being done over there can, or probably has been done over here. The technical progress in the States has shown that television has a definite entertainment value even at this early stage. One of the most up-to-date transmitters has been erected on top of the Empire State building in New York City for vision experiments on ultra-short waves.

For quite a long time it has been possible to send out programmes to Camden, some 90 miles distant, but these were restricted to plays and set scenes in the studio. Now for the first time in that country successful transmissions of outdoor scenes have been made. This means that race meetings, boxing contests, or any outdoor functions can be broadcast.

Actually, outdoor scenes that took place over a mile from the transmitter were sent out from Camden to New York. The transmitter was linked to the scene of action by means of a cable 1,500 feet long, then broadcast over 90 miles via a relay point at Collingwood to New York.

Both vision and sound were on the ultra-short wavelengths and it was claimed by the R.C.A. engineers that synchronisation was perfect. With a power of only two or three kilowatts the field strength at 90 miles was excellent and the picture definition equal to the standard 8 mm. home movie. At the convention a very large screen used for lantern projection was employed and pictures thrown on it of photographs of the cathode-ray receiving tube. With this high degree of magnification the horizontal scanning lines were visible, but the definition was of a very high order.

The developments on the technical side, it was stated, have been largely made possible by the design of the Iconoscope cathode-ray scanner for which Dr. Zworykin was awarded the Morris Leibmann prize for 1933. This device is capable of much greater detail than the remainder of the system and because of the characteristic of the cathode-ray tube it is possible not only to change the focus for close-ups, but fade-outs are also possible.

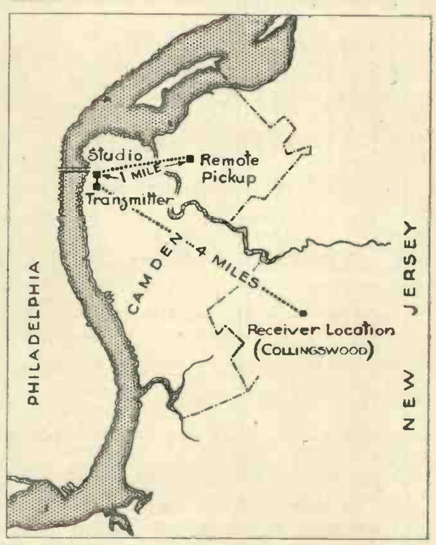
By proper change of deflecting voltages the point of interest can be moved from the actual centre of the picture to one side in the same way as a photogher uses the rising or falling lens board or moveable back to the camera. For these changes of view the camera need not be moved, a great technical advantage.

W. R. G. Baker, vice-president of the R.C.A. Company, spoke at length of the costs of setting up a national television system.

He estimates that the receiver is the least troublesome part of the equipment and that it should cost about 300 dollars (about £75). The main expense comes in the provision of the transmitting network which has to be a short-wave equipment, and he estimates that some 80 transmitters would be necessary to serve the country with a probable public of 700,000.

This would require an expenditure of $40,000,000 and to keep these stations running, including the depreciation costs, would account for $58,000,000 annually. The present investment in the American broadcast industry is only about $25,000,000 and this has been built up over a period of ten years.

Then again, a broadcast station radiates some 5,000 hours per annum. A television service would have difficulty in reaching half this amount. There are some 300 new films produced each year in America and the transmission of these would account for about 400 hours. Allowing a similar time for the transmission of all the new plays put on in New York and adding shorts and news reels, the total time would probably not reach 2,000 hours.



Map showing the location of studio and transmitter.

Mr. Baker suggested that the main problems ahead of television are not technical so much as economical, and that the industry will have to be handled on special lines if the television service which the public is patiently awaiting is to come to fruition.

TELEVISION AND ADVERTISING

A SPECULATIVE article appeared in a recent issue of the *Advertising World* on the possibility of linking television up with advertising. As a matter of fact this is receiving the consideration of concerns which are at present responsible for sponsored broadcasting and the prophetic ideas expressed in the article are of interest if not immediately practicable.

The writer says:

In America, particularly, television has been used frequently as a medium for publicity. One of the most ambitious efforts in this direction is accredited to the recent nine-day demonstration arranged in the New York departmental store of R. H. Macy & Co. In this instance one of the windows was equipped as a television transmitting studio and reception was shown on a five-foot screen, in a theatre on the fifth floor.

The demonstration is credited with attracting a total of over 150,000 people to the store, within the nine days, and in addition to entertainment the commercial angle was thoroughly exploited by televising such objects as wearing apparel, etc., accompanied by a sales talk as running commentary.

In the States there are now about thirty transmitters putting television programmes "on the air" either on regular programme schedules or experimentally, using direct pick-up from televised scenes and objects, or from films. Several of these transmitters, sponsored by commercial interests, are already using the new medium for sales propaganda purposes.

A new system of "wired television," recently perfected by British television interests, is shortly to be put into operation which will make it possible to utilise television as a propaganda medium without the necessity for any radio link.

The new system will put television programmes, sponsored by advertisers, into the "networks" of the radio relay services. A new simplified television receiver, which can be mass-produced at very low price, will be installed in the houses of those who are provided with the relay service. No initial charge or rental will be made for the equipment, but income will be derived from advertising revenue received from programme sponsors. The sponsors will form two main groups, the first covering such commercial interests as local stores, dairies, laundries and similar public services who will take time on the network to put on direct programmes of their own from the relay studio or by means of a portable television transmitter which has been designed for this service. The second group will cover national advertisers who will provide recorded vision programmes, samples of their products and accompanying sales talk to be put on the wires from the studio.

This newest propaganda will form a direct link between sales counter and the housewife, enabling the sponsor to display his merchandise to thousands of prospects simultaneously.

The Frequency Band Problem in Television—II

By E. L. Gardiner, B.Sc.

DISCUSSIONS raged in the technical Press about three years ago, as to the strict validity of the accepted side-band theory of radio transmission, and whether it was possible to separate transmissions so closely spaced in carrier frequency that their side bands actually interlaced. The experimental work and discussions on this matter brought much useful information to light, and is responsible for most of the improvements in modern radio receiver design brought about by the general acceptance of the method of design in which the low-frequency circuits are " tone corrected " to restore to their full proportion the higher modulation frequencies which have been weakened by side-band losses in the over-selective tuning circuits. Nearly all sets employ this technique to-day, and their excellent combination of selectivity and tone quality is largely due to it.

This is the second and concluding instalment of an article discussing the width of frequency band necessary for television and suggesting some lines of attack on what is one of the major problems.

The side-band theory, however, has emerged from these discussions with flying colours, if a little extended and clarified; little has been heard of those who criticised it since the publication of a most comprehensive blue paper by Colebrook, under the auspices of the Department of Scientific and Industrial Research, Report No. 12, 1932, in which the position was very clearly summed up, and the evidence for modification of the theory largely demolished.

Modulation and Frequency

The second theory which I must stress for a clear understanding of this problem is the one already referred to, that a carrier cannot be modulated by a frequency higher than itself; which is another way of saying that one cycle of the carrier frequency is the briefest unit of modulation with which we can deal, and must therefore be associated with the smallest element of our television image, the " picture point " as defined here.

Modulation problems, if considered generally, demand mathematical treatment, whereas this article is intended for the reader well provided with commonsense but lacking mathematical training, but consideration of certain easy cases will show how impossible it is to modulate with frequencies higher than the carrier frequency. Were it not so, many most intriguing things would enter the realms of possibility, such as the conducting of short-wave transmissions about the world to their destinations by means of long-wave carriers, free from fading and many other losses!

Consider the simple case of two sine waves added vectorially in which the amplitudes are equal, that is a carrier-wave 100 per cent. modulated by a higher frequency. Draw this, and you will find that the resulting wave-form is identically the same thing as the higher frequency modulated by the lower. The carrier and modulation have simply changed places, and the result is indistinguishable from a high-frequency modulated by a lower one, which we had hoped to avoid. The case of modulation within one cycle of the carrier is obviously equally impracticable, that is if we tried to impress the effects of two or more " picture points " upon the one carrier cycle.

Some means of distinguishing between the two must be retained within the cycle, and this implies either a change in wave-form or in phase relationship. Both are equivalent to the introduction of higher modulation frequencies into the carrier, which we have already decided is impossible, the first very obviously. Moreover, any variations in phase within the scope of individual carrier cycles would be effectively lost in the course of radio transmission and reception, from the action of even one fairly lightly damped tuned circuit.

(Continued on page 374.)

The German Post-Office has conducted experimental transmissions of television on ultra-short waves, from the Funkturm ever since 1932. A second ultra-short wave transmitter has recently been added and it is hoped to start a regular experimental service for sight and sound at the time of the opening of the German Radio Exhibition, 1934. The picture transmitted will be the new German standard 180 lines 25 frames per second. The photograph shows the aerial feeder cable and counterpoise on the top of the Berlin Funkturm.

"An Optical Paradox"

(*Continued from page* 359.)

have $P^2 = \pi/4$ or $P = 0.886$ approximately. This represents a better lens than the best photographic objective yet made, which has an aperture of $P = 0.99$ (the "goodness" of a lens increases, of course, as the P-number decreases).

Lenses Not Perfect

It might be thought possible to produce a pin-point of light, very small, but amazingly intense—so intense that we might disintegrate even a piece of platinum upon which it was focused—by forming an image of Sirius at the focal point of a good lens. Unfortunately, even the best lens is not a perfect instrument, and will not produce very small images. The smallest image which can be produced by a simple objective lens has a finite radius, calculated by Airy and given by:

$$r = 1.22 \frac{f\lambda}{D}$$

where f is the focal length of the objective lens,
λ is the wavelength of the light considered.
D is the diameter of the objective-lens.

This formula has already been explained by Professor Cheshire in these columns (see TELEVISION, Vol. 1, No. 3, p. 17).

Thus, it will be seen that the "most efficient optical system" is not a concrete thing like a motor-bus, but depends upon complex considerations, not the least of which is how much one is prepared to pay for a lens. One thing that does emerge, however, is that in the case of simple systems such as those in which a small aperture is to be brightly illuminated (for example, for mirror-drum or lensed-disc scanning) the best condition is obtained when the source itself is brought up directly behind the aperture, and no condensing lens is used.

"TELEVISION"
STAND No. 10
AT OLYMPIA

"The Frequency Band Problem"

(*Continued from page* 372).

If this fact be accepted, then it follows necessarily and at once that the band-width of the ratio transmission cannot be less than the maximum frequency generated by the television transmission, whatever this may happen to be. Much improvement may be obtained by reducing this maximum frequency in ways suggested earlier, and by making the most economical use of the frequency band by concentrating the energy of the television signal as far as possible into the lower frequency portion of the spectrum, and by avoiding in every way possible the generation of frequencies which are not absolutely essential to convey the actual information contained in the image; but when such reductions have been carried as far as possible, the resulting frequency band determines the minimum frequency band radiated by the radio transmitter.

This result follows rigidly from our accepted theories of transmission, and cannot be avoided unless such theories are more or less completely abandoned.

Of course, the statement that the minimum radio frequency band radiated is not less than that generated by the television transmitter does not represent the state of current practice, in which it generally exceeds this by at least two to one. The methods of modulation usually employed in radio transmission demand that the highest modulation frequency shall not exceed about 10 per cent. of the carrier frequency employed if distortion effects of various kinds are to be avoided. This, as we well know, implies the use of very high carrier frequencies in the ultra-short wave region if the band generated at the television apparatus is a wide one, as in present forms of high definition apparatus.

Clearly, however, there is no fundamental reason why the carrier should not be lowered up to the limit arrived at in the foregoing discussion, in which it equals the highest modulation frequency used; the figure of 10 per cent. being only dictated by practical considerations of communication engineering. To approach this ideal, however, means abandoning the conventional systems of modulation, such as the Hiesing or choke control most general in sound broadcasting; and the evolution of special methods.

The logical limit is reached if the " picture point " frequency is made to act as the radio carrier frequency. An effect of this sort was actually obtained in very early television work in which the light ray falling on to the photo-cell in the transmitter was interrupted by a " chopper disc " at a high rate, thus generating in the cell a carrier frequency, photo-optically modulated by the image signals. This disc was on occasions synchronised to operate at " spot frequency," thus producing a signal which could be amplified by amplifiers tuned to this frequency, or radiated as a radio signal.

More recent work in France has employed amplifiers in which the " picture point " frequency generated from a local oscillator is injected into them at an early stage, and then modulated by the photo-cell impulses to give a signal of the sort under discussion. In recent work in this country a similar signal is produced even more simply by the amplification of vision impulses already rich in the " spot frequency."

It is not my intention to discuss here, however, the various means of producing signals of this general type, but, rather to point out that they seem to represent the absolute limit in the reduction of both carrier frequency and modulation frequency band, and also that such a signal when radiated has an enormous side-band spread extending from zero frequency on the one hand to twice the carrier (in this case the " picture point ") frequency on the other.

This would seem to introduce special problems in receiver design, since many other transmissions will fall within this band of from the carrier down to zero cycles, and must somehow be excluded from the receiver without the use of ordinary selective methods which would eliminate the whole of the television modulation.

It is suggested that owing to their exceedingly transient nature and their symmetry about the carrier frequency, these collossal side-band effects would be subject to a cancellation effect in an ordinary receiver tuned to some other station, and would therefore be inaudible. This would seem very probable on purely theoretical grounds, or in an empty ether such as might be simulated in the laboratory. It is easy to grasp in the case of a receiver tuned to the television carrier, and perhaps less easy in the case of one tuned to some other wavelength which falls within the side-band area of the vision signal; since in this receiver the side-bands will not be symmetrically received.

Effect of Heterodyning

I find it difficult myself, however, to grasp how such a transmission could remain inaudible in the crowded ether with which we are blessed or cursed to-day, since the presence of other stations unsymmetrically placed around the vision carrier, but well within the side-band will heterodyne these side-bands and render them unsymmetrical. One would expect that in a receiver tuned to one of these other stations, the heterodyne transient effects caused by the momentary incidence of a vision side-band impulse would be strongly audible, having a character somewhat similar to an atmospheric. This is a matter on which I am sure the results of exhaustive experimental test is awaited with interest.

This brief and necessarily incomplete résumé of the frequency band problem in television would not be sufficiently complete without some reference to a type of system typified by that of Farnsworth, which may be regarded as intermediate between the two classes previously described. The characteristic of this system is the reduction of frequency band by the omission from the transmitted signal of some of the highest frequencies generated in the television transmitter itself; these missing frequencies are then replaced or synthesised in the receiving amplifier by a form of harmonic generator operator by the remainder of the signal, and are restored in very much their original form.

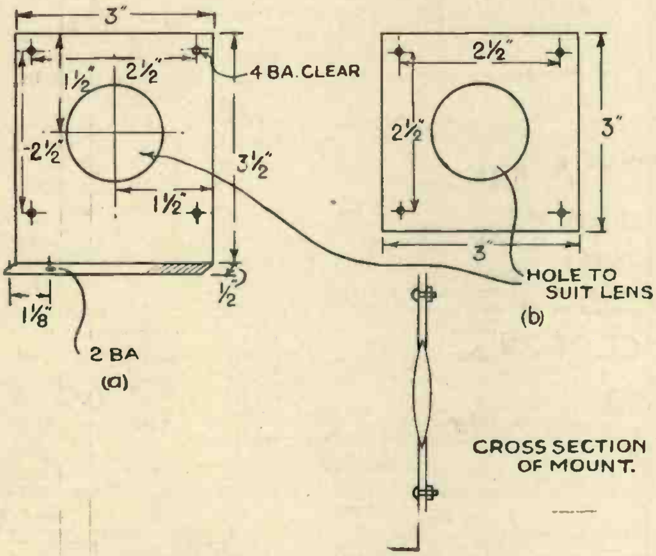
This process seems very parallel to the use of audio-correction now so common in sound broadcast receivers, and is in fact very mildly applied in any television system employing corrected amplifiers to increase the high frequency response to compensate for unavoidable losses and aperture effects. It only becomes a definite system, however, when high frequencies are intentionally suppressed in the radio transmission, and restored at the receiving end. Such an economising arrangement might be used with advantage in addition to other lines of improvement hinted at in the earlier part of this article, to still further extend the possibilities of vision broadcasting.

Advertisers like to know you saw it in " ' Television ' " overall diameter. Any other fairly accurate drum can of course be used, but if one of larger diameter is chosen slight modification of the motor bracket may be necessary. One word of warning is necessary in connection with the Unisphere kit, namely, when the drum has been assembled it is not normally balanced, and the motor should not be run up in speed rapidly until the drum has been balanced, or very violent vibration will be experienced which may lead to some mechanical damage. The writer found that the most successful way of balancing the drum was to drill a hole in every other spoke of the drum at a distance of about 2 in. from the centre, and put a 1 in. 4 BA screw through each hole. After fixing each screw with one nut, additional nuts can be put on to individual screws as may be necessary to balance the complete kit.

A later article will give details of final constructional points and adjustments, and a suitable amplifier will be described. The transmitter and amplifier are capable of modulating a cathode-ray tube direct from any object having a fair degree of contrast and not larger than 5 in. × 10½ in.

Materials Required

One wooden baseboard, ½ in. × 9 in. × 30 in.; 2 wooden battens, 1 in. × 1 in. × 9 in.; 1 sheet aluminium (16 s.w.g.), 14 in. × 17 in.; 1, 16 in. length curtain runner (obtainable from Woolworth's); 4 cranked runners for above (see diagram B, Fig. 4); 1 six-volt motor (Mervyn); 1 mirror drum (Mervyn Unisphere kit); 1 objective approximately 1 in. dia., 4 in. focal length; 1 condensing lens (bi-convex) approximately 2 in. dia., 3 in. focal length; sponge rubber, screws, black enamel, etc.; 1 S.B.C. baseboard-mounting lamp holder; 1 six-volt 24-watt S.B.C. car lamp; 2 five-amp. tumbler switches; 1 resistance for controlling motor (Peto Scott); 1 plane mirror approximately 2 in. square.



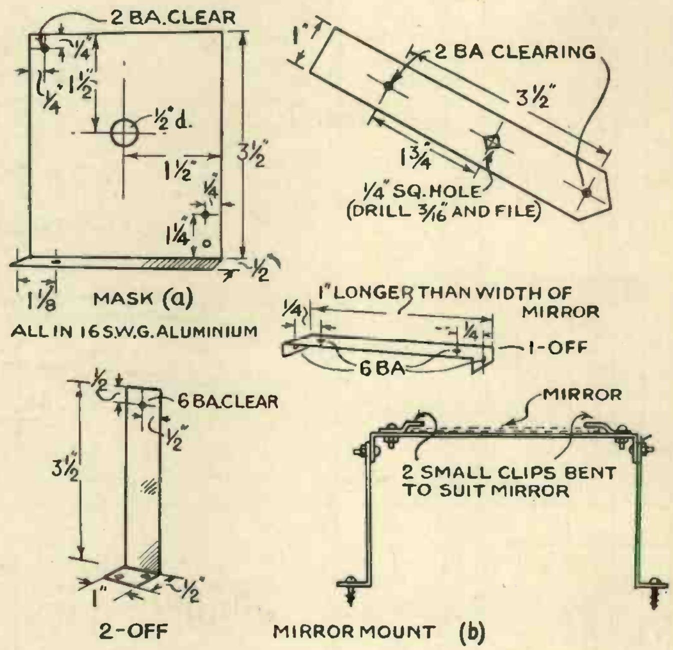


Fig. 5 (above).—Method of mounting the lenses.
Fig. 6 (right).—Details of second aperture and mirror mount.

German Ultra-short Wave Receivers—A Design Approved

NEWS regarding the erection of a second ultra-short wave transmitter in Berlin has created the general impression that the German authorities intend starting what will be, at the outset at least, an experimental television service for sight and sound on ultra-short waves with one hundred and eighty lines and twenty-five frames per second. The erection of the second transmitter has been considerably delayed. It was first expected to start the experimental service on May 1st, but some delay has been occasioned.

Recent Post-Office tests have shown that the power of the ultra-short wave station is sufficient to provide the whole of Berlin with adequate high-definition television reception.

At the last German Radio Exhibition held in August, 1933, the public were able to see one-hundred-and-eighty-line, twenty-five frames per second pictures, but these were shown on laboratory models. Meanwhile a lot of work has been done and recently Loewe Radio have supplied the German Post-Office Laboratories with two complete ultra-short wave combined sight and sound receivers.

The new Loewe receiver, which in its outer form greatly resembles that shown at the last Exhibition, contains a combined super-het receiver for simultaneous reception of sound and sight. It is stated that the picture is perfectly steady, is well illuminated and that detail is sufficient for really enjoyable reception.

It seems likely that Berlin listeners will actually be able to enjoy television this winter.

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