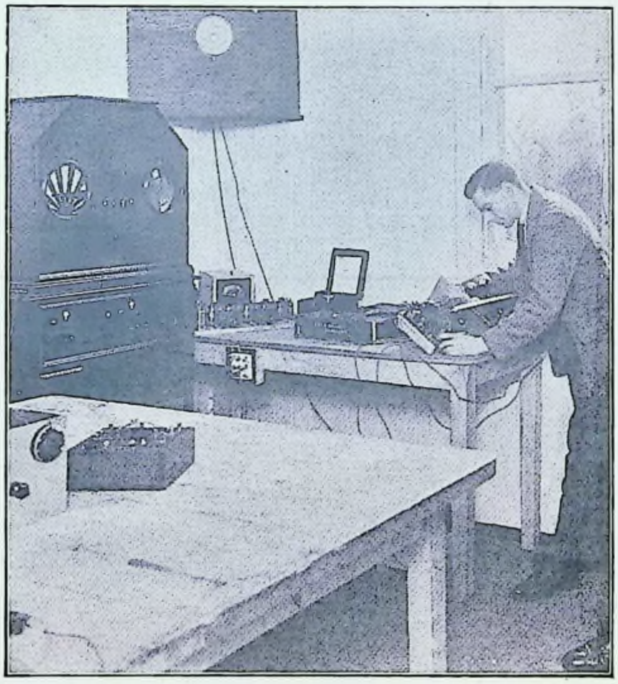
FACILITIES FOR BAIRD SYSTEM

6D MONTHLY

Television

The Official Organ of the Television Society

VOL. 2 MAY 1929 No. 15



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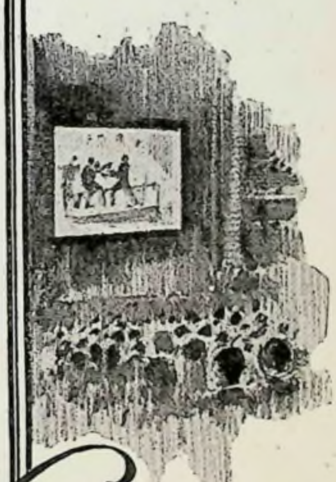
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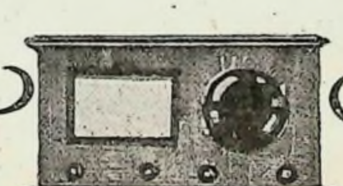

Television

THE WORLD'S FIRST TELEVISION JOURNAL

The Official Organ of The Television Society

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Vol. II] MAY 1929 [No. 15

EDITORIAL

BROADCAST FACILITIES GRANTED.

IN our last issue we placed before our readers the latest available information about the official test by the Postmaster-General and the B.B.C. of the Baird system of television. Since that issue was published our readers have no doubt read in the daily press the terms of the P.M.G.'s decision. We reproduce on another page the full text of his letter to the Baird Company. We regard the decision as being in every way fair and just.

* * *

AFTER outlining what the Baird system of television proved itself on the occasion of the test to be capable of doing, he goes on to point out the limitations of its scope at present. With that statement we have no quarrel; the record of all great inventions shows that many years are required to develop them to "perfection" and enlarge their scope. In our opinion Mr. Baird is to be congratulated on having, within such a short space of time, brought his invention to the stage of development which it has reached to-day.

* * *

THE Postmaster-General considers that the system represents "a noteworthy scientific achievement." Coming from one of His Majesty's leading Cabinet Ministers this is high praise indeed. But he does not consider that television should immediately be introduced into regular broadcasting hours. He is, however, anxious that facilities should be afforded for continued and progressive experiments to be made with the Baird apparatus, and agrees to the use of one of the B.B.C. stations for that purpose. The B.B.C. also agrees in principle to this proposal.

* * *

TWO STATIONS REQUIRED.

THE Postmaster-General also recognises the fact that, in addition to the station broadcasting television, another station will be required to broadcast the accompanying music, singing, or speech. So far as London is concerned, it will not be possible to provide a second station until the new B.B.C. regional station at Brookman's Park is completed in July.

* * *

THE P.M.G. further suggests that it may be necessary to employ for the broadcasting of television wavelengths outside the normal broadcast waveband, which is already congested. He recommends that experiments be pushed forward on "a much lower band." We may therefore expect a revival of interest in wireless reception on wavelengths below 250 metres.

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IN summing up the whole of the P.M.G.'s letter there are those who choose to regard it as being unfavourable to the Baird system. We do not share that view. One must expect a certain amount of extreme caution when the head of a Government Department places his seal of approval on the product of a commercial company and recommends that the facilities of a semi-government organisation be placed at that company's disposal for the purpose of conducting further experimental work.

* * *

OUR POLICY BEARS FRUIT.

AS our readers well know, we have consistently urged that broadcasting facilities be granted for the Baird system. More recently we have pleaded for the recognition in this country of a British invention and pointed out that unless this recognition was granted speedily our Continental neighbours were certain to experience the benefits of this British invention before we did, in the country of its origin.

* * *

WE felt very keenly on this matter, for we do not belong to that body of persons which delights in lauding *anything* of foreign origin in preference to something invented and produced in this country. As a result of our stand we have, in the past, been a greatly discredited journal. In future, we trust, we shall be regarded in a totally different light. We have reached this stage, not by spectacular methods, but by the force of solid conviction. It has been a war of attrition—and we were prepared for it when we first took up our stand.

* * *

A NEW BOOM AHEAD.

OUR wireless contemporaries are at last beginning to realise the truth of one of our contentions—that the introduction of television into the broadcasting service will revitalise a flagging industry. With the advent of television we predict that the biggest boom which this country has yet experienced is about to start in the wireless industry. Those who possess a wireless receiver for the reception of sound broadcasting, and wish to receive television as well, will require a second receiver; and those who are already the possessors of two receivers will require a power amplifier. The subject of H.T. battery eliminators (to which we have been devoting some attention in these pages) will also have to be considered more seriously, and in a new light, for two receivers must now be supplied with H.T. current.

* * *

THE wireless journals have adopted towards the P.M.G.'s letter a very praiseworthy attitude, upon which we congratulate them. We reproduce below some extracts which express their views.

* * *

"A NOTEWORTHY SCIENTIFIC ACHIEVEMENT."

The Postmaster-General is to be congratulated on his excellent summing up of the recent official tests carried out between the Baird Television Development Co., Ltd., and the B.B.C. The purport of his communication to the Baird Company indicates that we can look forward to real "seing-in" in a relatively short time. With television as an ally, broadcasting will take on a new interest.

The other day I read an article in an American paper which questioned whether wireless broadcasting would be so effective if it were accompanied by television. Summing up the situation, the writer held that he who travels by the wireless with imagination for his guide may enter into those realms of gold which are closed to those who, seeing all, blindly seek a certainty.

DOUBLY GIRDED.

I am afraid, however, that the arguments put forward were far from convincing. Imagination is a wonderful asset to the individual when applied in the right direction, but to use that as an excuse for discounting television is certainly wholly wrong. To the amateur this new science opens up what may be regarded as a virgin field of investigation, and for that reason alone we shall welcome its appearance. Of late, I have been making a careful study of the problems involved and find that once the elementary principles are thoroughly understood "seeing by wireless" is really only slightly more complicated than sound reception.—*Amateur Wireless*, April 13th, 1929.

. . . . .

We consider this to be a very fair and proper attitude for the Postmaster-General to have adopted, and it now remains to be seen what arrangements can be come to as between the Baird Company and the British Broadcasting Corporation to provide for experimental transmissions outside broadcasting hours.—*Wireless World*, April 10th, 1929.

. . . . .

It now seems very likely that Baird television will become a permanent part of B.B.C. transmission. The Baird people won such a complete political victory that no amount of technical obstruction can prevail, however well-founded. Fortunately, however, there is no disposition to revive any of the bitterness of the previous period of hostilities between Savoy Hill and Long Acre. What will happen will be something like this. The Baird and B.B.C. engineers will begin at once the preliminary experimental and installation work. In July there will be transmissions in London, with one low wave and one of the new regional waves. These experimental transmissions outside programme hours will last for about a year, after which television will be made a part of the regular programme service along with Fultograph, each adapted to its special use. Now that the B.B.C. has taken up the Baird method, it has received great impetus abroad, and there is something in the nature of a world monopoly being attempted by Lord Ampthill, Sir Edward Manville, and their colleagues. Incidentally, it was a curious sight to see Captain Eckersley dining with Mr. Baird in the Savoy the other night. Apparently the hatchet is properly buried. Another moral to be drawn from the incident is that the Post Office, when it likes, does dictate to the B.B.C.

. . . . .

VALUABLE STIMULANT TO B.B.C.

Nevertheless, despite enthusiastic supporters of television who have worked themselves at times into a very fine rage over the criticisms of television which have appeared in this and our contemporary journals, and who have accused us on more than one occasion of doing our best to crab television, and to display antagonism to Mr. Baird and his associates, we take this opportunity of congratulating Mr. Baird and Captain Hutchinson, his managing director, on the generally successful result of the recent test, and to express the hope that if and when facilities are given them for experimental broadcast transmissions, some practical solution to the wavelength difficulty will soon be found and that on the whole progress will be made satisfactorily enough to warrant the B.B.C. including television transmissions in regular programme hours in due course.

Should the Baird system . . . be brought to such a test of technical practicability which would warrant the B.B.C. making regular broadcast television transmissions in programme hours, broadcasting in general would receive a great fillip. The trade would benefit, public interest would be revived, and a new and very intriguing aspect of wireless technique would be opened up for the general amateur.

. . . . .

The recommendations of the Postmaster-General seem to be eminently satisfactory.—*Popular Wireless*, April 13th, 1929.

A QUANTITATIVE ANALYSIS OF TELEVISION

By J. H. OWEN HARRIES, A.M.I.R.E.

The following article is of considerable interest to all students of television. It is one of the first serious attempts to get to grips with the problems of television on a quantitative basis which we have seen. The writer submits his arguments tentatively, and would greatly welcome discussion on his paper. To that end we shall be very glad to place our correspondence columns at the disposal of readers who wish to discuss Mr. Harries' thesis.

Introduction.

1. The basic principle of television, as it is at present known, may be summed up as follows :—

A series of pictures have each their two geometrical dimensions of length and breadth analysed into what may be termed two corresponding dimensions of time and magnitude. In this form the pictures are each transmitted to the receiver where they are synthesised into geometrical two-dimensional pictures again.

When discussing various systems of doing this the usual form of statement is that a certain size of picture will be transmitted clearly with a given type and efficiency of analysis and method of transmitting the time dimensional form, or modulation, of the pictures sent. In this statement the terms " size of picture," " clearly " and " efficiency of analysis " have not been given the requisite degree of definiteness to enable one to apply the methods of mathematics to the consideration of their relationships, and to the devising of the mechanism to carry out the work we wish to do.

This paper is an endeavour to define and express these ideas, and others, mathematically, thus giving a series of simple equations capable of fulfilling the same function in this specialised field as, for instance, Ohm's law does in electrical engineering. This results, briefly, in making possible numerical measurements of the relative efficiencies of different television and photo-telegraphic systems with reference to any selected standard ; of the relationship between these and the transmission channels needed ; of the fields of view and picture sizes possible ; and other points.

Examples of practical results are also given.

Definition of Picture Size.

2. The term " picture " is intended to mean any two dimensional (i.e., flat) image of any object or scene.

From the elements of optics it is obvious that the angle the picture subtends to the eye is the true measure of its effective size from the point of view of its visual effect, and not its size expressed in some arbitrary terms of linear measurement.

Then if we have an object of height h at a distance r from the eye its height by this standard equals $\frac{h}{r}$ radians.*

It follows that the area of a picture may be also expressed by the product of its two dimensions in radians.

In illustration of this (Fig. 1) shows the various effective sizes of a 12-ft. high screen in a typical cinema theatre to members of the audience seated in different parts of the building.

For the rest of this paper the picture dimensions will always refer to this effective or " angular " size in radians unless otherwise stated.

It will be realised that it automatically allows for large or small distances between audience to screen.

For instance, a 3×3 inch screen, seen 12 inches from the eyes, has just

* Strictly speaking, of course, " radian " refers to the length of the arc of radius r, and is merely used here for lack of a better word. At the angles employed, however, the difference between the two values is negligible.

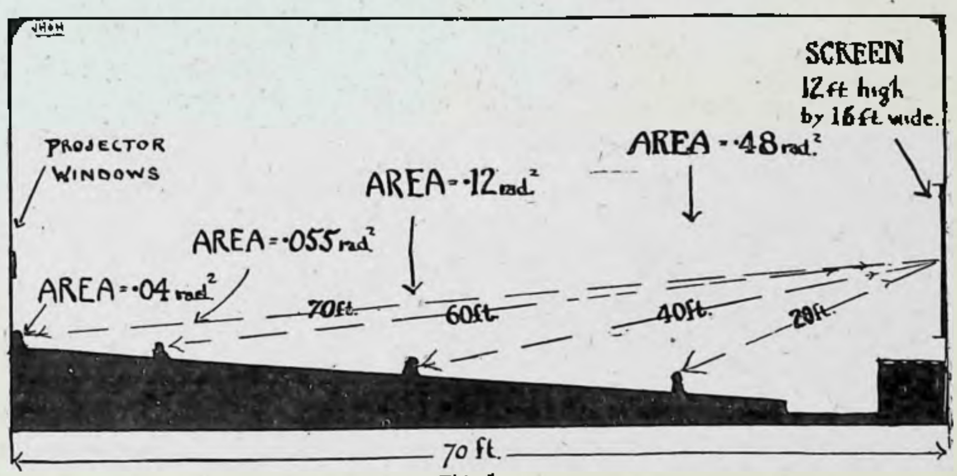


Fig. 1.
Elevation of a cinema theatre. Angular areas of the screen in radians² at various distances.

the same angular area as a 3×3 foot one at 12 feet from the eyes, and so on.

To find the angular area of a picture of linear size, say, a inches long by b inches wide: measure r in inches, then the area is—

$$A = \frac{ab}{r^2} \text{ radians}^2 \ldots (1)$$

Resolution of Picture Detail by the Eye.

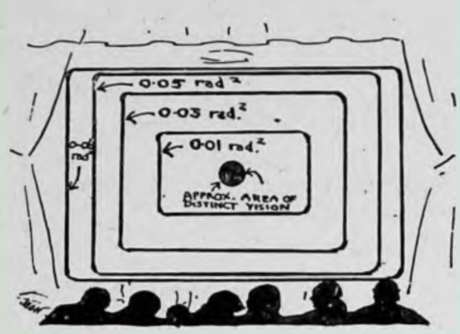


Fig. 2.

Picture areas in radians². If this is held 10 inches from the eyes the areas will be as marked. Note that if the picture is reduced in size in reproduction, this distance must be reduced proportionately.

3. The eye will be found to fail to distinguish the details in a picture where such details subtend a smaller angle to the eye than a certain amount.

If we have two dark dots on a light ground, or two luminous dots on a dark background, they will appear as one dot only when the angle subtended between them is less than about 1/3000 radian.

For example, the dots in a half tone reproduction of a photograph are only visible if the picture is close enough to the eye for it to resolve them in this manner.

It may be of interest to remark in passing that this does not mean, for instance, that if we have a picture built up of strips all of the same width and with no contrasting colour between them their breadth will have to be less than 1/3000 radian to give a continuous effect. This will be referred to later.

Optimum Picture Size.

4. If the received image on a televisor had an area equal to the field of view of the observer, then, obviously, he would appear to be looking straight out into the scene being transmitted, as it were; i.e., there would be no sensation of looking at a limited sized or "framed" picture.

If stereoscopic effects, etc., and colour were also added the observer would be apparently projected straight to the distant scene, and we should have reached the limit of faithfulness in the reproduction of that scene.

Such an ideal is practically an impossibility as far as the writer knows at present, because the area is limited by transmission and other difficulties.

"Comfortable Vision."

Therefore we must endeavour to find the optimum area for comfortable vision. "Comfortable vision" depends not merely on the clearness of the picture, but (especially if this portrays movements which must be followed with close attention) on the distance over which the eyes must be moved to cover the area of the picture with the point of distinct vision. Since the angular area of the picture is limited severely by practical difficulties the movements of the object being transmitted are generally arranged to cover the greater part of the picture in order to make the details of the movements as large as possible to the eye.

The magnitude of the movements of the eye necessary to cover the whole of the area of a picture will be realised when it is pointed out that the angular area of distinct vision is only about 0·0004 radian² (see Fig. 2). The fatigue felt in rapidly examining a wide field of view in order to follow changes in its nature is very great if the movements are kept up for some time. For this reason one feels the tiring effect of following the path of the ball in a game of tennis if one is too close to the net between the players.

Optical Mobility.

In a televised picture we must be able to follow rapid changes all over its area with no undue difficulty for a long time. The question now is what is the largest area which we can examine all over continuously and without trouble? It obviously depends on the mobility of our eyes, and fortunately we can easily deduce it from our everyday experience with an accuracy sufficient for our purpose.

For instance, the page of an ordinary newspaper is divided into columns of print because of the effort which would be felt in moving the eyes over lines running across the whole page. The angular length of a line in the usual sized book is about 0·25 radian. The columns in a newspaper are about 0·15 radian. The tiring effect of reading the few books having much longer lines is easily noticeable.

Further, consider the cinematograph theatre sketched to scale in Fig. 1. Here the best seats are usually those nearly at the back of the hall.

Here the angular length of the picture will be about ·2 to ·3 radians, once again. (Most movements portrayed occur in the horizontal direction of the picture). The height-to-length ratio of the screen is 0·75, giving an angular area at the best seats of about 0·05 radian.²

Since all these sizes have been found by experiment throughout many years we may take them as a reliable guide to the angular area of a television screen.

Resolving Power of the Eyes.

Some people's eyes have so low an acuity, or resolving power, that they may need a larger area of picture to enable them to see the details—i.e., the area of maximum definition (further explained later on) of a given reproduced picture will be much larger for their eyes than for the

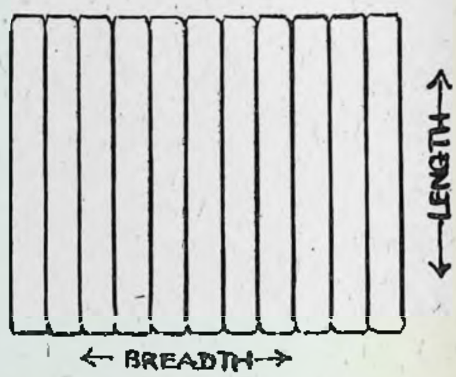


Fig. 3.

A televised or telegraphed picture is built up out of strips. Note the convention adopted for length and breadth with reference to the direction of the strips.

normal person's. Hence, they may prefer to be closer to the receiving screen than normal-sighted persons need to be, despite the extra fatigue of moving their eyes over the larger area. Such people prefer the cheaper to the more expensive seats in a cinema.

The only final criterion must be the more or less indeterminate physiological, as well as the exactly measurable physical, phenomena.

In the practical examples given later it is proposed to work to an area of 0·05 radian.[2]

This is better than any televisor has yet attained, so far as the author knows, and, if necessary in the future, the methods of computation to be given apply equally well to any size.

It was obvious that before we could hope to devise the formulæ mentioned in the introduction to this paper as being so desirable we must have a quantitative measure of picture size.

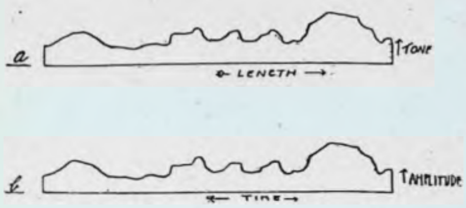


Fig. 4.
An imaginary graph of the picture tone over the length of one strip.

We may sum up the points so far explained as providing just such a measure, and also as showing the values of it to be expected in practice.

The unit is chosen to allow for the optical theory of vision as regards the effective size of objects seen. The question of the effect of the limited resolving power of the eyes has also been touched upon as far as it concerns the purpose in hand.

This brings us to the next factors in the equations, namely, first, the type of analysis of the pictures, and, secondly, the measurement of their ability to reproduce the transmitted image, i.e., their "clearness."

Fig. 2 illustrates some typical screen areas. The 0·75 height-to-length ratio used in the cinema is shown.

Types of Picture Analysis and the Corresponding Modulation Forms.

5. The type of the analysis of a picture may be defined as the nature and arrangement of the elements out of which the received picture is built up.

The picture modulation may be defined as the shape of an amplitude/time graph of the current which transmits these elements from transmitter to receiver.

By the tone of the picture is meant the intensity of its visual effect, i.e., light and shade.

The essential feature of any known system of television is that the picture is divided into strips sufficiently narrow and close to one another to, partly at any rate, blend into a whole; and each strip varies in tone along its length in accordance with the variation of the picture tone itself over that area (see Fig. 3).

The questions of picture analysis and transmission will not be discussed in detail in this paper, but it will be shown that, by means of the quantitative ideas already given, and ordinary electrical theory, important data on these points may be obtained, and, the author hopes, various controversial points settled.

Scanning Strips.

In Fig. 4*a* we have an imaginary graph of this picture tone over the length of a strip. Fig. 4*b* shows the exact similarly shaped current/time graph of the corresponding picture modulation in the case of a perfect scanning device. (For instance, an infinitely small hole in a scanning disc. A finite-sized hole will "average," or blur, details of the strip smaller than itself.)

By means of suitable scanning arrangements we may cause the picture modulation shape to consist of a series of steps, or "dots," the average effect of which may approximate to the correct shape.

The writer terms the former type of scanning (in Fig. 4*b*) "continuous" scanning, and the latter "intermittent."

In the rest of this paper we wish to show the relationship between the pictures sent and the modulation band widths and the like, with particular reference to finding the mini-band width possible in the future.

Now, with a given shape of picture tone/length graph to be transmitted, the "intermittent scanning" *obviously cannot decrease* the maximum rate of change of the graph on which the band width depends, but may be expected to increase it. Then the minimum band width will be that of the tone/length graph itself. Therefore we may conclude that continuous scanning is the basic case which should be considered, as this gives the picture shape itself. (Loss of detail due to a finite-sized scanning hole, as already explained, is neglected because it applies to both methods of scanning.)

Continuous Scanning.

Continuous scanning is assumed in the rest of this paper, though we may note that the equations apply to all forms, if we substitute the band widths of the other method for f_{max} (see on) and remember that here the bottom frequency of the band is not zero. The extension will be quite obvious in other ways and will not be considered further.

The record track on a gramophone corresponds to the picture strip, the needle to the scanning hole, and an electric pick-up to the scanner. Then intermittent scanning is represented by rapidly making and breaking the pick-up circuit, or by the needle only touching the track intermittently. The normal use in a gramophone is "continuous" scanning.

Summing up, the basic type of analysis is continuous scanning, as it results in a picture modulation of the same shape as the picture/tone graph itself, and because, obviously, all other types must reduce to it in essence, plus increases in the band width due to intermittent effects.

We will now proceed to consider the "clearness," which depends obviously on the picture modulation shape and the closeness of the strips of the picture.

Picture Modulation Band Width.

6. We see that the individual strips must be close enough together to blend to the eye. Presuming for the moment that this is arranged for, we will turn to the problem of transmitting the lengthways modulation.

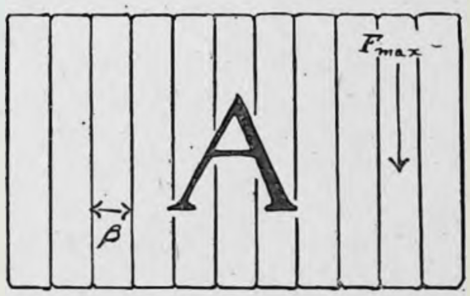


Fig. 5.
The units of measurement shown diagrammatically. A = The picture area in radians². B = The breadth of the strips in radians. Fmax = The top frequency of the modulation band width, i.e., a factor in the measurement of the lengthways definition.

Represented in Fig. 4*a* we have the length/tone graph for an imaginary picture. It is obviously purely dependent on the shape and movements of the object portrayed. Further, since the transmitted image has an infinite amount of detail so the modulation must have an infinitely large number of corresponding changes in its amplitude. But, fortunately, our eyes cannot resolve more than a certain amount of detail, so there is a limit to the number of changes in amplitude which need be actually transmitted.

Let us, for simplicity, postulate a given shape of current graph, such as Fig. 4*b*, and consider its transmission. Now suppose the time base is $\frac{1}{a}$th second. Then it is *not* correct, though the author has seen it seriously stated to be so, that the current will behave as one of a frequency of *ab* cycles, where *b* is the number of " bumps " in the curve (in this case six) over the time $\frac{1}{a}$th second. For one reason the term " bump " is too loose to be capable of mathematical interpretation, and therefore has no significance; and, further, because the " frequency " of a current is a term which only applies where the " bumps " are of periodic sine wave form—which, except as a momentary coincidence, can never be the case.

Width of Frequency Bands.

But transmitting apparatus is rated as regards its ability to carry a varying current in terms of the width of frequency band it will pass, i.e., from a frequency of f_1 to another of f_2 cycles per second. Therefore we must express the picture modulations in these terms to find to what extent they can be transmitted.

Fortunately there is the fact that it can be proved that any finite length of current/time graph can be represented as the sum of a certain number of harmonic currents of various frequencies and relative phase angles. Then, if our apparatus will pass these frequencies at these phase-angles (which may be found by mathematical analysis), it will pass the picture modulation they correspond to.

Then, obviously, the frequencies of these currents for a given modulation shape will be proportional to the rate of sending that shape, i.e., the rapidity of the picture scanning by the pick-up device.

For example, let the top frequency of the harmonic analysis of the modulation for a certain number of pictures per second be denoted by f_{max}. Then a doubling of the picture rate will give a top frequency of $2f_{max}$ and so on.

Further, we may note that the fundamental picture length/tone graph will give a modulation of zero frequency when a flat, even coloured area is being transmitted. Hence our transmitter must be capable of passing a frequency band from zero to f_{max} cycles, theoretically.

Breadthways Analysis.

7. Leaving the question of the picture modulation, let us return to the consideration of the strips of which the picture is composed. These are considered to be touching at their edges, and to be graduated along their lengths as previously explained. Consideration will show that if we decrease their (angular) breadth gradually, say, by moving away from the picture, a point will be found where the strips just blend into a whole. Call the angular breadth of the strips at this point β.

Further, the angular area of the picture at this point will be termed the " area of maximum definition " and denoted in radians² by A_0 (see Fig. 5).

It is a quantitative measure of the ability of the picture to show up details in its breadth—i.e., in the dimension at right angles to the strips.

(Note.—It is not a measure of the details *shown* in the breadth of the picture, since this must depend on the object portrayed).

This is obvious when we consider that reducing the picture below the angular area A_0 will merely tend to cause the difference in tone between the strips to be smaller than the eye can see, and an increase of A_0 can only show up the strips separately, instead of giving the mass effect we require.

Value of β.

Now β will be a constant quantity for all pictures, and may be found by moving away from a picture composed of strips of known width until they just disappear. Then—

$$\beta = \frac{b_2}{r} \quad . \ . \ . (2)$$

where b_2 = the linear breadth of the strips.

r = the distance at which they just disappear in a good light.

A_0 may be likewise observed, or may be found for any picture if the number of strips (denoted by n), in its breadth, is known.

We have then—

$$A_0 = \frac{(\beta n)^2 l_1}{b_1} \quad . \ . \ . (3)$$

where

l_1 = the linear length of the picture
b_1 = the linear breadth of the picture.

The writer has found that β should be taken as about 0·00065 to 0·0007 radian.

Hence the ordinary 48-hole scanning disc gives—

$$A_0 = \frac{(0{\cdot}00065 \times 48)^2 \times 1{\cdot}5}{1{\cdot}5}$$
$$= 0{\cdot}00097 \text{ radians}^2.$$

This means that the scanning lines on the 1½-inch square picture would be invisible at about 3 ft. 10 ins. from the eyes, which agrees with experiment.

From the point of view of practical measurement it may perhaps be argued that the estimation depends on indeterminate physiological phenomena. But since natural vision is, after all, our sole criterion of success or failure, there seems to be no way of avoiding this. Perhaps a more serious objection will be that in different lights, dim or bright, the acuity of the eye is different. But after all the televisor of the future must give quite a bright light, and so we will not be far wrong if we standardise on the β found by examining trial pictures in a strong white light. This practical estimation will be referred to later.

Area of Maximum Definition.

In passing, the area of maximum definition is not exclusively applicable to televised and telegraphed pictures. For instance, A_0 per square inch, is an excellent measure of the merit of the process of reproduction of printed pictures, since it estimates the closeness of the " dots " of which they are composed.

Indeed, we may generalise the definition of A_0 as the angular area which on being increased by a very little will cause the structure of the picture and its imperfections to become visible.

The " very little " mentioned is, mathematically speaking, too loose a term, but in practice there seems to be no need to define this further.

In the case of a painting A_0 will be the size which just does not show up the individual brush strokes. Or in that of a cinema film where the flicker, blurring of the details, and scratches on the film just become invisible.

In these last cases the breadth and lengthways definition of the picture is the same, hence A_o is a complete measure of the ability of the pictures to reproduce objects visually. But in the case of television strip analysis we have to consider further the case of the lengthways definition of the strips composing the picture, since here there is no "grain" or structure to guide us.

A Measure of Efficiency.

It should be clearly understood that A^o is a measure of the efficiency of the whole picture, and is not a measure of the efficiency per linear unit of area; which latter quantity is given, of course, by dividing A_o by the area of the picture in the units chosen.

For example, suppose a printed photograph in a newspaper is 2 sq. ins. in linear area. On test we find its A_o equals about 0·0018. Now suppose the printer had employed the same screen (i.e. the same number of picture "dots" per inch), but had increased the linear size to 4 sq. ins. Then A_o will also double (to 0·0036) but the "clearness" per unit area, which the printer means when he speaks of the "sharpness" of the printed picture, will be the same. It will be 0·009 per square inch in terms of our special unit A_o.

Summing up this and the last section, we may state the following points. Because the tone of the length of the strips of the received picture is obviously dependent on the shape of the picture modulation, the quantitative estimation of this latter in terms of the band width occupied is also a quantitative measure for any given rate of scanning of the lengthways definition of the picture, i.e. its clearness along the length of the strips. The breadthways definition, or clearness, is measured by the breadth of the strips, for which there is an optimum value β. The area of maximum definition A_o is the picture size which gives this optimum value for the strip breadth.

So far, then, we have units of measurement for picture size, lengthways definition for a fixed rate of scanning, and for the size for the proper breadthways definition or clearness. This is shown diagrammatically in Fig. 5. The next section will deal with putting these together as equations.

Lengthways Analysis.

8. We have shown that if the strip breadth is equal to β, and there is no space between the strips, the breadthways analysis of the picture is perfect.

A telegraphed picture.
Photo by courtesy of "Daily Mail."

The next question is that of the lengthways analysis (i.e. the lengthways graduation of the strips) which is given by the shape of the picture modulation.

Now the band width of the latter is, as we have shown in the last section but one, proportional to the rate of scanning, that is to $\frac{L_s}{t}$

Where L_s is the length of strip scanned in a time t. Obviously L_s is proportional to A_o; hence we may state that—

$$\frac{A_o}{t_1 f_{max.1}} = R \quad . . . (4)$$

where t_1 = the time of transmission of the picture.
$f_{max\,1}$ = the top frequency of the picture modulation.
A_{o1} = the area of maximum definition of the picture.
R = what we may term the "scanning ratio" for the system of transmission in use.

Finding Maximum Frequency.

It follows, by simple algebra, that if we wish to find, say, the top frequency $f_{max\,2}$ for the transmission of another picture having an area of maximum definition A_{o2} transmitted in a time t_2 we have—

$$f_{max\,2} = \frac{A_{o2}}{t_2 R} \quad . . . (4\cdot1)$$

for the system having a scanning ratio R. This result is of the utmost importance.

Now, just as in the case of the breadthways analysis, where we do not require β (and therefore A_o) to be any smaller than will make the strips just invisible to the eye; we do not need to make the lengthways definition (along the length of the strips) give more details than will be apparent to the eye with the optimum value of A_o (that is, the breadth and lengthways definition should be equal). Now, the magnitude of the picture modulation band width is the measure of the lengthways definition, and we may expect to find a maximum value for it for a given A_o just as we found a *minimum* value for β (since this latter was inversely proportional to the breadthways efficiency of analysis).

This is actually the case, and its measurement will be treated in full in the next section.

Standard Scanning Ratio.

We can, then, get a standard scanning ratio R_o by substituting in equation (4), and by means of (4·1) find the top frequency for any time of transmission, of any picture of given area, *to get perfect clarity in both dimensions.*

But perhaps we may desire to depart from this standard to a greater or less degree. For instance, we may use a larger angular area of the picture instead of its area of maximum definition (i.e. we will substitute a new area A for A_{01} in the equations (4) and (4·1), though this will not enable a normal audience to see more detail (see note on low acuity at end of section 4) or we may reduce the lengthways definition by reducing f_{max}, which will give blurred edges and general mistiness in this dimension, but will not show up the scanning lines.

The object of such a departure from perfect clearness would be to reduce f_{max}. The degree of imperfection of any system may be indicated by—

$$H=\left(\frac{f_{max_0}}{f_{max_1}}\right)-1 \quad \ldots \ (5)$$

which will be termed the " tolerance " of this system.* Here—

f_{max_1} = the top frequency given by the new arrangement for given values of A and t.

f_{max_0} = the top frequency given by the standard scanning ratio R_0 for A_0 numerically equal to the above value of A, and for the same value of t.

The standard R_0 may then be defined as the most efficient ratio between A_0 and f_{max}.

Care should be taken that the angular area of a picture at any distance is not confused with the area of maximum definition because of the use of the same unit of measurement in both cases, that is, radians[2].

Latitude in Definition.

Judging by the annoyance caused to the audience in a cinema by a slight darkening of the screen we may expect that nothing short of televised pictures of standard scanning ratio, or nearly so, will satisfy the public in the future, but we may note that moving pictures have rather more latitude as regards the necessity for perfect sharpness than " still " ones.

In illustration of this it is well known to nature photographers that a still view of, say, an animal moving in grass may entirely fail to show it up, but a cinematograph record will cause it to stand out boldly, though the individual pictures may not be so clear as before.

And the addition of sound, too, helps the illusion.

Fig. 6.

An enlarged portion of the telegraphed picture shown on the previous page. In the original the strips were about 0.2 mm. broad, and β was found to be about 0.00065 to 0.0007 radian.

The area of maximum definition in the ordinary cinema theatre would appear to be not far from 0·05 rad.[2], as inferred in section 4, which again confirms the choice of this value for television.

From these equations and definitions it is possible to obtain quantitative expressions for any known system of picture transmission. A double stereoscopic picture will double f_{max}, and a three-colour image will increase it theoretically, though the extra realism given by these methods might probably allow a large value of A_0 and hence also R_0 in practice.

A Unit of Tolerance.

Summing up again, we now have a standard of efficiency R_0 which shows the correct band width and picture rate for any picture size. If we wish to depart from this standard, as may easily be the case, we have a unit of tolerance just as in any other branch of engineering. By finding this for any system we have a unit of comparison. As an instance, it is merely necessary to know the band width f_{max} and picture rate $\frac{1}{t}$ of the system in question and the angular area of the picture size used (A). Then, from equation (4) we may find the standard band width for an area of maximum definition numerically equalling A. This will be f_{max_0} in equation (5) and from this, by inserting f_{max_1} we may get the tolerance (H) of the system being examined.

Elaborations of the equations and different uses of the units may be employed if needed for special purposes.

Measurements and Numerical Results.

9. One of the most important uses of equations (4) and (4·1) is the co-relation they give between photo-telegraphy and television. Practically perfect results have been obtained for some time with the former, and we thus find both β, R_0 and f_{max_0} easily available for use as the standard.

The results with both the Bell and Siemans-Karolus photo-telegraphy systems, for instance, are very similar.

In the latter system the picture is scanned by a very small light spot. A photograph 9·5×6·7 inches area is transmitted in 20 minutes. A carrier wave of 1300 cycles is modulated by the picture current up to 650 cycles top frequency.* The observed value of A_0 for this size was 0·44 rad.[2]

The definition in both directions is the same, and therefore we have for R_0, the standard scanning ratio, from (4)—

* Another measure of H is $\left(\frac{R_0}{R}\right)-1$ where R is the scanning ratio of the system to be assessed. This is not so suitable for explaining the principle however.

* This data was obtained from " Picture Telegraphy," by E. S. Ritter in the Post Office E.E. Journal, Vol. xxi., Part 3 page 191, October, 1928, and from a telegraphed photograph and data very kindly supplied by the editor of the *Daily Mail*, to whom the writer's thanks are due.

$$R_o = \frac{\cdot 44}{1200 \times 650}$$

$$R_o = 0{\cdot}564 \times 10^{-6}$$

β was found to be 0·00065 radian about, as indicated before.

is used at 450 r.p.m., giving about 7·5 pictures a second.

Judging from the published results* it is intended to be looked at from a distance of about 3 ft.

Tabulated Results.

System.	R	A		t	f_{max}	Tolerance H.
Photo-telegraphy (Standard; with area$=A_o$).	$0{\cdot}567 \times 10^{-6}$ $(=R_o)$	0·44	rad².	1200	650	—
		0·05	,,	0·06	1,500,000	
		0·01	,,	0·06	300,000	
		0·05	,,	0·1	930,000	
Mr. Geloso (television).	$2{\cdot}6 \times 10^{-6}$	0·00173	,,	0·133	5,000	3·7
		0·05	,,	0·06	320,000	
		0·01	,,	0:06	64,000	
Dr. Alexanderson (television)	$3{\cdot}75 \times 10^{-6}$	0·01	,,	0·133	20,000	5·8
		0·05	,,	0·06	220,000	
		0·01	,,	0·06	44,000	

Note that $A_o = 0{\cdot}00097$ rad.² in both the television systems.

We may take $R_o = 0{\cdot}57 \times 10^{-6}$ for simplicity.

A portion of a telegraphed picture sent by this system, enlarged to show the strips of which it is composed, is reproduced in Fig. 6. It will be found interesting to demonstrate the principles given in this article by finding β and A_o for this example.

The table shows the various values of f_{max}, given by various pictures sent at television rates. t equals the reciprocal of the picture rate per second.

Hence 0·06 second=16·7 pictures a second,

And 0·133 second=7·5 pictures a second.

Lack of Published Data.

Unfortunately, at the time of writing definite details of existing television systems are not available, and hence exact comparisons on the lines laid down are not possible. The author, however, ventures to hope that investigators may see their way to make actual measurements on their various devices and to publish the results.

Failing this more accurate data it will be of interest in the interim to examine some published television systems in the light of these principles.

Using a band width of only 5 k.c., Mr. Geloso has sent out from radio stations WRNY and W2XAL pictures about 1·5 ins. square. A 48-hole disc

$$A = \frac{1{\cdot}5}{36} \times \frac{1{\cdot}5}{36} = 0{\cdot}0017\text{rad}^2.$$

when $R = 2{\cdot}6 \times 10^{-6}$

$H = 3{\cdot}7$

Note that $A_o = 0{\cdot}00097$ rad.² (see section 7).

Unfortunately the band widths employed by Mr. Baird, in England, are not known to the author.

Dr. Alexanderson, in America, recently gave a public demonstration in a laboratory with a top frequency stated to be about 20 kc.† The transmission was of a man, shown full length, and included a boxing match. Teeth, tongue, and throat were visible in the man when seated, and the general definition was compared to that of the average amateur cinematograph. At a distance of ten feet from a foot-square screen the observers "could scarcely distinguish the scanning lines." The same 48-hole disc was used.

Then—

$A = \cdot 1 \times \cdot 1 = 0{\cdot}01$ rad.²

$R = 3{\cdot}75 \times 10^{-6}$

$H = 5{\cdot}8$.

The area of maximum definition is again only 0·00097 rad.², hence the large tolerance.

Before making comparisons it should be noted that these television figures are only deduced from published data, and are not from actual measurements. The following table shows the results at a glance. f_{max} is not given to more than two significant figures.

Of course it is quite possible, but scarcely necessary, to settle on a much more stringent standard than that of the photo-telegraphy systems considered. The final criterion is what the public will demand, and the reasons for not departing much from that standard have been given before. The next section will be found to give yet another.

Field of View.

10. For the television of large scenes, such as the Derby, the depth and breadth of the field of the "camera" in which the horses could be seen clearly, can be found as follows.

For simplicity a square screen is assumed, though the same principles can be applied to other shapes. First find the smallest area of maximum definition which will enclose the object to be seen—in this case a horse

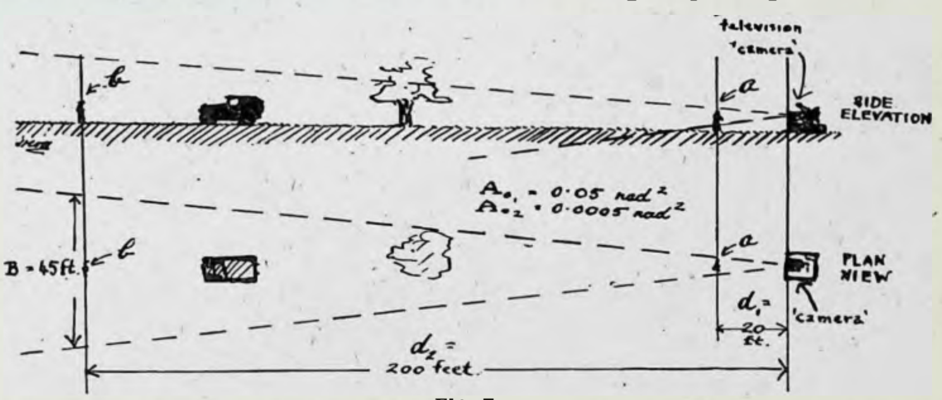


Fig. 7.
In illustration of the equations for fields of view. The side elevation and plan view of a televisor operating with the characteristics indicated. d_1 and d_2 refer respectively to the distances to the man at a and to the man at b.

* *Radio News*, page 411, November, 1928.

† *Ibid.*, page 527, December, 1928.

and rider—and give as much detail as is desired. This may be easily done by moving away from a photographic or televised version of the object. Call this area A_{o2}; the area of maximum definition of the system of television employed A_{o1}; the linear height of A_{o2} designate by h_2; and that of A_{o1} by h_1.

then $$\frac{A_{o1}}{A_{o2}} = \frac{h_1^2}{h_2}$$

It is obvious from ordinary optics that—

where $$\frac{h_1}{h_2} = \frac{d_2}{d_1}$$

d_1=the linear distance of the object from the camera when it fills A_{o1} completely, i.e. fills the full field of view of the televisor.

d_2=the linear distance the object must be from the camera for it to fill A_{o2} (equals the depth of view of the system employed),

hence—

$$d_2 = \sqrt{\left(\frac{A_{0_1}}{A_{0_2}}\right)} d_1 \ldots (6)$$

And further, the angular breadth of the field of view will equal $\sqrt{A_{o1}}$ radians. From the definitions of the angle of maximum definition, and with the square screen specified—

$$\sqrt{A_{o_1}} = \frac{b}{r}$$

using the same symbols as in section 2.

But $r = d_2$ and therefore b is the required breadth of view in linear units=B.

Hence—

$$B = \sqrt{(A^{\circ}_1)} d_2 \ldots (7)$$

As examples, suppose A_{o1}=0·05; A_{o2}=0·0005 and d_1=20 yards; then our depth of view will be, from equation (6)—

$$d_2 = 20 \times \sqrt{\frac{0{\cdot}05}{0{\cdot}0005}}$$

$$d_2 = 200 \text{ yards.}$$

And from (7)—

$$B = \sqrt{(0{\cdot}05)} \times 200$$

$$B = 45 \text{ yards.}$$

These results would, of course, have to be modified for a telephoto lens system. They are an excellent illustration of the quantitative results obtainable from the use of definite values for the "clearness" of a picture, and emphasise the fact that before we can te'evise a horse race the televisors must not merely be sensitive to the reflected light over the distance to the horses, but, further, the "grain" of the picture must be fine enough for the horses to be recognisable (i.e. A_{o1} must be large enough), which is equivalent to a small tolerance ratio H. They are also the basis of much of the technique of the television "camera-man" of the future.

In illustration of the foregoing, Fig. 7 shows a scene being televised.

King's College Centenary 1829—1929.

After one hundred years this College is appealing to industry for moneys to improve its science laboratories and to endow chairs in various faculties. The chair of physics requires £25,000. A succession of brilliant scholars have been at the head of this department.

The present professor of physics, E. V. Appleton, M.A., D.Sc., F.R.S., is recognised in this country and abroad as one of the foremost scientific workers in wireless research. A singular honour has been paid him by the American Institute of Radio Engineers. They have awarded him the Morris Liebmann Memorial Prize for 1929, for the most important contribution to wireless progress during the last twelve months.

Professor Appleton has, during the past five years, been conducting experiments for the Radio Research Board, on the influence of the upper atmosphere on wireless transmission. The work has included proof of the existence of the Heaviside Layer, and the first measurement of its height.

Communication with Belgian Colonies.

Another instance of the importance attached by European countries to direct wireless communication with their Colonies is the order just placed on the Marconi Company by the Société Belge Radioelectrique, on behalf of the Belgian Government, for a short-wave telegraph-telephone transmitter which will be used for communication between Belgium and the Belgian Congo and Belgium and South America.

Two short-wave receivers of the latest type, similar to those used in the Marconi beam stations, have also been ordered.

The Willis World-Time Indicator.

From J. H. Willis & Company, Ipswich Road, Norwich, we have received a most useful device known as "The Willis World-Time Indicator." This takes the form of a sheet of good quality cardboard measuring 7 inches by 8 inches. Lines marked in degrees of longitude radiate in all directions from a central point, and geographical areas and names of places are printed on the card in their proper positions according to longitude.

At the central point is fixed a little cardboard disc divided and numbered into 24 hours.

To find the time in any part of the world it is only necessary to turn the central disc until the time figure in the locality of the observer points towards the country in which he is situated. He then looks for the name of the part of the world in which he is interested, and the longitude line of that part of the world will then be found to intersect the central disc and give the correct time for that particular part of the world.

The central disc is also printed with light and dark sections indicating parts of the world which are experiencing day and those which are experiencing night.

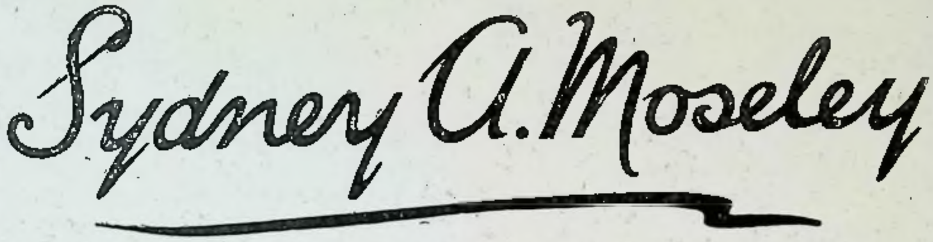
The device should prove extremely useful to long distance broadcast listeners who want to find the correct Greenwich time at which to listen for a programme broadcast at any given time and in any part of the world. In these days of trans-oceanic and trans-continental telephone services it should also be extremely useful to users of such services, so that they may avoid calling up a friend at, say, 3 a.m. when they really want to talk to him at 3 *p.m.*! Those who travel in ships will also find the device extremely useful.

The only criticism of the device which we have to offer is that it is not provided with eyelets and string, so that it can be hung up in a convenient position.

To a London Friend.

Hullo! I'm in the U.S.A.
I only landed here to-day,
As I should like to see you soon
Please ring me up this afternoon—
You'll see me now? All right, that's that,
We'll have a televisored chat!

—*Leslie M. Oyler.*



ON

"THE FIRST TELEVISION BROADCAST"

AND so, after all, the first regular transmission of television in this country is to take place shortly. This article appears in the May issue of TELEVISION. If all goes well the first official broadcast may take place some time in July. Not bad going when you come to realise the tremendous amount of misunderstanding and mischief that had to be cleared up. The way, then, is clear for the big steady advance towards our goal.

"And what," you may well ask, "*is* our goal?"

The answer, obviously, should be the old adage: "Sufficient unto the day," etc.

Our first principle is accepted. That, for the moment, is the main thing.

"Television has arrived."

Even hard-boiled critics now admit this fact, some of them very cheerfully, I am glad to say. Indeed, the whole atmosphere is one of extreme friendliness, and altogether there is a desire to forget the past. To this attitude I, above all, am prepared to subscribe most heartily.

What First?

And now what about this first broadcast—what are listeners to see in the immediate future That is a natural question. Well, there will be a living image of the face and shoulders of well-known singers and speakers. The other day, for instance I saw Miriam Licette for the first time. I had admired her *voice* again and again, but I couldn't conceive what she was like. I had to go all the way, in bad weather as it happened, down to the People's Palace, Mile End Road, in order to satisfy my curiosity and admiration. In future, this will not be necessary. Had we had television her features would have been familiarised long ago. Needless to say, one ignores the photographs of celebrities that one sees in the press! After all, journalists are very kind souls, and—need I say more? In the case of Miriam Licette, however, I think her photograph barely did her justice.

What Next?

"And what of the future?" you may well ask. "Are we always to see the face and shoulders of those who broadcast? Is that to be the end as well as the beginning of television?" Captain Eckersley was asking me the other day something of the same sort. He wants to know what would happen at, say, the end of a year's broadcasting of television. Would the listener have to be content always with a head-and-shoulder view?

My reply was in the form of a question: "Would the listener of the ordinary broadcasting programme be satisfied to-day with what was offered to him when broadcasting first started?" Obviously not, nor should I expect the "Seer-in" to be satisfied after a year or so with merely a head and shoulder view.

But we have reason to believe that the development of television will be at least as rapid as that of sound broadcasting. I told Captain Eckersley of improvements and developments which have already taken place since he and his colleagues were given a demonstration at Long Acre. He was very interested, not to say surprised, when I told him that the Baird Company are already able to televise two, three, and four people together.

Recent Developments.

Indeed, in Mr. Baird's laboratory I have seen the first of a broadcast play as well as the first boxing match ever televised. True, these bigger events are still in the same stage of development as television was when I first saw it some months ago, but the period of waiting will not be so long as even some of the friends of television anticipate. With the facilities now available, developments ought to be astonishingly rapid.

The world's amateurs who have been waiting for the move that has now been taken by the authorities will step in and aid in the development of television in much the same way as they did when broadcasting first began.

When I made prognostications before they were received by some of my best friends with expressions of incredulity. They really thought, some of them, until quite recently, that I was having my leg badly pulled, and as for my reputation, well, the damage done to it was "irreparable." The Postmaster-General's letter, in fact, came as a thunderbolt to those people who had been fed on propaganda pap from foreign sources.

The editor of a certain wireless publication would not believe that it was possible to put over television by wireless. He actually told a friend of mine: "It is all very well doing it over a land line, but let them try and transmit without these lines."

That other people concurred in these sceptical views we know, but it seemed an extraordinary thing to hear from the lips of a wireless expert.

Prognostications.

At any rate, these prognostications of mine will now be received with a little more reverence. I repeat, therefore, that now broadcasting facilities are about to be given to the Baird Company we should see tremendous strides in the development of this fascinating science. I am willing to wager that before twelve months have passed we shall be seeing scenes inside the studio and from the outside as a matter of course.

I beg those readers who have taken part in the earlier fight not to relax their vigilance or interest. Big things will now happen, and if possible we shall be in for still bigger fights. So far as I am concerned, jubilant as I am over the success of my efforts in bringing my friends of the B.B.C. together with my television friends, I nevertheless expect intrigue and opposition from foreign sources.

Before this article goes to press, I am very much hoping that a big arrangement with a powerful Continental concern will fructify. This will be the result of rather prolonged negotiations, and although I am glad to think that this big merger has been brought off, I am better pleased that it is the home of the British inventor which has taken the first steps to express its official belief in Mr. Baird's great invention.

In thinking out these wonderful sciences, one must not regard them merely as mediums of further entertainment. I personally agree with those who think that the great broadcasting services of this country should be used for educational as well as entertainment purposes. It would be a great pity if such revelations as were given to mankind should be utilised merely to hear a comic singer or to see Mr. George Robey grimace.

Merlin Hall Aylesworth, President of the National Broadcasting Company of America, who is at present on a visit to Europe to study our broadcasting conditions.

Type of Programmes.

We are reaching a point when attention is to be given to the kind of broadcasting programmes to be put over by the Baird Television Co. Such influence as I possess will be thrown into the scales to make such transmissions worthy of the fight from which we are now emerging. Just as television messages are not to be used merely for communicating puns and limericks, so must television, in putting over figures and plays remember that it has a high mission in life. Let us have the fun by all means, but let it be a fair mixture between the highbrow and the lowbrow.

Incidentally, if any reader has any suggestions to make as to what the first television broadcast programme should consist of, I should be happy to receive these suggestions.

For myself, were I asked to suggest the first television programme, I might be inclined to draw up an all-Scotch programme out of deference to the Inventor!

Noctovision and Phonovision.

I presume that now television is well under way and developments are proceeding more or less along more normal lines, Mr. Baird will devote some of his attention to that equally interesting invention of his, "Noctovision." I gather that here the fight is not likely to be so lively. There are no other Richmonds in the field—as yet—and if there were it would make no matter; we should deal with them as we propose to deal with them in regard to television.

For those whose minds will run along the lighter grooves of life, there is "Phonovision." I understand that interesting strides have been made here, so that before long readers will have an opportunity of "looking in" and seeing those robust tenors, or the gentlemen from the Southern States of America who have left their mammies and roses behind. What a vista this "phonovision" should open up!

The Editor invites writers to send in suitable contributions to this Magazine.

MSS. should be typewritten (double spaced) and accompanied by a stamped addressed envelope for return, if unsuitable.

THE FUTURE DEVELOPMENTS OF TELEVISION

By CECIL MALONE, M.P.

Mr. Cecil Malone is the Member of Parliament for Northampton. During the war he held various commands, and towards the close he was appointed first Air Representative on the Supreme War Council at Versailles. He was also Air Attaché at the British Embassy in Paris—being the first air attaché ever appointed to any Embassy. He also, in 1912, carried out the first experiments with wireless telegraphy from Naval Aircraft, and is one of the few Members of the House of Commons with scientific experience.

I AM very proud to have been the first Member of Parliament to raise the question of television in the House of Commons, and I am glad that as a result some of the preliminary difficulties have been overcome, and the satisfactory stage has been reached which is outlined by the letter of March 27th from the Postmaster-General to the Baird Television Company.

I have long been impressed by the marvellous and indeed revolutionary possibilities of the developments which the transmission of sight by wireless will bring to us. My first association with the broadcasting of pictures was in an experiment by the well-known scientist, Professor Fournier d'Albe, from 2 L.O., which was described in "Amateur Wireless" on June 9th, 1923. That was only the transmission of a still picture.

Subsequently, however, I assisted Professor d'Albe in an actual, albeit elementary, experiment in real television at the Royal Institution.

Now Mr. Baird has leapt ahead of all rivals, and in an incredibly short time has delivered the real goods. And Mr. Baird has made such strides since I first saw his experiments some twelve months ago to the time, last month, when by means of his apparatus I televised (is that the right word?) one of my colleagues in the House, Mr. Charles Ammon, M.P., that one might well say that he has improved his results out of all recognition—but perhaps in this instance it would be more accurate to say "into tangible recognition."

Mr. Baird's progress has given us a time factor. We have now some idea of how soon we may expect results. It shows us that the transmission of sight through the medium of broadcasting stations is an immediate possibility; and that the sooner experiments are carried out the sooner will it become a practicability as well as a possibility.

There are, however, many vested interests to be considered. We have in this country in the British Broadcasting Corporation, under the admirable management of Sir James Reith, and the very capable technical direction of Captain Eckersley, a broadcasting organisation more efficient, I believe, than any other broadcasting system in the world. Naturally many vested interests are bound up in such a great machine, and the changes necessary must, therefore, be worked out to cause as little injury to individuals as possible, provided that they do not stand in the way and retard development.

Then there are the outside interests to consider. There are the telegraph and cable companies and the newspapers. Television will mean the speeding up of the transmission of news and pictures almost beyond imagination. One foresees the householder reading his newspaper transmitted by television from the broadcasting station.

There is also the legal question. I doubt whether, in fact, the Postmaster-General has any statutory control over television, but the whole position is as yet quite undefined.

In the early stages of the negotiations with Mr. Baird, the Postmaster-General was quite rightly concerned lest the public should buy apparatus expecting results which were not yet possible. That period is, however, past.

I only wish that as much concern had been shown when "sound" broadcasting started, and the country was flooded with thousands of over-advertised "dud" receiving sets from firms, big and small, who made preposterous claims for their sets.

A difficulty has further been raised regarding the allocation of wavelengths for television, and the limited bands available make, I think, a policy of monopoly of broadcasting more essential. But it is the duty of whatever Government directs our destinies in the ensuing years to ensure that it is an enlightened monopoly.

I do not want to see the lusty young child throttled by jealous or frowsty foster parents.

What then is to be done? The immediate action required appears to me to be the allocation of a period daily for an experimental transmission such as has already been allocated for the transmission of still pictures, which I have always thought rather obsolete and futile. These experiments will lead to improvements in the apparatus, and should soon show the necessity for the allocation of a wave band or wave bands for continuous television transmission throughout the day.

Arrangements between the Baird Company and the Postmaster-General for the use of broadcasting stations do not present insuperable difficulties; and with the co-operation of that far-sighted genuis, Captain Eckersley, at the B.B.C., I am convinced that we shall see wonderful developments very shortly. Indeed, ten years ago anyone who had suggested the possibilities of television would have been registered as mentally defective.

What will be the effect of all this on the world?

Aviation, wireless, television could be great factors in breaking down barriers and bringing the nations of the world together.

We stand on the threshold of a new age, an age of new knowledge and new discoveries. The future—the day after to-morrow of time—is pregnant with vast possibilities. The giant strides made in science may either prove a blessing or a curse; but it is man alone who possesses the power to decide what the issue shall be.

TELEVISION PROVES ITSELF

News of the Post Office Demonstration

By "ENGINEER."

NOW that the P.M.G. has issued his report on the television tests—a very satisfactory report too—one may say a little about those tests from the Post Office side. Up to the present, readers of TELEVISION have heard what happened at Savoy Hill, and how the transmissions were received on a private installation outside. The *one* receiving post, however, was in the heart of the General Post Office, at St. Martins-le-Grand.

There, in the secretarial department, two receivers were installed.

The room selected was a large conference and committee room, on the walls of which hung portraits of all the Postmasters that have ever been since the post first started, somewhere about the time of Henry VIII, and the various secretaries who have helped them. Together with these were numerous cartoons of past Postmasters, drawings and paintings of postmen and post coaches. Even the war found its representative there in the shape of a water-colour of the Islington postwoman, while the modern postman is well represented by an oil painting done by a London postman. Into the austere presence of this august company the engineers of the Baird Company were introduced and speedily considered ways and means. Outside aerials were not possible, so rubber-covered wire was hung lengthways from the picture rails, making aerials about 30 feet long. The earth was equally primitive, nothing more satisfactory than a radiator being available.

Two televisors, with the necessary battery equipment were installed—one a complete talker and seer, and the other a simple portable, without loud speaker.

To make sure everything was correct the B.B.C. music programmes were tuned in and put on the television screen. One could not, of course, see the performers, but when the televisors were properly adjusted the music created a pattern of wavy lines on the television screen, varying according to the loudness or otherwise of the music. When the proper test television transmission came through after midnight—the ordinary B.B.C. programme service preventing any transmission before—everything shown was immediately recognised at the Post Office; whether it was a box of matches, a cigarette, an engineer's tool, or a face.

As the time for the official demonstration drew near one could not help wondering what all the past Postmasters, whose faces looked so coldly and expressionlessly down from the walls would have thought of this new means of communication.

Frankly, under their unvarying gaze, it did not seem possible. However, time for such reflections was speedily cut short by the arrival of the official party.

One cannot give the names of those present, nor does it matter, but they were a truly representative group. A House of Commons in miniature.

At the precise time of starting the televisors were tuned in, and there on the screen of each of them appeared a face. The deputation, to judge by their remarks, were keenly interested and could scarcely believe the evidence of their own eyes.

It is Extraordinary.

In fact, one of them remarked to one of the engineers in charge of the apparatus: "I believe this is a swindle. You can't get it like this by wireless. Are you quite sure there is no trickery about it?" Being assured there was no trickery the same Member remarked a few moments later: "It is extraordinary. It is truly wonderful."

His surprise, however, was as nothing compared to that of the Baird staff when, at the end of the demonstration, the well-known features of Captain Eckersley appeared on the screen.

Everyone recognised him at once, even if he had not given the well-known test phrases of the B.B.C.'s early days.

Such a conclusion seemed to put the seal of friendship (the friendship of the B.B.C. with the new offshoot of broadcasting) on the demonstration.

Of all that august assembly, present either in the flesh or from the past, on canvas, probably no one was better qualified to judge the value of the new idea to the postal services than Sir Ambrose Fleming.

Without doubt this historic event will not be overlooked as television proves its value to mankind.

Television Broadcasts from Rome.

A correspondent in Malta informs us that experimental television broadcasts have recently been transmitted from Station IRO, Rome. These transmissions took place after regular programme hours on the usual broadcast wavelength.

The power of the station is 3KW. According to our correspondent, the announcer invited reports.

Further details are not at present available.

HIGH TENSION CURRENT SUPPLY

Details for Eliminator Building

By W. C. FOX

In our April issue Mr. Fox discussed the pros and cons of H.T. batteries versus H.T. eliminators, and gave some preliminary information on the construction of an eliminator suitable for use by television experimenters. In the following article he gives full constructional details, together with a list of the actual components used.

IN building a mains unit to work off alternating current, the first thing to decide, as it controls everything else, is the output desired.

As a general rule it can be considered that from 100 to 150 volts will be dropped between the plate transformer output terminals and the final output terminals of the eliminator. These volts are dropped on the plates of the rectifying valve, in the choke, and through the smoothing condenser network. The valve should have a milliamp emission four times that required at the final output terminals. Here again some of the output is lost in the smoothing circuit, but not all, the remainder serving the very necessary purpose of safeguarding the valve from overloading and keeping up a steady supply of current on the choke and condensers so that there is no possibility of mains hum creeping through.

Transformer Requirements.

In the present case—an eliminator with an output of 300 volts at 40 milliamps—a transformer having a voltage of 550 across the secondary terminals, with an amperage of ·13, will be required, together with a valve capable of handling that voltage and with an emission of at least 160 milliamps. The filament requirements of the valve do not matter very much, as a transformer can be secured to supply it, and in any case the make of valve purchased will determine it.

Suitable transformers can be secured from the firm mentioned in connection with the battery charger described in a previous issue (January, 1929, issue, page 15), Messrs. F. C. Heayberd, 9, Talbot Court, E.C.3.

Almost any well-known firm of valve-makers can supply a suitable full-wave rectifying valve. A half-wave rectifying valve is scarcely suitable for any but very small outputs.

It is not proposed to give any details of transformer construction here, because it is assumed that an eliminator is wanted for other experimental work, and is not being constructed for the sake of the amusement that the work provides. Reasons for using two transformers, one for filament current to the valve and the other for the plate supply, have already been given, and although these might well be used by an enthusiastic amateur as reasons for building his own transformers, anyone who may be contemplating such a thing will be well advised not to attempt it unless he has special skilled knowledge.

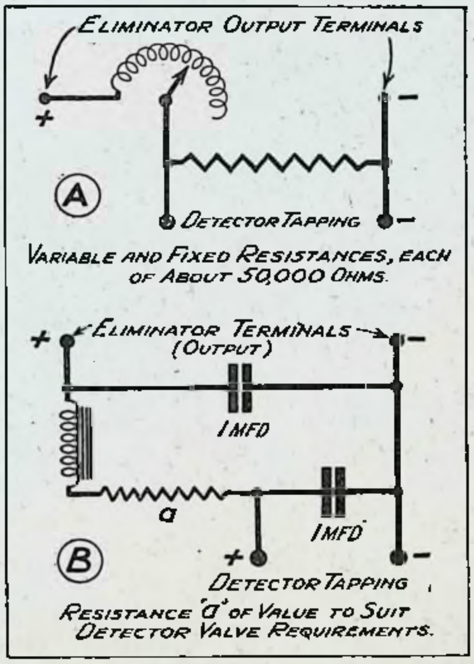


Fig. 1.
Arrangements which can be made to overcome "motor boating."

The windings run into some thousands of turns, insulation is an important matter, so is core design, while the whole job, if it is to be satisfactory, depends very largely on the skill and experience of the designer and maker in combining all these conflicting requirements into a harmonious whole. Most well-known makers have this skill and experience, and produce an instrument costing very little more than the necessary raw material as purchased by the amateur.

Amateur-built Transformers.

If, however, details of construction are required, these can easily be given in a later issue. One other point. The writer has heard of transformers built by amateurs, and fairly skilful ones at that, which on *no load* took over 200 watts, and speedily got so hot that one could fry bacon on them! Need more be said against home-made transformers?

Having decided on the total output required and selected the valve and transformers to meet this, the next point is the choke. In the set being described this is a general purpose one of 50 henries, with a carrying capacity of 100 milliamps. This has been found quite satisfactory, even when the eliminator was tried on a short-wave set.

Voltage Tappings.

The various voltage tappings are the next points to be fixed, and here it is essential to know, within reason,

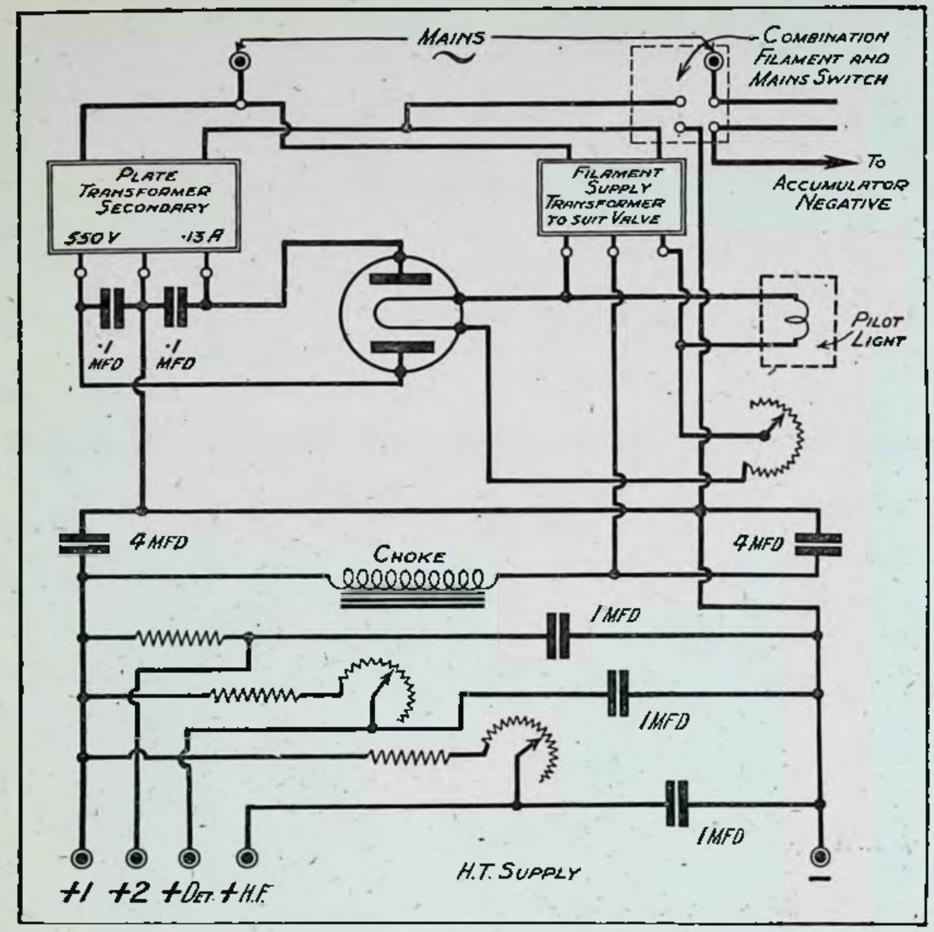


Fig. 2.

Schematic diagram of the eliminator. This layout can, if desired, be followed in the actual building, but for greater convenience the main combination switch and pilot light should be placed in front near the output points.

how many milliamps are required from each. Without this information the necessary calculations for the resistances cannot be made, although if expense is not a serious matter, each tapping point can be provided with an adjustable anode resistance followed by a Clarostat or similar finely variable high value resistance. Such a combination makes it possible to get quite low voltages of the order of 40 or so up to the full figure available.

In the present instance four tapping points are provided, one being the full output voltage, one a reduced voltage determined by a fixed resistance, while the remaining two are controlled initially by a fixed resistance with a variable resistance following for fine adjustments.

The resistances in use are 150,000 ohms for the first tapping point (which supplies an L.F. amplifying valve), 250,000 ohms for the detector (variable resistance following), and an adjustable resistance with a range from 32,000 to 500,000 ohms, followed by a variable resistance supplying an H.F. valve. This combination of resistances, after considerable experiment, has been found to be a very useful one, capable of giving a wide range of voltages at any of the three tapping points.

Avoiding "Motor Boating."

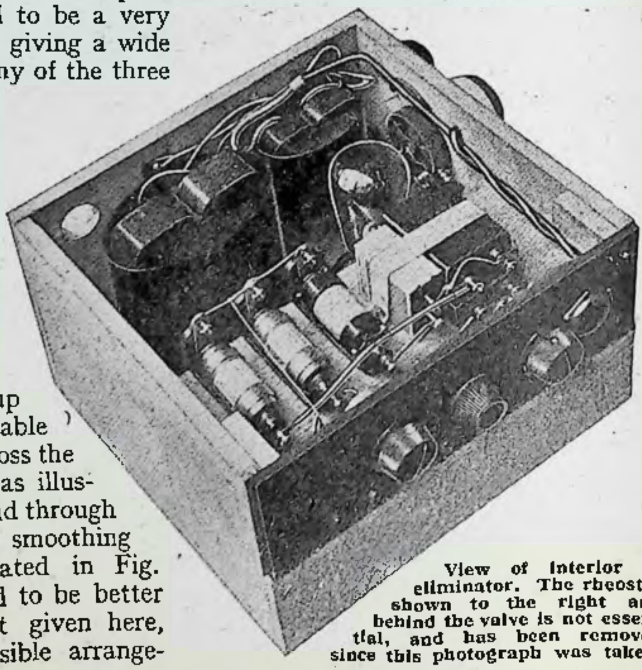
While on the question of tapping points it may be of interest to mention that the supply to the detector valve has been taken from a potentiometer arrangement made up of a fixed and a variable resistance in series across the full output terminals as illustrated in Fig. 1 (*a*); and through a separate choke and smoothing resistances as illustrated in Fig. 1 (*b*). Neither proved to be better than the arrangement given here, but as each is a possible arrangement to get over feed-back or "motor boating," they are mentioned in case anyone experiences that annoying trouble.

A full circuit diagram of the eliminator is given in Fig. 2. The small lamp shown being run off the filament transformer was an afterthought, added as a safety device.

The rectifying valve used is of the dull emitter class, and is so dull that one can scarcely tell whether it is switched on or not by looking at the filament. As part of the rectifier circuit carries 550 volts, and is capable of giving a very nasty shock, the small lamp (one of the pocket flash lamp class) was arranged to be fed off the filament supply to the rectifying valve, and placed behind a red window to act as a warning device. The window through which it shines, and its position inside the case, can be clearly seen on the right of the photos of the completed instrument. (See also photo on page 69 of the April issue of TELEVISION.)

Avoiding Shocks.

If the reader is very nervous of shocks, it is quite a simple matter to arrange a double-pole switch in connection with the lid of the case, so that the mere fact of raising it to get at "the works" automatically breaks the circuit. Don't forget, however, that there are condensers totalling about 12 mfds., all fully charged. These can give a very nasty shock, and they hold their charge for some hours at least.



View of interior of eliminator. The rheostat shown to the right and behind the valve is not essential, and has been removed since this photograph was taken.

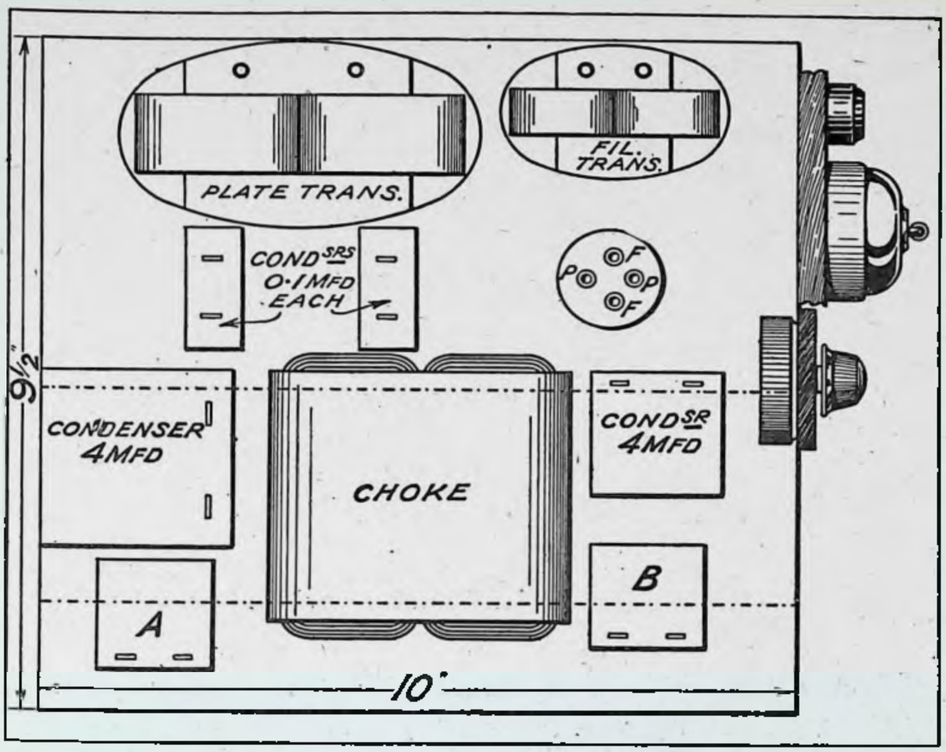


Fig. 3.

Baseboard layout of components. The dotted line running across the choke to the full width of the baseboard represents the bridge carrying the smoothing circuit resistances and condensers. A and B are condensers of 2 mfds. each, added across full output terminals.

If the reader wishes to safeguard the condensers from surge voltages due to the sudden switching off of the load, it is quite possible to do so by arranging a neon lamp in series with a suitable resistance across the full output terminals, so that it does not light until a voltage a little higher than the working voltage of the set is applied to it. Normally no current will flow, but when a rise of voltage occurs the neon will " strike " and speedily get rid of any surge.

Safety Measures.

The dangers of surge voltages can to a large extent be overcome by the use of a combined switch. Such a switch is manufactured by Messrs. A. F. Bulgin & Co. The knob by which it is worked can be seen next the red window in the illustrations. It automatically connects the negative of the filament accumulators to the negative of the eliminator during the first portion of its rotation; a further movement brings the filament current up to about half its value when the mains are switched on to the eliminator. The final movement of the switch brings the filament current up to its full strength.

The reverse process reduces the filament current, breaks the mains circuit, and then switches off the accumulators, leaving accumulator and mains eliminator circuits both " dead " and unconnected.

When the eliminator is to be used for a number of different purposes, where largely divergent supplies are needed, it is an advantage to have a variable resistance in the filament circuit of the rectifying valve. By reducing the filament current one can to a limited extent reduce the output of the eliminator. This resistance, however, should be capable of carrying two or three amps., as the current taken by most rectifying valves is fairly heavy.

Building the eliminator calls for no particular skill, provided one can use a soldering iron. Whether it is put in a metal box or not is largely a question for the constructor himself to decide. In any case, however, it is essential to earth the transformer cases, condenser cases, and the metal parts of any other components.

This can quite conveniently be done by running a bare wire from point to point, making sure that it is in electrical contact with each piece of apparatus, and is joined to the negative output terminal. In the case of a metal container, each component can be earthed to the container, which in its turn will be connected to the negative output terminal. All other wiring should be insulated, either with systoflex tubing or in some other way.

If space is limited things can quite well be packed together as closely as possible (the present unit is contained in a box measuring on the outside 10 ins. by 10½ ins. by 6½ ins. deep), but in any case ample provision must be made for ventilation. The transformers and the valve each generate a little heat which, if kept in a tightly closed box, is sure to give rise to trouble of one sort or another.

How tightly the packing of the components can be is clearly shown in the photographs of the interior.

The resistances and their condensers are carried on a bridge over the choke, while either side of it are the main smoothing condensers. Upright at the back are the two transformers with the valve in front.

A strip of ebonite can well be used to carry the control switch, the variable resistances, and the tapping points. With regard to the latter, completely shrouded terminals or a number of banana plugs and sockets should be used.

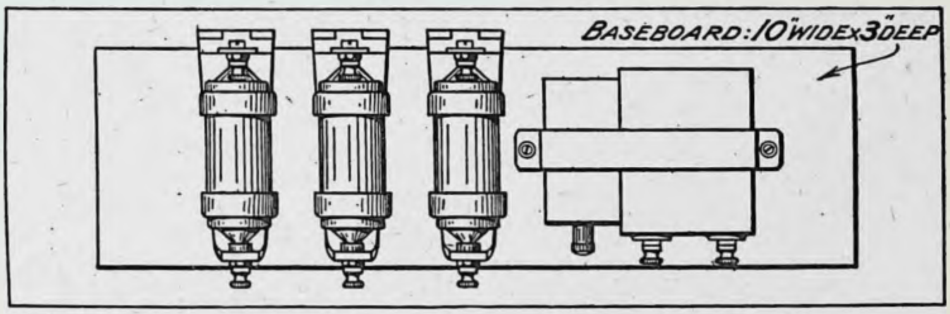


Fig. 4.

Layout of the smoothing circuit components on the bridge which is shown dotted in Fig. 3. Compare the two drawings on this page with the photographs.

In any case, do *not* use bare terminals. Voltages at these points are high, and the chances of getting shocks when adjusting the voltages and using the eliminator are many.

Exact measurements and the positions of the components are given in the layout shown in Fig. 3, but if, other components are used (and there is no reason why other parts of equal quality should not be employed) the lay-out and measurements will require to be adjusted accordingly.

The present instrument started life laid out on a board about 2 ft. 6 ins. long. Gradually it has been folded up and folded up into its present compact form, but as between the two arrangements—the one as spread out and straggling as it could very well be, and the other, about the last word in compactness—there is nothing in the working and efficiency to indicate any difference.

For convenience the unit is fitted with a plug and a tumbler switch to the mains supply in addition to the rotary switch which is normally used in working the set.

On the other hand, a long length of flex permanently connected to the transformer primaries, and terminating in a socket to fit the ordinary domestic lamp-holder, would be just as efficient a method of connecting to the mains. Special fuses have not been considered necessary, as the total call of the eliminator on the mains does not exceed 90 watts.

List of Components Used.

Transformer to Supply Plate Current.—Transformer "Supercision" G.P. 550 (Messrs. Heayberd) for use on 240 volts 50-cycle alternating current mains. Secondary output 550 volts at ·13 amps. Secondary winding centre tapped. Voltage for each half of winding 275 volts.

Transformer for Filament of Rectifying Valve.—Transformer "Supercision" (Messrs. Heayberd) for same mains current as above, to light filaments of rectifying valve. Centre tapped secondary. Full output 2·5 volts at 3 amps. Rectifying valve. Telefunken R.G. N1503 filament current 2·5 volts at 1·4 amps. Plate current, 2 plates, at 300 volts each with 150 milliamps each. *Note.*—These are maximum figures.

Condensers.—Two hydra, 500 volts A.C. tested, ·1 mfd. each.

Condensers.—Two hydra (mica), 500 volts A.C. tested, 4 mfd. each.

Choke.—1 "Supercision" (Messrs. Heayberd), 50 henries, carrying capacity 100 milliamps.

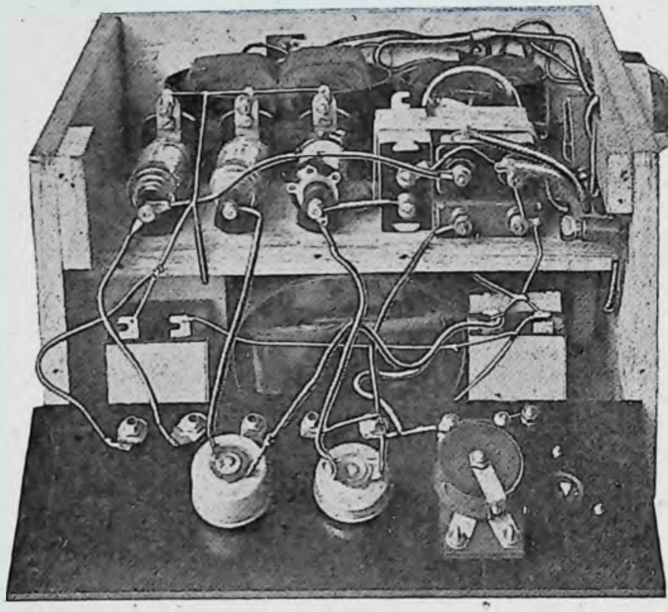
Voltage Dropping Resistances.—2. R. I. Varley annode resistances and holders suitable for voltages required. (Values as given in text.)

Variable Voltage Dropping Resistance.—1. R. I. Varley adjustable rheostat and holder.

Clarostat Resistances, adjustable carbon compression type.—2.

Condensers.—3, 1 mfd. each, any well-known make, 500 volts D.C. tested for secondary smoothing circuit.

Main Operating Switch.—1, Bulgin combined H.T. and L.T. switch.



Interior of eliminator with front panel removed, showing clearly the disposition of the components and wiring. The bridge carrying the smoothing circuit is also clearly shown. The ebonite panel measures 10½ in. by 3½ in. The knob centres are 3½ in., 5½ in., and 7½ in. from the left. Window centre is 1½ in. from the right-hand side—all on centre line of panel. The socket holes are all on a line ⅝ in. from the bottom of the panel.

Rectifying Valve Filament Rheostat.—1, "Royalty," 5 ohms to carry 3 amps.

Pilot Light.—1, pocket flash lamp, 3 volts, and screw-holder.

Red Window for above.—1, Bulgin.

Condensers.—2, Mansbridge type, 4 mfd. each, across final output.

For Mains Connection.—1 tumbler switch, 1 two-pin plug and socket.

Lengths of wire and flex, screws, timber, piece of ebonite, banana plugs and sockets, etc.

This list of parts is given simply for the amateur who fears to launch out for himself. To help the same class of constructor the following simple examples of how to calculate the value of the various voltage dropping resistances are given.

Total output of the eliminator, 300 volts.

Voltage of 150 at 1 milliamp required at first tapping point.

According to the well-known formula, volts to be dropped = amperes × resistance in ohms.—this gives us the formula:—

$$150 = \cdot 001 \times X$$

or $$\frac{150}{\cdot 001} = 150{,}000 \text{ ohms.}$$

A further example: Voltage required 80, at 3 milliamperes.

80 from 300 leaves 220, the volts that it is required to drop.

This gives the formula:

$$220 = \cdot 003 \times X$$

or $$\frac{220}{\cdot 003} = R.$$

This brought to whole numbers, because milliamps are only 1/1000th of an ampere, gives us:

$$R = \frac{220{,}000}{3}$$

which on working out comes to

73,333·33· ohms.

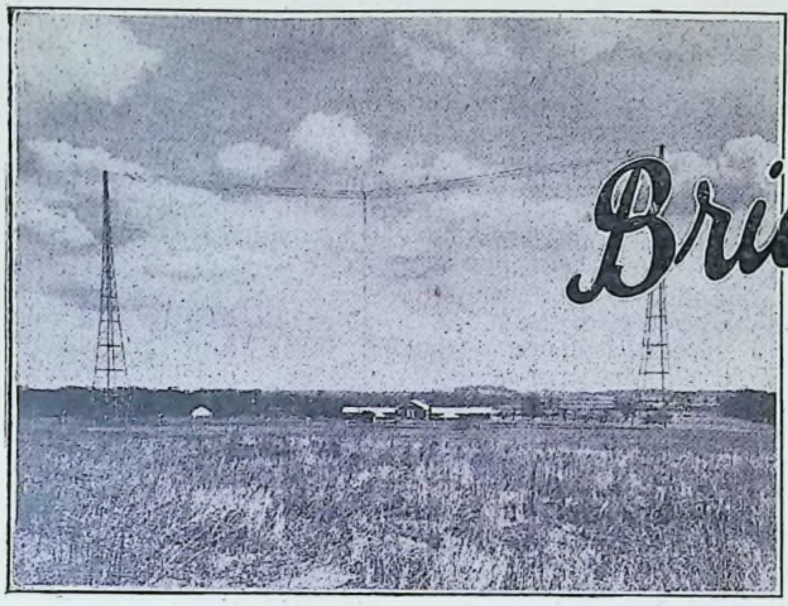
A resistance of 80,000 ohms, a commercial size, will be suitable in this case, or if one adds a little extra for safety's sake, 100,000 ohms will be suitable.

The list of parts actually used in this elimination are given for the benefit of those constructors who might wish to follow as closely as possible the original. There is one point however which, without outside aid, they could not follow. As far as the writer knows, Telefunken valves are not purchasable in this country, although quite common abroad.

An Alternative Valve.

An alternative valve, and a very good one too, which is quite suitable, is the Ediswan type H.U. 235 full-wave rectifier. This valve will handle considerably more power than the transformer can supply, and it is therefore advisable to turn the filament rheostat down a little and so limit its output.

There is, too, an advantage in using it, for when working it gives a violet-blue glow which makes it unnecessary for one to have the pilot light and red window as a warning that the mains are switched on.



Bridging Space

by

JOHN. WISEMAN

Part XI.—AMPLIFICATION

As mentioned near the end of last month's article, we shall devote the remainder of this series to a simple consideration of how amplification is effected in any wireless receiver, for we have satisfactorily disposed of the questions of modulation and rectification. From past experience I find that nearly all users of wireless sets encounter difficulty in comprehending how they can get more power out of their set than is actually put into it and are puzzled to know from whence this extra energy is derived.

We have shown that the actual voltages induced in the receiving aerial are very minute, so in what way does the set function to allow, say, a cone or moving coil loudspeaker, or the Neon lamp of the televisor, to be successfully operated. The small rectified voltages from the aerial direct are obviously far short of requirements in this direction.

Let us refer to the simple circuit of Fig. 1, which gives the bare essentials of any high frequency amplifying stage, since we shall deal initially with high frequency working—that is, amplification before rectification. The diagram indicates that there is some form of circuit marked input which will allow energy either from the aerial or a preceding valve to be fed between the grid of the valve and the filament. In the plate circuit, and in series with the high tension battery, is an output circuit, and if amplification is to take place we shall here expect to find magnified impulses as compared with those across the extremities of the input circuit.

What to Avoid.

It should be fairly obvious that, other things being equal, the larger we can make the voltage variation introduced between grid and filament the larger should be the amplified impulse measured across

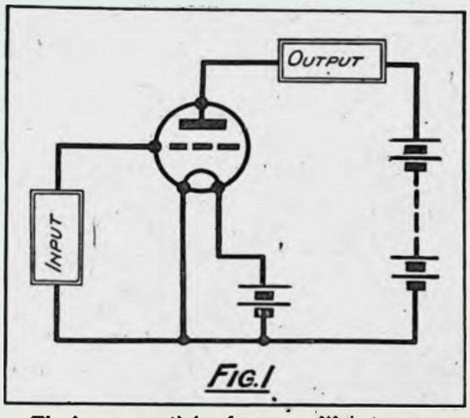


FIG. I

The bare essentials of any amplifying stage.

the output circuit. That is one reason why we tune the grid circuit, for we have learnt from previous articles in this series that we can thereby get the largest response to the particular frequency (and of course wavelength) which we are desirious of receiving and amplifying.

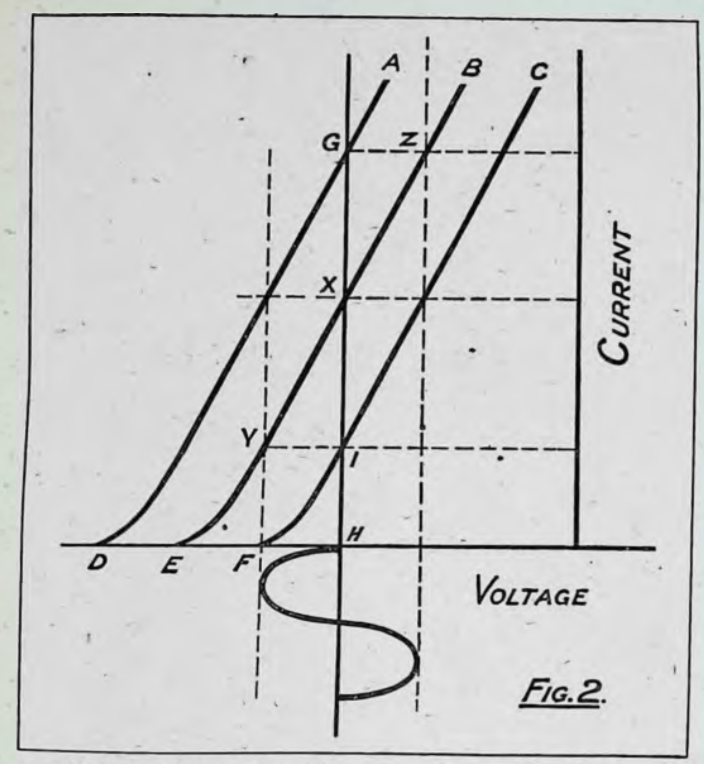
Our first step in the amplifier stage, therefore, is to tune the grid circuit by placing a coil and variable condenser in parallel between the grid and filament. In order to overcome any loss of energy at this point it is essential to choose components of the highest grade, and hence the popularising of "low loss" coils and efficient variable condensers. Any form of energy leakage in this tuned circuit brought about by poor insulation, unwanted capacity or coupling effects, will reduce the amount of useful energy which is handed on to the grid of the valve, so this must be avoided at all costs.

Valve Amplifications.

Before turning to the plate circuit, consider for a moment what is happening inside the valve. We have already studied its working in a simple manner, but by turning to Fig. 2 we should be able to trace how amplification is brought about. Let the point X represent the steady working condition for the valve of Fig. 1 on its characteristic curve (see Part V.) BE. This actual point will depend upon the plate and grid voltages chosen, but when no oscillation of any kind is imparted to the grid then XH represents the steady plate current.

Now assume that an incoming signal causes a voltage change on the grid such as is shown by the sinusoidal curve below the base line. This will change the valve plate current over a length represented by YZ on the curve. To put this change into figures we will say that the total plate current change is one milliampere, this being effected by a

4-volt grid change, that is, 2 volts above and 2 volts below the steady working position. Now, to bring about the same change of plate current through an alteration of



Typical valve characteristic curves, which help towards an understanding of how amplification takes place.

plate voltage when the grid volts are steady, we can see from the curves that this would mean changing from the point *I* on the characteristic curve *CF* to the point *G* on the characteristic curve *AD*.

The Amplification Factor.

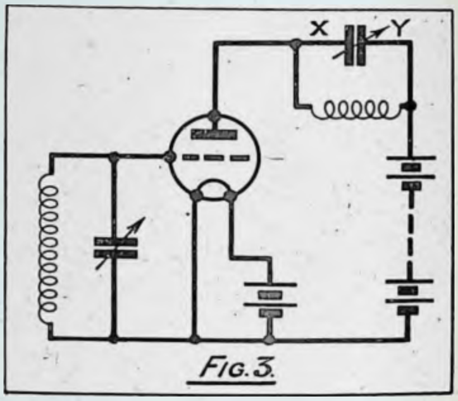
An examination of any family of characteristic curves for a valve (such as can be seen on the paper slip in a valve carton) will show the reader that to change from one characteristic to another in the manner indicated can only be brought about by a relatively large increase in plate volts, let us say in our case by 40 volts. We therefore have an interesting case of a 4-volt change on the valve grid producing the same alteration of plate current as a 40-volt change on the valve plate, or in other words, by working our valve through the medium of its control grid we get an amplification effect of 40 divided by 4—that is, 10—and this is commonly called the amplification factor. This indicates how the valve in itself brings about amplification, and is a point which should be thoroughly understood by the reader. The actual additional power is derived from the high tension battery.

Resisting Current Change.

Now, when we bring about this current change in the plate circuit of our valve it is necessary to have some form of electrical impedance in that circuit so that the resultant voltage change can be passed on from this impedance to the next valve. Put into concrete terms, we say that the function of the plate impedance is to resist changes of anode current and thus make any signal at the grid reproduce itself in the form of the largest obtainable fluctuation of anode potential.

If we include any ordinary resistance, this will, in addition, resist the flow of our steady current, and with large values of resistance the plate battery has frequently to be of a very high voltage. Since, however, the effects are alternating in character and of high frequency, some form of inductive circuit with a low direct current resistance would appear to be best suited, and in actual practice this is what is done.

A simple form is shown in Fig. 3, where an ordinary tuned circuit is in series with the valve plate and the high tension battery. When

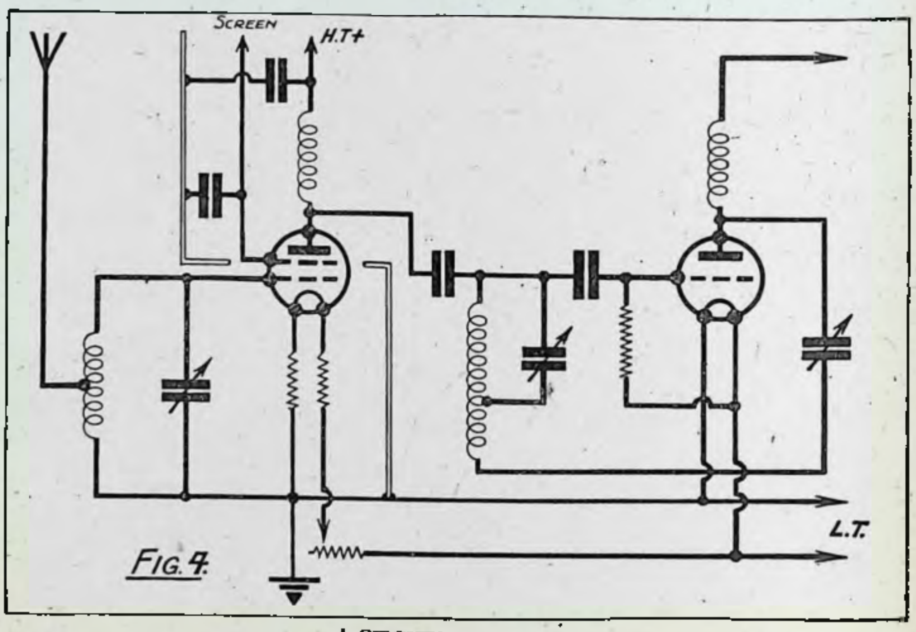


A simple tuned circuit, employed as a coupling device to pass on amplified energy to the output circuit.

tuned to any particular frequency there is a high impedance between the points *X* and *Y*, and in consequence a large voltage change across them, and this can be fed to the grid of a succeeding valve by means of a coil coupled magnetically to the tuned coil, or through the medium of a fixed condenser.

Unwanted Oscillations.

Actual circuit details do not concern us at the moment, merely



A CIRCUIT TO TRY.
A circuit recommended by the writer for H.F. amplification. One of the new screened grid valves is used.

operating principles ; and it is desirable to point out where difficulties are likely to arise. With the advent of more efficient valves and components it was found that high frequency amplifiers exhibited a tendency to oscillate or to be unstable in operation. We know that to increase signal strength in a wireless receiver reaction in some form or another is artificially introduced, but the spurious oscillation which is so often met with in high frequency amplification is due to other causes. Without going into detail, suffice to say that for oscillations to occur there must be some form of coupling present which will enable energy to be fed back from the plate to the grid circuit. As a rule, this parasitic effect is attributable to three main causes, namely, conductive, magnetic and capacitative coupling.

Three Main Causes.

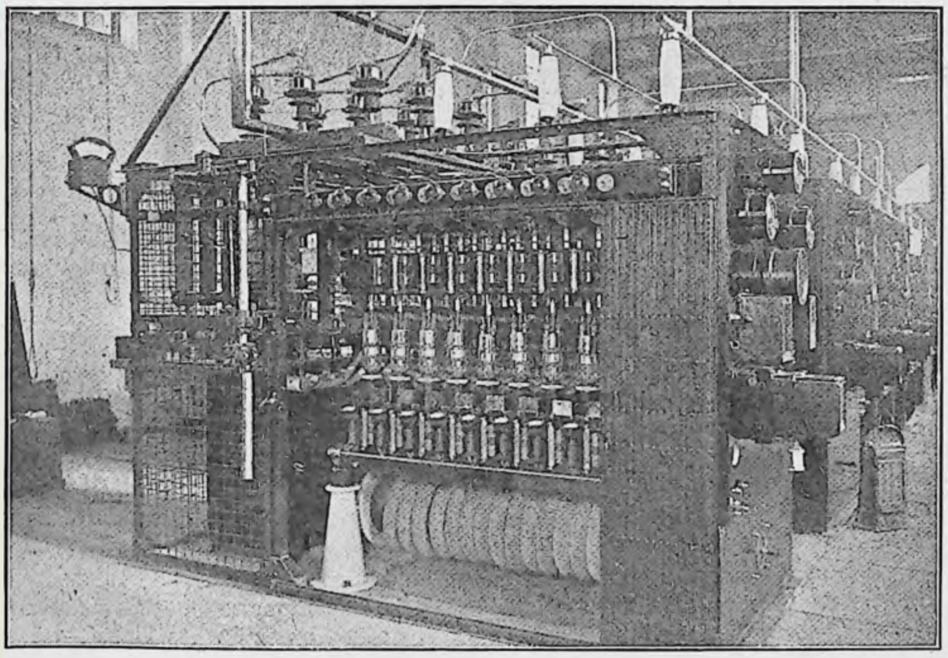
The first-named is primarily the outcome of high resistance batteries or long connecting leads and calls for a rigid observance of layout, "short path," wiring, anode feed devices, etc. In the case of magnetic coupling the trouble is usually avoided by using fieldless coils or metallic shielding, but when we come to capacitative coupling the problem cannot be dismissed so easily. In the majority of cases it is due to the stray capacities existing between the valve electrodes themselves, especially that between the plate and grid.

Cures have been effected by what is termed neutralising or balancing out the capacity feed back by equal and opposite effects, while more recently we have seen the development of the screened grid valve which gives very high and stable amplification, provided certain simple precautions are adopted.

A Circuit to Try.

To attempt to deal with the many forms of high frequency amplifiers and their operation would be entirely out of the question in an article of this length, but undoubtedly the advent of the screened grid valve has placed in the hands of wireless enthusiasts a solution to their problems of getting efficient results. Many circuit details have been published by valve makers and in ordinary wireless journals, but one circuit which I have found particularly efficient is that shown in Fig. 4, details of the high frequency valve and detector valve only being shown.

The filament resistances in the high frequency valve are for the purpose of giving a negative bias to the grid and also to allow a 2-volt valve to be used in conjunction with 6-volt valves in the other stages of the receiver. Capacity reaction is included in the detector stage, while the high frequency valve is provided with a metallic screen across its shielding grid. Perhaps at a later date it will be possible to give complete receiver details of a set based on these lines, but at the moment this does not fall within the purview of "Bridging Space."



A Bank of High-Power Amplifying Valves at Rugby.

The Postmaster-General's Decision

[Below we reprint from "The Times" of March 28th the full text of the Postmaster-General's letter to the Baird Television Development Company, embodying the decisions which he arrived at after witnessing the official test of television which we reported in our last issue.]

SIR,—The Postmaster - General has considered the results of the recent television demonstration, in conjunction with the British Broadcasting Corporation and his technical advisers, and he has reached the following conclusions, which accord generally with the opinions of those who witnessed the demonstration. The demonstration showed that the Baird system was capable on that occasion of producing with sufficient clearness to be recognised the features and movements of persons posed for the purpose at the transmitting point. It is not at present practicable to reproduce simultaneously more than perhaps two or three individuals or to exhibit any scene or performance which cannot be staged within a space of a few feet in very close proximity to the transmitting apparatus.

In the Postmaster - General's opinion the system represents a noteworthy scientific achievement; but he does not consider that at the present stage of development television could be included in the broadcasting programmes within the broadcasting hours. He bases this view not so much upon the quality of the reproduction which further experiments may be expected to improve as upon the present limited scope of the objects which can be reproduced.

The Postmaster-General is, however, anxious that facilities should be afforded, so far as is practicable without impairing the broadcasting service, for continued and progressive experiments with the Baird apparatus, and he would assent to a station of the British Broadcasting Corporation being utilised for this purpose outside broadcasting hours. He understands that the Corporation would agree in principle to this course, provided satisfactory terms were negotiated between the Corporation and the Baird Company.

It will probably be essential that any experimental demonstrations of television should be accompanied by the broadcasting of speech, and in consequence two wavelengths and two transmitters would be required. It will not be possible to provide a second transmitter in a suitable locality which will avoid interference with important wireless services in Central London until the completion of the new station of the British Broadcasting Corporation at Brookman's Park, which is expected to be ready in July. In the meantime, it is suggested that the company should open negotiations with the Corporation as to the financial and other arrangements which may be necessary, and it would probably be advantageous to them to enter upon discussions of the technical aspect with the Corporation's Chief Engineer.

In order to find room for a television service in broadcasting hours, it will probably be necessary to utilise for the reproduction of vision wavelengths outside the bands now being used for speech broadcasting. These bands, as you are doubtless aware, are already highly congested, and it is important, therefore, that the company should press on with experiments on a much lower band, which will be notified to you in due course.

In conclusion, it is necessary to emphasise that in granting facilities for experimental demonstrations in which the public can if they so desire take part, neither the Postmaster-General nor the British Broadcasting Corporation accept any responsibility for the quality of the transmission or for the results obtained. The object of the demonstration is to afford the Baird Company a wider opportunity than they at present possess for developing the possibilities of their system of television and for extending the scope and improving the quality of the reproductions. While the company will not be precluded from selling apparatus to anyone who desires to purchase it, the purchaser must understand that he buys at his own risk at a time when the system has not reached a sufficiently advanced stage to warrant its occupying a place in the broadcasting programmes.

I am, Sir,

Your obedient Servant,

G. E. P. MURRAY.

General Post Office,

March 27th, 1929.

Short Wave Broadcasting Transmitter for Italy.

The Italian Broadcasting Company has authorised the Marconi Company to proceed with the manufacture of a short-wave broadcasting transmitter for Italy.

The Marconi Company has had considerable experience in the technique of short-wave broadcasting through the operation of the short-wave station (5SW) at Chelmsford. The Italian station will to a large extent follow the design of 5SW, and will enable the Italian Broadcasting Company to carry on a broadcasting service for the Italian Colonies.

Italy will thus be one of the first countries to make special provision for its Colonies in its broadcasting organisation.

The Story of Electrical Communications

by

Lt. Col. CHETWODE CRAWLEY, M.I.E.E.
(Deputy Inspector of Wireless Telegraphy, G.P.O.)

Part V.—The BIRTH of the TELEPHONE

CHARLES WHEATSTONE, of England, whom we have already mentioned as one of the greatest of telegraph pioneers, was probably the first man to grope for telephony. At the age of nineteen he invented "the enchanted lyre," which was really a stringed instrument connected to a musical box by a long rod. The instrument was set in vibration by the rod connection to the musical box, and as both the rod and box were hidden from view the device was christened "the enchanted lyre," and was well known in London in 1821. Wheatstone undoubtedly saw the possibility of communicating speech, and even dabbled with a microphone, but he was too far off the track, and telegraphy soon claimed him for its own.

The Pioneers.

The whole idea of telephony lay dormant for nearly forty years, until Phillip Reis, a German electrician, produced a telephone for the transmission of sound. As a matter of fact, Charles Bourseul, a Frenchman, had hit on much the same idea a few years before, but Reis knew nothing of that, and Bourseul had made no attempt to put his idea into practical form.

Reis's transmitter consisted, quite appropriately, of the hollowed-out bung of a beer barrel with the skin of a sausage as the diaphragm. A piece of platinum was fixed to the sausage skin in such a way as to make and break an electric current when the skin was set in vibration by a sound. The receiver consisted of a knitting needle on a sounding board, with a coil of wire round the needle. The interrupted current from the line passed through the coil and set the needle and board in vibration, by which means a sound was produced similar to that made at the sending end.

Inarticulate Noises.

Reis could transmit noises, vowel sounds, and, to a certain extent, music, but he could not reproduce articulate speech. In Germany he is often claimed as the inventor of the telephone, but in other countries the invention of the telephone is invariably linked with the name of Alexander Graham Bell, of Scotland, that land of pioneers.

But as we have found before in considering the birth of other electrical communications, the picture is never complete without a dash of American genius, and we must not pass on now without mentioning the names of two Americans, Royal House and Elisha Gray.

House, before Bell, had patented an electro-phonetic telegraph, capable of operating as a telephone in just the same way as Bell's apparatus; but he never realised the possibilities of his invention—a case like that of Hughes, in wireless, as we shall see later on.

Elisha Gray filed specifications of a telephone on the very same day as Bell, but a few hours later. He brought an action in the courts, but Bell's prior rights were sustained by the Supreme Court; and Gray, though he eventually took out some fifty patents, was completely overshadowed by the Scotsman. Gray's telephone was precisely similar to Bell's, except that he used a constant current to augment the current produced by the vibrating membrane, in much the same way as Edison did later, when he converted Bell's telephone to the form used at the present time.

Bell's father was a great pioneer of lip-reading. His absorbing passion was to bring science to the aid of the deaf, and this passion he passed on to his son, Alexander, who assisted him in his work in Edinburgh. But as at the age of twenty-four the son was threatened with consumption, of which two of his brothers had died, his father took him to America, and it was there that Alexander Graham Bell carried out his great pioneer work on the telephone. His first work was as an instructor of his father's lip-reading system, and it was then that he met Thomas Sanders, whose son was deaf, and Gardner Hubbard, whose daughter was deaf. Bell was so successful with his pupils, in more ways than one as he afterwards married Miss Hubbard, that Sanders and Hubbard combined to help him financially with his experiments; for Bell was rich in that pioneer's attribute, which we have dwelt on before —lack of money.

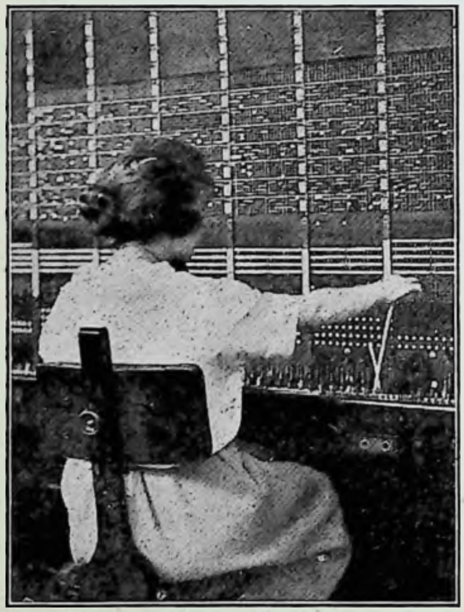
Bell meets Watson.

Bell's friends all laughed at his idea of speaking over wires, and prospects looked very black indeed until, in 1874, at Boston, he met Thomas Watson, a young American electrician. Watson, now Doctor Watson, is happily still with us, and gave a lecture in London only last year.

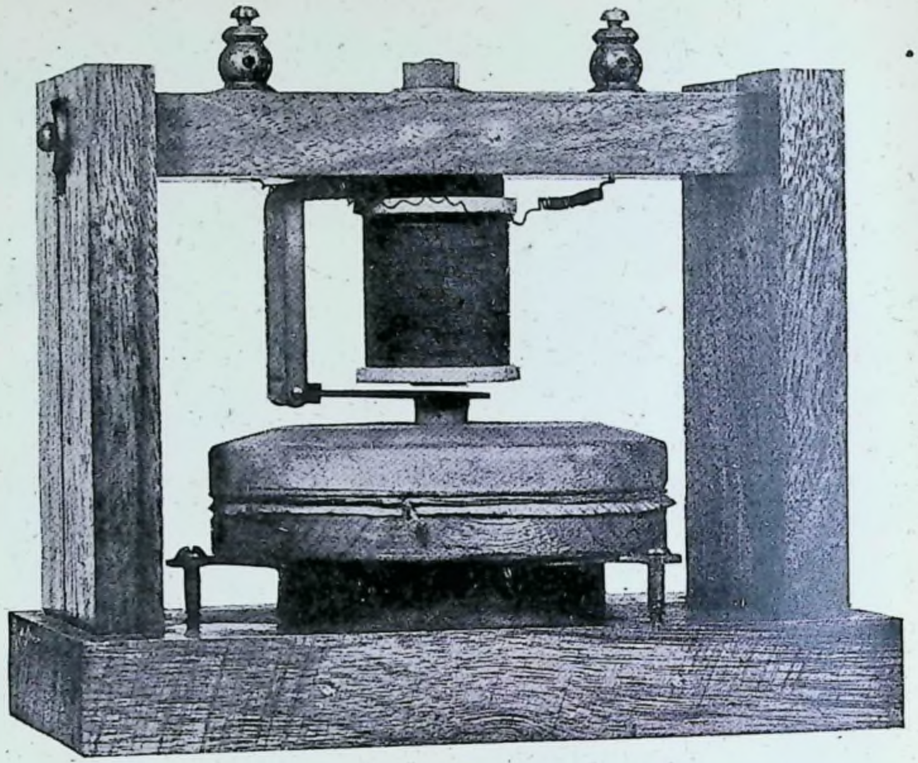
It is not too much to say that, without the assistance of Watson, it is more than likely that Bell's great idea of a speaking telephone would have fructified too late. Indeed it would be as difficult to think of Sherlock Holmes alone as of Bell without his Watson. When first they met, Bell had the idea of a "harmonic telegraph," and took his idea to an electrical workshop where Watson was employed. Watson took on the job, and from that moment the two men were seldom separated by more than a few yards of wire until the telephone had been demonstrated as a practical method of speaking over great distances. In trying to perfect their harmonic telegraph, Bell, who had never let go of the possibility of conveying speech, stumbled up against the principle of the telephone during some tests which they were carrying out, and on that very day Watson constructed the world's first telephone.

Most Valuable Patent.

These two pioneers worked day and night on their experiments, and on Bell's twenty-ninth birthday, March 3rd, 1875, he was granted "the most valuable single patent ever issued," a patent which gave rise to some 600 lawsuits.



A Telephone Operator at work in a London Exchange.



Bell's first Telephone.

A year later, at Boston, on March 10th, 1876, a seven-word message made history. For the first time a human voice came clearly over a wire. The voice was Bell's, and the famous message is again reminiscent of Sherlock Holmes: "Mr. Watson, come here, I want you."

The harmonic telegraph was then dropped, and as a matter of fact was afterwards perfected by Elisha Gray.

Bell's Telephone.

In Bell's telephone the disc which was vibrated by the voice did not, like Reis's, break the electric current, but by cutting magnetic lines of force produced currents in the coil of wire round the magnet. These currents flowed along the wire to the receiver, where the process was reversed, *i.e.* the currents flowed through the coils of an electro-magnet, thus varying the magnetisation, and so moving the receiving disc in synchronism with the transmitting disc. In this way the sound waves at the sending end were reproduced at the receiving end without the use of a battery, as was required by Reis, and as was introduced in later developments of Bell's apparatus.

In the year 1876 Bell showed his apparatus in an exhibition at Philadelphia. William Thompson, the great cable pioneer, saw it there, and reported that "this, perhaps the greatest marvel achieved by electric telegraph, has been obtained by appliances of quite a homespun and rudimentary character." Watson did not mind "the rudimentary character," but says that he has never quite recovered from the "homespun"!

Another great electrician, Moses Farmer, of America, saw the apparatus about this time, and Dr. Watson quotes him as saying: "If Bell had known anything about electricity he would never have invented the telephone." How often have we noticed in electrical communications that the pioneers have been led by an "amateur"? But it is not all jam. To quote Dr. Watson again: "Is it any wonder that my memory of those two years seems like a combination of the Balkan War, the rush hours on the subway and a panic on the stock market?"

It was not, however, what Thompson thought that impressed the public;

it was what Dom Pedro, the Emperor of Brazil, said when he tested Bell's telephone at the exhibition: "My God, it speaks!" was all he said; but it was enough to tickle the public imagination and to broadcast all over the world the name of Alexander Graham Bell.

The First Telephone Company.

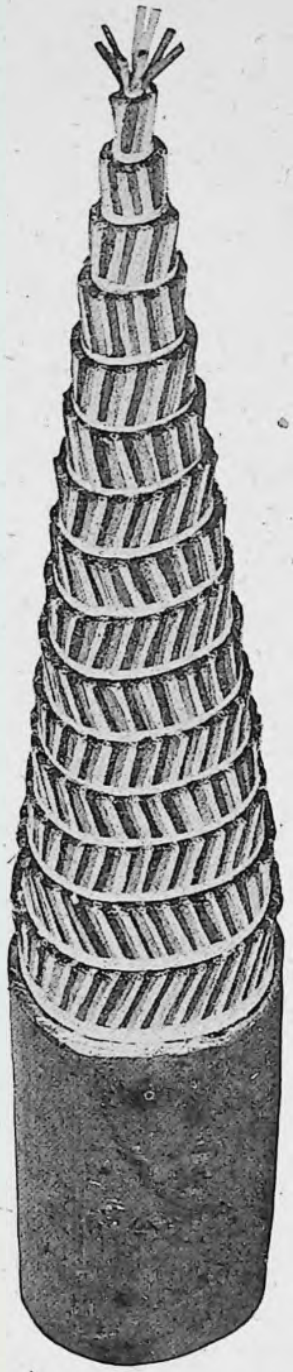
It was nearly a year and a half after Bell had filed his specifications that the first telephone company was formed. The Bell Telephone Association was started in August, 1877, with no capital and four shareholders, Hubbard, Sanders, Bell, and Watson. Bell had offered his invention to the Western Union Company, who refused it, so he formed a rival concern. Bell fought them in the law courts and won. His shares rushed up to 1,000 dollars each. Bell, Watson, and Sanders sold out, and the commercial development of the telephone passed into other hands.

On August 4th, 1922, Bell died in his summer home at Cape Breton, after a life spent in inventing devices to shorten the labours of humanity, and at his burial, as a tribute to the work which crowned his career, all communication was suspended for the space of one minute over the vast network of lines serving the seventeen million telephones in Canada and the United States of America.

Development Begins.

We have noted the work of the most outstanding pioneers in the early days of telephony, but as soon as the telephone entered the commercial arena their name becomes legion.

Needless to say, Thomas Alva Edison, the world's most prolific and versatile inventor, was soon to the fore. In 1878 he produced a carbon transmitter, though he was then in the throes of his epoch-making discoveries in electric lighting, and, when he found that his transmitter would be of no use with the existing receiver, he promptly invented a new receiver. About the same time our old telegraph friend, David Hughes, of England, independently invented the microphone, and unfortunately for patent lawyers, but fortunately for the telephone industry, did not patent it. Hughes is generally accepted as the inventor of the microphone, but, in addition to Edison, there were two Frenchmen whose names we should not omit. Du Moncel seems to have been the first man to recognise that an increase of pressure between two conductors in contact increased the conductivity; and Clerac, of the French telegraphs, had applied this principle in practice, and had actually lent his microphone to Hughes before even the telephone was invented.



End of a telephone cable, stripped, showing the large number of twisted pairs of wires (one pair for each subscriber) arranged in concentric layers within the outer lead sheath.

Origin of Modern Instrument.

Still the fact remains that the telephone transmitter as used at the present time is a direct descendant of Hughes's instrument. Francis Blake, of England, made the first outstanding advance, with his carbon button transmitter, and it is of interest to note that at the beginning of broadcasting, seven years ago, an old Blake transmitter was used for some test transmissions on account of its reputation for good articulation.

The Reverend Henry Hunnings, a curate in Yorkshire, produced an excellent granular carbon transmitter about the same time as Blake's invention, and it might be noted by amateur workers in television that Hunnings had not the slightest difficulty in obtaining £1,000 for his invention, which was used commercially for some time in London.

Later on, Michael Pupin, of America, at the beginning of this century, invented the loading coil which went so far to improve long-distance telephony over land, and submarine telephony over short distances, and here again we see the hand of the great mathematical physicist, Oliver Heaviside, of England, as loading coils, like the loaded cable, were based on theories which Heaviside had published some years before.

In the next article we shall consider shortly the present state of telephone development throughout the world, but in a more impersonal way, as we should never be finished if we tried to mention the work of the outstanding telephone experts during the last thirty years. There is one name, however, which we should like to mention now, and indeed which could hardly escape mention in an article on the telephone, however short, the name of the man who has been a leader on the technical side of telephone development from the earliest days, and to whose genius is so largely due the possibility of transmitting speech over vast distances, a name well known to us all—John Ambrose Fleming, of England, the distinguished President of our Television Society.

A Review—and the Result

The following review of the Editor's book on Television appeared in the issue of "Nature," dated March 9th, 1929:—

"*Television.* By Alfred Dinsdale. Second edition. Pp. xx+180+33 plates. (London: Television Press, Ltd., 1928.) 5*s*. net.

"In a foreword to this little book Dr. J. A. Fleming recommends it to those who desire an all-round view of the art of television as it exists at present, and of the problems and difficulties which still face the inventors in this novel field of adventure. We entirely agree with him. He also points out that in all inventions like the telephone, radio telegraphy, and television there are two stages of development. First of all an idea strikes someone; then various people try to realise it in practice. The next stage is when an inventor like a Bell, a Marconi, or a Baird, makes an invention or discovers a device, sometimes very simple, which opens up a new pathway, and then progress is rapid. When the right clue is obtained success follows, provided financial aid is forthcoming and systematic experiments are undertaken. The history of the past furnishes many similar cases.

The reader, even although his knowledge of physics is limited, will have little difficulty in understanding this book. There is a great demand by the public for anything new, for anything which contributes to the convenience of life, to entertainment, and to the dissemination of instruction and news. The physical importance of the new discoveries and inventions is considerable, and unlike many theories they are built on a sound experimental basis. The great obstacles to radio television to great distances at present are the disturbances caused by fading, Morse signals, atmospherics, and all the other causes which mutilate the broadcasting of speech and music."

In consequence of the above, the following letters were addressed to the Editor of *Nature*, and appeared in the March 23rd issue of that journal:

"PRACTICAL TELEVISION AND ITS PROBLEMS.

"Though I see that it is largely taken from a foreword written by so high an authority as Sir Ambrose Fleming, I should like to put on record my strong dissent from a sentence in the review of A. Dinsdale's book 'Television,' in the supplement to *Nature* for March 9th. The statement that I object to is: 'The great obstacles to radio television to great distances at present are the disturbances caused by fading, Morse signals, atmospherics, and all the other causes which mutilate the broadcasting of speech and music.'

On the contrary, as a matter of fact, if the difficulties occasioned by all these troubles were entirely eliminated, there would remain two fundamental and, so far as present methods are concerned, insuperable difficulties against obtaining really successful practical radio television.

The first, which applies to all television, either by radio or by wire over distances either long or short, is that with present mechanical methods it is only possible to produce transmitting or receiving apparatus with which the pictures can be divided into numbers of units which, for real success, would have to be multiplied at least by hundreds, if not by thousands.

The second difficulty applies only to television by radio and not by wire, but applies obviously to broadcasting, and consists in the fact that where television is made by radio, such broad bands of frequencies must be used in order to get the necessary details to form really successful images that these bands must cause unbearable interference with all other wireless systems in the neighbourhood.

I may add that I have received both a letter, dated March 1st, and a copy of an article in the *Elektrotechnische Zeitschrift* for Nov. 29th last, from Prof. Arthur Korn, of Charlottenburg, the well-known pioneer in the transmission of pictures by telegraph, that fully bears out these views of mine. He says in his letter: 'In reality, I think that all the present trials of television are without great practical value, and only when it will be possible to receive many hundreds of thousands of elements per second practical television will begin'.

A. A. CAMPBELL SWINTON."

"Mr. Campbell Swinton loses few opportunities of attacking mechanical methods of television. We have seen what we and many experts, including Sir Ambrose Fleming, consider excellent pictures transmitted by mechanical television. It is somewhat late in the day to point out difficulties in the way to experts. As Mr. Campbell Swinton has quoted Prof. Korn, we may be allowed to quote the following extract from a letter dated Feb. 19th, by Commandant Brenot, Chief Engineer of Radio Paris, one of General Ferrié's most brilliant pupils: 'What Mr. Baird has done is far ahead of what the most optimistic spirits could have dared thinking only a year ago at the International Wireless Conference held in Washington'.

Six or seven stations in America are already broadcasting television pictures by various methods with a somewhat limited amount of success. Experimental transmissions on the Baird system will shortly be tried in various continental countries. The matter is being considered at present by the Post Office officials in Great Britain and we are quite content to leave the question of broadcasting television in their hands, as we know that they are competent and quite unbiased.

THE REVIEWER."

It is a matter of considerable gratification to us to find that the potentialities and virtues of mechanical systems of television, which we have always supported, are now receiving such widespread and authoritative recognition.

The Cathode-Ray Tube in Practical Television

By W. G. W. MITCHELL, B.Sc.

(Joint Hon. Secretary of The Television Society)

In our February issue Mr. Mitchell dealt with some of the aspects of this important subject. In the following article he goes further into the question, and points out some of the (at present) insuperable difficulties which lie in the way of the practical application of the cathode ray tube to television.

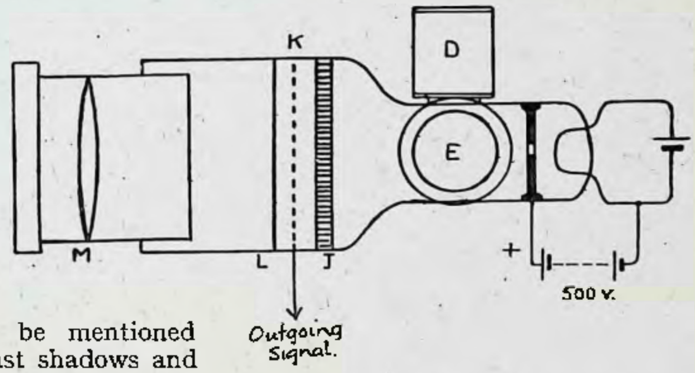
WE have previously considered (February TELEVISION), in a general way, the question of controlling a beam of cathode rays for the purpose of practical television. Such a beam, composed of mobile electrons of extreme tenuity and weightlessness, would appear, in theory at any rate, superior to any mechanical method of exploring or picture integrating. But the fact remains that although several attempts have been made, notably by Belin, Holweck, and Dauvillier, the last-named for receiving purposes only, very little success has so far attended these efforts.

It is well known that the negatively charged particles, or cathode rays, consist of flying electrons shot out in *straight lines* from the cathode or negative end of a discharge tube. The position of the anode is of little importance, for the rays will always take a straight path. The average velocity of these rays is about 10^9 cm./sec.* depending upon the type of tube and upon the potential applied to the electrodes. We shall do well to bear in mind that cathode rays are not in the nature of ether waves, but are a stream of electrons, although it is quite practicable to change them into Röntgen rays (X rays) by placing a thin plate of quartz, mica, or glass in their path, or into Lenard rays through a thin aluminium plate.

The cathode rays can be deflected from their normal undisturbed path, either electromagnetically or electrostatically. Magnetic deflection with coils produces an effect exactly the same as would be produced under the same circumstances in a flexible conductor carrying current towards the cathode along the axis of the tube. In electrostatic deflection, using plates, the particles (being negatively charged) are attracted to the positive plate. To get some idea of the stresses which must be set up, it is usually sufficient with modern tubes to cause a change of 1 volt potential or 1 ampere-turn to produce a deflection of approximately 1 millimetre on the viewing screen. This deflection occurs in the same direction as the electric field, and at right angles to the direction of the magnetic field.

Further, it must be mentioned that cathode rays cast shadows and can exert pressure to the extent of turning a small windmill, as explained in any standard text-book on the subject. When concentrated or focussed to a point they cause intense heat, and platinum, tungsten, etc., can be fused in this way.

It is my purpose in this article to consider some of the inherent objections to their use in practical television and to look into some possible remedies. Before doing so, let us summarise the "pros" and "cons" of the case, putting the favourable aspect first. Cathode rays possess little or no inertia. Under suitable magnetic or electrostatic control a beam of electrons could be made to traverse a screen *either in zig-zag fashion or spirally* at speeds far in excess of any travelling light-spot mechanically operated. They can faithfully reproduce frequencies at



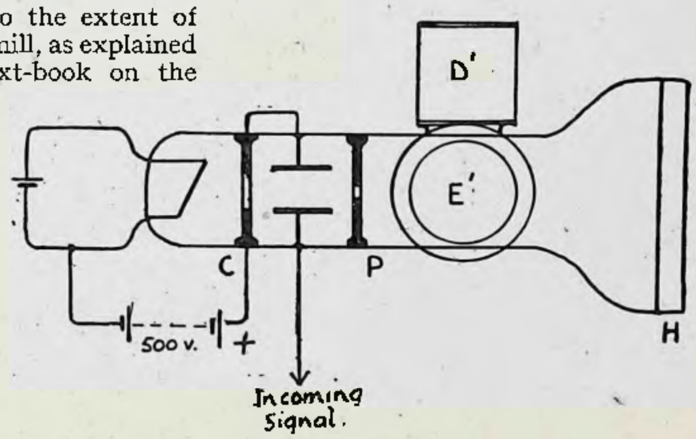


Fig 1.

Mr. A. A. Campbell Swinton's scheme for achieving television by means of cathode ray tubes. Transmitter above; receiver below.

* Becker Ann. der Phys. XVII., page 381, 1905.

least as high as the upper radio frequencies; their failure in this respect occurs only when the time taken to traverse the screen is comparable with the time taken to cross the tube from the cathode.* A point of considerable importance is the fact that the incoming vision signal, provided that it is of a certain definite threshold value, can be applied *directly* to the cathode stream without amplification.

Against these reasons we must offset the disadvantages. Unless ample precautions are taken there will be a lack of "sharpness" where the cathode stream impinges on the fluorescent screen. Canal rays move from the anode with a velocity of about 10^8 cm./sec. in the opposite direction to the cathode rays. These canal rays have a strong pulverising or disintegrating power, and by bombardment of the cathode liberate the cathode rays. The life of the tube under these circumstances is comparatively short; 200 hours is a figure given by the manufacturers as the average life of a tube.

Unreliability.

In the present stage of manufacture the tubes themselves are not very reliable; in some cases the oxide coating of the filament tends to separate from the wire, and sometimes, for no apparent reason at all, the tubes fail. And lastly, the high cost and apparent lack of enterprise on the part of most manufacturers are not at the moment conducive to further experimental research along the lines which this article sets out to indicate.

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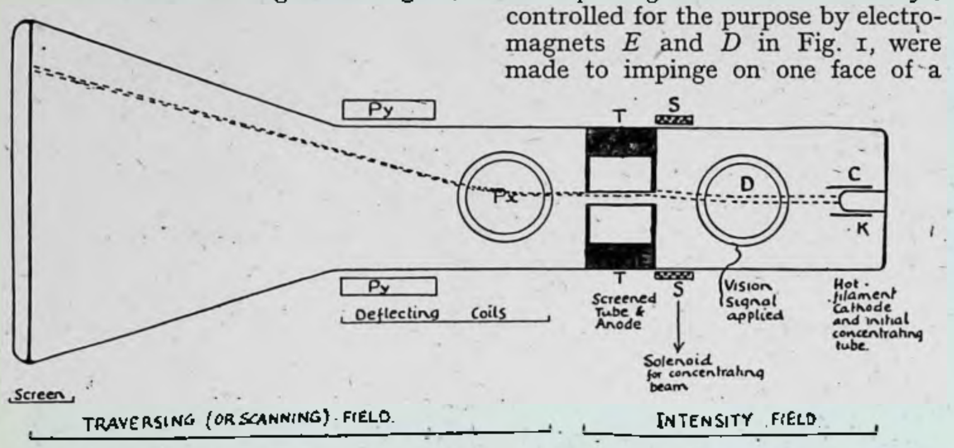


Fig. 2.
Theoretical diagram of Improved Receiver.

With these general observations, we will return to the scheme put forward by Campbell-Swinton and already outlined in our previous article. There are two serious objections. In the first place it will be remembered that at the transmitter an exploring beam of cathode rays, controlled for the purpose by electromagnets E and D in Fig. 1, were made to impinge on one face of a composite screen J. This screen consisted of a large number of separately insulated metallic cubes of rubidium, presenting on the one side a clean metallic surface to the exploring beam and faced on the side remote from the rays by a chamber K containing sodium vapour.

The image to be transmitted is projected by a lens M through a metallic gauze screen L on to the screen J through the vapour contained in K, which is there for the purpose of assisting conduction. It is difficult to see how, under the influence of light, the *entire* plate of photo-electric (rubidium) cubes can be prevented from discharging together. The difficulty is even intensified when the shifting images of moving objects are presented.

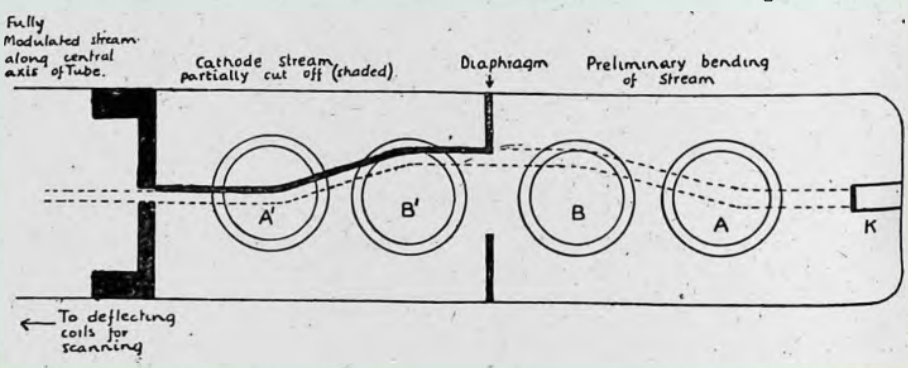


Fig. 3.
Dr. R. S. Clay's proposed method of modulating cathode rays.

So that individual exploring by a travelling or zig-zagging pencil of rays, causing a line discharge across the space to the grid, could never really effectively take place but would be overshadowed by the general mass discharge.

Modulation.

Turning now to the receiver (also Fig. 1) we find that use is made of a variable cathode stream modulated in accordance with the incoming vision signal by being deflected from its normal straight line path and will thus be weakened to a greater or less extent by the curvature of its path as it hits an obstruction or passes obliquely through a narrow tube. It will be noticed from the diagram of the receiver that the cathode, which is evidently of the hot-filament type, is set angularly with respect to the axis of the tube so that the cathode rays impinge obliquely on the lower side of the obstruction C. The incoming signal is applied to the plates O, modulation being effected by electrostatic means by allowing more or less of the electron beam to pass through the obstruction. This preliminary deflection not only varies the direction but also to a very small extent the velocity of the beam. Sir J. J. Thomson has shown that the velocity of cathode rays is not strictly constant; the velocity varies even in the same discharge.

The Ideal.

The ideal to be aimed at is obviously to vary the intensity of the cathode ray stream without varying its velocity or direction. A suggestion as to how this may be done will be considered later on in this article, but in the meantime the unsatisfactory nature of an arrangement of this kind will be all the more apparent when it is understood that, in addition to being deflected for the purpose of varying the intensity, the same beam has to be rapidly oscillated backwards and forwards across the screen as part of the scanning or image-forming process.

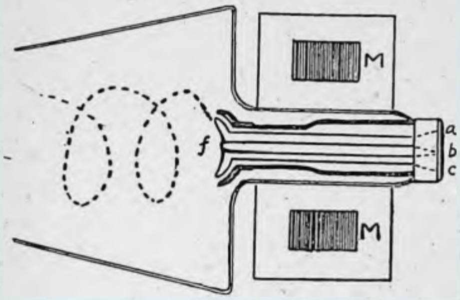


Fig. 4.
Spiral Scanning.

The effect is more clearly shown in Fig. 2, where *Px Py* are two pairs of coils or plates set at right angles to one another either within or without the tube. One set deflects horizontally, say, 20 times per second, the other pair vertically 2,000 times per second. This traversing action alone produces a uniformly illuminated field on the screen by persistence of vision, but before reaching the traversing field the cathode beam has suffered preliminary deflection in the intensity field. Consequently, any initial bending of the stream is superimposed on the deviations produced by the traversing field, causing the beam to move unevenly over the screen and thus injuring the definition.

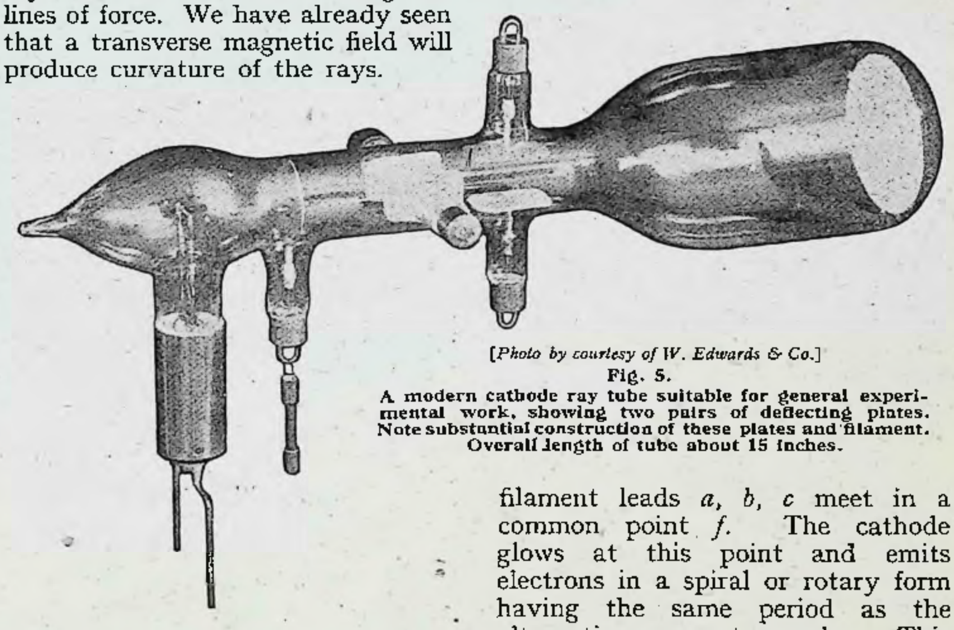
Dr. Clay's Suggestions.

To lessen the ill-effects produced by the intensity field the electron beam, when passing through the tube *T*, is screened from the influence of this field by enclosing the tube itself in a magnetic shield of iron or permalloy, or when the modulation is effected by creating an electrostatic field with plates instead of a magnetic field with coils, the tube *T* must be made a good conductor of electricity. These suggestions are due to Dr. R. S. Clay, whose final scheme is shown in Fig. 3.

Here we have no less than four pairs of modulating coils. *A* and A^1 are alike and of opposite sense to *B* and B^1, and the diaphragm is inserted between *B* and B^1. But in passing near the coils the electrons are being accelerated, so that to produce equal deflections from each pair and so restore the stream to its original direction Dr. Clay progressively increases the intensities of the coils by increasing the number of turns of wire as the current flows through them in series. Initially, all electrons are cut off and the intensity of the light will rise as the deflection is increased. With this method the maximum swing of the beam may be comparatively large. There is in consequence no reason for keeping the aperture in the diaphragm too small and thus to decrease the threshold intensity of the electron beam as would certainly happen in the case of the arrangement shown in Fig. 2.

Effect of Magnetism.

Considerable prominence has already been given in the preceding paragraphs to the magnetising effect of a coil on the negative particles forming the cathode stream. Some 40 years ago Hittorf found that when the direction of the rays at their starting-point coincided with the direction of the lines of force the rays continued to travel along the lines of force. We have already seen that a transverse magnetic field will produce curvature of the rays.



[*Photo by courtesy of W. Edwards & Co.*]
Fig. 5.
A modern cathode ray tube suitable for general experimental work, showing two pairs of deflecting plates. Note substantial construction of these plates and filament. Overall length of tube about 15 inches.

If the velocity of the rays is constant and the magnetic field uniform, then the curve into which the stream is bent round the lines of force will be a circle. If the direction of velocity is inclined to the direction of the field, the course of a particle will be compounded of a circular motion round a line of force and an unchanged rectilinear motion along it. Under these conditions the beam will be twisted into a spiral more or less elongated in the direction of the axis of the tube.

In 1921 Schoultz patented a system of spiral scanning in which the cathode beam, instead of being deflected backwards and forwards, was caused to cover a screen by a rotary motion of spiral form. Two synchronous *rotating* electromagnetic fields of varying intensity were employed for this purpose. In this connection it should be remembered that ordinary alternating current dynamos are not designed to produce frequencies of more than about 1,000 cycles per second, and, moreover, there are great inherent difficulties in setting up suitable magnetic fields with such dynamos, apart from the undesirability of introducing moving parts in close proximity to glass tubes.

It has been more recently discovered that rotation of the beam can be effected by using a three-filament cathode heated by three-phase low pressure alternating current. The filament system is shown in Fig. 4, where the separate filament leads *a*, *b*, *c* meet in a common point *f*. The cathode glows at this point and emits electrons in a spiral or rotary form having the same period as the alternating current supply. This spiral motion can be amplified by the electromagnets *M* fed by current from the same source as the filaments. A metal reflector is fitted behind the filament, which serves both as a screen for the filament and also to project the stream along the axis of the tube. This method is due to Plauson, although no claim is made for its specific use in television.

(*Continued on page* 134.)

Televising the General Election

As It Might Have Been

A little intelligent Anticipation

By SHAW DESMOND

Author of "Democracy"; "Labour: The Giant with the Feet of Clay"; etc. etc.

WHEN it was known that television was a fact, and that it would be possible for the budding M.P.'s to *show* themselves to the haughty electorate, as well as merely to speak to them, there was a flutter in the Westminster dovecotes.

Mr. Lloyd George at once had a shingle. His friend the enemy, Ramsay MacDonald, had an extra curl put in his moustachios. Winston, the one and only, instantly took a new size and (as some said, thank heavens!) a new shape in hats. Whilst Messrs. Baldwin and Chamberlain rehearsed an entirely new double turn for the television screen.

As for the half-dozen lady members and the half-hundred blushing lady candidates who soon hoped to be M.P.'s, when *they* knew that the television screen was going to be the decisive factor in the 1929 election, they smiled all over. They knew what good looks could do with a male elector.

For both sexes knew that it was not for tariffs or for land schemes that "the tried, trusted, and true" would cast their votes, but for the "good-lookers."

As Mr. Baldwin said ruefully to Austen Chamberlain: "If you didn't have the looks you might as well be off the political map . . . especially with this flapper vote."

"I believe you, Stanley," said Austen in reply. And stuck his monocle a trifle more rakishly in the Chamberlainic eye. There was indeed life in the old dog yet.

The first bombshell flung by the new televising of candidates and their speeches was thrown by, above all others, Mr. Baldwin himself.

He was shown one night just before the poll *without his pipe*, and with a cigarette "on"!

This caused the most dreadful recriminations by the Welsh Wizard, who declared that Stanley had stolen a march on him, and most unfairly. "It's not playing the game, you know, Baldwin," he said. "The flappers love a fellow with a fag. They don't like pipes. And *you knew it*, you bad boy! I was going to do the cigarette trick myself."

The next number was, however, performed by Mr. Lloyd George, and with great effect.

"The little Welsh Wizard," as he was billed, bounced on to the television screen in every home in the land doing his now well-known double conjuring act, during which he showed that black was white and proved beyond cavil that when a politician said what he really meant he ceased to be a politician. Also, he *really* had nothing up his sleeve.

> **"AT some future general election we might, by having land lines to cinemas and halls, show on the screen to thousands of people, say, Mr. Baldwin making a big speech. His words would be heard and his every movement and gesture seen as well."**
>
> [*Extract from a report on television developments, "Evening Standard," April 12th, 1929.*]

At the same time he made a number of promises of what he would do if returned as prime minister—but as all the promises were in Welsh that was all right.

Several excited Welshmen in Tooting and Clapham Common dairies smashed the screen in their excitement.

Labour, feeling that it was up to it to do something now that Wales had stolen the Labour thunder, decided to put on the well-known comedian, Ramsay, "to do his stuff" accompanied by a harp and wings.

If it had not been for a certain unfortunate incursion on the screen this act would have been a complete success.

First, as the intelligent electors gazed upon the television screen attached to their broadcasting apparatus, they saw Ramsay as an Arcadian, clad in an abbreviated angelic garment, a halo around his curling locks, and carrying a broken-stringed harp in his hand, singing his well-known Labour Lament :—

> For often to myself I've said :
> Cheer up, Ramsay, you'll soon be dead—
> A short life and a gay one.

It was towards the end of this cheerful little ditty, given with utter *verve*, that the unfortunate incursion mentioned occurred.

For there rushed on to the screen a thin, sallow, handsome, and dark young man, with a tie of fiery red (for in the new colour television colours are shown). Pushing his chief out of the way, the young man, a dark lock falling across his Robespierre forehead, sang that well-known song: "The One and Only Way!" the chorus of which ran :—

> Boys and girls come out to play,
> Russia's the one and only way ;
> Stahlin's the boy we all want to-day,
> When we go to the polls in the morning.

It was at this moment that the infuriated Ramsay, lifting the harp, brought it down at a sharp and uncomfortable angle upon the jutting Maxtonian jaw. Unfortunately, ere the now delighted electors could see Mr. Maxton's reply, the televisor was cut off.

It was Winston who brought order

out of chaos by appearing upon the now relighted screen to tell the world that " Codlin's the boy, not Short." " I do not name any names " the great Westminster knockabout said in his inimitably modest way, " but, although it is not for me to say so, I think you will find that in the long run you'll decide that it doesn't pay to do business with Welshers, nor yet with Scotchmen, but with the old firm, the old firm ! "

With that, Mr. Baldwin, who evidently had been waiting in the wings, came diffidently on to the stage dressed as a bookmaker, white topper, checks, spats, and bag all complete, his pipe well on to give confidence.

" The ole firm—the ole firm ! " he cried in husky but fatherly accents as he got up on a little stool underneath which his friend Winston stood as a bookie's clerk. " Any odds yer like on anybody yer like. The ole firm—the ole firm ! Pay or be paid ! Pay or be paid ! The old Westminster firm with the old government guarantee ! The ole firm ! The ole firm ! "

It being felt that the Conservatives were stealing all the Liberal thunder, and something desperate being necessary to counter the effect, on the following evening the now thoroughly enlightened electorate were still further illuminated by a stream of beautiful and bouncing chorus ladies rushing on to the television stage when the curtain went up. As it was announced across the curtain : " All under the EXCLUSIVE direction of Mr. Lloyd George, helped by Mr. Charles Cochran."

These delightful young ladies, who, it afterwards appeared, had been specially fattened for the occasion, under the guidance of the famous physician, Dr. Havebutnot Pain, then entranced their invisible audience by singing modern ballads to quaint old settings.

" My Souvenir " sung to " Here we suffer grief and pain," and " Goodbye Blackbird," set to the tune of " I can't come back again, Kathleen," were perhaps the outstanding successes. The solos were : " Homes for Heroes to live in " and " Rare and Refreshing Fruit;" the latter set to " The Voice that breathed o'er Eden," both sung by Mr. George, who was in great fettle, caused much emotion amongst the television fans.

" I never heard anything like it in my life," was indeed the comment of Mrs. Bert Budger, of 3a, Laburnum Road, Finsbury Park. The comments of Mr. Budger, an ex-service man, were also interesting and to the point, but need not here be repeated.

The enormous success of the Lloyd George revue aroused, one regrets to say, the basest jealousy in the breasts of a certain small group of his opponents, who promptly announced for the ensuing evening a special act by Colonel Barker, to be entitled " The Softer Sex."

This, however, was a failure, due to its being " jammed " by the clever little Welshman who hired half a dozen special high-powered apparatus for the purpose, showing all his old resource.

Although conjuring acts and bed-time stories, especially the fairy tales in which the leaders of all parties specialised, continued to be the *pièces de resistance* of the political screen, it was due to the almost diabolical cleverness of Mr. Broncho Blurb that a most effective appeal was made to the flapper vote.

Mr. Broncho Blurb, as is well known, was once an agricultural labourer who was brought to see the light (red) in one of the Home Counties through a speech of one of the Auld Lichts of Labour. His ingenuity seems to be endless.

It was he who got the idea from Mrs. Blurb, who got the idea (soon after she had been presented at Court) from Lady Snuffenough, who simply dotes upon Labour members' wives, and to whom Mrs. Blurb had once been " cook and general."

With the intuition of genius Broncho Blurb saw that if you could only knock a guinea off the cost of three-guinea hats " you could get any flapper in England to vote for anybody you damn well please," in Mr. Blurb's homely but convincing language, racy of the soil.

So it was that Mr. Snowden, just before a Labour mannequin parade was thrown on the screen, was put forward to announce that, as a former Chancellor of the Exchequer, and as one who hoped to be one again very shortly, the cause of First Class Hats for Flappers at Second Class Prices had always been dearer to him than anything else in life. " If I am returned," said Mr. Snowden on the screen to the delighted and now screaming flappers, " I shall at once knock off all taxes upon imported straw for hats and forbid any Regent Street or Oxford Street firm to charge more than half a guinea for a two-

Mr. Lloyd George at once had a shingle. His friend the enemy, Ramsay MacDonald, had an extra curl put in his moustachios. Winston, the one and only, instantly took a new size and (as some said, thank heavens !) a new shape in hats. Whilst Messrs. Baldwin and Chamberlain rehearsed an entirely new double turn for the television screen.

guinea—what did I say ?—I mean a three- or even a five-guinea hat."

In vain did the Conservative television headquarters, as that of the Cocoa Party, seek to blanket both the speech and the winning smile of Philip. The deed was done. And as Birkenhead, following the other Napoleon at Waterloo, put it succinctly : " Dammit, the game's up—why didn't *I* think of that ! "

After that what was the good of the

" Any odds yer like on anybody yer like. The ole firm—the ole firm ! Pay or be paid ! The old Westminster firm with the old government guarantee ! The ole firm ! "

Countess of Borax and Lady Chillinggum having a hundred Bethnal Green babies specially washed for them to kiss, in order to introduce the democratic touch ? What was the use of Winston appearing in a last desperate effort to capture the labouring vote ; coming on in corduroys and shirt upon the top of a high building to lay his bricks ? The mannequins, plus Mr. Snowden, had done the trick. The game, indeed, as Birkenhead had truly said, was " up."

Of course there was a certain set-off to the effect of the mannequin parade by an unhappy *faux pas*, as a Ruskin College man put it, of one of the Labour leaders.

This gentleman had forgotten that not only could his voice be heard, but also that *his face could be seen.*

So it was that, actually in a very bad temper, from a slight domestic difference upon the cost of *tulle*, and not exactly knowing what he was talking about (something shared by many of his political opponents), he made all sorts of wild promises, unfortunately *not* in Welsh, to the listeners-in, who now also were the " lookers-in."

He promised sixpence off the income tax ; bonuses for babies ; marzipan for nursing mothers ; and a sort of Garden of Eden if he were returned. *But he forgot his face.*

Whilst he uttered the beautiful and soothing promises his face was set in an angry scowl (because of that little difference with his wife), whilst in his eyes was the diabolical smile peculiar to politicians who promise something for nothing.

The result was that, seeing the sardonic smile and the scowl alternating, the electors took his promises at their "face," and not at their word, value. And so he lost his voters and his seat.

Truly, the televisor has introduced a new terror into British politics.

It forces politicians to tell the truth. Dear, dear !

SHAW DESMOND.

Cathode Ray Tube.

(*Concluded from page* 131.)

Before cathode rays can be utilised for practical television, a good deal of further research is necessary in arriving at the best method of focussing the cathode beam to a *sharp* point on the fluorescent screen. Allied to this and of equal importance is the question of improving the fluorescent screen itself. In the old type Braun tube concentration of the beam was brought about by emptying a cup-shaped cathode so that the rays are brought to a focus at approximately the centre of curvature of the cathode. With the modern low-voltage hot-filament type of tube a short metal collar is usually placed round the filament, and, further, a solenoid producing a uniform field may be wound round the tube to assist in increasing the intensity and helping the concentration of the beam to a point on the screen, as shown diagrammatically in Fig. 2. The introduction of a small quantity of argon gas into the tube also serves to concentrate the stream to a point.

The coating of the fluorescent screen usually consists of a mixture of calcium tungstate and zinc silicate which, in viewing recurring or transient phenomena, results in a spot sufficiently bright for visual observation and yet containing enough blue light to be fairly active photographically. Brunn has advocated the use of a plate or film of phosphorous for improving the definition. This film may be carried on an endless band which travels successively past the fluorescent screen.

Plauson uses a window made of beryllium or an alloy containing a large proportion (95 to 98 per cent.) of beryllium and 2 to 5 per cent. of aluminium to which a small quantity of magnesium has been added. A thin layer of resistant metal about 1/1,000 mm. thick, such as nickel or platinum, may form a coating of this window.

In the foregoing no reference has been made to the most effective way of producing rapid field changes for causing the electron beam to traverse the screen. This, alike with the many other problems involved in effectively controlling cathode rays, calls for much patient experiment and research.

The Story of Chemistry

Part VIII

Ionisation

By W. F. F. SHEARCROFT, B.Sc., A.I.C.

THOUSANDS of years ago the Greeks came to the decision that all matter consisted of minute, discrete particles, which they called atoms. Their speculations were vague, and it remained for Dalton to give them precision at the beginning of the last century. We have seen how his mathematical conceptions proved the central point, around which chemistry has revolved since his time. We have seen how the atoms combine together to form other particles, called molecules, and now we come to another order of particles, the IONS, formed when certain molecules dissolve in water.

There is a school of chemists who refuse to believe in these ions in solution, and prefer to explain solution and electrolysis in a different way. Whether they are right or wrong does not matter very much from our point of view. The process of ionisation, as it has been expounded, does offer an explanation, a simple explanation and one which has given rise to much that is of importance. It might be said that the starting point from which television has arisen is the ion as we have described it.

Such a striking phenomenon as electrolysis, and one which had such immediate and practical results, naturally attracted considerable attention. The great experimenter Faraday thoroughly examined electrolysis, and was able to state its laws, which are now known as Faraday's Laws.

Let us return to the electrolytic cell. There, between the electrodes, we detect what we call the *flow* of a current by any of the familiar means of detecting currents that we may choose to select. There is no difference between this current and the current flowing round a wire attached to the poles of a battery or the terminals of a dynamo. But to explain the chemical changes which accompany this *flow* of current through an electrolyte, we have had to imagine that all that happens within the electrolyte is the *flow* of tiny charged particles, which we have called ions. There is a stream of negatively charged particles flowing in one direction, and a stream of positively charged particles flowing in the opposite direction.

This is the eighth of our contributor's series of articles on the story of chemistry, written in simple language, with the introduction only of those chemical formulæ as are essential to an understanding of the subject. In his last article he dealt with the subject of electrolysis. In this article we learn something of another order of particles, called ions, which are formed when certain molecules dissolve in water.

This flow of actual particles constitutes the electric current in the electrolyte. Now, as the electrolyte itself is electrically neutral, it is obvious that the sum of the charges on the negative ions must be equal to the sum of the charges on the positive ions. Further, we have seen that, when the ions reach the electrodes, they give up their electric charges, become uncharged matter such as we are used to, and are either deposited on the electrode or evolved as gases.

It may be possible that the atoms forming any particular ions are not capable of existing as themselves, or as any re-arrangement of themselves. Thus, if we dissolve copper sulphate ($CuSO_4$) in water we get a mixture of positively charged copper ions, and negatively charged sulphate ions. On putting the charged electrodes into such a solution the copper ions will travel to the negative electrode, give up their charge, form molecules of copper, and be deposited upon the electrode, which is the usual method of copper-plating any article, it being made the negative electrode in such a cell. Now the sulphate ions consist of the atoms SO_4, bearing a positive charge. They will travel to the positive electrode, give up their charges, and become ordinary uncharged atoms, and, as the group SO_4, can have no separate existence. No such substance having the formula SO_4 is known, or from valency consideration could such a group of atoms have a separate existence.

We may imagine the group as possessing free valency—free "hooks"—which must be attached to something. Therefore this SO_4 group looks round for something to attack. The only alternatives are the electrode and the water in which the solution is made. Supposing that the positive electrode is made of platinum then the SO_4 group will not attack it, but will go for the water, thus—

$$SO_4+H_2O \rightarrow H_2SO_4+(O)$$

The oxygen atoms liberated by this reaction will combine together to form oxygen molecules (O_2), millions of which, sticking together, form little bubbles, and we note the evolution of the gas oxygen. If the positive electrode is made of copper, then the SO_4 group will attack this, thus—

$$SO_4 + Cu \rightarrow CuSO_4$$

The copper sulphate formed will promptly go into solution and ionise, and the ions become subject to the ionic drift as before. These reactions, taking place at the electrodes between the groups of atoms freed from ionic charges, have nothing to do with the electrolysis. They are *secondary reactions* independent of the influence of the electricity, and taking place only *locally* in the solution. The ionic drift takes place throughout the solution. The word electrolysis is usually stretched, however, to include everything which takes place within the cell. It may be as well to state that there are other ways of looking at the local secondary actions, but for our present purpose the above is sufficient.

Measuring Quantities.

Now it follows that we can, by carefully arranged experiments, collect the materials which are deposited or evolved at the electrodes. We can also measure the quantity of electricity which passes through the electrolytic cell, that is, the quantity of electricity carried by the ions. It is not necessary for us to go into the details of Faraday's work or the considerations which followed it. It will suffice to say that from the results obtained from the figures which were arrived at we can conclude that the charge on any ion is always constant. It was found that the charge on a hydrogen ion was the smallest charge, and that charges on all others ions were either equal to that on the hydrogen ion or simple multiples of it. In no single case do we ever find a fractional charge in terms of the unit ionic charge on a hydrogen ion.

This suggests a limit to the possible magnitude of an electrical charge, the limit being reached with the charge on a hydrogen ion. All ionic charges are made up of a whole number of these unit ionic charges, a conclusion which points to an atomic structure for electricity. The evidence derived from these chemical considerations indicates that electricity is discontinuous as far as ions are concerned. Unfortunately, at the time this possibility was not explored. Faraday and his contemporaries were satisfied with the elaborate schemes of lines of force in a surrounding medium, and felt no inclination to look at electrical problems from any other angle.

The ultimate extensions of this work are outside the province of these articles, belonging more to the province of physics than to chemistry, but it was a chemical phenomenon which laid the first length of track towards our present electronic theory of matter, on which rests the practical details of wireless and its latest development—television.

The ionic theory of electrolysis as we have outlined it was developed by Arrhenius. It offers a ready explanation of the regularity which we have observed in the action between salts, acids, and bases in water solutions. These classes of substances are those which form conducting solutions, that is, solutions consisting of charged ions. In a solution containing a mixture of ions, say A^+ B^+ C^- D^-, we imagine a continual motion taking place, resulting in the collision of many millions of ions in a very small fraction of a second.

When oppositely charged ions come into contact we see the possibility of their forming a complete and uncharged molecule such as AC, AD, BC, BD. In fact we are probably near the picture if we imagine these molecules being formed at enormous rates. Now these molecules may either be soluble or insoluble. If they are soluble, then immediately they will split up into their ions again, and as far as we are concerned we shall see no visible sign of the innumerable changes taking place within the solution. If, however, any of the four possible molecules is insoluble then, after formation, it will not re-ionise, but will be precipitated as a solid in the bottom of the vessel.

Ions in Solution.

Thus, for example, if a solution of sulphuric acid be added to a solution of barium chloride, then the following ions will exist in solution—hydrogen (H^+), ($SO_4^{=}$), (Ba^{++}), (Cl^-). (The positive and negative indices represent the ionic charges, each sign denoting one unit ionic charge. It will be noticed that the number of charges on an ion is equal to the valency of atom or group of atoms of which it is formed.) These four ions give us the possible formation of the molecules of the substances forming the original solutions, that is, sulphuric acid, H_2SO_4, and barium chloride, $BaCl_2$, and also hydrogen chloride, HCl, and barium sulphate, $BaSO_4$. Of these all are soluble except barium sulphate, which is precipitated as a white solid. The chemical action we represent by the equation thus—

$$H_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2HCl$$

It would be nearer the truth, according to this view, to write the equation thus—

$$2H^+ + SO_4^{=} + Ba^{++} + 2Cl^- \rightarrow BaSO_4 + 2H^+ + 2Cl^-$$

It is not imagined that when a soluble salt, acid or base is dissolved in water that the whole of the molecules are ionised at once. At any particular instant only a certain proportion of them are actually ionised, and there is a residue of unionised molecules. Actually a state of equilibrium is set up between the ions and the molecules, which for sulphuric acid we might represent thus—

$$H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{=}$$

and imagine a continual change taking place, in what looks like a quiescent solution.

Degree of Ionisation.

The proportion of molecules ionised depends upon the nature of the solute. Most salts are almost entirely ionised. The strong—not concentrated—acids are very highly ionised in solution, a fact which is used to explain their strength. Their solutions contain a high proportion of hydrogen ion, which is the active part of an acid, or rather the characteristic part. Weak acids, like vinegar, are only slightly ionised. Strong bases are likewise highly ionised. Dilution of the solution of an electrolyte increases the proportion of ionised molecules.

It will be seen also that the important chemical action which we have called neutralisation consists of the union of hydrogen ions derived from an acid with hydroxyl ions from a base to form water molecules, which are hardly ionised at all.

$$H^+ + OH^- \rightarrow H_2O$$

The ionic theory underlies most of the practice of chemical analysis which is designed to determine the qualitative composition of a substance. The substance is got into solution, and then the ions formed are recognised by making them combine with other ions to form insoluble molecules which can be recognised.

The Television Society

Mr. J. CAMERON RENNIE, B.Sc., A.M.I.E.E., ON "SOME NOTES ON EXPLORING"

THE April meeting of the Television Society, held at the Engineers' Club, Coventry Street, London, on April 9th, marked a new departure in such meetings, for it was divided into an informal and a formal section. The informal section was presided over by Mr. W. G. W. Mitchell (joint hon. secretary), and was devoted to the discussion of a brief paper on Selenium Cells, presented by Mr. H. S. Ryland. In his paper Mr. Ryland dealt with the main characteristics of selenium cells, and the members present then discussed this interesting subject and asked a number of questions, which were answered.

The formal section of the meeting listened to a paper read by Mr. J. Cameron Rennie (member of council) on "Some Notes on Exploring."

The Vice-President's Speech.

Lord Angus Kennedy presided over this section of the meeting and, introducing the lecturer, said that as the chairman, Dr. Tierney, was unfortunately laid up with influenza, he had been asked to take the chair. They were fortunate in having Mr. Rennie, for he had travelled up specially from Bristol that day. He was going to lecture on "Methods of Exploring." They would remember that Mr. Poole recently dealt with the building up of the picture. Mr. Rennie was taking the other end of television, which was an equally important process.

The last time they met they had their President, Sir Ambrose Fleming, with them. That was on March 5th, the day of the post office official test of Baird television. Since then every member of the Television Society had received a copy of the P.M.G.'s letter as it was published in the Press on March 28th—an epoch-making date, being the first time that the British Government officially recognised television.

He understood that the joint secretary, Mr. Mitchell, had had some correspondence with the managing director of the Baird Company which would, he thought, interest members.

Lord Angus then called on Mr. Mitchell to read a letter from the Baird Television Company, which was dated April 9th, and signed by Captain O. G. Hutchinson, managing director of the company. It stated:

Baird Company's Intentions.

"At present we have under construction about 4,000 televisor sets. These are due for delivery before the middle of June next, and will, therefore, be ready by the time the Brookman's Park Station has been completed.

"It is our intention to sell these as complete units, but later on further lots may be sold in complete kits for those who wish to assemble them themselves.

"In regard to delivery of these machines, it is our intention to give preferential treatment to members of the Television Society."

This letter was in reply to an inquiry from the secretary of the society, pointing out that now it has been definitely promised that experimental transmissions of television will take place at the new B.B.C. station at Brookman's Park in July, a statement as to how soon television receivers would be available for reception would be greatly appreciated by the society. The members, too, the secretary pointed out, would also be glad to hear whether the receivers would be sold complete or in separate parts for assembly. Such information would be of very great interest to the society, as its members included many keen experimenters.

Mr. Rennie, in the course of his lecture on exploring, referred to the "dot" theory of transmission, and said:—

"This conception of looking at individual points of a picture is a true one, but only in a limited degree. Many people, and quite well known scientific men at that, have accepted this view, and have likened the process of transmitting a picture to the examination of a half-tone block in which an image is produced by correlating the different degrees of lighting of small dots which are close together. If this conception of a picture being transmitted and received as a large number of dots were true, it would be impossible to carry out wireless transmission of images. This has been very clearly discussed by Dr. Robinson in the November and December numbers of the TELEVISION magazine, and there is no need for me to go over the ground again.

Older Methods.

"Let it be clearly understood, however, that it would be possible to transmit a picture in that way, and, in fact, for still pictures such a process had been used, although not commercially, by means of a code which represented different tints, so that the picture could be transmitted in the form of a message, the received image being reconstituted by decoding the message and transforming it back into shades or tints over separate equal areas assembled together in a particular order. That, however, was not what happened in television as they knew it to-day.

"The process of exploration of an object can be carried out in various ways, and the simplest example is the disc with the spiral set of holes. With this exploring device, the circumferential pitch of the holes determines the height of the picture, and the pitch of the spiral determines the width of the picture. Of course, the height and width are interchangeable if the top of the disc is used as the operative portion instead of the side.

"With this kind of device each hole travels down and exposes a strip or band of the object, and each successive hole exposes a further band which lies beside the first band, and this process continues until the whole area is explored.

Dr. Robinson's Articles.

"Dr. Robinson has made it clear in his writings that the transmission does not consist of a series of isolated dots such as occur in a half-tone block, but that for each band the signal is a continuous but varying one, and on these lines he has argued that the fundamental signal should be considered in terms of a number of bands rather than a hypothetical number of dots.

"He worked out examples to show that on this basis wireless transmission of television is possible without occupying an undue space in the ether. I do not think it was made clear in his articles, however, that this argument was capable of still further development in the same direction.

"I am inclined to say that the number of bands is of very little more importance than the hypothetical number of dots, for fundamentally there is no discontinuity between the end of one band and the beginning of the next.

"In the light-spot system of exploration in which the light sensitive cells are continuously exposed to the illumination of the object, and a small spot of light travels over the object in parallel vertical bands, it seems to me perfectly clear that there is no discontinuity behind one band and the next; so far as the cell is concerned it is receiving light from the whole of the object, and at every instant the light which is operative on the cell is made up of two parts, a constant due to the reflected normal illumination of the whole object, and a variable due to the local reflection from the particular point of the object on which the intense spot of light is directed at any instant.

"It is immaterial, so far as the cell is concerned, from what direction the variable quantity of light happens to come, so that if the extent of the picture is defined by the circumferential pitch of the holes, as soon as one spot of light leaves the bottom margin of the picture another spot enters the top margin.

matter of the last two years shows that wrong conceptions have been prevalent, and, in fact, still are prevalent in some quarters. I feel, however, that the extension of Dr. Robinson's statement of the nature of a television signal is justified by actual practice, for although I do not know of any published results, I think it is safe to say that the frequency band occupied by television transmission is considerably less than is called for on Dr. Robinson's

The Engineers' Club, Coventry Street, W., where meetings of the London Section of the Television Society are held.

"It might easily be arranged that the total area illuminated by the intense spot of light is a constant on the edges of the picture, and if that were so there would be perfect continuity of signal in transferring from one band to the next band, and the signal arising from the exploration of the whole object or scene would be in the nature of one variable signal.

"One must be rather tentative in offering suggestions as to what actually takes place in the exploration of an object or scene, because all the published

theory, and all I am doing is carrying his argument to its logical conclusion to fit in with actual fact.

"In some television systems the synchronising of the receiver and transmitter was effected by means of a special signal occurring once in each band, the signal being such as was given by a black frame to the picture, or a special white band. In that system there would probably have been a discontinuity between the different bands, since the synchronising signal was of a different order of magnitude from the picture signals; it might be, however, that when the synchronising systems were improved the synchronising signals would be of the same order as the picture signals, so that discontinuity would be avoided.

"As I have said above," emphasised Mr. Rennie, "any ideas which one may form in respect of the phenomena encountered in the exploring must be tentative, and they must, moreover, be subjected to the acid test of experiment."

The Meaning of Exploring.

Preceding the remarks quoted above, Mr. Rennie had introduced the subject of "Methods of Exploring" by saying television, or seeing at a distance, was fundamentally a method of acquiring information or knowledge of something, and in all the practical proposals for television some system of exploring was used. Everyone knew what was meant by exploration; the dictionary meaning was "to travel or range over for the purpose of ascertaining the nature or extent of something," and that was exactly what was done in television.

While speaking of dictionaries, he pointed out a divergence between British and American practice: the Americans spoke of "scanning" where we spoke of "exploring." The dictionary meaning of "scan" was "to examine point by point; to examine closely or minutely," and that, of course, was equally applicable to the process which was carried out in television. He wished, however, to register a protest against the use of the word "scan," for there was no reason why we in this country should adopt American terminology, since television was first developed in this country.

When first offering the subject he had it in mind to deal with some of the problems which arose, particularly in exploring for television purposes, but those questions had already been dealt with in the TELEVISION magazine by Dr. Robinson and others, and he now proposed rather to wander round the subject so as to get some general views on it, for it was always useful to be able, as it were, to sit back and get a view of detail problems in their proper perspective.

At first sight it looked as if exploration in television was something inherently different from our mental and physical processes in acquiring knowledge, but it was not so different. Human beings were blessed with five different senses by which they could make contact with or get information about the world outside. These five ways were feeling, tasting, smelling, hearing and seeing, and they differed from one another in their scope and in their limitations. He had arranged them in that particular order because it was the order of the maximum range at which observations could be made by each one of them.

Feeling implied or necessitated actual and complete physical contact. Tasting was allied to feeling in that a particular kind of physical contact with the object was needed, but, on the other hand, a sample of the object was sufficient. Smelling could take place at a longer range, but again, a particular kind of physical contact was still needed. These three all required a greater or less degree of physical contact, but there was a jump in the series when passing to hearing, for there was no direct physical contact required in that case, but only an indirect contact through some material medium.

Finally, in the case of seeing, there was another jump in the series, for there it seemed that no kind of material contact was required at all.

The range at which the object might be was also governed by the particular mode selected for acquiring information about it. In feeling, they must be close to it; for tasting, they must also be close to it; smelling took place at a longer range; hearing could be at a still longer range; whilst for seeing, the range was unlimited.

The Range of the Senses.

If there was any truth in the suggestion that different modes of obtaining knowledge constituted a progressive series, they might have expected that other characteristics were similarly progressive. Seeing and hearing were both produced by the sensitiveness of an organ to a wave motion, and there was a similarity between them in that the long range at which seeing was possible was effected by high frequency waves, the shorter range at which hearing was possible was effected by lower frequency waves, and if they jumped to the other end of the series, feeling could be defined as zero frequency. Did taste and smell exhibit themselves also by a wave motion at two different frequencies somewhat lower than audible frequency? That seemed to be a question for biologists or physiologists.

He suggested that they take another set of characteristics of the five different waves. Feeling gave in a limited time but little information. Taste and smell, however, each gave the full information of which they were capable, even in a short time. Hearing in a short time gave practically no information, whereas seeing might in some cases give complete information in a short time, or alternatively it might give practically none.

If a prolonged examination by each method was possible, feeling could give fairly full information. Taste and smell could add nothing further to their first instantaneous results; hearing would give full information, and seeing would give full information if it had not already done so in the first instance.

Time Required.

It was probably not correct to say that seeing gave full information instantaneously, because the instances in which it did so were only those in which they were looking for an isolated fact. It appeared, therefore, that for feeling, hearing and seeing they must spend time in order to get the full information, and the time was spent in exploring the field. If one looked at a page of print it was not possible to take in the whole of it instantaneously, but the eye must traverse it line by line in order to become acquainted with it. It was true that the eye could be educated so as to be capable of appreciating gradually larger areas simultaneously; a child when reading started by examining each individual letter, and in time was able to appreciate short words as units without spelling them out. The faculty varied quite considerably with different people, and was largely a matter of experience.

In judging the education of the eye one must not be led away and ignore the very rapid exploring movements of which it was capable.

If they made some tests on their own eyes to see whether they did actually explore the field of vision or not, he thought they would be surprised to find how much actual exploration the eye did.

When they turned to the problem of television, they found that all the known methods involved exploring the scene or object of which an image was to be transmitted, just as our senses did. The device which took the place of the human eye was a photo-electric cell, selenium cell, or other light-sensitive device, but it was unlike the human eye in that it was not capable of education to the extent that it could appreciate more than one point at a time in its field of vision.

Education of the Human Eye.

The question of the education of the human eye was one that ought to be rather more fully appreciated than it was, because the eye was capable of a very high degree of education, and in fact was educated to a considerable degree in everybody. He was inclined to believe that although the field of vision of the human eye extended over quite a considerable area, the area of really distinct vision, or the information which was conveyed to the brain, was limited to an extremely small amount, and what happened was that a very limited exploration was made in practice.

The education of the eye took place gradually throughout life, and it was very difficult to put oneself in the position of having a completely uneducated eye. For example, when looking at printing in some unknown foreign type, such as Greek, Russian, Japanese or Chinese, one would find one couldn't appreciate the shape of even a single letter without exploring that letter. One might recognise some Russian letters at a glance, but that was only because they bore a strong resemblance to a Roman character with which one was already acquainted.

Another proof lay in the fact that one did not need to see the whole of a letter or character to identify it. The eye recognised some particular feature and assumed from its prior knowledge the presence of the rest of that character.

This characteristic of the eye was well exhibited by the old trick of covering up the lower or upper half of a line of print. If the lower half were covered, it was usually quite easy to read what had been printed by seeing only the upper halves of the characters. The converse was not quite true, because so many of the characters were alike as to their lower halves, but even then it was frequently possible to make a good guess at what was printed by an assumed knowledge of the words which were likely to be present.

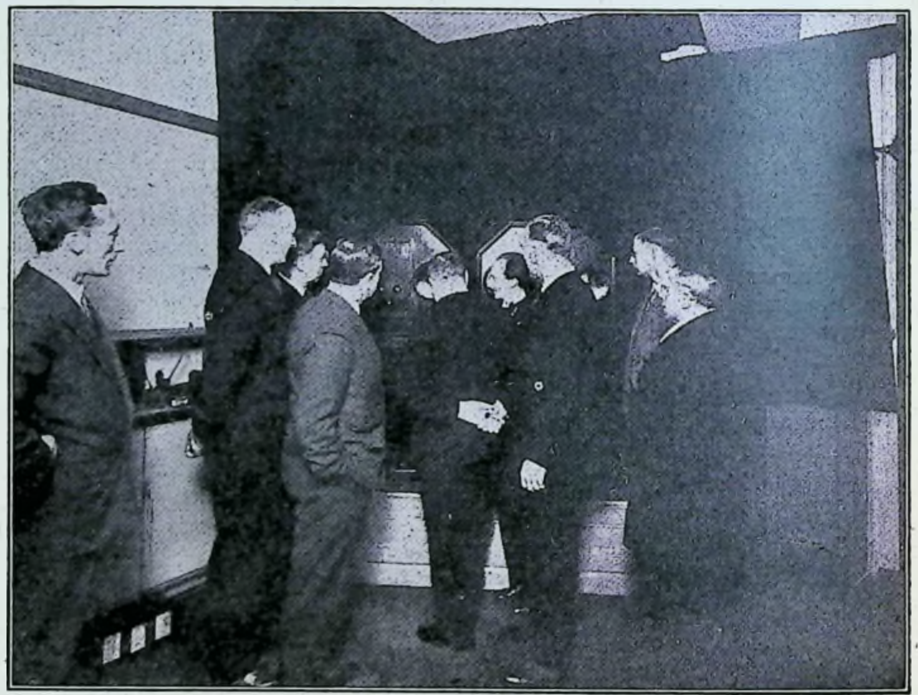
There was an old saying "the eye only saw what it carried with it—the power of seeing." There was no need to give any instances of the truth of that statement.

From all points of view it seemed clear that the electrical eye used in television was not materially inferior to the human eye, except in that one aspect that it was not capable of education.

"The first problem therefore which occurs in a television system is that of providing some device by which the electrical eye can explore the object or view which is to be transmitted," said Mr. Rennie, "that is to say, the eye is to be directed to each point of the object in turn so as to receive an effect proportional to the light emitted from that point, this effect being transformed into the electrical signal which is transmitted to the receiving station."

Mr. Rennie followed up his remarks on the dot theory of transmission, already quoted at the opening of the article, by saying that the process of exploring by a disc with a uniform spiral of holes was one in which, the individual bands were traversed all in the same direction, from the top to the bottom of the picture, and the bands appeared successively across the picture from left to right; that was to say, there was a definite continuity in both the vertical and horizontal components of the exploring movement, and he thought it would be found that continuity was extremely important.

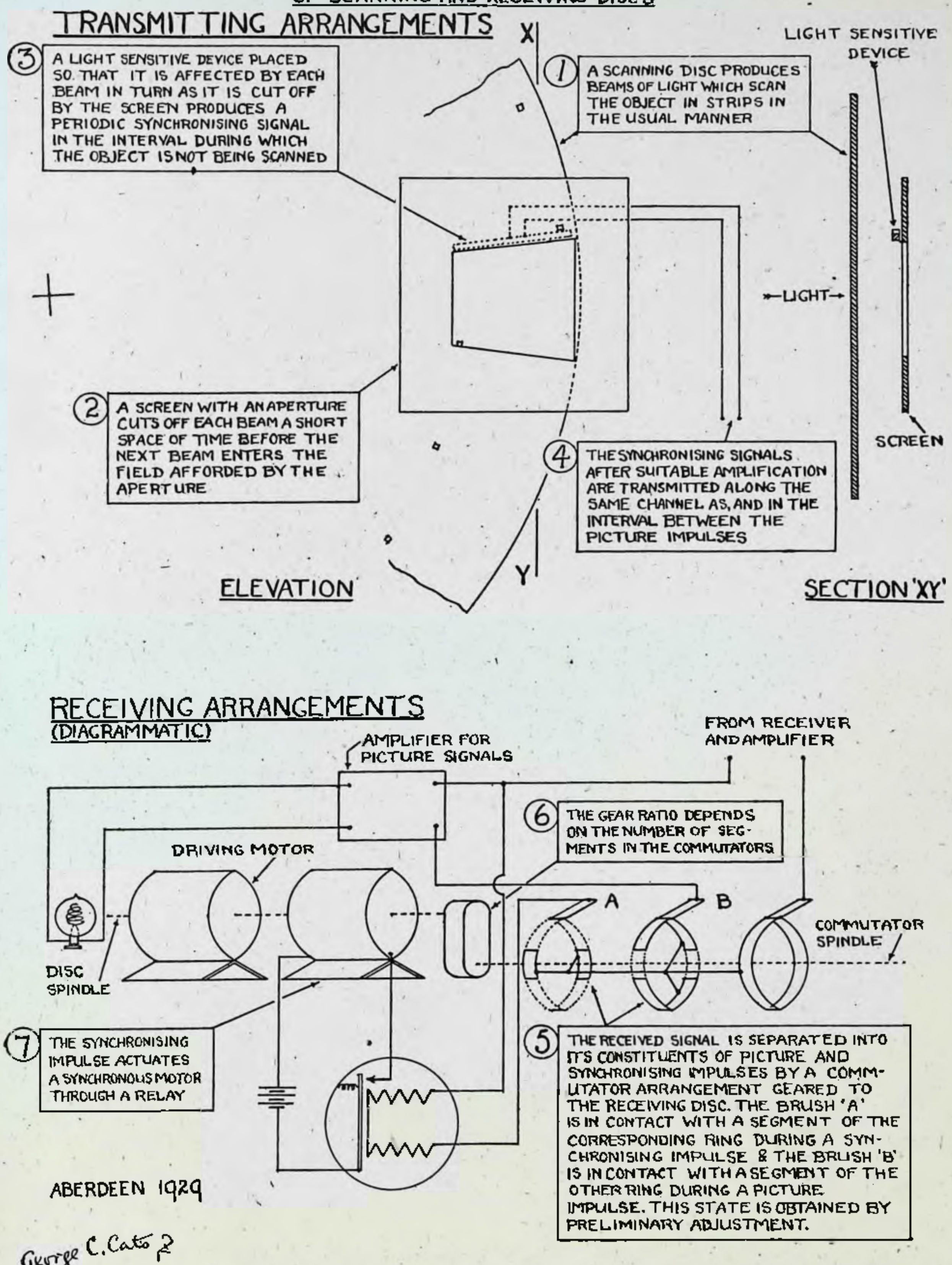
The ability to see a complete image derived from some exploring action depended upon what was known as persistence of vision. No one doubted that there was some characteristic of the human eye which gave this effect of persistence. It was admitted also that a fairly definite frequency was necessary to give a continuous effect from an intermittent image; it was usually said that sixteen images per second, as used in kinematography, would give a continuous picture. That meant if the eye was subjected to some light impulse, which might in itself be of quite short duration, the



An interesting group attending a demonstration of Television.
Second from left to right:—Mr. Patterson, Director of Messrs. J. & E. Hall, Ltd., Dartford, together with one of his co-directors; Mr. R. Smith, F.I.C., Chemist, Messrs. Vickers-Armstrong, Ltd., Erith; Mr. Wilson, Director, Messrs. Vickers-Armstrong; Mr. W. Mulholland, of Vickers-Armstrong, the Member of the Television Society responsible for the visit of the party; Mr. B. W. A. Dickson, General Manager, Vickers-Armstrong; Lord Angus Kennedy and Mr. Denton.

SCHEME FOR AUTOMATIC SYNCHRONISING

OF SCANNING AND RECEIVING DISCS



George C. Cato

The above diagram was exhibited at the Society's Exhibition in March, and was unavoidably excluded from the report contained in our last issue, owing to lack of space.

effects of that impulse would endure for one-sixteenth of a second, more or less.

If a television picture was explored entirely within one-sixteenth of a second, it would not matter how the exploration took place. They might, for example, explore a picture in bands, with an arrangement which displayed first a band on the left of the picture, then a band on the right, then a second band on the left and a second band on the right, and so on. The light impulses would have reached the eye and their effects would have each lasted over a period during which the whole picture was explored. There seemed to be no obvious reason why that would not be equally as good as a method of exploration in which the two components, vertical and horizontal, were continuous. If tried, however, they would find that the effect on the eye was different, and he would be glad to hear some reason for it. The eye, it seemed, liked a continuous movement, as distinct from a discontinuous movement.

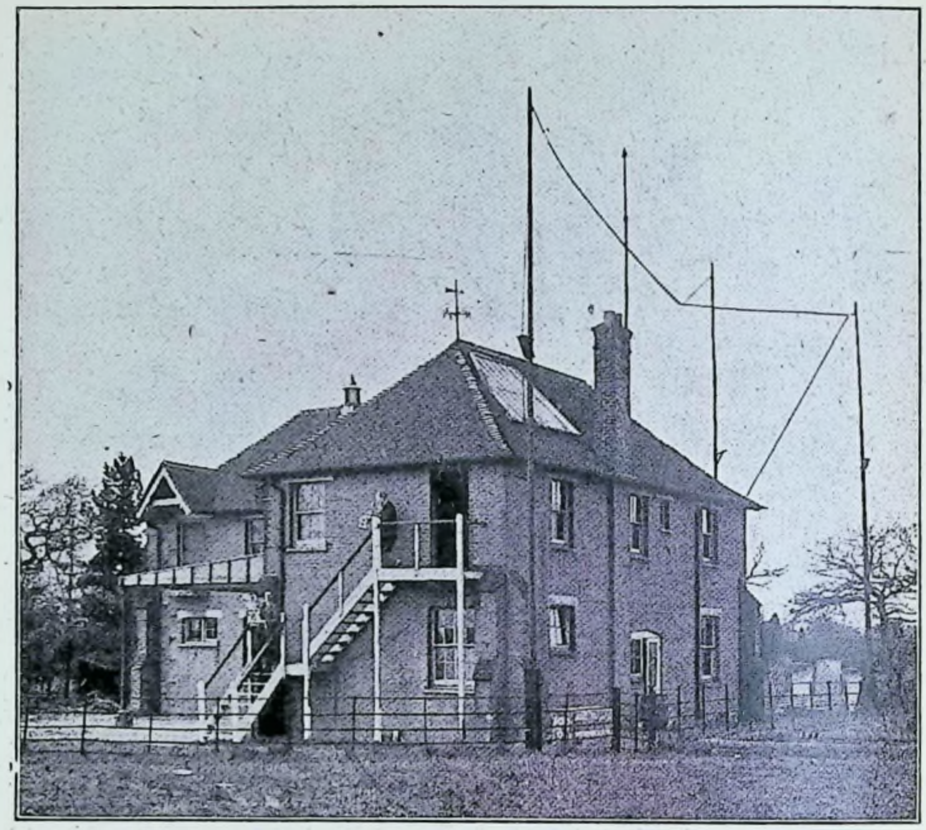
On the question of continuity and discontinuity, there were two interesting facts. If they ran a neon lamp on an alternating current of, say, 50 cycles, they could easily observe multiple images of a moving object which was illuminated by the lamp, and that effect could be obtained with comparatively slow movement.

The other fact was an ordinary kinematograph show. They expected to see pictures without any noticeable flicker.

Peculiarities of Human Vision.

"Is it not peculiar," said Mr. Rennie, "that in the case of the kinematograph, where the object at which we are looking has undoubtedly a discontinuous movement, an appearance of continuity is obtained, whereas in the case of the neon lamp the movement of the object is admittedly continuous, but we get an appearance of discontinuity. A kinematograph picture flickers at the rate of about sixteen per second, while the neon lamp flickers three times as fast, fifty per second.

"If we could run a kinematograph at fifty per second, we should expect it to be, and I think it would be, very much better in its effect of continuity than when running at sixteen per second, but the conditions then would be identical with the neon lamp which gives a discontinuous effect. Education of the eye has something to do with this paradox, the education consisting in the ability of the brain to ignore deficiencies in the information which it receives, but it does not satisfy me as an explanation."



A view of one of the Baird Company's Experimental Laboratories, situated on the outskirts of London.

It had been suggested that exploration might be effected in a spiral direction, or one continuous sweep from the edge to the middle of the picture. If any of them had ever tried that he would like to hear something about it. He had not tried it himself, but he did not think it would be satisfactory for at least two reasons: he doubted whether the continual change in direction would be pleasing to the eye, and he also expected some effects to arise from the big changes in the ratio of linear velocity to angular velocity, or the change which must take place in one if not both.

He had not yet had an opportunity of trying a zigzag exploration, and that might be interesting. That was, of course, the type which was very suitable for use with cathode rays.

There was one other point he wished to mention in connection with exploration. In everything he had read, whether emanating from this country, America or Germany, it had been assumed that the size of the exploring aperture determined the fineness of detail of the image, or the sharpness of the image. It seemed natural that it would, and in any case it obviously had a bearing. There had been quite a lot written about the effect of the size and shape of the exploring aperture, end-effects, and so on, but he ventured to make the suggestion that they had yet a great deal to learn on that particular matter. In practice, and that was what mattered most, he was satisfied from his own observation that if was possible to see detail which was smaller than the aperture and, moreover, to see it clearly. According to ordinary conceptions if the object had two lines on it which were both visible at the same time through an exploring aperture, they should appear as one broad line.

The fact that they didn't might be due to a trick that his educated eye was playing on him, but equally there might have been some other cause. He didn't know whether anyone had investigated the relationship of rate of change of light with rate of change of cell output at television frequencies.

What is Detail ?

While speaking of detail in pictures, there was another aspect of the matter which he had found by accident some time ago. In many natural objects the detail was not so fine as they imagined, and it could be accurately reproduced by quite coarse dots in a half-tone block. One way of observing that was to look at a half-tone block with a considerable degree of magnification, say, 15–25 diameters.

If they focussed the dots sharply, they appeared to be quite definite and discrete dots, and were hardly recognisable as a picture. But then, if thrown gradually out of focus, in many instances they would find that for a certain rather critical degree of blurring, the picture became quite clear in spite of the magnification of the dots. Was that another case of the eye deceiving, or was it a fact ? It didn't much matter so long as he saw a picture, but it made him wish he had time to investigate all those peculiar facts and see where they led.

All those matters, however, were, so far as he was concerned, largely speculative, for the more one looked into the question the more one realised that research, and possibly only tedious research, would give an answer, so in conclusion he wanted to be more practical and concrete. He had opened his paper by referring to dictionaries, and he wanted to close it by suggesting that the time was ripe for the society, or the council, to appoint a standing committee which would compile and keep up to date a dictionary or glossary of technical terms used in television.

There was a danger of wrong or misused words becoming standardised by practice in a new art, and in later years that would lead to difficulties and sometimes even hinder development, so if the chairman would allow him he would like to put forward a proposition that a committee of three should be appointed to prepare such a glossary for approval by the council, and further to make proposals whereby the work could be kept up to date as the art and science developed.

* * *

Mr. Ryland, at the conclusion of the lecture, said he would like to say a word or two, first of all on the question of scanning or exploring. If the picture was made up like a chessboard with a lot of black and white dots then he thought the frequency band occupied would be enormous, because one would get a true dot system of transmission, but the mere fact that the average image transmitted had a very large part of its surface practically equal in illumination, cut down the frequency band occupied enormously. With regard to vision there was only a very small part of the eye which gave correct definition, the rest was trained for movement.

With regard to the very interesting query Mr. Rennie raised concerning a moving object lit by a neon lamp and the kinematograph screen, the object lit by the neon lamp was illuminated fifty times a second, and if it was moving, what one saw was not the object moving but the object illuminated at a number of different places.

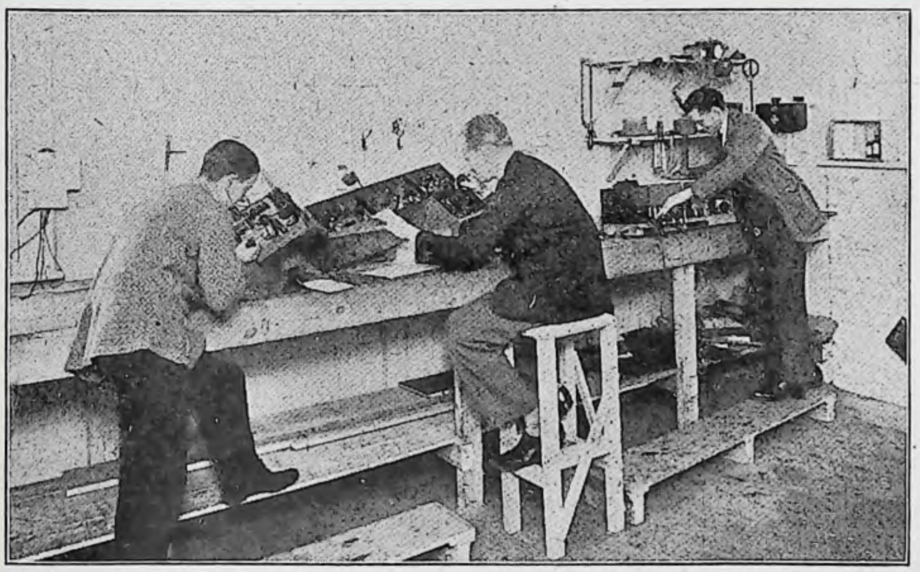
The human eye gave continuous vision with intervals as slow as one-eighth of a second, provided it is approximately the same part of the retina which is illuminated each time. That was the explanation of the fact that a moving object lit by a neon lamp was seen not as continuous movement but as a number of distinct objects, the same part of the retina of the eye not being illuminated, but an adjacent portion due to the movement of the object. That, too, probably explained a lot of the detail that one saw in television images despite the actual coarseness of the exploring disc.

Continuous Scanning.

Another member present wanted to know if there was a definite break between the end of one picture and the commencement of another in television transmissions when they were being scanned by a rotating disc with a given number of holes. Replying to this, Mr. Rennie said that there was no break between one picture and the next.

A very hearty vote of thanks was passed to Mr. Rennie for his interesting lecture. Replying to these, Mr. Rennie said that although he had followed up television very closely he felt that he knew absolutely nothing about it ; all he had done in his lecture was to put forward a number of statements all based on experience, particularly where he had made positive statements. He had, however, no explanation to offer for any of them, and all he could say was that with regard to television scanning it was a very vast field for work. The one big conclusion he had come to was that we did not really appreciate the half of what our eyes did for us.

Following the vote of thanks, Mr. Keay said he thought they might (*Continued on page* 147.)



Research Engineers at work in the Laboratory illustrated on the preceding page.

HONOURS

By NOËL SWANNE

I GLANCED casually through the honours list, among the S's, but no glow suffused my heart. Of course, a young science like ours cannot expect too much at one time, and so "hats off" to the winner.

* * *

Marjorie put down the April number of TELEVISION.

"It's an awful shame," she remarked.

"Hardly a shame," I said. "Of course, in time recognition must come, but . . ."

"That's just it," she interrupted, "recognition! I don't think you have any right to go on like this."

"My dear girl, I am not going on. Jealousy is not one of my sins. Neither do I envy. Sir Ambrose is . . ."

"What are you talking about?" asked Marjorie.

"As for that, what are you talking about?"

"Electrons," she snapped.

I jerked my mind round, giving myself a nasty crick in the neck.

"Exactly," I continued. "Sir Ambrose is an authority on the subject, as you will have doubtless gathered from that illuminating article, which I hope you have read carefully."

"I say it is a shame," she repeated, and I greeted the remark with silence. "It is just messing about with the things. I wonder if any of you scientists" (I bowed from a sitting position) "ever think about the electron itself."

"We do nothing else," I said, simply.

"Then why not leave it alone, poor little thing."

As usual, I felt lost, and so did some more masterly silence.

"What is an electron?" said Marjorie.

"An electron is . . . well . . . not to be too precise . . ."

"Why not just say you do not know?" broke in Marjorie.

"There are those who hold that the electron is a concrete entity . . ." I began.

"That is more than the stuff is which you promised to put at the bottom of the lily pond," commented Marjorie.

". . . and there is a school which considers that the electron is a wave," I continued.

"There you are—with your entities and your waves! Actually you don't know what an electron is. I expect it will turn out to be a vitamin. It is perfectly shameful the way you go on with the thing. It may have feelings of its own. It may have a wife and a family, and all you do with it is to make it bombard things. I think the Royal Society for the Protection of Something or other ought to know about you."

All that I have ever done with an electron is to . . . well . . .I don't think I have ever done anything with an electron. I'm a peace-loving man and never bombard anything, either. It is all very well for Marjorie to blame me, but just because I happen to contribute to TELEVISION, it does not follow that I am one of those . . . well . . . you know what I mean. Of course . . . yes . . . of course. You see that, don't you?

"Look here, let's get this straight," I said. "This electron business is not my fault. There was a time when the electron was unknown."

"Like yourself," said Marjorie.

"Yes . . . I mean . . . yes. There was . . . WAS. Past tense, passive mood . . . I do wish you wouldn't interrupt like this. I lose the thread of my thoughts."

"What you need is tarred twine to keep your thoughts together," said Marjorie.

"Tarred twine?"

"Yes, the stuff you didn't tie up the rambler with," explained Marjorie.

"Lily pond! Rambler!" I mused. "I'm getting mixed At this time of the year I always write gardening articles. What are we doing now?"

"Electrons!" said Marjorie pointedly.

"Ah yes, of course, the dear old electron. Well, anyway I did not do it."

"Then it is time you did," said Marjorie.

"What?" I asked.

"Took a hand in the game and stopped all this messing about. Just settle the thing quickly in a business kind of way, and let the wave-like entity get on with its job of jumping about, and when you have finished that, there is a trench to be dug for the sweet peas."

* * *

After all, we do not know, do we? There may be something in this dea of stretching out a helping hand to the little electrons. I should be very upset if someone discovered that I was a kind of wave. Supposing they just used me to bombard things. Supposing I was made to jump out of my orbit and lose energy.

I shall found a Society—*The Electron's Aid Society*. The avowed object of this society is to protect the electron from its early youth up to old age. The society will provide vehicles to convey electrons from one orbit to another and so save that devastating jump.

It is a good idea. I shall be known as the man who saved the electron—about the only thing I seem likely to save. Please send your subscriptions at once. There is no limit; and, after all, philanthropy has been known to lead to the honours list.

New Broadcasting Station for Sweden.

The Swedish Government has placed an order with the Marconi Company for the supply of a 60 kilowatt, aerial energy, transmitter for installation at Stockholm.

This contract was obtained by the Marconi Company in the face of the keenest competition. This success is a tribute to the excellent design and performance of British broadcasting transmitters, which have now been installed in over twenty countries outside Great Britain.

The new Swedish broadcasting station will be effective over a very large area. It will be operated on the low-power modulation system, with deep and distortionless modulation; and will be worked direct off a three-phase public electric power supply.

Focal-Depth in Optical Instruments

The Solar Spectrum as used for the Specification of Optical Glasses

Part X

By Professor CHESHIRE, C.B.E., A.R.C.S., F.I.P.

FOCAL-DEPTH plays an important rôle in the use of the eye and optical instruments generally. Photographs, perhaps, show it in the way best understood, so that the student is advised to carry out the following experiment with a camera :—

Focus as sharply as possible, with the aid of a magnifying glass, the mage of an object, some 15 or 20 feet away, upon the ground-glass screen of the camera, the lens of which is stopped down to about half its maximum aperture.

Now examine the focussed image without the aid of the magnifying glass, and, whilst doing so, get some one to move the object slowly away from, and towards the camera.

It will be found that for quite a considerable range in both directions no perceptible change results in the sharpness of the image on the screen. We will call the nearest point to which the object can be moved without perceptible change of focus the near-point (N.P.) ; and, similarly, we will call the most distant point which satisfies this condition the far-point (F.P.).

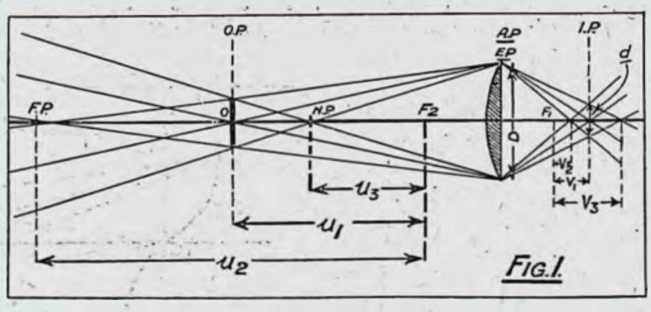
Thus, when an object at O, Fig. 1, is in the conjugate plane to that of the focussing screen, all object-points on the axis of the lens, between F.P. and N.P., appear to the unaided eye equally in focus with the point O.

The distance F.P.–N.P. is known as the focal-depth of the photograph taken under the conditions set out. As every photographer knows, this distance is lessened by increasing the working aperture of the lens, and increased by decreasing it.

Focal-depth depends for its existence upon the fact that the human eye cannot distinguish the focussed image of a point from an out-of-focus image so long as the latter—a so-called "disc of confusion"—does not exceed a certain magnitude. The allowable diameter of this disc, in the case of photographs to be viewed with the naked eye, from the usual distance of 25 to 30 cm., is generally assumed to be of the order of a tenth of a millimetre (1/250 in.).

When a magnifier is employed to view the image, as in the case of the microscope and telescope, a smaller tolerance is necessary. A confusion disc more generally, it may be stated, must not subtend a greater angle than 1/3000 at the eye to be accepted as undistinguishable from the image of a point.

In Fig. 1, let an object-point O, in the object-plane (O.P.), at a distance u_1, from the focal point F_2, of the lens, be focussed in the image-plane (I.P.) at a distance v_1, from the second focal point F_1, of the lens. Let the greatest allowable disc of confusion have a diameter d. As the object-point moves from O, towards the far-point at a distance u_2, the point-image will move towards the lens to a point at a distance v_2, from F_1, such that the cone of rays after passing through their focus will expand and fall upon the ground-glass screen within a circular disc—the disc of confusion—having a diameter d. For object-points to the left of F.P. the out-of-focus image, as projected on the screen, will obviously have a greater diameter than the permissible disc of confusion.



Focal-Depth Diagrams for a Photo Lens.

Similarly, cones of rays from the N.P., at a distance u_3, will, after passing through the lens, converge to a point behind the screen, at a distance v_3, and in doing so fall upon the screen in a disc, again with a diameter equal to d. For object-points nearer than N.P. the image-disc will have a greater diameter than d.

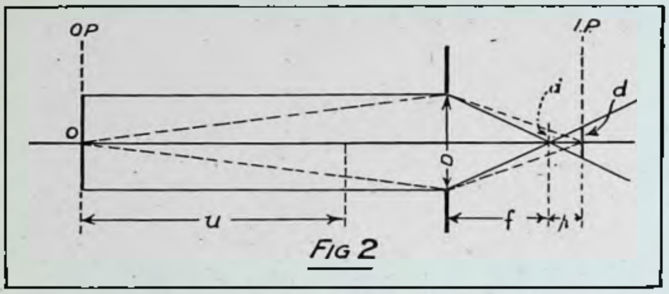
For the given position of the image screen, and the given aperture D of the lens, the focal-depth will extend from N.P. to F.P. Cutting down the aperture D, clearly, must result in the lessening of the diameter of the confusion disc for object-points at F.P. and N.P.

To obtain the full permissible diameter d, with the reduced aperture, the F.P. must be moved further to the left, and the N.P. further to the right, with the result that the focal-depth is increased. Increasing the working aperture, on the other hand, results in a similar way in a lessening of the focal-depth.

An interesting focal-depth problem occurs in connection with the adjustment of the hand-camera of the fixed-focus type for landscape work.

In this case the greatest range of focal-depth is required. Let us suppose then, in the first case, that the lens is adjusted to give the sharpest possible focus for objects at a great distance, or infinity. The ground-glass screen must for this purpose be in the principal focal-plane of the lens.

If, however, a confusion disc of diameter d is permissible, then an object in the plane O.P. giving such a disc on the screen, in the focal-plane of the lens, will be equally in focus with an object-point at infinity, and objects within the distance u will be more or less out of focus. This distance u gives us the N.P. for the case in which the focussing screen is in the focal-



Adjustment of fixed-focus Camera.

plane of the photo lens. Now $D=f/n$, where n is the f-number, and $p=f^2/u$ so that

$$u=\frac{f^2}{nd} \quad . \ . \ . \ (1)$$

If, now, we move the focussing screen from the focal-plane back to the plane I.P. it will be seen that an object-point at infinity is still in focus, because its disc of confusion is not greater than d. The point O is now focussed sharply in the I.P. plane so that it can be moved still nearer to the lens to give an image disc of diameter d in that image-plane.

This will occur when the emergent cones of rays from the point O come to a focus at a distance $2p$ from the focus of the lens. Calling u_1, the new N.P. it follows, since $2p=f^2u_1$, that u_1, is half the distance u. By shifting the focussing screen from the focal-plane to I.P. we have then, whilst still retaining the sharp focus of distant objects, halved the distance of the near-point, beyond which all objects are in equally good focus as seen by the eye. Our final equation, therefore, is

$$\text{N.P.}=\frac{f^2}{2nd} \quad . \ . \ . \ (2)$$

where f is the focal-length of the lens, in inches, n the f-number, and d, the diameter of the greatest allowable disc of confusion, say 1/200 in. The N.P. is thus found in inches.

Example.—Find the N.P. in feet, for a six-inch focus lens working at $f/8$, when the F.P. is at infinity.

$$\text{N.P.}=\frac{6\times 6}{2\times 8\times \frac{1}{200}}=450 \text{ in.}=37{\cdot}5 \text{ ft.}$$
(approx.)

Find the N.P. for the same lens working at $f/32$. Since the N.P. varies inversely as the f-No., other things remaining the same, the N.P. must now be $8/32=\frac{1}{4}$ of 37·5 ft.= 9·4 ft.

Fig. 3 shows a beautiful method of studying focal-depth problems introduced by Professor von Rohr. An image of an object, O, with depth along the axis of the projecting lens, is projected by a lens into the curve I. The focussing screen is at I.P. say, and a plane conjugate to this occurs in the object-space at O.P. All points of the object, such as o_2, which occur in the plane O.P. are imaged as points, such as i_2, in the plane I.P. whilst object-points at greater and lesser distances away than the point o_2 will be focussed in front of the plane I.P. in the former case, and behind it in the latter.

Let us consider the object-point o_1 in the object-spaces. The effective cone of rays taken up from it by the lens and determined by the E.P. intersects the O.P. in a disc of diameter d_1, and the same rays in the image-space intersect the I.P. in the disc s_1 which is, therefore, the image of the disc d_1, since I.P. and O.P. are conjugate planes. Similarly with the object-point o_3. The rays projected backwards intersect the O.P. in a disc of diameter d_3, and this is virtually imaged by the disc s_3 in the plane I.P.

In this way object and image points are replaced by discs projected on to the conjugate planes I.P. and O.P., and instead of dealing with object and image points at various distances from the lens, we consider instead their projections from the pupils on to two conjugate and fixed planes—the O.P. and the I.P.*

The Solar Spectrum—Fraunhofer lines—Optical Glass.

The numerical expression of the different refractive powers of glass, and other media, for the different colours, or wave-lengths, of sunlight was made possible by the work of Newton. Propositions I. and II. of his famous treatise on "Opticks," published in the year 1704, summarise his experimental work, carried out some years earlier, on this subject. They read as follows :—

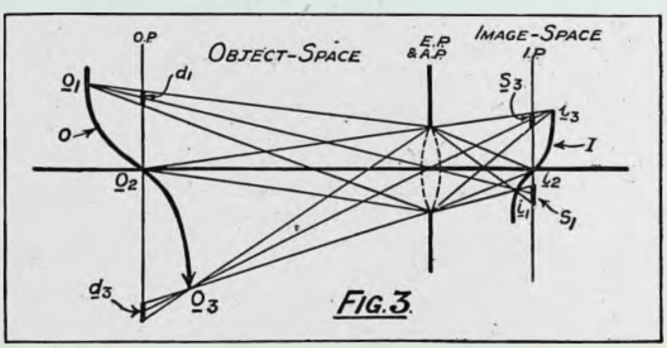
(I.) Lights which differ in colour differ also in degrees of refrangibility.

(II.) The light of the sun consists of rays differently refrangible.

Newton showed that sunlight is made up of a mixture of all the colours of the rainbow, in which he distinguished the seven colours : *red, orange, yellow, green, blue, indigo,* and *violet*, and that these colours could be separated, and spread out fanwise, by the action of a prism of glass.

Such a prism, he found, deflected the blue rays more than the yellow, and the yellow rays more than the red.

Having made this discovery, Newton went on to find the refractive indices for the various colours in passing from air to glass. He could not, however, do this with any great



Professor von Rohr diagram to illustrate Focal-Depth.

accuracy, because he could not isolate the spectrum colours suffi-

* Readers interested in this subject are referred to *The Photographic Journal* for January, 1909, p. 3, in which the Traill-Taylor Memorial Lecture, "On the Regulation of the Ray in Photographic Objectives," by Dr. Wandersleb, is published.

ciently, *i.e.* speaking in modern language, he could not limit his experiments to well-defined and definite wave-lengths of light—he could only obtain bundles made up of rays with refrangibilities varying over an appreciable range.

In the year 1814 Fraunhofer published an account of a remarkable and classical series of experiments which he had made "on the refractive and dispersive power of different species of glass, in reference to the improvement of achromatic telescopes, with an account of the lines or streaks which cross the spectrum.†

The achromatic telescope had been invented by Dollond in 1758, but its performance, in the larger sizes used for astronomical purposes, was severely limited by the fact that the mating of the crown and flint glasses required could not be satisfactorily effected for want of data as to the refractive powers, for the different colours of the sun's spectrum, of the glasses available. Optical bench-marks, to use an analogy, were required for the survey of the spectrum, and these Fraunhofer discovered in "the lines or streaks which cross the spectrum," and which, in honour of their discoverer, are called the Fraunhofer lines of the sun's spectrum.‡

Fig. 4 is a copy of a photograph of the original chart of the solar spectrum, made by Fraunhofer. Throughout the range of the visible spectrum he discovered and mapped some hundreds of these more or less dark lines, now, of course, known to be due to the absorptive effects of the incandescent vapours in the sun's atmosphere, on the light passing through them on its way to the earth.

The more important of the lines were designated by the letters of the alphabet, *A* to *H*, as shown. Since these lines were always associated with the same colour and, therefore, the same wave-length, it was only necessary to make prisms from the glasses under examination and then find the refractive indices for selected lines of the series *A* to *H*, for each, to secure the necessary data for the production of achromatic object-glasses of a much higher order of optical excellence, than had ever before been attained.

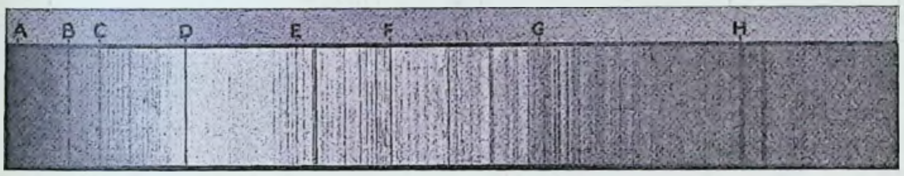


Fig. 4.—The Fraunhofer lines of the Sun's Spectrum.

Professor Cheshire deals with the important subject of focal depth, and in this introduction to the subject of optical glass, and its optical specification, gives us an interesting and authentic reproduction of the famous spectrum chart drawn with the Fraunhofer lines in position by Fraunhofer himself.

The wave-lengths and sources of the chief lines of the solar spectrum are given in the following table :—

Fraunhofer line.	Wave-length in tenth metres.§	Source of light.
A	7661	Oxygen in atmosphere.
B	6867	Do.
C	6563	Hydrogen (α-line).
D	5890	Sodium.
E	5270	Iron.
F	4861	Hydrogen (β-line).
G	4308	Iron.
H	3968	Calcium.

§ A tenth-metre, or Angström unit, as it is often called, is 10^{-10} of a metre, equal to the one ten-thousandths part of the thousandth of a millimetre. It should be remembered that the wave-length of the *D*-line is ·000589 mm., ·589 μ, 589 $\mu\mu$, or 5890 tenth metres.

In our next article we propose to take a page from a glass-maker's catalogue and show how the data there tabulated is derived.

† A translation of Fraunhofer's original paper will be found in the Edin. Phil. Journ., Vol. IX., pp. 288–299, 1823; and Vol. X., pp. 26–40, 1824.

‡ Newton, so far as is known, never saw the Fraunhofer lines in carrying out his numerous experiments; and this has occasioned wonder. Apart from any other explanation, however, it is very doubtful whether the prisms used by Newton were good enough, optically, to show these lines. In one significant passage Newton states that certain effects could be seen only "if the glass of the prisms be free from veins, and their sides be accurately planed and well polished without those numberless waves or curls which usually arise from sand holes a little smoothed in polishing with putty."

Television Society.

(*Concluded from page* 143.)

ask one of the secretaries to give what assurance he could that the suggestion with regard to the compilation of a glossary of terms put forward by Mr. Rennie should be put before the council for consideration. It seemed to him very necessary that such a work should be begun now, in order to prevent the general adoption of any inaccurate or misleading terms in regard to television.

Mr. Mitchell, one of the joint honorary secretaries, said he thought it was a splendid idea, and he would lay it before the council.

A very hearty vote of thanks to Lord Angus Kennedy for presiding concluded the meeting. But, before the members broke up, Mr. Mitchell announced that the next month's meeting would be a practical one. Captain Wilson would talk about his television apparatus, and show them how he had made it and why it worked. It was also hoped that Mr. Garside would bring along his little television receiving machine and demonstrate it. In addition to this, Messrs. Edwards and Company, a London firm, had promised to bring along a cathode ray tube and demonstrate it.

ANNOUNCEMENTS.

The last meeting of the session will take place on Tuesday, May 7th, at the Engineers' Club, and is in the nature of a "practical" evening. An informal discussion will take place at 7 p.m., particulars of which have already been notified to members. At 8 p.m. Captain Wilson and Mr. A. A. Waters will read a paper dealing with the practical aspect of constructing a television transmitter and receiver.

A demonstration will be given by the authors, in conjunction with Mr. Colin P. Garside. Mr. R. R. Poole, B.Sc., is showing a demonstration model explaining the normal process of exploring, and also some unusual methods. A model talking film projector will be shown and explained by Mr. H. S. Ryland.

Any non-members of the Society who would like to be present should apply to the Lecture Secretary for tickets.

J. J. DENTON,
W. G. MITCHELL,
Joint Hon. Secretaries.
95, Belgrave Road, Kensington.

Three Recent Photo-Electric Devices

By H. WOLFSON

In previous issues Mr. Wolfson has contributed several valuable articles on light-sensitive devices of different types, and on the photo-electric effect. In the following article he describes three photo-electric devices which have recently been developed.

THIS month I am going to discuss three further types of photo-sensitive devices, about which very little information is at present available. The first of these is the so-called "Thalofide" cell, which was discovered by the American worker, T. W. Case.

According to certain accounts of the device which have appeared in scientific publications, the name was given as indicative of the fact that the light-sensitive material of which it is composed contains thallium, oxygen, and sulphur. Some accounts suggest that the active material is thallium sulphide, but they all carefully refrain from pointing out whether thallous or thallic sulphide is meant, while even thallosic sulphides might play a part in the composition of the cell.

Thallous Sulphide.

Its discovery was the result of a long series of investigations with crystalline mineral specimens, and it seems probable that the material used is nothing more than pure thallous sulphide, specially prepared and fused. The liability of thallous sulphide to oxidise in moist air does seem to indicate that the light-sensitive material, starting life as thallous sulphide, Tl_2S, becomes partially oxidised to thallous oxide so that the final composition of the substance would be an indefinite mixture of Tl_2S and Tl_2O. This would reconcile us to the statements referred to above, in which oxygen is mentioned as being present in the active material of the cell.

The preparation of the photo-sensitive "thalofide" material is to be regarded in the nature of a trade secret, as no new facts were brought to light during a recent correspondence between the writer and the Case laboratories.

Thallium sulphide can be most conveniently prepared, however, by fusing together in a small crucible powdered thallium metal, and sulphur. The proportions should be varied and the most satisfactory one determined by experiment, using small quantities for each trial. It will be found that somewhere in the neighbourhood of two parts of thallium to one of sulphur gives quite good results, and it is as well to cover the mixture contained in the crucible with a thin layer of sulphur, in order to prevent undue oxidation when the heating is in progress.

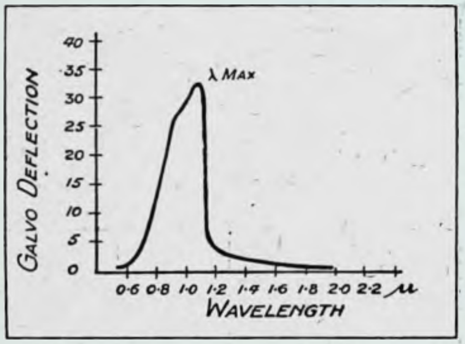


Fig. 1.
Showing colour sensitiveness of the "Thalofide" cell.

Some of the data which is available goes to show that there is a great future for the thalofide cell, and it seems to me that we shall be able, with care, to make these cells as easily as the ordinary selenium cell, and apply it to television transmitters with greater success than is possible with selenium cells. These latter, as is well known, suffer from the time-lag defect, which means that their response to light is not instantaneous. A recent patent (No. 300183), granted to J. L. Baird and the Baird Television Development Co., suggests the use of thallium sulphide in a new form of light-sensitive cell, and this indicates that the thalofide cell is of sufficient importance to warrant a study of its construction and properties.

Two Years' Research Necessary.

Two years' research, according to Case, were necessary before it was possible to produce cells which were very sensitive to light, though apparently ordinary fused thallium sulphide showed a change in resistance on exposure to light.

The photo-active material, after careful preparation, is fused on to a disc of quartz, three-quarters of an inch in diameter. This disc, with two wires attached to act as conductors, is then placed within an evacuated glass bulb, which should preferably be of flashed ruby glass. We shall see the importance of this when we come to consider the colour sensitiveness of the cell.

Effect of a Vacuum.

Enclosing the cell in a vacuum has the effect of increasing the sensitiveness to light about five times, while the life of the cell is also considerably enhanced. Failing the use of ruby glass for the bulb, some suitable colour filter must be used, though this cannot be so satisfactory, as a considerable portion of the light will be absorbed, and much of the intensity lost. This means that current which we obtain from the cell will be much less than with a thin bulb of red glass. Those of my readers who make up the cell may have difficulty in making or obtaining a red bulb, and I would advise that the next best thing is to interpose between the light spot and the cell a sheet of *very thin* flashed ruby glass. This should be bought with care, as much of the red glass of commerce is not suitable.

Consider now the curve (Fig. 1), which was obtained by plotting galvanometer deflection against the wavelength, in microns (thousandths of a millimetre) of the light to which the cell was exposed.

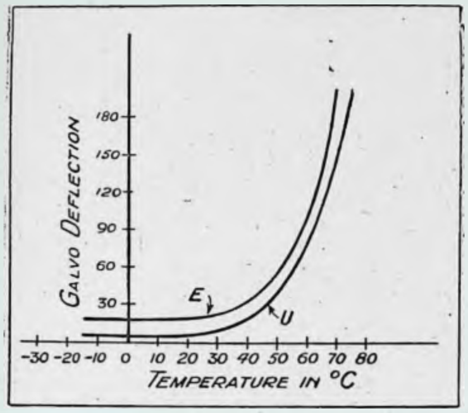


Fig. 2.
Effect of temperature on photo-conductivity of the "Thalofide" cell.
E=Exposed to light during the experiment.
U=Unexposed to light during the experiment.

We see that there is a maximum sensitiveness in the region $0{\cdot}8\mu$—$1{\cdot}0\mu$, while more accurate measurements, carried out at the Bureau of Standards in Washington by Coblentz, show this region to be very narrow, that is, there is a sharp maximum, which is found to occur at $1{\cdot}0\mu$ or 10,000 Å. This region is outside the visible spectrum, being situated in the infra-red, and the usefulness of this type of cell in noctovision, i.e. infra-red television, will be readily appreciated.

Obtaining a Panchromatic Combination.

This extreme sensitiveness is counteracted by the fact that the sensitiveness in the blue and violet regions of the spectrum is negligible, so that the cell is useless unless the light which falls upon it has a red and infra-red component. In conjunction with a photo-electric cell of the alkali metal type, in which the maximum colour sensitiveness is at the blue end of the spectrum, we would appear to have an ideal combination, which, though by no means panchromatic, is nevertheless a much nearer approximation to this condition.

Harmful Effects.

Blue and violet rays, in addition to their inability to create a response in the thalofide cell, have a definite and marked harmful effect upon it, and it has been found that cells irradiated with blue light for a short period lose their quick response to red light, and continue to do so till they have been kept in the dark for a matter of hours or even days.

The graph in Fig. 2 shows the effect of temperature, which is plotted as abscissæ, while the galvanometer deflection is plotted as ordinates. Two curves are shown. In one case the cell was kept in the dark while its temperature was being raised, and in the other case the cell was exposed to light at the same time as the temperature was being increased, and the readings so obtained are thus representative of the change in conductivity due to the combined effects of light and heat. The conductivity, which is practically nil at zero, rises gradually over the first fifty degrees rise in temperature, and then shoots up suddenly, when the temperature attains about 60° C.

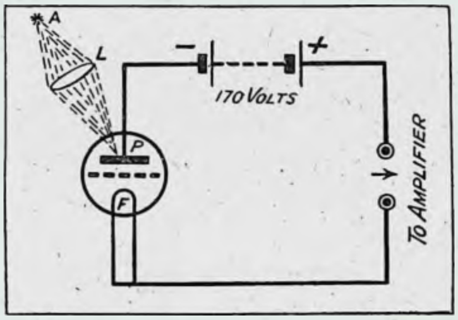


Fig. 3.
Using a valve of oxide coated filament type as a photo-electric cell.
A=Arc lamp. L=Lens system.
P=Plate of valve. F=Filament.

Owing to the special design of the cell, the dark resistance is considerably higher than in the case of selenium, being anywhere from 5 megohms to 500 megohms, but this resistance is lowered, on the average, by 50 per cent. on exposure to light from a tungsten filament, of intensity 0·25 foot candles, though some of the latest and best cells require only 0·06 foot candles to bring about this lowering of resistance.

The cell is worked with a battery in series with it, as in the case of selenium, both these cells being *photo-conductive*, as distinct from the true photo-electric cell. The potential of this battery should never exceed 50 volts, otherwise the cell will be permanently ruined.

Use of Thermionic Valves.

The second type of photo-electric cell, also discovered by T. W. Case, which we are going to discuss briefly, resulted from the investigation of certain high vacuum radio valves, in which the filaments were of the oxide coated variety, the oxides used being those of barium and strontium.

The active material is deposited on the plate of the valve, due to the ordinary changes which take place during the working of the valve in a wireless set. The plate of the valve should be made *negative* to the filament, and the potential required to obtain instantaneous response from this type of cell is the saturation potential, which is about 170 volts. Fig. 3 gives an idea as to the circuit arrangement necessary to use an old valve, which must have been of the oxide coated filament type, as a photo-electric cell. Infra-red rays exercise a deleterious effect, and must be screened out. A current of 7 microamperes can be easily obtained in bright sunlight.

Source of Electrons.

The source of the photo-electrons is found to be a brownish deposit of barium and strontium on the plate of the valve, and this has resulted recently in the manufacture of strontium photo-electric cells, which have been placed on the market. These give on the average a current of 100 microamperes, and they have a maximum colour sensitiveness at 5,000 Å. This is situated in the green-blue region of the spectrum. The barium cells, on the other hand, show maximum sensitiveness between the

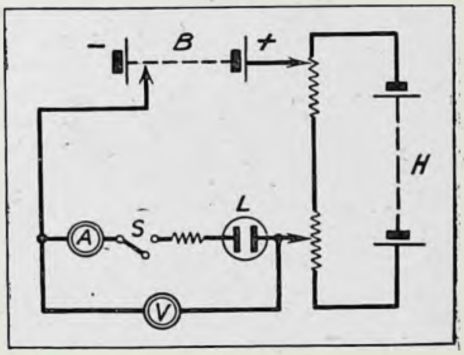


Fig. 4.
Circuit used in investigation of the photo-electric effect in neon lamps.

red and the yellow, while even in the infra-red some effect is produced, though, as already mentioned, these should be cut out by the use of a water cell.

The third, and by no means least interesting type, which I shall discuss was accidently discovered by Oschwald and Tarrant, while working with a neon lamp. They found that the external illumination exercised a marked influence on the minimum voltage necessary to start the discharge. We have already discussed

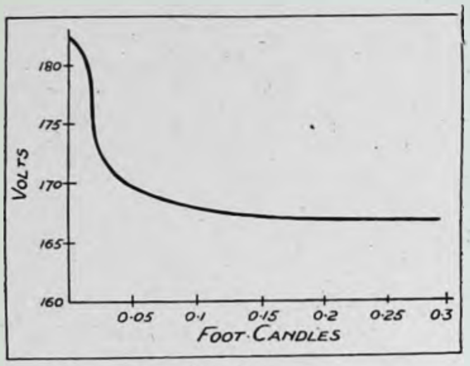


Fig. 5.
Variation of striking voltage of a neon lamp with variation of illumination.

the neon lamp and the various controlling factors in a previous issue of this journal. (See TELEVISION, No. 10, p. 40 *et seq.*)

Ionic Discharge.

The glow of the lamp is analogous to the ionic discharge which we know in the form of the electric arc. In the neon lamp there is a discharge between two metal electrodes. Oschwald and Tarrant found that if the voltage exceeds a certain value (in their case 180 volts, since the figure varies with the particular lamp used) the discharge will commence even though the lamp is shielded from all external ionising agents.

There is likewise a minimum potential of about 140 volts, below which no discharge will take place, nor is it possible to alter this minimum potential by any external agency. By the term "external agency" I mean such ionising radiations as X-rays, radio-activity, etc.

These workers found, however, that a most remarkable external agency will influence the voltage at which the discharge commences, and this is light. As already mentioned above, the normal voltage at which discharge commences is 180 volts. When, however, the lamp is exposed to light, the discharge will start at any voltage exceeding 164 volts.

The method of conducting the tests is really very simple, and since the subject has by no means been thoroughly exhausted, it will be both interesting and important for other workers to take up a similar line of investigation.

Tests for Television Society Members.

Local centres of the Television Society could with advantage repeat and amplify the experiments described in this article, and a few words as to the necessary apparatus will not be out of the way.

Two high-tension batteries having a maximum voltage of about 200 volts are arranged as shown in Fig. 4, the one (*B*) with its ordinary wander-plug as a means of varying the potential, and the other (*H*) shunted by a high-resistance potentiometer having two sliders. This is best achieved by the use of two ordinary potentiometers in series (*P*). An ammeter is placed in series with a switch (*S*), and the lamp and ballast resistance (*L*), all of which are in series with the source of potential difference. A voltmeter (*V*) reading to 200 volts is placed across that portion of the circuit which contains the lamp and ammeter, and should be capable of being read to one or two volts with ease, and should be of a reliable make.

The lamp is first switched on for a few seconds, and then allowed to stand idle for a measured period of time, conveniently two minutes. The voltage is then adjusted to slightly less than that at which it is expected that the discharge will take place, and the current then switched on and raised quickly and steadily till the lamp discharge is started. The lamp switch (*S*) is then opened, and the open circuit voltage is noted.

Results of Tests.

Further readings were taken at two-minute intervals, and it was found that even small intensities of light, such as that produced by a match flame held one metre distant, produced a lowering of the discharge voltage to 164 volts. A graph, which is shown in Fig 5, can be drawn, showing the relationship between intensity of illumination in foot-candles, and the starting potential.

Experiments were also made with a view to determining over what particular range of the spectrum the photo-electric effect was a maximum. The results which they obtained are best summarised in the form of a curve (Fig. 6). The maximum sensitivity is shown by the minimum voltage required to start a discharge, and we see that this is in the orange part of the spectrum.

The next question which arises is the location of that part of the lamp from which the photo-electric effect of the lamp arises. The results obtained show clearly that the seat of the effect must be located on the electrodes, and not in the gas of the lamp. There is no distinction, however, between positive and negative electrodes. Chief among other miscellaneous experiments carried out on this problem by Oschwald and Tarrant, they found that there was no appreciable time-lag with the effect. After long exposure to bright light, if the light was shut off and the current automatically switched on to the lamp at the same time, no discharge took place with a potential of 164 volts across the lamp, which shows that there is no delayed action of light. That is, the effect ceases rapidly and instantaneously when the light which is shining on the lamp is cut off.

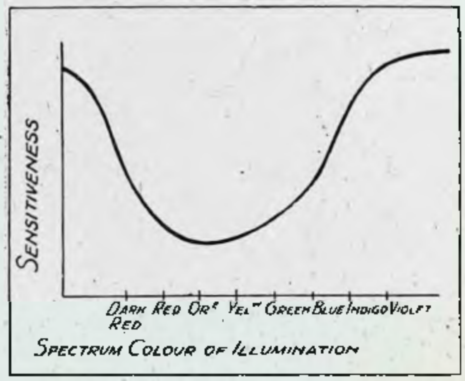


Fig. 6.
Graph giving approximate colour sensitiveness of neon lamp when used as a photo-electric cell.

Type of Lamp Tested.

The type of lamp used was the star electrode Osglim lamp, of the British G.E.C., though the effect is shown to a less marked degree by the beehive type.

Some of the more recently manufactured lamps do not show the effect; indeed it is not desirable that the starting voltage of the lamp should depend on the external illumination, though if there were any demand for lamps showing this characteristic, it would no doubt be met by the manufacturers.

BROADCASTING AND TELEVISION

The B.B.C. and the Baird Systems

By CLAN CHATTAN

The following very excellent article appeared in the current issue of the " Review of Reviews." The real name of the writer is Major E. R. Macpherson, O.B.E., F.R.G.S., F.A.G.S. He is a Fellow of the Television Society, and has been wireless correspondent to the " Review of Reviews " for over two years. The article is reproduced here by kind permission of the Editor of that journal.

JUST over two years ago I touched on the romantic side of television in these pages. Since then romance has given way to practical development. Television, in the stage of development which it has reached to-day, may be described as a combination of the various branches of science. Mechanics, optics, chemistry, electricity, and even wireless have all contributed to it their quota of knowledge, and have helped in solving the many special problems which are contained in the general problem of true television. By true television I mean ability to see, by some kind of electrical transmission, the reproduction on a screen of the image of moving, living, or stationary objects which are at a great distance from the observer.

Following on the early experiments of Szczepanik, Rosing and Mihály, the problem of television in recent times has been taken up by MM. Belin and Holweck in France; by Mr. C. Francis Jenkins of the U.S.A., and the American Telephone and Telegraph Company. M. Belin, working with M. Holweck, of the Radium Institute, Paris, has succeeded in sending shadows of simple objects. M. Belin's system employs essentially what are known as oscillating mirrors.

Mr. Jenkins uses his novel prismatic disc, an entirely new contribution to optical science, and he has succeeded in broadcasting special shadow films from his laboratory in Washington. The American Telephone and Telegraph Company have achieved a certain amount of success, and their system, whilst very ingenious, is somewhat complicated; they employ the Baird light-spot system. The General Electric Company of America has also explored this system.

However, the credit of being the first man to demonstrate, publicly, true television belongs to John Logie Baird, a brilliant young Scot.

In order to achieve successful television the requirements may be briefly stated as follows :—

*(1) Means of scanning an image, so as to subdivide it into tiny sections, or elements.

(2) Means of transforming the resulting picture elements, or light

John Logie Baird.

impulses, into electrical impulses, which can be transmitted to the distant receiver, either by wire or wireless.

(3) Means of reconverting electrical impulses into light impulses, and by means similar to (1), causing them to cover, or illumine, a screen, thus reproducing the image at the transmitter.

(4) Means of synchronising the transmitter and receiver, i.e. causing them to run in step or exactly at the same speed.

These were the requirements as Mr. Baird saw them six years ago.

Many optical methods were already known which would fulfil (1).

The selenium cell and the photoelectric cell were in existence and seemed to cover (2); and for (3) there was the neon tube.

Methods of synchronism had already been developed to a high degree, and seemed to meet the requirements of (4).

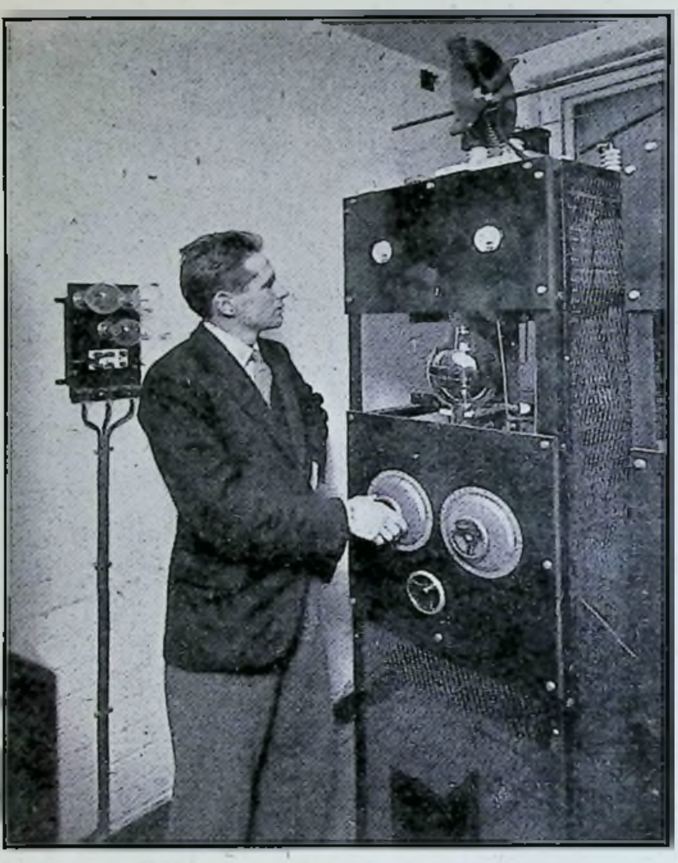
It all appeared so simple that Mr. Baird fancied there must be a catch somewhere. He soon discovered that the stumbling block lay in requirement (2)—viz., the light-sensitive cell. A further difficulty lay in (4), for Mr. Baird realised that the usual methods of synchronism were quite unsuitable for television. After six months' work he was able to transmit shadowgraphs, but he found that to transmit the images of the objects themselves was a very different thing.

It was not until October, 1925, that he had the satisfaction of seeing the doll's face (which he used for experiments) on his receiving screen not as an outline, but as a *real* image with shading and detail.

On January 27th, 1926, he gave a demonstration to more than forty members of the Royal Institution, the first demonstration of true television ever witnessed. This demonstration, and others which followed (including the trans-Atlantic tests), aroused considerable interest and enthusiasm. The original machine can now be seen in the South Kensington Science Museum.

Since then Mr. Baird has continually improved the technique of his instruments; and his system (an adaptation of the spot-light and

* " Television." By Alfred Dinsdale. (With acknowledgments.)



The new Baird Wireless Television Transmitter.

scanning disc) may be briefly described as follows :—

A light proceeding from a brilliant source is condensed into a slender beam not more than an eighth of an inch in diameter.

By means of a revolving disc this spot of light is made to traverse the face of a sitter in such a fashion that it flies across it again and again at slightly differing levels, so as to scan the face completely in less than one-tenth of a second. In front of the sitter's face, but screened from direct light, are a number of photo-electric cells of special design. These cells gather light reflected from that part of the face which at any distance is illuminated by the spot of light.

The photo-electric cells generate a current proportional to the intensity of the reflected ray, and this current is used at the receiver to build up an image by the aid of a neon glow lamp. At the receiving end, slotted and rotating discs then select the light from part of this glow, and deposit it on a screen in such a fashion that each patch of light occurs exactly in the same relative position on the picture screen as it occurred on the part of the object from which it was reflected.

It will be realised that television essentially depends on the fact that an impression made on the retina of the human eye persists for about one-tenth of a second. As this spot of light flies across the screen it builds up an image of the distant object which is seen in its entirety by the persistence of vision.

It is interesting to note that several other well-known experimenters are being converted to Mr. Baird's methods of solving the television problem. Mihály has abandoned oscillating mirrors for discs. Professor Hans Thirring, of Vienna University, is of the same opinion as Mihály.

Our own leading men of science, including Sir Ambrose Fleming, have expressed their high appreciation of the Baird system.

A few days ago I was permitted, through the courtesy of Lord Angus Kennedy, to visit the Baird Laboratories in Long Acre, where every facility was given me to see things for myself.

I was much impressed by what I saw. The improvement in technique since the Radio Exhibition last autumn was most marked. The clarity and detail of vision were such that I easily read the time to a minute on a boldly marked watch held in front of the transmitter (the receiver was, of course, in another part of the building), and I easily recognised the faces of people whom I had seen before.

Music and speech were almost simultaneously transmitted in perfect synchronism ; and in the case of a man playing the piano the limits of the picture permitted the whole keyboard to be seen. I was informed that extended scenes had been successfully transmitted taking in all the performers, though of course the figures were much smaller. They had to be compressed, as it were, into the same area as a head and shoulder view. One can sum up the Baird system in two words : " It works ! "

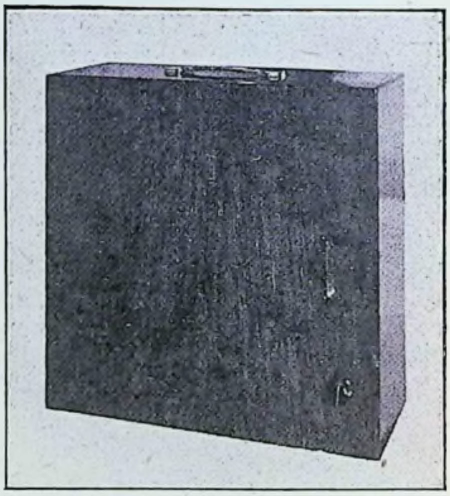
I was also introduced to the wonders of noctovision, where the sitter is in complete darkness, but his face is flooded with infra-red rays (which are invisible to the naked eye), and the image comes out clearly on the receiving screen at the other end. One can imagine the most startling developments from this side-line of Mr. Baird's discoveries. I clearly recognised my friend's face and all the contortions he did for the experiment, despite the fact that he was in complete darkness at the other end.

* * *

During the past few months I have been asked repeatedly : " When is television going to be broadcast ? " Let me explain the situation as I see it.

In *The Review of Reviews* for February, 1927, I wrote : " Television will have to be correlated with broadcasting, otherwise we shall have chaos in the ether." Last October I again wrote : " What the public wants is *living* images. Let us encourage Mr. Baird in his magnificent triumph and press for the broadcast of living people and actual events."

What I have since seen and heard



Baird Portable Televisor, suitable for use in place of Loud Speaker on any good 4-valve set. Price £12 10s.

has only served to strengthen those opinions.

After the last Radio Exhibition the Baird Television Company applied to the Postmaster-General for facilities to provide a broadcasting service of television. The Postmaster-General sent a deputation of his engineers to examine the apparatus. They reported that, in their opinion, it was sufficiently advanced to warrant tests being made through the B.B.C.

The B.B.C., however, were not of the same opinion, and declined to allow the tests. A complete deadlock followed for nearly six months.

Vocalist sitting before Baird Television Transmitter.

Pressure (backed up by public opinion) was brought to bear upon the B.B.C., with the result that, quite recently, a series of demonstrations were carried out, and were witnessed by a Committee of Members of Parliament and by the Governors of the B.B.C., with a view to some working arrangement with the Baird Company upon the result of the test.

The strictest secrecy was observed —a policy the harder to understand because the whole subject is of eminent public interest. But I am credibly informed that, during the recent demonstrations, images were successfully received both at the Post Office and at Savoy Hill, and the accompanying speech was heard simultaneously.

Amongst those who were broadcast was Mr. Jack Buchanan, the well-known actor. Captain P. P. Eckersley, the chief engineer of the B.B.C., also took his place in front of the televisor and was recognised at the Post Office.

As a result of these experiments I am delighted to see that the Baird television system has now been officially recognised by the Postmaster-General, who, in a letter addressed to the Secretary of the Company, states that he would agree to a B.B.C. station being used for experimental broadcasts outside broadcasting hours. He refers to Mr. Baird's invention as a "noteworthy scientific achievement." Negotiations are to begin between the B.B.C. and the Baird Company, in order to discuss the technical aspects and other points. This is a happy turn in what was becoming a delicate situation.

I am, and always have been, a great admirer of the B.B.C. Generally speaking, it has ministered to the nation's needs. I felt confident that common sense would triumph, and that Mr. Baird would be given a well-deserved trial. By virtue of its Royal Charter the B.B.C. has a very wide responsibility which it has realised by readiness at all times to consider constructive proposals for its broadcasting service. Also, it has rightly afforded the fullest facilities to the broadcasting of still pictures under the Fultograph* process. The practical value of these pictures to the general public is, however, doubtful. I have been receiving them now for the past two months; and while I admit the cleverness of the instrument, I am disappointed with the technique. But I should imagine that there is a great future for the Fultograph system in the transmission of press photographs over land telephone lines. Some interesting experiments have recently been carried on in this direction.

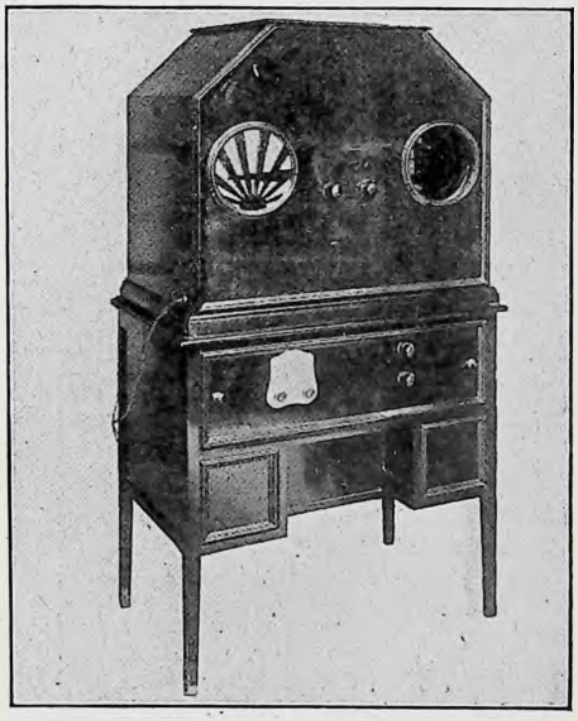
One of the most gratifying aspects of the Postmaster-General's recognition of the Baird system is that a British invention of admittedly outstanding merit is to be developed and explored by British controlled interests. Abroad its value was speedily understood. The Baird Company have been offered every facility by the Rundfunk (the B.B.C. of Germany) and a transmitter has been sent to Berlin. This was done after Drs. Bredow and Reissler had seen demonstrations at the Baird Laboratories. In France no fewer than five stations have been placed at the Company's disposal.

* Wireless Pictures (1928), Ltd.

For domestic use the Baird Company have produced a number of televisor models. The smallest machine (a portable model) shows a picture about twice the size of a cigarette card. In this set 6 volts are required for the motor and 200 to 350 volts H.T. for the neon glow lamp. This instrument only reproduces vision, speech being reproduced on the user's loud speaker. It can be used with any standard four-valve set with a good output valve. The complete Baird televisor reproduces both speech and vision.

In view of the greater H.T. required for television receivers the question of current supply immediately claims our attention, and a suitable eliminator with a large output must be sought.

In the course of my experiments I have been testing large output eliminators. Those supplied by Partridge and Mee of Leicester are excellent in their performance. I have been successfully using their A.C.3 model for some time. This model has a fixed tapping of 400 volts at 50 m.a. and two variable tappings giving 0 to 300 volts. In addition, A.C. filament current for two LS5A valves (in parallel) are provided.



Complete Baird Televisor with Loud Speaker. Price £90.

The lay-out of this instrument conforms to the most exacting requirements. There is practically no hum, and the manufacturers guarantee their scheduled output, which my tests have confirmed.

With the advent of television I can recommend this firm's eliminators, which are particularly suitable and adaptable for this purpose.

* * *

It has been widely stated in the press that the transmission of television occupies a very wide waveband, so wide that every other station would be obliterated. This is not the case. Recent tests have definitely shown that television can be transmitted within the ten kilohertz band, that is, the frequency band allotted by the Geneva Convention to European broadcasting stations. Mr. Baird readily admits that finality has by no means been reached, and he is confident that further progress will be made in his system if he is given the opportunity to use one or more of the B.B.C. stations. He does not wish to interfere in any way with the ordinary B.B.C. programmes, but suggests that, for one hour every evening, the actors who are broadcasting should also be televised through an additional station—e.g., the Marconi House station, which is, as a general rule, not in use. This would permit the public at large to see practical television for themselves.

The popularity of television is growing rapidly. Little more than a year ago The Television Society* was formed. Its members now number nearly 500, including 200 Fellows. Its President is Sir Ambrose Fleming. The society is international in character, its whole aim being to develop and foster the science of television. I attended the last meeting and was struck by the enthusiasm of its members. Its monthly official organ, TELEVISION,† contains excellent technical articles by acknowledged authorities. The desire to know more grows daily; *listeners-in* now want to be *lookers-in*. I do not doubt that, in twelve or eighteen months' time, we shall have a regular service of *Aurivision* in the British Isles.

* The Television Society, 95, Belgrave Road, Westminster, S.W. 1.

† Published by the Television Press, 26, Charing Cross Road, London, W.C. 2.

Special Broadcasts for Byrd.

An antenna that increases the directional power of W2XAF, the short wave station of WGY, Schenectady, N.Y., ten times, making a 20 kilowatt station the equivalent of 200 kilowatts in effectiveness in one direction, has been erected at the South Schenectady transmitter laboratory of the General Electric Company. This antenna faces the south and it is used for one broadcast programme only, and then but once every other week. The engineers call it the "Byrd" antenna, because when this particular radiator is in use the message is directed to Commander Richard Byrd and his men at Little America, Bay of Whales, Antarctica.

The Byrd antenna is Dr. E. F. W. Alexanderson's contribution to happiness of the expedition personnel as they winter through the long antarctic night. In erecting this special antenna, General Electric engineers are bringing to the Byrd broadcasts the latest devices known to the art to promote reliability of reception. While it is too much to hope that all programmes will reach their Polar destination, it is expected that by the use of the Byrd antenna the chances of getting through static with a good signal are very much enhanced. This particular antenna was used for the first time Saturday night, March 23rd, and within fifteen minutes after the conclusion of the programme, WFA, the Byrd transmitter, reported in code that the entire programme had been received through loud speaker.

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, W.C.2. Price 1s. each.

LIGHT MODULATOR.—*Patent No.* 305074, granted to Eccles, W. H., Whitaker, A., and the Gramophone Co., Ltd. The change of illumination in an ordinary Kerr cell is proportional to the square of the applied voltage, but in certain materials there exists a "Pockels' effect" which produces a change of illumination *directly* proportional to the applied voltage. Crystals which exhibit this "Pockels' effect" are used in light valves designed for operation at audio-frequency, so as to yield a photographic sound record. A crystal of Rochelle salt, having the structure shown at (7) in Fig. 1B, is cut along the plane (8), the lower part (14) being discarded. The areas in which the "Pockels' effect" are most marked are indicated at (9), (10). The crystal (1) is shown in Fig. 1A, mounted between two insulating tubes (2) which are closed at their ends by windows (3), and filled with alcohol or some other suitable liquid, and provided with co-axial electrodes (4) and leads (5). The crystal may be arranged between Nicol prisms to yield a photographic sound record. The applied voltage is of telephonic frequency as distinct from modulated high frequency, the use of which is disclaimed, and may be superimposed on a direct current polarising voltage in the same or a different direction.

FIG.1a. FIG 1b.

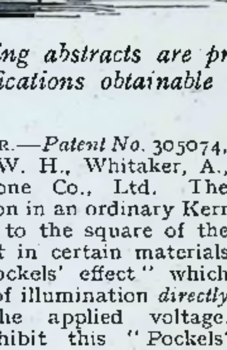
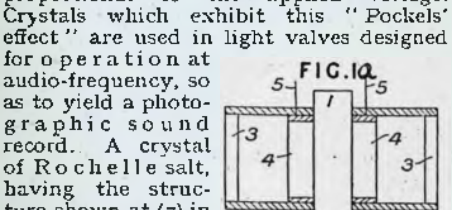


FIG.3. FIG.2. FIG.4.



SCANNING DISC AND LIGHT VALVE.—*Patent No.* 305079 granted to Rowe, J. J., and Rowe, C. L. The scanning discs B and B^1 (Fig. 3) are formed with slots b and b^1 (shown with broken lines) respectively. The two discs are made to revolve in opposite directions, one twelve times as fast as the other for scanning purposes, and the slots intersect one another at right angles. Alternately these rotating discs may be replaced by endless bands B^4, B^5 fitted with slots b^2, b^3 respectively, the bands moving in opposite directions at different speeds (Fig. 4).

In Fig. 2 is shown the light valve. The picture to be transmitted is projected through scanning discs of the form already described on to a light-sensitive cell. The output from this cell is amplified and then transmitted either by wire or wireless to operate a magnet G at the receiving station. The magnet controls a shutter A which works in conjunction with another shutter or slotted screen A^1. Thus the amount of light passing through the dual shutter from a lamp H, and thence through scanning discs on to the receiving screen, is controlled in intensity in accordance with the picture being sent.

EXPLORING AND SYNCHRONISING.—Protection is sought in *Patent No.* 304730 by Strange, R. W. (Convention date, Jan. 25th, 1928), for a system of television where a number of objects (10) in Fig. 5 are *simultaneously* explored by a series of spiral perforations in a ring (2). Each object is illuminated from a source (8), and reflected light actuates light-sensitive cells (21). It is claimed that the light may be interrupted by a perforated rotating disc in order to superimpose an alternating current on the output from the cells.

At the receiver the scanning ring (2*b*) has a number of rows of holes shown in Fig. 6 as (3*b*), so that a plurality of images *I*, *II*, *III*, *IV* is reconstructed at each viewing point. A mask (31) can be adjusted so that it may block out the unwanted portions of these images. In this arrangement it is pointed out that it is sufficient for the driving motor at the receiver to run isochronously with the motor at the transmitter.

PICTURE TELEGRAPHY.—The British Thomson-Houston Co. (Assignees of Alexanderson, E. F. W.) claim patent rights in No. 304653 (Convention date, Jan. 23rd, 1928) for a photographic receiving apparatus for picture telegraphy. Picture signals are received on a neon or other lamp (18) in Fig. 7, and the varying illumination is projected through the lens combination (17) on to a photographic film carried by the drum (1). The particular novelty of the invention lies in the method employed for scanning. The drum (1), already referred to, is carried by rods (7) (8) which are mounted on hollow shafts (5) (6), and driven from a motor through a gear wheel (4), so that the drum and shafts rotate within the fixed outer tube. The drum is provided with nuts (11) (12), which engage a screwed shaft (9). The shaft (9) can either run free or it can be held in position by means of the friction brake (10), (13), (14). When the shaft (9) is free it rotates with the drum owing to the friction exerted by the nuts; but when the shaft is held firmly by the friction brake it causes the drum to progress axially while rotating.

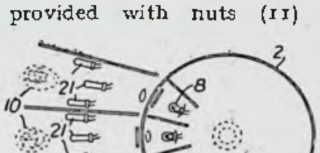


Fig. 5.

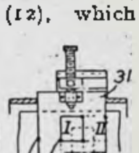
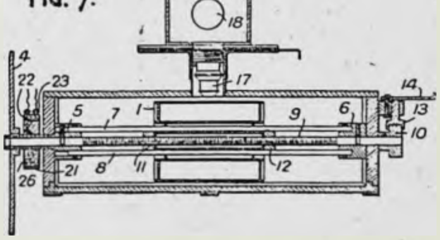


Fig. 6.

A synchronising signal is caused to be emitted once during each revolution at the transmitter. This signal is received in a circuit which includes a telephone and is completed through brushes (23), so long as these lie on conducting portions (21) of the disc (26), which is made to revolve with the drum. When the receiving drum is in phase with the transmitting drum, the signals arrive when an insulated segment (22) is passing under the brushes (23), so that the signals are then extinguished in the telephones. When synchronism has been attained aurally by this means the picture signals are switched through the receiving lamp.

FIG. 7.



THE BEST LETTERS OF THE MONTH

The Editor does not hold himself responsible for the opinions of his correspondents. Correspondence should be addressed to the Editor,* TELEVISION, *26, Charing Cross Road, W.C. 2, and must be accompanied by the writer's name and address.

UPPER SYDENHAM.

April 4th, 1929.

THE EDITOR,
"TELEVISION."

SIR,

Sir Ambrose Fleming, in an illuminating article in the April number of TELEVISION, says: "We can only conceive of a wave as an undulation in something. What is the 'something' in the case of electrons?"

Substitute spatial ether by a spatial field of static energy. Is this conceivable?

In water or in air eddies may be formed which travel as waves, transferring energy, but neither water nor air. Does a magnetic field of force permit of the passage of undulations such as are carried through and by means of the ether? Apparently it does, as all types of waves move amidst this planet's field of force, yet the lines of force in the magnetic field are one of the elements in the formation of the electric currents which originate some types of waves that are travelling from place to place over this earth.

Magnetism and electricity—as they are exhibited in the physicist's laboratory—are only known as connected with matter. But theory has it that matter is derived initially either as waves or as vortices from the action of electricity upon the ether. We are thus on the horns of a dilemma. We have either to assume electricity as pre-existent to matter, or matter as pre-existent to electricity. In either case the ether does not help us—the ether of current theory, for it is purely a negative substance or condition—subjective, not objective.

Magnetism, lines of force, fields of force, electricity, electro-magnetism are terms freely used in discussing the origin of matter. All we know of magnetism is that certain groups of substances possess qualities resulting in force, while other substances when brought into contact in a certain manner with these will give us motion. For this to be the case the static and kinetic energies existing must be pre-existent to the substances affected. Is it then a far cry to assume a spatial field of static energy capable of becoming kinetic when the conditions are so designed?

Magnetic lines of force are very real and very operative. Planetary fields of force (judging by that of this earth) are real and potent. Following the square law if they exist round about a sun or star or planet, they must fill all space, thus the necessity for a link to avoid "action at a distance" is met. The vehicle is that which is an element in the waves it carries, waves created where right-angle currents are acting, converting static into kinetic energy, travelling as eddies of active force through an ocean of static energy.

I am, Sir,
Yours faithfully,
A. HAYWOOD.

MORE USES FOR TELEVISION.

SHORTRIDGE TERRACE,
NEWCASTLE-ON-TYNE.

April 2nd, 1929.

THE EDITOR,
"TELEVISION."

SIR,

Now that official recognition is coming to television it is to be hoped that the general utility of this great invention will not be lost sight of by those who are inclined to regard it as a specialist thing and treat of it in "Television and Radio" or, as some are doing, "Television in War." There are other and more social uses than these and one that occurs to me is its potentiality along what might be called sentimental lines. We hope in the future to establish television broadcasting stations, when monopolies cease to be, and then it will be possible for persons to see relatives and friends who live at a distance, the person to be seen paying a small fee to pass before the transmitting instrument for his visage and form to be seen in the home televisor hundreds of miles away.

If it is worth a few shillings to telegraph birthday or Christmas greetings to friends at a distance it should be worth a like sum to see them. Those separated from dear ones who have had to seek work or fortune elsewhere will be able by television to see them as in the flesh, after the time had been pre-arranged by letter. Think how cheering it would have been for all his subjects to have a vision of the King recuperating at Bognor transmitted at intervals, which, I understand, the Baird system could do now if permitted.

I am, Sir,
Yours faithfully,
ALFRED S. REEVE.

AUCKLAND,
NEW ZEALAND.

THE EDITOR,
"TELEVISION."

DEAR SIR,

Having acquired an active interest in television through the medium of your very helpful magazine, I should be deeply indebted to you for a little advice and assistance in this growing subject.

Briefly, I have evolved a weird and wonderful system for television transmission and reception which calls for a multiplicity of light-sensitive cells of as small a dimension (individually) as possible. Are such cells obtainable? Say, in cubes of from $\frac{1}{16}$in. to $\frac{1}{8}$in. each. Or could you advise me as to any known means for preparing a screen which would be able to respond to light impulses, the individual cells (or other devices) of which might be as small as approximately $\frac{1}{8}$in.? Situated here in New Zealand it is exceedingly difficult to secure much information, etc., and your assistance in the matter would be very much appreciated. Such details as where to procure, probable cost, and general cell-efficiency will meet my requirements admirably if you would be so kind as to officiate for me.

Needless to add I have gained the incentive to put my idea into practice through absorbing the very instructive and interesting articles published in your TELEVISION magazine. I am a regular subscriber and have followed the "new science" very closely as I foresee a probable extension of my activities here as radio engineer.

Apologising for encroaching upon your time and trusting that you will be able to assist me in the manner indicated,

I am, Sir,
Yours faithfully,
ALLAN PARSONS.

Mention of "Television" when replying to advertisements will ensure prompt attention

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