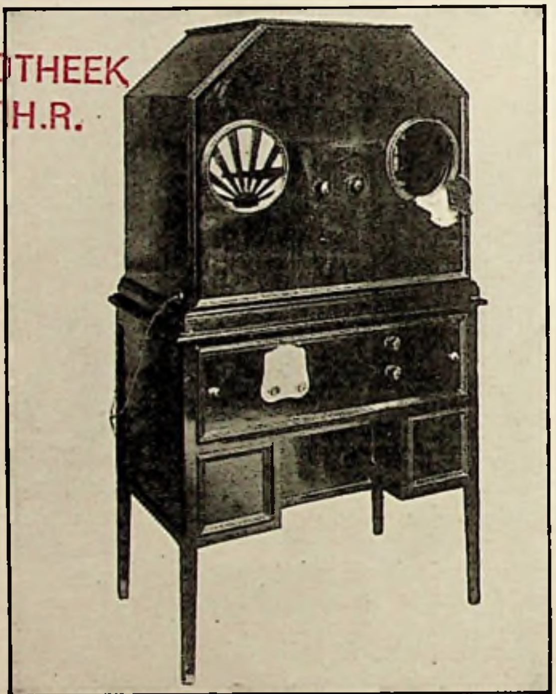
TELEVISION TO BE BROADCAST

6D MONTHLY

Television

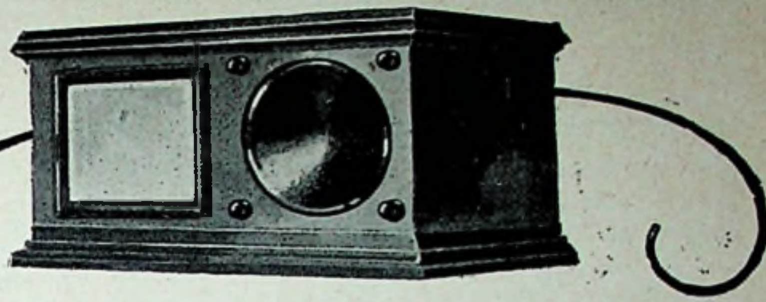
The Official Organ of the Television Society

VOL. 1 NOV. 1928 No. 9



Our illustration shows the Baird Dual Super Radio and Televisor Set which was on view at the Company's Stand at Olympia, and demonstrated in premises adjoining. It was later publicly demonstrated at Selfridge's. The upper half contains the Televisor and a moving coil loud speaker. The lower half contains two separate wireless receivers, one for speech and music and one for television.

THE WORLDS FIRST TELEVISION JOURNAL



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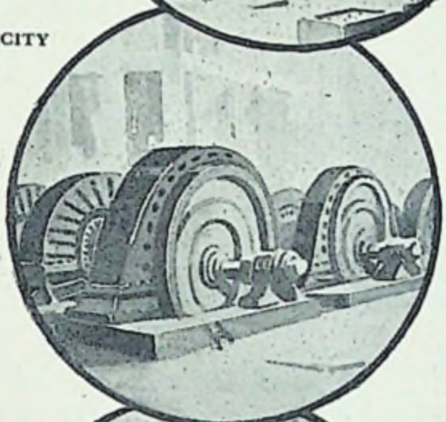


MECHANICS

NOVEMBER 1928

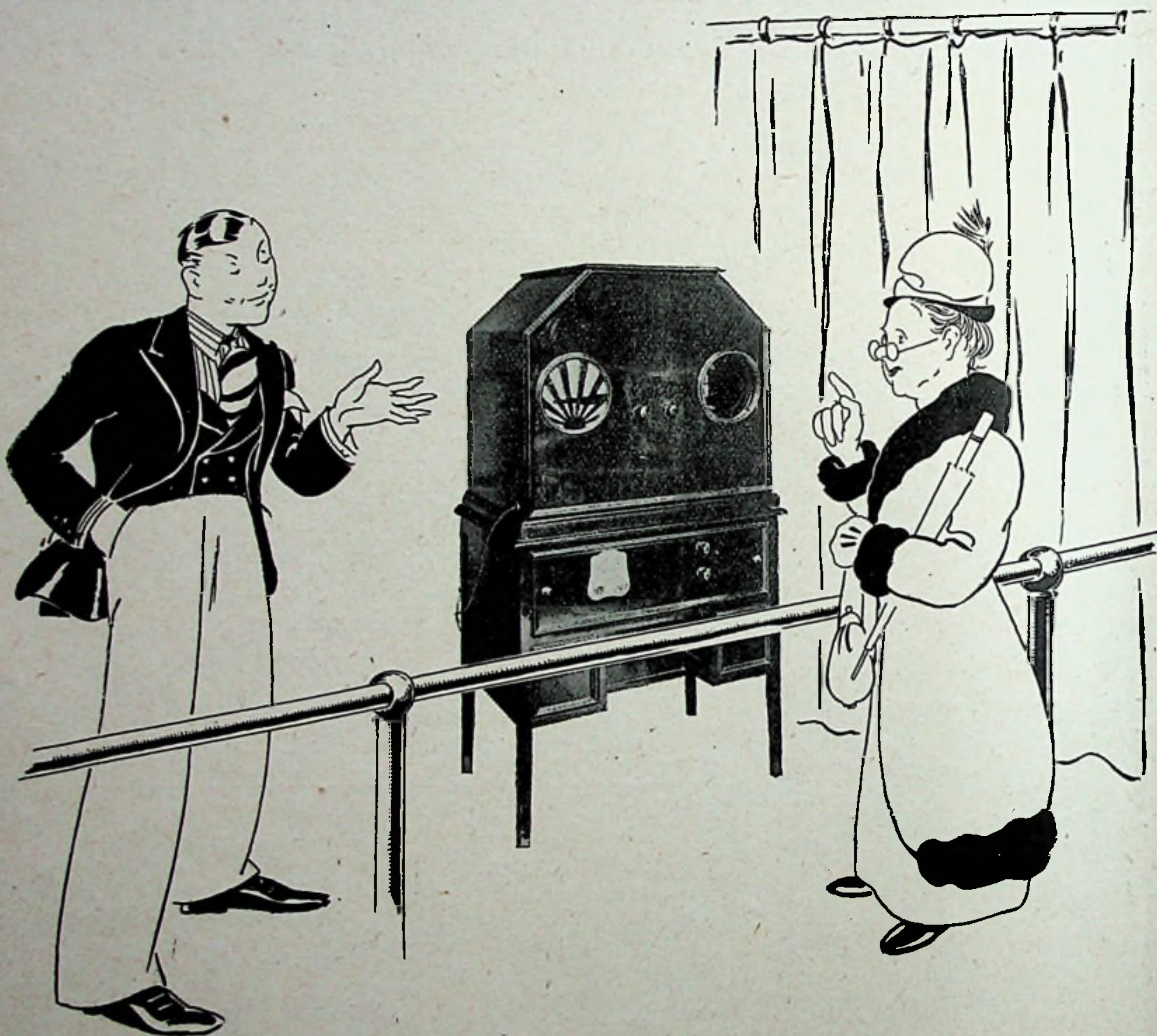
OPTICS

CHEMISTRY

CINEMATOGRAPHY

SEEING INTO THE FUTURE

Overheard at Olympia—Demonstration Rooms, 1928.



Elderly Lady, talking to herself: **Dear! Dear! The wonders of this world will never cease—we shall be looking into the future next.**

Smart Salesman: **Well, madam, "When it's night time in Italy it's Wednesday over here"—Er, excuse me—I should have said—This machine is capable of picking up a picture from Australia, and it is to-morrow there—NOW.**

THE WORLD'S FIRST TELEVISION JOURNAL

The Official Organ of The Television Society

Edited by A. DINSDALE, A.M.I.R.E.

Consultants: Dr. C. TIERNEY, D.Sc., F.R.M.S.; W. J. JARRARD, B.Sc. (1st Hons. Lond.), A.R.C.S., A.I.C.

Technical Editor: J. C. RENNIE, B.Sc., A.M.I.E.E.

Vol. 1] NOVEMBER 1928 [No. 9

EDITORIAL

TELEVISION AT OLYMPIA.

SINCE our last issue appeared the annual Radio Exhibition has come and gone. Undoubtedly the most outstanding feature of this year's show was the Baird Company's stand, where various commercial models of the televisor were exhibited. Throughout the exhibition week the biggest crowd was always to be found round this stand.

* * *

THE cheapest instrument, labelled "Model A," is a portable instrument which contains a televisor only. "Model B," a somewhat more elaborate instrument, contains, in addition to the televisor, a moving coil loud speaker. The most elaborate instrument of all, however, is "Model C," a very handsome-looking piece of furniture. The top part of this instrument (which is illustrated on our cover) consists of "Model B," while the lower part of the instrument contains two super radio receivers, one for speech and music, and one for the television signals. Both these receivers, operating on different wave-lengths, work off the same frame aerial which is enclosed in the cabinet; or they can be connected to an outdoor aerial. The instrument is entirely self-contained and can be operated from the mains, or, where these are not available, from a 12-volt accu ulator. The necessary high tension current (350 volts) is obtained from a rotary converter contained in the lower half of the cabinet.

* * *

IN accordance with the announcement made in our last issue, tickets were given out at the Baird Company's stand for demonstrations of television, which were given throughout the exhibition week in premises adjacent to Olympia. Approximately nine hundred people per day witnessed these demonstrations, which were a tremendous success. Several well-known artists appeared before the televisor, and assisted materially to make the demonstrations a success from an entertainment point of view. The entertainment value of television is dealt with in this issue in a very able manner by Mr. R. F. Tiltman.

* * *

TELEVISION AT SELFRIDGES

OWING to the limited accommodation of the demonstration rooms at Olympia, the Baird Company were under the necessity of turning thousands of people away. In

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order to mitigate the disappointment as far as possible, arrangements were made to give public demonstrations on the fourth floor of Messrs. Selfridges' Oxford street store. These demonstrations ran for a week, and were also a huge success. It was estimated that between eight and ten thousand people per day witnessed demonstrations, and, judging from the comments which we overheard, everybody came away delighted with the "show," and loud in praise of the wonderful progress which has been made.

* * *

THE B.B.C. DECISION.

JUST as we were on the point of going to press the announcement was made in the newspapers that the B.B.C., after witnessing a demonstration of television, have decided not to undertake experimental television broadcasts for the present, giving as their reason that they do not believe it possible to broadcast television with the present apparatus, and that when further developments have been made they will be ready to reconsider their decision.

* * *

IMMEDIATELY we read this, we sought an interview with Captain O. G. Hutchinson, the Business Managing Director of the Baird Companies. We found him in a very optimistic frame of mind, and not in the least perturbed by the B.B.C. announcement.

* * *

"THE decision is the outcome of our application to the Postmaster-General for a licence to broadcast television, or for permission to use one of the B.B.C. stations for experimental transmissions," he said. "The Secretary of the Post Office replied, requesting us to afford facilities for the Postmaster-General's representatives to witness a demonstration of our apparatus. This we did, and the Post Office officials who attended were very favourably impressed.

* * *

"AS a result the Secretary of the Post Office wrote to say that the Postmaster-General was prepared to direct that one of the B.B.C. stations be placed at our disposal, but that first he thought it reasonable to request us to give a demonstration to the B.B.C. officials. We agreed on this point, and invited the B.B.C. to send representatives here to witness a demonstration. Certain officials duly arrived, and were given a highly successful demonstration, after which the B.B.C. held a meeting, the outcome of which you have read in the papers.

* * *

"HOWEVER, we have the support of the Postmaster-General, and the matter is by no means ended. Television is bound to come. Thousands of people have seen it recently at Olympia and at Selfridges, and it will not be long before public opinion will demand television broadcasting as an adjunct to sound broadcasting. We have already made certain arrangements, and you can take it that television broadcasting will definitely be available in England very shortly.

ON press day hundreds of letters reached us expressing our readers' opinions resultant upon the publication of the B.B.C.'s decision to delay the inclusion of experimental television broadcasts in their programmes. Every mail now brings us hosts of letters couched in the same tones of disappointment, disgust and surprise. Being already on the point of printing, it was only possible for us to include four of these letters in this issue, and it is proposed to devote considerable space in our next issue to our readers' opinions.

* * *

"IN view of the ease with which we we have been able to arrange for broadcast facilities in many other countries in different parts of the world, it is indeed strange that here, in the country of origin of the invention, so many difficulties should be put in our way."

* * *

THERE are one or two other aspects of the B.B.C. decision which occur to us. One is that the B.B.C. is not, as many people have been led to suppose, the supreme authority on wireless matters in this country. It holds a licence, issued to it by the Postmaster-General, which permits it, under certain conditions, to transmit certain wireless signals for a certain specific purpose. It does not rest with the B.B.C. to determine whether television signals shall be transmitted by wireless or not. That is the Postmaster-General's prerogative, and he in turn may, in the last resort, be governed by the supreme authority on wireless communications in this country, which is the Imperial Communications Committee. This committee was set up by the Government to determine matters of policy in connection with electrical communication throughout the Empire.

* * *

ANOTHER point arising out of the B.B.C. decision, it seems to us, is the important one of the liberty of the subject. It is not intended, under the laws of this country, that it should be possible for a monopoly to exist and operate in such a way as to impede trade or throttle an industry. The B.B.C. decision not to broadcast television would, if the B.B.C. were the supreme authority, definitely tend to interfere with the liberty of the subject by preventing the development of the new industry of television.

* * *

TWO British public companies are in existence for the purpose of exploiting television. They have developed the Baird inventions to the point where they have reached a commercial stage. They are ready to market apparatus as and when a television broadcasting service is inaugurated. The British public is being deprived of television simply and solely because broadcasting facilities are not yet available. However, we have the assurance of Captain Hutchinson that it will be possible to receive television broadcasting in this country very soon.

CRITICISMS AND CRITICS OF TELEVISION

By Dr. J. A. FLEMING, F.R.S.

In the following highly interesting article our well-known contributor draws upon the fund of his very extensive experience in scientific developments, and draws a very illuminating comparison between television and certain other sciences, now commonplace, which had to go through just the same period of difficulty which television has had to contend with.

IT is curious to note the very similar treatment which all new inventions or technical advances meet with from critics or enthusiasts.

When the incandescent electric lamp made its first public appearance in England at the Crystal Palace Electrical Exhibition in the spring of 1882 as a practical illuminant, gas engineers were unanimous in their declaration that it could never by any chance displace gas as a source of domestic light.

When the first samples of Bell's speaking telephone came to England it was regarded even by high officials in the Postal Telegraph Service as merely an interesting toy. . . The same opinion had been expressed concerning the early electric-telegraph instruments, such as the Five-needle Cooke and Wheatstone.

Interesting Feats.

There were not a few who considered Marconi's early demonstrations with his electric-wave telegraphy as more in the nature of interesting feats than practically useful achievements.

On the other hand, whilst these new inventions were depreciated and undervalued by some people, others went to the opposite extreme and prophesied a speedy triumph for them. In the very early days of incandescent electric lighting, when the problem of "dividing the electric light" (that is, creating a small unit of light suitable for room lighting) was considered to be solved, many holders of gas shares flung them on the market under the impression that gas had become a "back number."

In the case of the speaking telephone hardly two years had elapsed from its first appearance before the General Post Office began to set in motion all the legal machinery of the State to prove that the telephone was a telegraph within the meaning of the Telegraph Acts, and that telephone exchanges with subscribers must therefore be controlled by or worked under licence from the State, lest it should injure the revenue derived from postal telegraphs.

Dr. J. A. FLEMING, F.R.S.

The carbon filament electric incandescent lamp and the exploitation of it as a domestic illuminant by various public companies and corporations was considered by Parliament to threaten another monopoly in public service so seriously that the Legislature hastened to promote and pass the first Electric Lighting Act of 1882, which effectually throttled the development of electric lighting in Great Britain for about six years.

We find, therefore, in connection with every such cardinal invention, some persons who depreciate and underrate its utility in its initial stages and others who let their enthusiasm run riot and anticipate a too speedy fructification.

Television is, and will be, no exception to this rule. What has been done may not be altogether perfect, and there is undoubtedly much scope for further development, but the achievements to date have a scientific basis, and television's record so far compares not unfavourably with the initial stages of the phonograph or gramophone, or with photography, wireless telegraphy, or telephony and electric illumination at a similar age, and all of these were regarded at their first start as unpractical or useless curiosities.

A Few Examples.

It is a very difficult matter to form a just estimate of the true power of development as regards utility of a new technical achievement. Some inventions are noteworthy, but are also sterile. They never grow beyond a certain initial stage. They may promise well, but they do not steadily advance.

The telephone receiver is an example of this. The magneto telephone as we use it to-day, although improved in detail, has not gone beyond the stage of its first creation by Bell. It is still marvellously inefficient. Yet no one has been able to substitute for it anything essentially different in principle.

On the other hand, our microphones or telephone transmitters are very remarkably in advance of the early instruments, and our gas-filled metal filament incandescent lamps are an immense improvement on Edison's first tar-putty or bamboo filament lamps, or Swan's first carbonised thread lamps. It is also very difficult to forecast exactly whether a new invention will exhibit sufficient utility to hold its ground.

Suppose anyone well acquainted with the physiology and mechanism of human speech had been shown a Bell telephone receiver as first made in 1877 or 1878 and asked to say whether he thought it could create speech sounds. It is almost certain that in the absence of experience of it he would have said the motions of the small steel diaphragm could never do it. In fact, the Bell telephone does reproduce certain speech sounds extremely badly or not at all.

Let anyone try the experiment of saying through the telephone "Come to tea" and the listener will have the "ē" sound in "tea" very poorly given. Say also "Sister Susan serves soup" and notice how inarticulately the "s" sound comes through. Also the fricative consonants "f" and "v," and the sound of "n" are given very indifferently. Yet for all this the telephone receiver is sufficiently good for practical purposes. The reason for this is that the educated human ear can guess from a mere suggestion of a vocal sound the intelligible meaning of it as a word.

The actual wave form of the aerial motion near the transmitter is reproduced near the receiver diaphragm as a mere caricature. The ear, however, interprets it very well. It is just as with very bad handwriting. Not a single letter may be properly formed. The written word may be a mere scrawl, but yet it becomes intelligible when seen in a letter, especially from a familiar correspondent.

Object Recognition.

It is the same with the eye as with the ear. We are able to recognise well the object represented by some image even although a good deal of detail is absent.

In fact one may say with regard to the eye that we take pleasure in not having too much detail given to us, but in leaving the mind open to interpret, as it were, a mere suggestion.

Those who practise the art of water-colour sketching from nature know this very well.

Suppose an amateur set to make a water-colour sketch of a tree or of a stone bridge over a stream. He or she generally spoils it by trying to put in too much detail. He tries to depict every stone in the arch or the leaves on the tree as he sees it exactly. The result is a failure to make a pleasing picture. The good artist, on the other hand, cultivates what is called "breadth" in his sketch. He puts in enough detail to suggest rather than depict. A few deft touches of the brush suggest the separate stones of the arch or the masses of foliage of the tree. The general perspective and the disposition of light and shade, the shadows and broad masses must be given in correct colour and general form, but to give pleasure too much detail must not be put in.

The mind enjoys being left to contribute something to the perception and not having everything done for it. Hence a good water-colour landscape sketch is a more pleasing thing than a photograph, even if the photograph is in colour.

The real principle underlying all this is that we take pleasure in the exercise of our own faculties of sight, hearing, and comprehension, and we do not require more to be done than is sufficient to stimulate our own activities.

Seeing is Believing.

The pleasure we derive from a joke or some witty remark is often dependent on the point not being too obvious but requiring some intelligence on our part to "see" that point.

Now all this has a great bearing on television.

That recognisable images of moving and living objects such as human faces have been transmitted even to large distances by wire and by wireless, by Mr. Baird's methods, admits of no manner of doubt. Those who deny it have simply not seen it.

There are sufficient credible witnesses of it to place it quite beyond the region of dispute.

The questions that then arise are First: Are such images sufficiently good to be recognisable for the objects or persons they depict? Secondly, Is the process one which admits of improvement and extension? Thirdly, Is the effect or result one which will be continuously attractive to the general public?

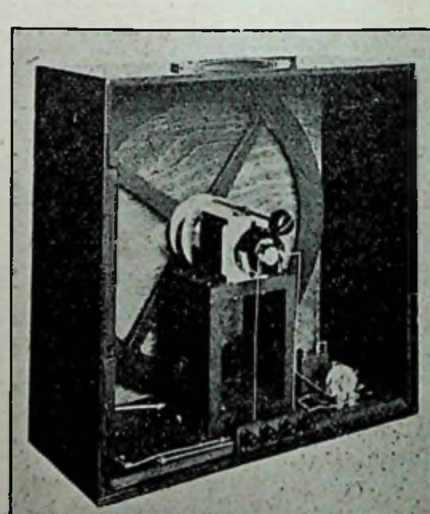
ON this page Dr. Fleming points out that we take pleasure in having to use our intelligence to assist our eyes and ears to interpret something which we prefer to have imperfectly presented, so that some essential effort is necessary if we are to understand what it is we see or hear.

Picture Formation.

Those who reply in the negative to the first question are those who have only seen the early experiments, or else who approach the subject from a theoretical point of view and have not actually seen the best results yet obtained.

The general argument urged against the process so far is that the image is built up of a number of patches of light, or rather a continuously moving patch of varying brightness which covers the whole area of the image in less than one-tenth of a second.

It is pointed out that a process block picture consists of a number of black dots of varying intensity, and that to obtain any clearly recognisable image of a human face, say, there must be about 50 dots per linear inch or 2,500 per square inch, and that hence the television of a



Back view of the portable televisor.

face requires the transmission of several hundred thousand impulses per second. This is a speed far in excess of any used in ordinary telegraphy or in the transmission of pictures by wire or wireless.

It is perfectly true that the electric current obtained from even many large photo-electric cells in parallel in the moving light-spot method of television is extremely feeble and requires to be amplified millions of times to obtain power sufficient for broadcast. But that amplification is not more than can be obtained by existing valves. Shielded 4-electrode valves, if used two or three in tandem with resistance capacity coupling will transfer to the grid of the control valve of a large oscillating transmitter sufficient power to modulate a powerful carrier wave continuously and proportionately to the light-intensity falling on the cell.

The objection has also been urged that no merely mechanical system of scanning can be sufficiently rapid to present detail in the image adequately. **But it is a false analogy to represent the television image as made up of a number of discrete patches or dots of light similar to the structure of a process block picture.**

Disc Details.

Take the case of a scanning disc with fifty holes in the spiral. Let the disc be rather more than two feet in diameter and revolve at 1,200 r.p.m. Let the holes be 1/32 inch diameter and 1½ inches apart. Then if we use a neon lamp with 1½-inch square glow plate it is easy to see that each hole takes 1/1000 second to pass across the field of view and the whole plate is scanned in 1/20th second—which is quick enough..

But now the image cannot be regarded as simply made up of 2,500 discrete spots of light of different brilliancy. **The true state of affairs is that as each hole moves across the field the brightness of the neon plate behind it varies continuously in accordance with the varying photo-electric cell current. There is no discontinuity as in the case of the process black dots.**

The image is built up by a continuously moving light-spot continuously varying in brightness, which runs over the whole area exactly in step with the scanning light-spot.

What is required for good television is exact synchronism and phase-keeping of the transmitter and receiver discs and entire or practical absence of lag in the photo-electric cell and neon glow tube. But the physical phenomena in these last-named pieces of apparatus is electronic in nature and therefore quite nimble enough for all we require of it.

There is no reason, then, to despair of the possibility of television carried on with mechanical movements.

Moreover, the mechanical motion can be multiplied indefinitely in an optical one by means of Mr. Baird's

MR. A. F. BIRCH,
the young technical assistant of the Baird Laboratories, who is rapidly becoming widely known as a star entertainer during television demonstrations. At Olympia, and again at Selfridges, Mr. Birch spent hours every day sitting before the televisor, singing songs and keeping up a steady, running fire of amusing chatter.

highly ingenious "optical lever," the mechanism of which is clearly explained by Mr. A. Dinsdale in his recently published book on "Television," in Chapter VII.

Hence the conclusion is valid that we can, even by mechanical motions, give detail enough to ordinary objects such as human faces to render recognition easy in television images.

The writer has had the opportunity of testing this point by seeing different persons take the place of the "sitter" in television transmission over short distances on wire circuits and noticing the distinct manner in which one can see differences in arrangement of the hair (smooth or wavy) and of the general facial expression or likeness.

We then come to the second question—viz.: The possibility of improvement in the process.

This power of improvement is very great in some inventions. Compare, for instance, Edison's original old tin-foil covered cylinder phonograph with the modern gramophone. The former could just say a few intelligible words in a gutteral and growling tone; the latter can reproduce with perfect fidelity the finest music by the greatest artists.

Capturing Public Attention.

The same thing is true of camera photography, and even more so of wireless telegraphy.

If there is any scientific basis or real technical advance, improvement is largely a question of expenditure and patient experimenting. If the new idea captures the public attention and interest, then it will be worth while to press forward with improvements.

The great attraction of television from the public point of view is that it presents images of moving and living objects and not merely static pictures.

One can see in any street how readily a moving object or machine in motion attracts attention in a shop window. Advertisers know well that shop signs in motion are much more attractive than anything at rest.

By television one can see operations being performed—say, for instance, a lady's hair being waved and dressed, which would draw far more attention than any static picture. **Motion indicates life, and life is more interesting than the mere lifeless things.**

At the same time it should be clearly understood that we are a long way from being able to broadcast the television of a theatre stage and the actors on it, or a street procession or scene with many persons on it. Up to the present the reproduction of a single face or some object of about the same size is all that has actually been accomplished.

It is not, however, scientific to declare this to be futile because the achievement of greater things is at present out of range. All invention progresses by steps of evolution, and we cannot at one jump attain the ideal perfection.

(*Continued on page* 46, *col.* 1)

Some Figures

By The Technical Editor

THERE has been a great deal of criticism levelled at television, based on false premises, to the effect that the speed of wireless signalling necessary to broadcast it is impossibly high. In the following article the Technical Editor corrects many wrong ideas which are current on the subject.

I PROPOSE this month to be rather more orthodox, by returning to the consideration of some of the purely technical aspects of television. The display of apparatus at the recent show, and still more the demonstrations, created an immense amount of new interest—by which I mean interest among people who had not previously given any thought to the subject—and it also created, not unnaturally, a lot of criticism. As I said last month, criticism is one of the most useful fertilisers for the seedling which has taken root at last, but that presupposes that it is thoughtful criticism.

Demonstration to P.O. Experts.

However, we must expect thoughtless and ignorant criticism until the general public know something more about television, and I am glad to hear whilst writing that the Post Office experts have had a demonstration from Mr. Baird, and at last recognise that television is an accomplished fact. Perhaps the broadcasting of moving images is nearer than we imagine.

However, I proposed to be "technical" this month, and I would like to consider briefly some questions that have been asked recently. It has been pointed out that if a picture is explored or analysed in very small areas, the frequency of the modulation becomes very high and may cause difficulty in wireless transmission. Incidentally, why should it? But that is not the proper answer.

If a picture 1 inch by 1½ inches is analysed into small areas, 30 to the inch, there will be 30×30×1½ or 1,350 such areas, each of which will require a separate signal to be transmitted. If only ten pictures per second are transmitted it is pointed out that this will mean 13,500 signals, or a modulation frequency of half this, say 7 kilocycles. I agree with these figures *if* we are transmitting a picture of a black and white tartan or a chequer pattern having 30 squares per inch, but the ordinary picture is not like this; its light and dark areas are massed together, and the change from light to dark, and *vice versa*, is almost always a gradual one.

If we plot a curve showing the signal strength (i.e., dark, light) of each successive elementary area something like Fig. 1 will result. I have shown 30 areas, or a strip of picture one inch long, and this includes, say, two complete waves of modulation *from the practical aspect*, or a modulation frequency of 2×45×10 for the size of picture mentioned above. 900 as a modulation frequency is of course not excessive, being well within audio frequency. Perhaps I have made the figure somewhat low, but it can be doubled, or doubled again, without being excessive.

Anyone can easily verify this aspect of the question by examining a half-tone reproduction in a newspaper. Take for preference simply a face, or head and shoulders (for that is what is being done at present in television) and look closely at a vertical line of dots in it. I have just tried it on the first photograph I found in this evening's paper. In various vertical lines each two inches long there are the following numbers of waves: 5, 5, 3, 7, 7, 5, 8, and I cannot find one with more than 8. It looks, therefore, as if a modulation frequency of 4 per inch length of picture is all that is wanted, and this is 1 kilocycle instead of the 7 kilocycles originally suggested.

There is still another matter to be considered. The exploration of the picture in most television systems is continuous, and not step by step like the viewing of a kinematograph film. The light sensitive cell is not shut off while one area is being changed to the next area; it would be more accurate to consider that as one area is moved away from the cell another area is gradually brought on, so that if the picture has on it a perfectly hard and sharp line of demarcation between light and dark, there will be—so far as the cell is concerned—a gradual change from light to dark, and the hard line will inevitably be slightly softened in the transmitted image, just as it is in a half-tone block. This is the reason for the high speeds used in exploration, for the higher the speed, and the smaller the area which acts on the cell, the sharper and more detailed is the final picture.

There is still one other fact to be noted. Television pictures have been recorded on and reproduced from gramophone records, and the signals can be heard on a telephone receiver, and the ordinary limits of human audibility are 40 to 4,000 vibrations per second.

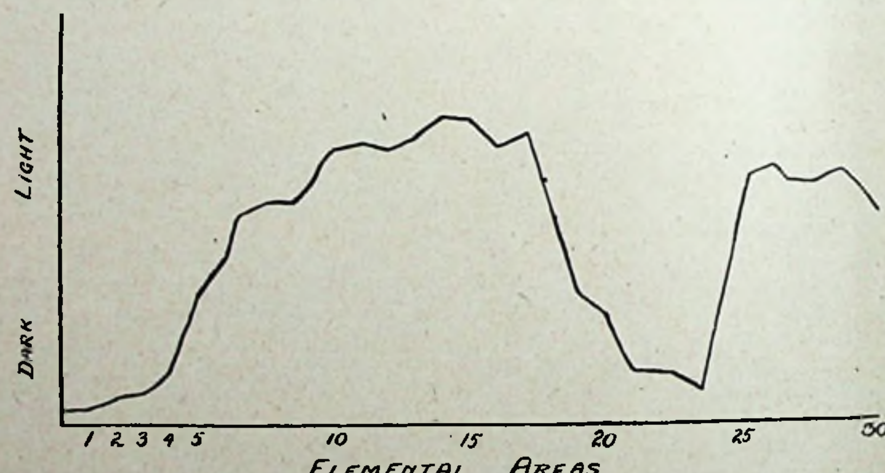


Fig. 1. Curve of signal strength (i.e., dark, light).

PRINCIPLES OF IMAGE SCANNING

By J. ROBINSON, M.B.E., D.Sc., Ph.D., M.I.E.E., F.Inst.P.

For some time past many writers, from a purely theoretical consideration only of television, and without any actual experience of the methods now being used, have set out in print their reasons for believing that television, using present methods, is impossible. One of the principal arguments has consisted of a mathematical analysis of the image to be transmitted, and these critics have proved to their own satisfaction that in order to obtain a reasonably lifelike picture the image must be divided up into hundreds of thousands of dots, necessitating the transmission of millions of electrical impulses per second. In the following article Dr. Robinson, once and for all, explodes this "dot theory" very effectively.

IN these early days of television there is considerable ignorance of the elements of the subject, and in consequence there are criticisms which are not warranted. One feature which is wrongly quoted by critics relates to how a scene is scanned, and by virtue of their method of looking at the subject they draw incorrect conclusions. In order to reproduce the whole of a scene it is essential to divide it into a large number of parts, to obtain a light effect from each part in turn, and to convert each light effect into an electrical effect which can be suitably transmitted to the receiver.

The first point on which to concentrate attention is how the scene is divided into parts, and the usual remark of critics is that it must be divided into a large number of dots. The use of this word "dots" is very loose, and I have never seen any attempt to explain definitely what is implied. I shall assume here that what is meant is that a scene is divided into a large number of squares by two series of parallel lines at right angles to each other, and that one square is what is meant by the word "dot."

The critics then proceed to calculate how many dots are required to define a picture or scene perfectly. It is assumed that the intensity of light over the area of any dot is the same, and thus in order to obtain the utmost detail of a picture, it is essential for the dots to be exceedingly small. A typical case is a picture in one of the newspapers of an area of, say, one square foot. In order to give suitable detail of such a picture it is assumed that there should be 40 lines per inch, and thus there are 480 lines parallel to each edge, giving the huge number of the square of 480, or about 250,000 dots.

In order to obtain great detail it is essential to transmit one signal for each square or dot, thus requiring a quarter of a million signals for one picture, this being a still picture. For television it is essential to record motion, and thus a single scene must be transmitted in a very short interval of about 1/16th of a second, thus meaning that we must transmit 16 times 250,000 signals per second, or 4,000,000 signals per second.

This Huge Figure.

Having reached this huge figure, and remembering what is done at present in telegraph signalling where a high speed is about 100 words per minute, the conclusion is drawn that at the present moment 4,000,000 signals per second makes the whole idea of television impossible. We must, however, examine these calculations in detail and find out what is wrong.

In the first place the idea of dividing a picture into dots is unsound. If we think of transmitting 4,000,000 distinct signals per second, the whole thing is absurd. It would be impossible to allow a spot of light to fall on one dot, then to extinguish the light or shade it until the next dot is in position for exposure, at the rate of 4,000,000 per second. Such a motion would be similar to the gate motion of the cinematograph, which operates at the rate of 16 per second, or in the case of the high-speed camera at a somewhat higher rate.

For such large signalling speeds as those in television we must have continuous motion, and a spot of light must fall on one dot or square after another in turn without extinguishing the light or shading it at all. But this means that our spot of light will be on one square at one instant, and then partly on one square and partly on the next, and later on the second square completely, and thus we must give up the idea of dots or squares altogether and have parallel strips instead.

This completely alters our conceptions of numbers, and instead of having to contemplate the transmission of 4,000,000 dots, we have instead a number of strips equal to 4,000,000 divided by 480—*i.e.*, about 8,000 strips per second. Our spot of light must now move along a strip of a picture in 1/8,000th part of a second and, in doing so, it will cause a varying light effect along each strip, depending on the density of the picture or the light and shade along each strip.

This different conception of the problem brings television more into the field of practicability, but we must go still farther in our examination of the conditions postulated by the critics.

Is it necessary to proceed to the detail of a picture as already given here—*i.e.*, a picture of one square foot divided into parts of 1/40th of an inch? This is a very rigorous condition, and probably completely outside of commercial requirements. The analogy that we must have is,

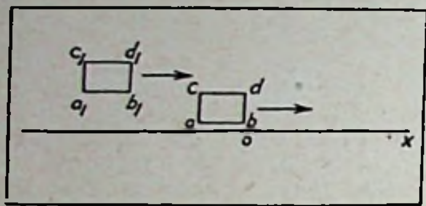


Fig. 1.
A rectangular slit.

in my opinion, the detail given by an ordinary cinematograph. The detail demanded above is, I think, far greater than that of the cinematograph. It would correspond to the division of a cinematograph negative, which is of the order of one square inch, into parts of 1/500th of an inch, and in order to give the same results as the cinema a much coarser grain would suffice, say into 1/100th or even 1/50th of an inch. Thus, even on the original dot method, we should get very satisfactory television if we divided the picture or scene into fewer parts, say 10,000 instead of 250,000, thus requiring on the original calculation about 160,000 signals per second when considering dots, or 1,600 strips per second.

Small *v.* Large Scenes.

So far we have discussed the conditions for television of large scenes which would allow the whole of a theatrical performance, or a boxing match, to be transmitted and reproduced. Such, however, has not yet been achieved practically for the reason that the problem is difficult, without a doubt, but it is not incapable of solution.

To transmit even fewer signals per second than those for the complete cinematograph screen, and to arrange the received signals correctly to form a good reproduction is not easy, but television is of the nature that we can deal with smaller dimensions, and thus transmit a smaller portion of the complete scene. We are fortunate in this respect that we can solve the problem almost completely for small scenes, after which the extension to larger scenes should follow without very great difficulties.

In this respect television differs in its development from such things as the gramophone. In the initial stages of the gramophone it was never possible to obtain clear speech or music at all, and there was always considerable distortion. Thus the commercial application of gramophones had necessarily to wait until the distortion had been sufficiently removed to allow speech and music to be recognised with fair clearness.

In television, however, it is possible to give very good reproduction of small scenes, and the type of development required is to increase the size of the scene that can be dealt with. At present the type of scene that gives satisfactory television is of the order of magnitude of the head and shoulders of an individual, and this is being achieved with from 15 to 30 strips, each being scanned 16 times per second. Thus, for practical purposes, at present it is necessary

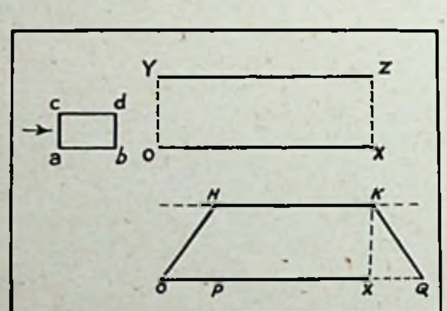


Fig. 2.
Showing how distortion can arise.

to scan from 240 to 480 strips per second, and this is now being satisfactorily performed by the Baird apparatus.

Examining the criticisms of television still further, the statement is made that there is really no difference between the dot and the strip method for considering television. Critics state that in the strip method each strip is continuously viewed or illuminated through a slit, and that ultimately the dimensions of the slit really determine the number of dots into which the picture is to be divided.

"Abolish the Idea of Dots."

There is something to be said for this point of view, but there are so many consequences of the practical method of operation that it is necessary once and for all to abolish the idea of dots in order that we may understand clearly what is happening. The first aspect of the subject is the definition of the picture that is possible, and how this is practically obtained. On the dot idea, if we could have the clear-cut illumination of each separate dot without the intermediate stages, where the illumination passes gradually and continuously from one dot to the other, thus sometimes including parts of two dots at once, then the determination of the definition of the picture would be very easy, and we could have a scene reproduced as accurately as we wish by making the dots as small as we wish.

Strips Continuously Scanned.

Owing, however, to the fact that we must employ strips and scan along each strip continuously, the definition of a picture or scene is not so easily determined, and it depends on the dimensions and shape of the scanning slit. If we make this scanning slit very small indeed, we should obtain the best possible definition, and in doing so, it is equivalent to increasing the number of dots of a picture, but without increasing the mechanical difficulties of scanning.

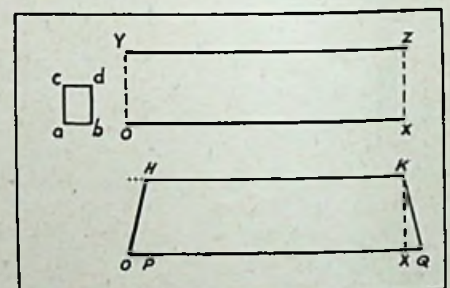


Fig. 3.
A narrower slit causes less distortion.

However, in practice, there is a limit to the smallness of the scanning slit, which is that it must be large enough to allow sufficient light to pass to influence the photo-electric cells. We could of course increase the intensity of the source of light used for illumination and thus cut down the size of the slit, but practical experience determines the magnitude of both of these factors.

As the slit must have definite dimensions, it is necessary to examine what influence these have on the possible definitions of the picture which is reproduced. This is a very interesting subject, and one which is certain to be discussed very fully in the future as television progresses, and it will be profitable to consider some simple cases in detail. Further, this problem has some influence on another aspect of television, which is referred to below.

It is fairly well known to readers of this journal how a scene is scanned completely. There is a series of holes or slits on a disc which is rotating, the holes being staggered

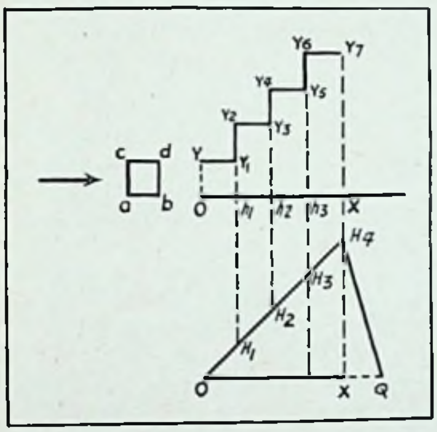


Fig. 4.
Analysis of causes of distortion.

so that the successive holes scan neighbouring strips of the scene. We must, for the moment, concentrate on a single hole or slit which scans a particular strip of the scene. In practice it is convenient to make these holes circular, but for our present purpose, that of the influence of the shape and dimensions of the hole on the quality of the reproduced scene, a circular hole does not lend itself readily to easy discussion. It will be much easier to consider this problem with rectangular holes.

Complications Introduced.

In Fig. 1 a rectangular slit *abcd* is shown, this slit being arranged to traverse the scene in the direction OX. The width of the strip thus scanned is *ac*, and if OX is the width of the scene, there would be another slit similar to *abcd* at *a'b'c'd'*. However, we shall for the moment consider only one slit, *abcd*. As it travels to the right the edge *bd* comes into view first, and the whole of the slit is not in view until the edge *ac* has reached the point O. Thus, in this initial stage near the point O, complications are introduced owing to the width of the slit *ab*. There are similar complications at the end X of the strip.

To examine how this influences a special case, let us assume that the strip of the original scene is of uniform density, as shown at YZ in Fig. 2. As the slit moves towards the right we shall not get the full effect of it until the edge *ac* has reached the point O, when the edge *bd* is at P.

During the interval for the slit to move so far we shall have the effect of the slit increasing uniformly, as shown at OH. From the point P, until the edge *bd* reaches X, the intensity will remain constant, as shown at HK, but after this the slit will still have some effect until the edge *ac* reaches X, and we obtain a light effect KQ. Thus, with a slit *abcd*, we find that the original scene as at YZ becomes distorted in the reproduction, as shown at $OKHQ$, there being two features to observe, first that the slit, as reproduced, is longer by the width of the slit, and secondly that there are two end effects which are quite different from the original picture.

Effect of Narrower Slit.

In Fig. 3 similar effects are given for a narrower slit, when it is seen that the distortion, both as regards the lengthening of the reproduction, and of the end effects, is much less pronounced. Obviously, from these two figures, to eliminate distortion completely the slit should be very narrow indeed, which is an impossible condition owing to the necessity for obtaining sufficient illumination.

Consider a more advanced case, such as that shown in Fig. 4, where the light of the original strip varies in steps from O to X, being constant for Oh_1, then rising suddenly to double its value for an equal length, h_1h_2, then rising suddenly to three times the value for another equal length, h_2h_3, etc. In a case of this kind of distribution of light and shade, the dimensions of the scanning slit are exceedingly important. For the best reproduction we must have all changes of light intensity faithfully recorded, but as will be seen, there is one particular width of slit which will not record these abrupt changes.

Best Width of Slit.

This width of slit is that which is equal to the distance Oh_1, h_1h_2, etc. As the slit *abcd* moves to the right, so that the edge *bd* travels from O to h_1, we have a similar condition to the initial condition of Fig. 1 and we obtain our record OH_1. When the edge *bd* reaches h_1 we obtain the full effect of the light in the region YY_1, but as the slit moves further to the right the original intensity is doubled to Y_2Y_3, so that we have the initial conditions of Fig. 1 produced again. Thus, in the second period, h_1h_2, our reproduction is given by H_1H_2, similarly for the third and fourth periods, so that until the edge *bd* reaches the point X there is a constant increase in the intensity of the reproduction. After the edge *bd* passes X we have the end condition similar to Fig. 1, so that our complete record is two straight lines, OH_4 and H_4O. All abrupt changes in the original strip Y_2Y_1 Y_2Y_3 . . . have thus been deleted, except that at the end.

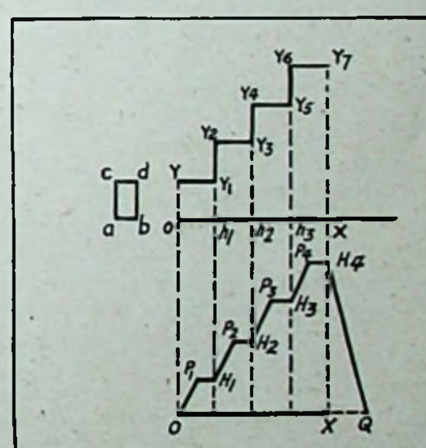


Fig. 5.
The type of record obtained from a narrower slit.

In order to retain some trace of these abrupt changes, and we must do so for faithful reproduction, it is thus necessary to use a narrower slit. Fig. 5 shows the type of record obtained with such a narrower slit, though even now the slit is fairly wide. The record obtained consists

(*Continued on page* 26.)

The Television Society

MEMBERS are requested to note that the opening meeting for this session will take place at the Engineers' Club, Coventry Street, W.C.2, at 8 p.m. prompt, on Tuesday, November 6th, 1928.

The lecturer for the occasion will be Major Church, who chooses for the title of his subject "Science and Progress." Members and their friends are invited.

During the vacation a notable though informal meeting of the executive committee was held at Glasgow. Gentlemen interested in the formation of the Glasgow group met in the University Buildings at the invitation of the committee, and Dr. Tierney outlined the objects of the society, and it was decided to proceed with the formation of this important northern centre. All interested at Glasgow should communicate with the secretary, so that he may put them into communication with the proposed local secretary.

A fortunate outcome of this meeting was the acceptance of the offer of W. G. Mitchell, B.Sc., F.R.Met.I., to lecture to the senior scholars of the local schools, with the very successful result reported in the last issue of the journal.

Over two hundred and fifty attended, including leading gentlemen of Glasgow, H.M. Inspector of Schools, and Professor Gray, who took the chair, so that this meeting should prove to be a first-class opening for the Glasgow centre.

At another meeting of the executive committee in London it was decided to form a strong London committee, with chairman and local secretary, to ensure smooth running of this important centre of the society's work.

Active London members should communicate with the secretary so that their views may be placed before the executive committee.

A further matter of interest to members is being considered by the committee, and that is the best arrangements that can be made for the possession of televisors by group centres, either by purchase or loan. The committee are in communication with the Baird companies with a view to some possible working arrangement.

The next meeting of the council will be concerned with the final arrangements regarding badges and certificates, also the working of group centres.

It is hoped that W. G. Mitchell, Esq., B.Sc., F.R.Met.Soc., a member of council, will undertake duty as joint secretary, and so utilise the enthusiasm he displays in helping to maintain the various programmes of the society's work.

During a visit to Holland the secretary met many active members of radio societies who expressed a wish to form group centres at Rotterdam and The Hague. Mr. W. H. de Gorker, 120B, Essenburghstraat, Rotterdam, will act as correspondent to all inquirers of this district pending the formation of the Holland centre.

New Address.

Will all members kindly address their communications in future to

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

Announcement.

Meetings arranged at the Engineers' Club, Coventry Street, W.C. 2, at 8 p.m. prompt.

Nov. 6th, Lecture: Science and Progress. By Major A. G. Church, D.S.O., M.C., B.Sc.

Dec. 4th, Lecture. By Professor Cheshire, C.B.E., A.R.C.S., F.I.P.

The title of the lecture, which concerns wave motion, will be announced in the next issue.

J. Denton, *Hon. Sec.*

* * *

Conditions of Sale of Televisors.

Enclosed in the Baird Company's catalogue, which was obtainable at the Company's stand at Olympia, was an order form on the back of which were printed the following conditions of sale:—

"1. The present facilities of the Company for the broadcasting of music, singing or speech in conjunction with television are limited to the hours between 12 midnight and 12 noon, but the Company have recently given demonstrations to representatives of the Postmaster-General and confidently anticipate that extended facilities will be granted for the broadcasting of music, singing and speech in conjunction with television during ordinary broadcasting hours, and this order is accepted subject to extended facilities being granted by the Postmaster-General. The Company will notify the Purchaser as to the extent of the broadcasting facilities allotted, and the Purchaser shall have the right within seven days of such notification to cancel this order by notice in writing to the Company.

"2. Negotiations are in progress for the licensing of a number of manufacturers to manufacture and sell the apparatus described in the Company's catalogue. The Company, therefore, reserves the right to pass on this order for execution to one or more manufacturers who may be so licensed by the Company.

"3. The Company will use all reasonable endeavours to effect early execution of this order, but will not be responsible for any delay in the execution of the same.

"4. *Pro forma* invoice, including cost of packing, will be forwarded to the Purchaser, and upon payment of the amount payable the goods will be despatched to the Purchaser at his risk, carriage forward."

MAGIC

"The stuff that dreams are made of" realised,
Envisaged now before our wondering eyes;
Life-like and eager every well-known face,
Each feature, each expression we can trace.
Voices upraised thousands of miles away
In listeners' ears are echoing to-day;
Space is annihilated, and the sea
Is over-ruled by wireless majesty:
Old fairy tales re-live their glowing past
Now television's made them true at last!

Leslie M. Oyler.

THE ENTERTAINMENT VALUE OF TELEVISION *TO-DAY!*

Being an eye-witness's account of the public demonstrations—and the lessons they taught

By R. F. TILTMAN, A.M.I.R.E., A.Rad.A.

THE first public demonstrations of the Baird television system, which were held in premises adjacent to Olympia, London, during the time the National Radio Exhibition was open, naturally aroused immense interest.

Three commercial receiving televisors of the "super" type were installed in premises in Maclise Road, London, W., each being in a cubicle of blue curtains. Six people at a time were admitted to each cubicle, and after inspection of the receiving apparatus the light was dimmed and a short demonstration of combined sight and sound was given.

No more than eighteen persons could watch the reception at one time, and during the first day or so each little audience witnessed a fifteen minutes' programme, but afterwards, owing to the exceptionally heavy demands for tickets, the arrangements were speeded up and a demonstration was given practically every five minutes of the afternoon and evening. In this way about two thousand engineers, radio traders, and members of the public witnessed the demonstrations—although that does not represent one-twentieth part of the number that applied for admission tickets.

Eye and Ear in Step.

On the reception screens one saw the living head-and-shoulder image of the person being "televised," and the voice was heard from the moving-coil type loud speakers alongside.

The images were brightly lighted, appeared to be somewhere about 8 in. by 4 in. in size, and the synchronism of voice and movement was perfect. One saw the whites of the eyes and the eyelashes, the teeth could be counted, and every play of expression was clearly seen. The collar and tie of the men subjects could be seen, and in the case of several of the artistes dimples were noticeable.

I was reporting these demonstrations for a certain paper, and was therefore present every day.

Although a number of professional entertainers appeared on the screens at different times, a good deal of the demonstrations consisted of impromptu "divertissements" by members of the Baird laboratory staff.

In this respect the "palm" for the week must surely be awarded to Mr. A. F. Birch, a young technical assistant who spent hours before the transmitter. His features came through exceedingly well; he has developed an excellent "broadcast" manner, and he held the attention of the audience with choruses of popular songs and an easy flow of amusing chatter accompanied by facial gestures.

Television "Uncle."

It seems very evident that as the broadcast television service in this country develops we shall see and hear a lot more of this Mr. Birch, and when a children's hour is included in the programmes he should easily prove the most popular "Uncle."

A number of leading lights of the theatrical world attended these demonstrations and gave short "turns" before the transmitter, which for convenience was located in another shop a short distance down the road.

On the opening day, Saturday, the first of these was Miss Peggy O'Neil, the charming and popular actress who is so well known to all theatregoers. She was starring in "The Flying Squad" at the Lyceum Theatre, London, at the time.

Miss O'Neil watched one of the reception screens for about ten minutes while Mr. Birch was going

WE reproduce below a facsimile reproduction of an account of the first transmission by television of an advertisement. The little experiment described here provides food for thought, and clearly indicates that we have in television an entirely new advertising medium. Out of this experiment, what will develop?

"DAILY MAIL" TELEVISED.

CONTENTS BILL SEEN THROUGH BRICK WALLS.

A *Daily Mail* contents bill was seen at a distance through several brick walls yesterday at the public demonstrations of the British television system which are being given during Radio Exhibition week at Olympia, Kensington, W.

Mr. R. F. Tiltman, a television expert, suggested that an attempt should be made to send moving lettering by television. He obtained a *Daily Mail* contents bill from a newsagent and had it sent to the transmitting studio a short distance down the road.

A few moments later the person being televised announced through the loud speakers, "We will now show you the contents bill of a London daily newspaper."

The image of the sitter faded from the reception screen, and gradually from the blur of orange light emerged in bold type the word "Daily" This moved across to the left and gave place to "Mail" The rustling of the bill could be heard from the loud speakers as the audience read from the slowly moving letters "24 Pages Again: County Prize Beauties Pictures."

The wording could be clearly read, and this hastily arranged test may be said to constitute the first advertisement to be sent by television in the world.

The three receivers were of the standard commercial type. A grill on the left concealed the loud speaker, and on the right was mounted a circular viewing screen about 12 inches across, on the lighted portion of which the *Daily Mail* lettering appeared.

through his amateur performance. She then agreed to be "televised" and was escorted by Mr. Baird to the transmitting studio. Immediately Miss O'Neil was seated before the transmitter her living image (instantly recognisable without the faintest trace of doubt) appeared on the screens and her voice was heard from the loud speakers.

A charming photograph of Miss Peggy O'Neil, one of the first professional actresses to appear before the televisor.

For about half an hour Miss O'Neil gave us a most charming entertainment, chatting and smiling at us, telling Irish stories, and, in response to telephoned requests, she sang "I'm a little bit fonder of you" and several other delightful songs. Finally, although it was not at all apparent, Miss O'Neil apologised for what she termed her "modest effort" on the grounds of having a severe cold.

The Television Face.

It was most fascinating to hear the familiar Irish-American brogue from the loud speaker and see on the screen the well-known features with captivating flashes of the eyes and dimpling of the face. Incidentally, among those who had the good fortune to witness this performance was Mr. Sydney A. Moseley, the well-known writer whose name is familiar to readers of this magazine.

I chatted for some time with Miss O'Neil afterwards, and she agreed that there was nothing to make anyone nervous in being seated before the electric "eye" of the transmitter. As one who had witnessed numerous television demonstrations previously I was able to assure Miss O'Neil with perfect truth that I had never seen a subject "come through" on the screen better.

On the Monday evening Mr. Harry Tate, of music-hall fame, attended the demonstrations with Mrs. Tate and their son. After inspecting the receivers and witnessing the reception for some time Mr. Tate senior and junior went round to the transmitter, while Mrs. Tate and I stayed before one of the screens.

Tate—Senior and Junior.

Very soon Mr. Tate's features appeared on the screen and the voices of him and his son could be heard in a short excerpt from one of the well-known music-hall sketches. It was found that the famous Tate moustache did not come through at all well on the television screen and it had to be removed.

Afterwards Mr. Tate junior sat before the transmitter for a quarter of an hour and kept an audience highly amused with a collection of funny stories and impersonations of Harry Champion. He came through on the screen very much better than his father, although that, of course, could have been put right in a normal television programme by the use of correct make-up.

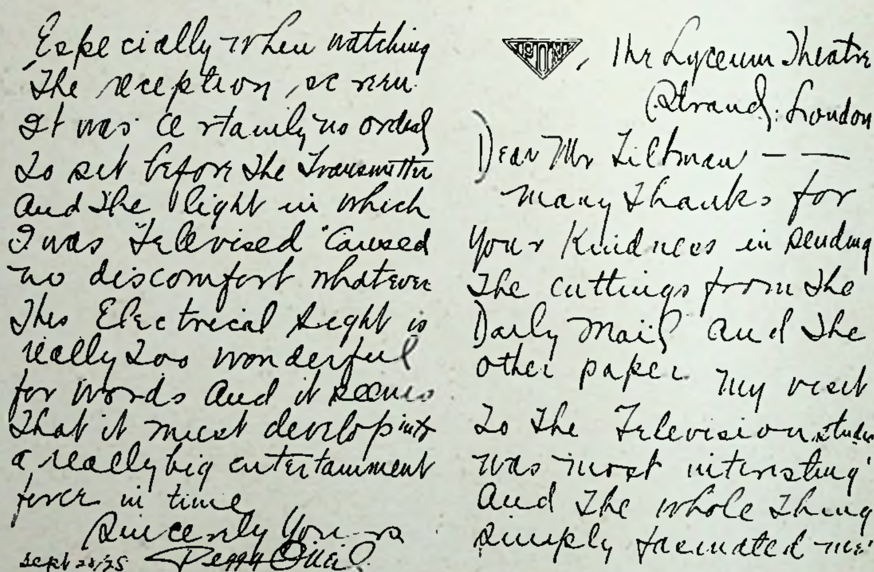
During Monday afternoon I noticed that one of the most interested visitors to the demonstrations was Dr. J. A. Fleming, F.R.S., who spent over two hours inspecting the transmitter and receivers.

Miss Lilian Davies, the well-known actress, was the next stage celebrity to undergo a television test. She came and viewed the reception screen one afternoon and then went and sat before the transmitter and chatted to the audience. Miss Davies was another whose voice and features came through exceptionally well.

There was a good variety in the programmes on the Wednesday afternoon and evening. Harry Tate paid a second visit with his son, and with Mr. Marriot Edgar, the entertainer, kept things going with a swing, and one or two other professionals appeared on the screen. One of the real tit-bits, however, was when our friend Mr. Moseley was asked to go to the transmitter again. He went obediently to the studio and let us see his jovial countenance, and then as the pianist was picking out a few bars of various well-known airs Mr. Moseley gave us his *very* bass rendering of the tunes—he did not know the words, but that was a mere detail and nobody minded.

Miss Cicely Dandy, a singer with most expressive features, appeared many times in the programmes. I saw most of the artistes when seated before the transmitter, and none appeared to experience the slightest discomfort from the necessary lighting.

And now to come to the real purpose of this article. Is there any entertainment value in television as it is *to-day?* In view of the fact that at the time of writing it is expected that some form of broadcast



The Lyceum Theatre (Strand) London

Dear Mr Tiltman — Many thanks for your kindness in sending the cuttings from the Daily Mail and the other paper. My visit to the Television studio was most interesting and the whole thing simply fascinated me. Especially when watching the reception screen. It was certainly no ordeal to sit before the transmitter and the light in which I was televised caused no discomfort whatever. This Electrical Light is really too wonderful for words and it seems that it must develop into a really big entertainment force in time.

Sincerely Yours

Sept 24/28 Peggy O'Neil

We print above a facsimile reproduction of a letter which Miss Peggy O'Neil wrote to our contributor, in which she records her impressions of television, and what it felt like to be televised.

television service will be started in this country in the immediate future, this question is one of prime importance.

Great Entertainment Value.

The majority of people who witnessed the public demonstrations of the Baird system for any length of time will be in no doubt on this point. Having personally been present for hours on end every day of the demonstration week I am not for one instant in doubt.

There is a real, definite entertainment value in television as it is to-day—allied with telephony, of course.

The dear old so-called "authorities" who have used up so much ink during past months in letters to the Press damning television will not like that statement at all. They have settled themselves so firmly in their arm-chairs and "proved" (to their *own* satisfaction) that television doesn't exist, it cannot be done, it needs a radical discovery before being a practical proposition, that—but why repeat all the old parrot-cries?

The fact remains, however, that while these ill-informed critics have *for months belittled a British television system which they had never seen demonstrated*, that system has been developed up to a point where it is well fitted to be introduced to the large body of interested amateurs.

Wonders of Electrical Sight.

I am not by any means alone in suggesting that television is entertaining, for I heard so many opinions expressed by members of the public as they left after witnessing the demonstrations, and they not only referred to the wonders of this electrical sight, but they had quite evidently *enjoyed* the brief sight-and-sound programme. I also had the opinions of other Press representatives present.

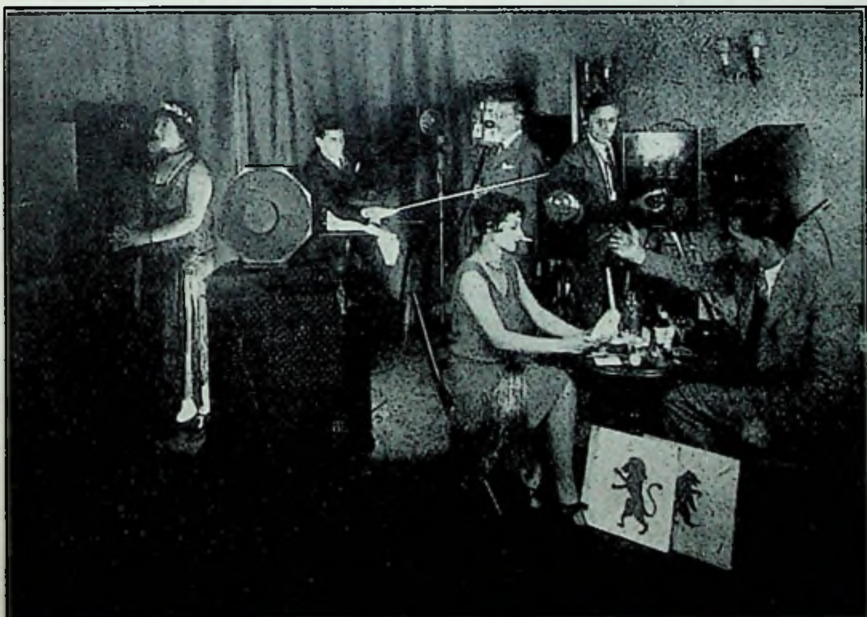
A few weeks back *Amateur Wireless*, one of our leading radio journals, gave a very fair report on two television tests specially arranged for them by Mr. Baird, and in the course of this they mention that the transmission "was in every sense enjoyable." One of these tests, by the way, was a wireless test with signals broadcast from the Baird London station in Long Acre.

Writing in the *Daily Express* some time back Mr. Moseley, after viewing a demonstration, referred to the experience of looking-in as "fascinating." He went on to refer to the test as the most stirring sight he had ever experienced, and mentioned the interest and awe aroused by this vision of distant objects.

There is not the slightest doubt that television *now*, in its early stage that is so pregnant with possibilities, has a real, enjoyable, entertaining, awe-inspiring interest.

[*Photo by courtesy of G.E.C.* (U.S.A.)

Izotta Jewel, former star of the American stage, and now the wife of Professor Hugh Miller of Union College, U.S.A., became first leading woman of a play presented by television. The radio audience, who had suitable receivers, saw and heard Miss Jewel in the presentation of "The Queen's Messenger," by J. Hartley Manners, which was broadcast by WGY of Schenectady recently. Miss Jewel is shown standing before the "camera," which consists of two smaller cases containing the photo-electric tubes and the larger and highest case containing the scanning disc and the light source. A microphone picked up the lines of the drama.



[*Photo by courtesy of G.E.C.* (U.S.A.)

A PLAY BROADCAST BY TELEVISION IN AMERICA.

In the centre is the director, who controls each of the three television "cameras." By a twist of a knob he brings any of the three "cameras" into the circuit. At the left is Izotta Jewel before one "camera" (camera in this case refers to the unit containing the scanning disc and light source, and the two eyes or boxes containing the photo-electric tubes) and before the camera on the right is Maurice Randall. The two people in the right foreground manage the "props," which are placed in the view of the third "camera." In the left foreground, facing the director, is a television receiver, in which the director is able to check the image as it is broadcast.

Among the anti-television "die-hards" who will violently disagree with me must be included the editor of a certain wireless paper and some of his staff. That paper has for months been most virile in its campaign against British television, although it was ready to throw bouquets abroad at the slightest vague suggestion of any early research work by foreigners.

Uninformed Criticism.

But—note this carefully—I was given definitely to understand that up to the time of the public demonstrations in September *none of the editorial staff of this paper had witnessed a single demonstration of the system they were so gallantly crabbing*, and I certainly saw no sign of their presence during the demonstration week!

This state of affairs has become positively ludicrous to persons in touch with the real facts, but at the same time it is possible that there are some people who take such violent anti-television *propaganda seriously—for at times it is dished up in a manner worthy of a far better cause.*

Now to get back to a fact—television is an enjoyable entertainment in its present early stage. Bah! (or words to that effect) snorts the television critic, rapidly sorting over his parrot-cries. Very well then; let us analyse the matter a little closer.

Take, for example, one item on the long list of entertainments enjoyed at the Baird television demonstrations. As I said previously, Miss Peggy O'Neil went before the transmitter; this was the first time for her, and she was without any special make-up and had no schooling as to how to conduct herself in such ultra-modern circumstances.

Perfect Synchronism.

At the receiving end I watched the screen and heard the voice in perfect synchronism for half an hour, and it was just real delightful entertainment, far more fascinating than could be any appeal to one sense only.

"That is no test at all," will insist the typical wilfully obstinate critic. "It was merely the novelty that had a fleeting appeal."

That theory of novelty only will not hold water in this particular case. Viewing the television screen has got well past any fleeting "novelty" stage for me, for I have witnessed dozens of demonstrations in the past two years, and in the one week of public demonstrations I was watching the reception screen for hours on end each day—actually I have probably witnessed more television reception than anyone else in this country, excepting the regular staff of the Baird laboratories.

For point number two. It was no "novelty" for me to be entertained by Miss Peggy O'Neil, for I saw this star several times in her famous lead in "Paddy the Next Best Thing," and have seen her from time to time in her various London successes. It happens that I saw her in her latest rôle at the Lyceum Theatre only a very short time before witnessing her television performance.

Seeing for Themselves.

Lastly, it was no "novelty" to hear Miss O'Neil's voice via the loud speaker, for I have listened previously to her broadcasts from B.B.C. stations.

Altogether, this theory of a purely "novelty" appeal does not seem to fit in at all, and so we are left with the unquestionable fact that the appeal was on purely entertainment grounds.

It was just the same in the case of Mr. Birch, the young member of Baird's staff whom I have watched for hours in all without any lessening of interest. I attended this week of public demonstrations from business reasons, but I found it mighty entertaining business throughout the time!

Now that television is so definitely here, and has been demonstrated fully and accepted by so many as a real entertainment force, let us leave the few remaining canting, carping, crabbing critics to waste their parrot-cries on thin air—for television has come out into the light of day; it has nothing to be ashamed of, and the public are seeing for themselves and are learning the true facts.

What should this television system be ashamed of when a reputable and impartial paper like *Amateur Wireless*, after a thorough investigation, used phrases like: "We must emphasise that the image is instinct with life . . . we must state with pleasure that it is miles ahead of the televised picture of three or four years ago. . . . Now we have the actual face . . . every movement is observed clearly . . . the image was a better one than we expected to find. . . ."

Our illustration shows the Stand of "Television" at the recent Radio Exhibition at Olympia.

Light: The Essential of Television

Part III.

By CYRIL SYLVESTER, A.M.I.E.E., A.M.I. Mech. E.

Light is one of the most important factors in connection with television, and one which must be carefully studied by all serious students of television. The principles and nature of light are by no means so widely known and understood as one would anticipate, and in this series of articles our contributor is elaborating them month by month.

IN television all that we are concerned about are the light rays which go to make up the normal spectrum, termed the visible spectrum. These, combined, form white light. We are also concerned with the deviation from the normal spectrum through the use of artificial light. In comparison with normal daylight the intensity of artificial light is very small. When taking a photograph we do not measure the intensity of daylight, beyond giving a plate more or less exposure according to the quantity, or intensity, of the light prevailing at the moment the plate is exposed. Since all objects which are seen on the televisor screen are manifest from the light which is reflected from them, it will be seen that the projection of a picture will depend, not only upon the quality of the light but upon its intensity.

Light Variation.

The intensity of normal daylight varies between 2,000 foot-candles and 20 foot-candles; it depends upon the location and conditions which prevail when the tests are made. If we are in the country, in the middle of a meadow surrounded with tall trees which are more or less dark green, thus cutting off a certain amount of the skyline, the intensity of the light as measured from the sun will be merely the intensity of the *direct* light. If, with the same intensity of direct light, we take our measurements (foot-candles) in a stone quarry from which white stone or marble is obtained, the intensity of light will be higher. The reason is that we have the intensity of reflected light in addition to that of direct light.

The same may be said of artificial light. A light source, an ordinary electric lamp, gives off light rays in all directions. If a light source is located in a room, the interior of which is painted dead black, the intensity of light which can be measured is that of direct light. The reason is that black absorbs all light rays and reflects none. If a sheet of white or coloured paper were placed over the light source, as illustrated in Fig. 1, some of the upward light rays would be collected and reflected in a downward direction. In this way the intensity of the

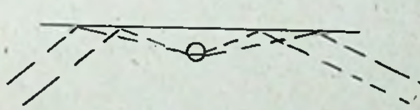


Fig. 1.

light, if measured on the floor of the room, would be increased.

The reflection factors of coloured materials vary considerably. To mention a few—

Colour of material.		Reflection factor.
White paper	..	80 per cent.
Grey paper	..	66 ,,
Ivory white	..	79 ,,
Caen stone	..	69 ,,
Ivory ..	..	70 ,,
Primrose ..	..	65 ,,
Lichen ..	..	64 ,,
Pearl grey	..	66 ,,
Buff ..	..	63 ,,
Satin green	..	63 ,,
Sky blue ..	..	34 ,,
Shell pink	..	51 ,,
Pink ..	..	46 ,,
Forest green	..	19 ,,
Cardinal red	..	19 ,,

These reflection factors are for normal daylight. The effect of coloured light upon coloured material has already been explained, from which it will be seen that, with artificial light, the proportion of reflected light, when it is projected upon coloured material, will depend upon the colour of the incident light. This, as I have pointed out in a previous article, varies considerably.

Some Basic Facts.

I have referred to the intensity of light; this must not be confused with the velocity of light, light of all wave-lengths. The term "light" may be used in two different ways: (*a*) To designate the visual sensation produced normally on the eye by radiant flux. (*b*) To denote the luminous flux which produces the sensation of sight. This brings us to the units used in the measurement of light, without a knowledge of which a clear conception of television is impossible. There are four funda-

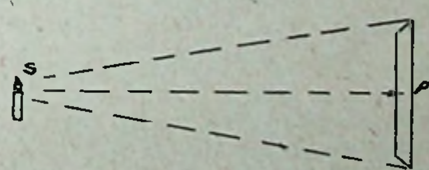


Fig. 2.

mental subjects, or concepts, associated with light; the luminous flux, luminous intensity, illumination, and brightness. Luminous intensity is sometimes termed candle-power.

Luminous flux may be stated as the *rate* of flow of radiant energy evaluated with reference to visual sensation. The following analogy may make this more clear. Let us assume that we connect a hollow ball, studded with small holes, to a water tap; the pressure is regulated by the cock. The water would stream out in all directions through the holes, and the force of the water would depend upon adjustment of the cock. In the same way, electrical energy is transformed in a lamp filament into radiant energy which streams out in all directions; that which is visible to the eye is the luminous flux. It is analogous to power, the rate of doing work. It is sometimes referred to as being emitted, transmitted, or intercepted.

Light Intensity.

Luminous intensity, or candle-power, is the term used to indicate the solid angular density of the flux in a given direction. Let us assume, for instance, that we have a light source *S*, of one candle (Fig. 2) situated at a distance of one foot from a sheet of Paper, *P*. The intensity of light would be one foot-candle. If the *strength* of the light rays were the same in all directions the intensity of light at any point round the candle, at a distance of one foot, would be one foot-candle.

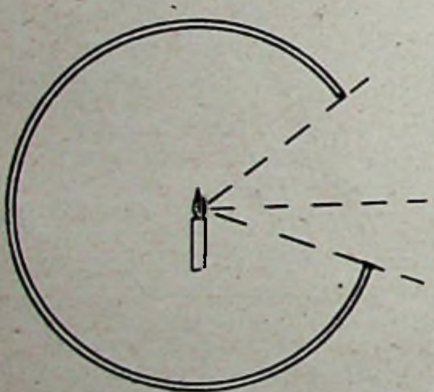


Fig. 3.

If we were to enclose the light source in a sphere, with a portion of the wall cut away as illustrated in Fig. 3, providing that the reflection factor of the interior of the sphere is zero the intensity of light at one foot distant would still be one foot-candle. This brings us to the term lumen, which is the unit of luminous flux and is equal to the flux emitted in a unit solid angle whose average candle-power throughout the unit solid angle is one candle.

Referring again to Fig. 2, the intensity of illumination falling upon the sheet *P* is not even. The reason is that the distances from the light source to the sheet are different. Let us assume that the sheet is one foot square, that it is perfectly vertical, and that, from an alignment point of view, the candle is situated in a horizontal plane with the centre of *P*. The centre of *P* would be the nearest point to the light source. The corners of *P* would be the farthest away. It can be seen how difficult it would be to measure the quantity of illumination of a light source by any means in which angles or sides were involved. Since, however, the intensity of illumination from a light source must be readily calculated, it may be said that the method adopted is to imagine a light source in the centre of a sphere which has a diameter of two feet. The distance from the source to any point of the sphere is one foot, and, assuming an even distribution of light from the source, the intensity of illumination

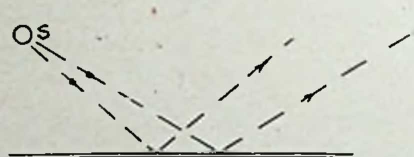


Fig. 4.

at any point on the inside of the sphere will be the same.

Ray Absorption.

We now have to consider the inside of the sphere and how the unit, the lumen, is derived. The area of the sphere is $4\pi = 12{\cdot}57$ square feet. If we take one square foot of the interior, a difficult quantity to measure, although simple for our purpose, we can say that the illumination falling upon an area of one square foot in the sphere is one lumen. Similarly, the quantity of illumination which can be obtained from a uniform light source of one candle is $12{\cdot}57$ lumens. It may be well to emphasise the importance of candle-power and its relation to luminous flux. The total flux in lumens of a standard lamp (a lamp against which the intensities of other light sources are measured) is determined by obtaining the mean spherical candle-power, either directly or through measuring the mean horizontal, and multiplying this by 4π. Candle-power, then, is always associated with a source, whether self-luminous or otherwise, and gives information regarding the luminous flux at its origin.

When an opaque (black) body intercepts the rays of light from a source the rays are absorbed. With all other materials, however, no matter how low the reflection factor may be, only a proportion of the rays are absorbed; the remainder are reflected. There are many interesting factors about reflected light which should be understood.

Reflected Light.

I have already referred to the light rays from a luminous point being

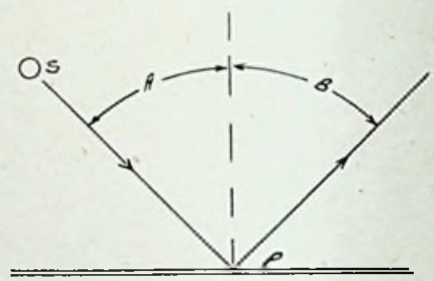


Fig. 5.

divergent. That is, they emanate from a light source at different angles. If, therefore, direct light rays strike an object they will be reflected from that object at different angles. This is illustrated in Fig. 4. Here *S* is a light source from which the two rays shown strike a horizontal reflecting surface. The direction of the rays is indicated by the arrows. This proves that, since only a small pencil of light enters the eye, the intensity of light from an object cannot be accurately gauged by the eye.

There is a definite relation between the light incident upon an object and the reflected light. This can be best shown by an illustration. In Fig. 5 *S* is a light source and *P* is a reflecting surface. The arrow shows the direction of a light ray from *S* to *P*, and from *P* into space. The angle *A* is equal to the angle *B*; angle *A* is known as the angle of incidence, and angle *B* is termed the angle of reflection. This law of incidence and reflection holds good only when light is reflected from the surfaces only of materials.

(To be continued.)

Sydney A. Moseley Reveals some Secrets!

Last month Mr. Moseley described how Mr. Baird and Capt. Hutchinson "took a risk" when they invited him to witness a demonstration of television in the Long Acre Laboratories. He clearly stated "if television had turned out to be the trivial affair I had heard it to be, I should have used every influence I could have brought to bear to expose it." In inviting such a free lance journalist to join the board of Television Press Ltd., it was fully realized that we also took a risk. We entirely agree with Mr. Moseley that rightful recognition is long overdue to the only British inventor who has produced a commercial system of television which was demonstrated to the public at the Radio Exhibition at Olympia in September last. We also are convinced that more criticism of television is based on ignorance than on fact—as the following article shows.

WELL, a good many interesting things have occurred to television in Britain since I wrote my first article for TELEVISION. For one thing, we have had Olympia, the Post Office, the B.B.C. (an amazing decision), and—Success!

* * *

My Fleet Street colleagues looked askance when it was announced that I had joined the Board of the Television Press. One of my best friends, who runs one of the big dailies, asked me if at last I had lost my senses. "The thing's a ramp," he said. When I asked him whether he had seen it, he replied "No!" Fleet Street is not always like this, yet its ultra-convervatism, or cautiousness, has often made me impatient.

I could tell of "story" after "story," as they say colloquially in the "Street," which I was first to get away with long before it percolated through the thick editorial portals. But it stirs me to greater activity when I come up against this Hindenburg line of scepticism, and I usually get through!

Well, I certainly have got through this time. Critic after critic has thrown down his arms, and has yielded to facts in true sporting spirit. It is invidious to mention names, but I must mention the conversion of Wm. J. Brittain, who was amongst those severe critics of Mr. Baird in the past, and who frankly confessed his wonderment at recent developments. His article in this issue bears out what he told me. In future numbers of TELEVISION these franks confessions of other critics will doubtless appear.

In order to celebrate my new responsibility I gave a private lunch to a few of my Fleet Street friends at the Hotel Cecil. Among them was a young man who had previously seen me at my office. He wanted to know all about "this television stunt," which he had heard associated with my name.

Early Incredulity.

He sat before me bored, and almost forbidding, in his complete disbelief about the wonders that I was revealing to him. I felt that if he continued in this attitude much longer I should show him the door.

That young man afterwards came along and saw for himself what I had been describing, and the result was a column splash article in the *Morning Post*, with placards pasted all over the country. "Television Secret Revealed" was what the *Morning Post* called it, and you would think that even after this independent expression of opinion there would have been a general rush on the part of other newspapers to follow up the story. No! With the exception of the *Daily Express*, which was almost, if not actually, the first newspaper to print technical articles on television, they held off. Cautiously, yet inevitably, they have since come over—one by one! Newspaper after newspaper has since written that it is quite possible to recognise the living image of a speaker or singer before the microphone. The new wonder of the age has been acknowledged, grudgingly, yet unmistakably.

* * *

What has pleased me most of all is the tribute paid by the technical experts to the latest developments in England. I make no bones about being an out-and-out Bairdite. "J. B." has borne the brunt of the battle in England, and as far as our American friends are concerned

—well, they don't need us to shout for them! To go back to our friends the technical experts, I spoke to some of them at Olympia, who openly said they had come to damn, but remained to praise. These men, like the writer in the *Wireless World*, have written down in their leisure what might well have been an impulsive acceptance of newly discovered facts. You don't often find men of such character who will admit in print that they "are surprised." These interesting and historic documents of conversion may be gleaned by readers themselves from the latest numbers of the technical press.

The Press Convinced.

I am particularly glad to see that my friend Bernard Jones, editor of *Amateur Wireless*, who has maintained an open independent attitude, has come out wholeheartedly for television after several demonstrations that were given to him by Mr. Baird.

Some of my friends of *Popular Wireless* have not been quite so generous. I gave the editor an opportunity, one of the earliest opportunities, to realise the error into which he was being led by his advisors regarding the latest developments of television. Obviously the attitude of his contributors was based on what they had seen some eighteen months or two years back. They had not moved with the times.

I write this in all friendliness, for although *Popular Wireless* printed my article, which was one of the first, if not *the* first, written by an independent layman, it at the same time more than counterbalanced this concession by printing a criticism by a technical expert, who had not had the same opportunity as I had of witnessing the latest developments. Since writing this, however, the editor, Norman Edwards, and I have had a pow-wow, and he is to be given what he was evidently most anxious to get–a special demonstration. This is all to the good, for the result must obviously bring him into line.

My kick against the critics generally is that almost without exception they write from an arm-chair. Men like Campbell Swinton (who will live to regret the attitude he has taken up) have not been near the Baird laboratories in Long Acre, *which happens to be the only place in England where the latest achievements of television can be observed.*

I have the greatest contempt for critics who attack the attainments of a man without having actually seen the work he has accomplished.

I do not write bitterly, for in my view we have passed through to a stage where we can afford to be generous to those who have unfairly attacked us.

Misunderstandings removed.

I repeat, however, that those of my Fleet Street friends who did me the honour of coming to see the demonstrations for themselves have all, without exception, written most fairly of what they have seen.

An interesting secret, which, for the benefit of future historians, I feel I am entitled to reveal, is that the liaison between the Baird Company and the B.B.C. was brought about by myself—rather impulsively, and without prior reference to either party.

Mr. Gladstone Murray, of the B.B.C., I regard equally my friend as I do Mr. Baird and Captain Hutchinson, the financial wizard who has steered the Baird Company amid all its storms, since its inception, and, without bothering to go into details, within twenty-four hours I had found both sides friendly and willing to meet, which we did, at the May Fair Hotel, at lunch.

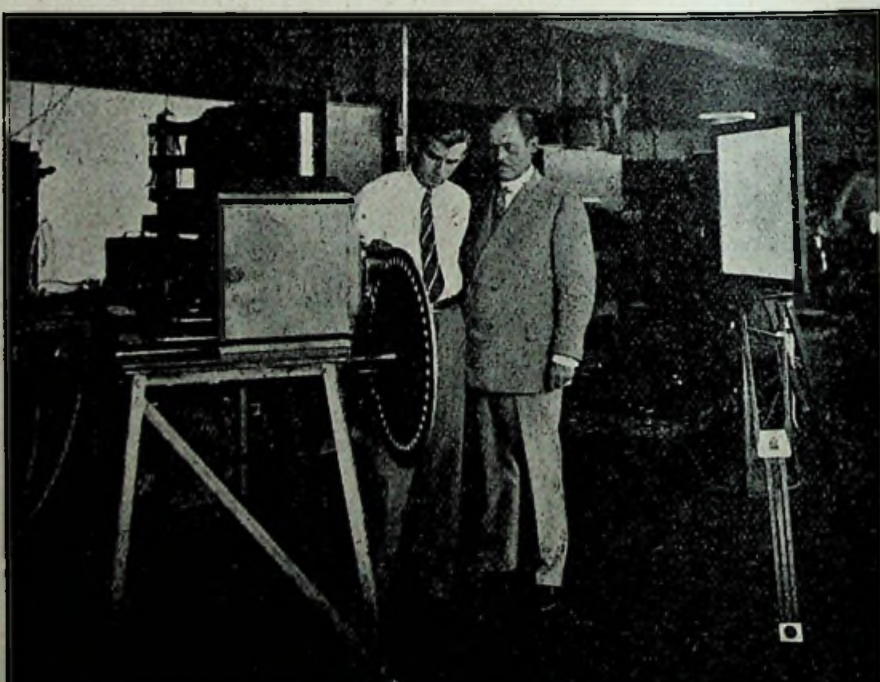
The four of us had a heart-to-heart talk, and I came away convinced that my early impression, namely, that all that was needed to clear away misunderstanding was a personal meeting, was more than borne out.

Yet I found the attitude of the B.B.C. difficult to appreciate. I hate to say it, but, so far as the engineers were concerned, one seemed to be up against a dead wall of prejudice. On the other hand, I fully understood the position of the Baird Company. Against all possible handicaps it had built up and consolidated its position, until it had, quite rightly as I think, regarded itself as possessing in sight what the B.B.C. possessed in sound.

Post Office Interest.

The next thing that happened was that the Post Office officials came up to the Baird laboratory, and again, on the impulse, I myself televised to them—perfectly confident that even an amateur performer like myself could not fail to impress upon these important representatives that they were in the presence of the birth of a great new science.

As I write, other developments are moving quickly, and, although I shall endeavour to keep pace with what is happening until the day this article goes to press, I am certain



[*Photo by courtesy of G.E.C. (U.S.A.)*

Dr. E. F. W. Alexanderson, consulting engineer of the General Electric Company and chief consulting engineer of the Radio Corporation of America, with his assistant, R. D. Kell, viewing the new television projection apparatus. The disc contains 48 lenses and the image reproduced on the ground glass screen is 12in. square. This apparatus is reported to have been shown at the Radio World's Fair, Madison Square Garden, the week commencing September 17.

that things are moving so fast that I shall not be able to overtake them.

Readers of this journal who took part in its birth may be assured that from now on they will be joined by a multitude of other supporters—people who have for the first time been enabled to see just what television really is. Those who had faith, founded on what was told them, and what they were able to envisage in the light of other wonders of the past, are now justified. Television is here!

And what next? I have been in the nature of an optimist since I was given my first demonstration some weeks ago. So far, this optimism has been justified.

I will now venture a prophecy that before the end of the year some form of broadcast service will be in being, and that Mr. Baird will bring down that rather long sleeve of his at least one more epoch-making invention which will startle the world, and that the remnants of the sceptics who are still either too shy or ashamed to come and grasp his hand will be at his feet.

The B.B.C. decision I shall leave to the Editor. All I can say is that I am sorry. I have always been a friend of the B.B.C., and I think the decision deplorable and wrong. A thousand B.B.C.'s couldn't prevent the march of television.

Commercial Foresight.

In this connection I should like to pay a tribute to the enterprise and foresight of Selfridges in arranging for the first commercial public demonstrations of television at their stores. Young Mr. Gordon Selfridge, Mr. Williams, and Mr. Wragge were all delighted when they were given demonstrations at Long Acre recently. "The development is extraordinary," Gordon Selfridge told me, and this was borne out by Mr. Wragge, who has been following the invention from its earliest stages.

* * *

John Baird has had the dickens of a time of it. He makes no bones about it in telling you of the appalling handicaps under which he worked. One day I hope I shall tell the full story of it. Meanwhile, all I can say is that anybody acquainted with the story of his indomitable will is bound to feel sympathetic towards this young Scots inventor who has brought sight as well as sound into our homes.

WHAT I THINK NOW OF BAIRD TELEVISION

By WILLIAM J. BRITTAIN

In the past Mr. William J. Brittain has been a very severe critic of the Baird system of television, and a strong supporter of various foreign television workers. Now that he has at last seen what the Baird apparatus can do he has altered his opinion of the British system, and expresses himself very strongly in support of it.

WHO has attacked Baird television more than I have? I can understand that Mr. Baird and his officials should think I had an axe to grind, despite my repeated assurances that I had not.

I have seen a few sets of television apparatus by inventors in different countries, and I have said in my writings that Mr. Baird's television machines did not do what many people imagined they did. That looked like attack, but it was honestly written down.

Now I have been given a demonstration of the latest commercial televisor. Immediately I saw the image I turned to Mr. Baird, Captain Hutchinson, Mr. Sydney A. Moseley, and others who were with them, and said: "That's good enough!" I felt much more.

The £40 Televisor.

The receiving set I saw demonstrated was that offered for £40 at the Radio Exhibition at Olympia. It was in a beautifully polished case. In the front of the wooden case was a lens about seven or eight inches wide, and to the left of it was the gauze covering a loud speaker.

At the transmitter I saw the spiral-holed disc spinning before a bright light, and the beam of light covering rapidly and repeatedly the face of the sitter.

At the receiving end I looked through the lens and saw tiny pink circles moving upwards as the disc in the televisor began to spin before the neon lamp. Soon the moving circles grew into images which flew upwards as the circles had done.

A touch of the speed controlling device in front of the cabinet, and there behind the lens was an image of a man's face in detail—startling detail for me who had seen of Mr. Baird's machines only his earlier or much simpler models.

WILLIAM J. BRITTAIN, the writer of this article.

The young man at the other end sang a song, and I saw his eyes move pathetically. He passed his hand over his forehead, and it was as though I were looking at an actual hand.

Later Miss Peggy O'Neil came. As soon as her image appeared behind the lens I realised that she had the

(Continued on page 27, col. 1.)

My Impressions of Television

By Dr. FRANK WARSCHAUER

Dr. Warschauer, who is a well-known scientific writer both in Germany and in this country, has had unrivalled opportunities of comparing the various Continental television systems with that of Baird in this country. In the following article he gives our readers a first-hand account of his experiences.

AFTER hearing of the great progress in television which had been made by Mr. Baird, I came specially to London to see his apparatus. Before leaving Germany I had already seen the apparatus of Karolus and Mihaly.

At the annual radio exhibition at Berlin this year three systems of television apparatus were shown, by the Telefunken Co., Dr. Karolus, and Denys von Mihaly. Details of the Karolus apparatus were given in the last issue of this journal, but no information as to the results obtainable was published. I have been fortunate in being able to attend both the Berlin and the London radio exhibitions, and also in being able to witness demonstrations of the three German systems mentioned above, and also of the system of Mr. Baird here in London.

Mihaly's Receiver.

On the screen of Mihaly's receiver, which was very small (about 4½ inches square) there was to be seen a shadow of a pair of moving scissors, and then single black letters, which spelt out the name "Mihaly," etc. These letters were moved at the transmitter.

In the case of the Telefunken demonstration the receiver and transmitter were about 40 yards apart. In this demonstration a transparent photograph (like a lantern slide) was placed before the transmitter. On first looking at the receiving screen one saw a flickering light, and on looking closer one could recognise the picture of a girl. **It was not a girl personally who was being transmitted, but a magic lantern slide which Dr. Karolus moved back and forth at the transmitter, and the movement could be seen at the receiver.** The image was, however, lacking in detail. The eyes, for example, could not be seen clearly, but merely as shadows. This receiving screen was about 80 centimetres (about 32 inches) square.

Karolus also had a small machine running which made use of the well-known Nipkow spiral-holed disc. To illuminate this image he used an arc lamp, the light of which is varied by the action of a Kerr cell, through which the beam passes. In the larger apparatus Karolus does not use a Nipkow disc, but a wheel around which are arranged little mirrors (see page 35, October issue of TELEVISION). The image seen on the smaller screen was much clearer than that shown on the larger screen. Again he showed the same lantern slides, and showed movement by moving the slides at the transmitter. **He did not give any demonstrations of actual television of objects or persons, but showed only the transmission of lantern slides.**

[P. & A. Photo.

At the Radio World's Fair, held at Madison Square Garden in New York City, Miss Lita Korbe, "Queen of the Radio," was televised as shown in this picture, taken September 19th, at the show. This apparatus is made by the Carter Radio Co., of Chicago.

The German public, whilst appreciative of the results obtained, recognised that it was not yet television, but only the beginning. **I therefore did not see television until I came to London.**

What I saw made a tremendous impression, because it was indeed the first time that I had seen real television—all that I saw before was only the beginning. **I think the British people will be very interested to hear that Mr. Baird has been so successful,** because he has already placed on the market a commercial instrument.

Especially I was very interested to see how distinct were the persons transmitted, because the engineers and inventors in Germany say it is impossible to get the results which Mr. Baird is getting from the neon lamp. They think that the reproduction must be too dark to recognise the persons. But I saw very distinctly many particulars of the face, the eyes, facial movements, etc., and there is no doubt that the problem of television has been solved by Mr. Baird's system.

Baird System Pre-eminent.

I am very glad to have seen this apparatus, and I think that the future of the Baird system will be pre-eminent. For many years I have been writing about broadcast developments, because I believe broadcasting is one of the greatest inventions; but I think that the invention of television, and its practical development, so that every man can have television apparatus, is even greater, and still more important to the human race.

Broadcasting is international. When I sit in Berlin at my apparatus I can hear all stations, especially

(*Continued on page* 44, *col.* 3.)

The Influence of Temperature and Light Intensity on the Photo-Electric Effect

By H. WOLFSON

The photo-electric effect, first discovered by Hertz, has a bearing on television which is of such vital importance that the study of it, in all its phases and details, warrants the serious attention of all experimenters. Continuing his series of articles on the subject, Mr. Wolfson gives his readers this month some interesting information on the effects of temperature and light intensity.

THIS month we must consider carefully two factors which are very important in the study of photo-electric cells.

In a previous article we have already seen that we may regard a photo-electric current as an emission of particles of negative electricity, which are known as electrons, from the surface of the photo-electric substance under the influence of the exciting light.

If, then, we consider the effect of temperature on these fast-moving electrons in the light of modern physical research, it becomes necessary that we first understand how the phenomenon of temperature is explained by the electronic theory.

Let us imagine for a moment that we can see the atoms which compose, say, the ordinary domestic poker, and that by some means or other we are able to measure and record their velocity under varying conditions of temperature.

If now we place the poker in the fire, and record the velocity of the atoms and molecules as the temperature gradually rises, we should find on inspection of the results that as the temperature rises the atoms and molecules composing the metal of the poker are in a more violent state of agitation. In adopting this method of considering temperature changes we must, however, realise that the molecules are incapable of moving continuously from place to place, for the motions associated with heat take place about a fixed position.

In the case of gases, however, the motion of the molecules suffers no such restriction, the progress in any direction depending only on the occurrence of collisions with other molecules. Finally, in the case of liquids, though the molecules do move continuously from place to place, the rate of transfer is comparatively small.

A change in the temperature of the photo-electric substance should then

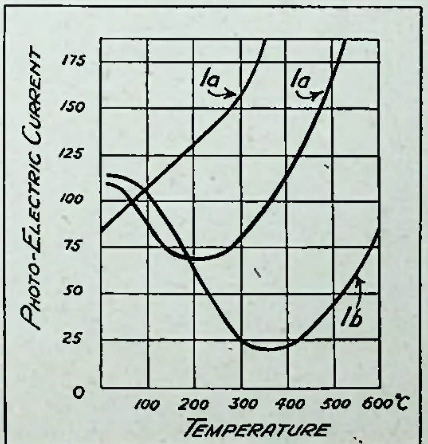


Fig. 1.

cause a change in the initial velocity of the electrons composing the substance, and may also cause a change in the number of electrons emitted. We have already seen the effect of temperature in the case of gases, and it would not therefore be surprising if the presence of a gas or gases in the photo-electric cell were to further complicate the effect of temperature on the photo-electric cell.

Furthermore, there may be a secondary action or actions, such as might arise through a chemical or physical modification of the surface of the photo-electric substance, or of the gas in contact with it. Those of my readers who have constructed the selenium cell as described in the first issue of this journal will remember how important a consideration was the temperature regulation in the annealing process. This process illustrates quite simply what is meant by a physical change in the substance. From being a black, amorphous substance, the selenium has changed into the grey, crystalline variety.

Experiments have been carried out with plates of various metals heated in an air-bath to some known temperature, after which observations of the photo-electric current were taken at intervals while the plate was cooling down to the room temperature.

For example, Hoor found that the activity of zinc increased greatly while cooling from 55° C. to 18° C. This result was not confirmed, however, by the experiments of Elster and Geitel, but they were able to show that the activity of a potassium photo-electric cell increased with increasing temperature up to 60° C., the cell in this case containing gas at the critical pressure of 0·3 mm. of mercury. J. J. Thomson found a great increase in the photo-electric current from the alkali metals on raising the temperature to 200° C. or thereabouts.

Other workers, experimenting with platinum plates, found somewhat complicated changes to occur when the apparatus was gradually heated up to 200° C. Although there was a very definite increase in the activity, taken as a whole, it was observed that there was a secondary maximum and minimum value, the minimum being between 100° C. and 200° C. This is illustrated in a graph shown in Fig. 1*a*.

Some interesting results were obtained by Varley and Unwin as the result of a long series of observations under varying conditions. The tests were carried out at (1) atmospheric pressure, (2) a pressure of 50 mm. of mercury, and (3) very low pressures. The temperature of the platinum foil was varied between 5° C. and 500° C. by passing an electric current through it, this current being obtained from large accumulators. The temperature of the platinum was measured by means of a thermo-couple consisting of a platinum-rhodoplatinum junction used in conjunction with a sensitive micro-ammeter, having a scale marked to correspond to "degrees Centigrade" in place of the usual microamp scale.

Experiments of Varley and Unwin

The second electrode employed was a copper disc, since Varley had found the usual gauze electrode unsuited to his purpose. The cell was illuminated by means of the light from a discharge between iron electrodes in an atmosphere of hydrogen. If we plot the results at atmospheric pressure a curve (Fig. 1*b*) similar to Fig. 1*a* is obtained, but the minimum value is at a temperature some 200° higher. This is explained by the different potential differences, employed by the various workers in their measurements, and by the different time intervals allowed between the readings.

Fig. 1*c* shows the steady increase with the temperature of the photo-electric current in an atmosphere of hydrogen.

At the pressure of 50 mm., in air, there was no increase of activity with the temperature, though the value of the current diminished at first in a manner similar to the previous case.

In the third series of experiments, where the pressure of the residual gas was very small, the nature of the gas was found to have very little influence on the result. When the temperature was raised very slowly there was at first an increase in the value of the current, but after the temperature reached 60° C. there was no further change in the value of the photo-electric current, even when a temperature of 350° C. was reached.

Consideration of the results of Lienhop, obtained by working at very low temperatures, as low as −270° C. in fact, shows us that below the ordinary room temperatures there is no change in the value of the photo-electric current.

As we saw in the case of photo-electric fatigue, that the cell which did not suffer from this defect was one containing an alkali metal in a very high vacuum, so now we note with interest that Dember could detect no influence of temperature on the activity of a high vacuum alkali-metal cell.

A number of elaborate experiments have been carried out by other workers, chief among whom are Millikan and Winchester, and Ladenburg. With a vacuum as high as 0·00001 mm. all experiments showed that in the case of a large number of metals, such as aluminium, copper, silver, gold, antimony, zinc, etc., there was no change in the photo-electric current when the temperature was changed.

Ladenburg has pointed out that the occluded gases on the surface of the plate are responsible for many of the contradictory results previously obtained. To overcome this the plate was heated while the evacuation was still being carried on, and in this way he succeeded in obtaining a perfectly gas-free plate. If air or hydrogen are occluded in a platinum plate the activity may be as much as 50 per cent. higher than with a gas-free plate.

Apart from a slight variation in the current in the neighbourhood of 100° C., Ladenburg, too, found the activity to be independent of the temperature. This variation was attributed to the presence of traces of water vapour.

If, therefore, we omit or eliminate secondary actions, most of the available evidence goes to prove that the photo-electric effect is independent of the temperature. Pochettino has shown that the light-sensitiveness of selenium does not change between 20° C. and 185° C.

Two possible theoretical explanations of this result have been put forward by Lienhop and Ladenburg, which, though more satisfactory than previous attempts which endeavoured to explain the result from the standpoint of the older mechanics, are nevertheless not altogether satisfactory when their significance is fully understood.

The Baird Television Development Company's Stand at Olympia.

If, however, we examine the result from the point of the quantum theory we can fairly safely assume that the system passes between two stationary states, corresponding to the emission or absorption of an amount of the same type of radiation, represented by the quantum of energy $h\nu$. In the case under consideration the two states would be (1) the atom with its electron, and (2) the atom and electron after separation has taken place.

In examining the influence of the intensity of the light on the photo-electric effect a brief study of the various light sources will not be out of place.

The source of light in use at the time of the original discovery of the photo-electric effect by Hertz was the electric spark, obtained from an induction or Ruhmkorff's coil. The terminals of the spark gap can be of aluminium, zinc, cadmium, etc., and a number of later workers have

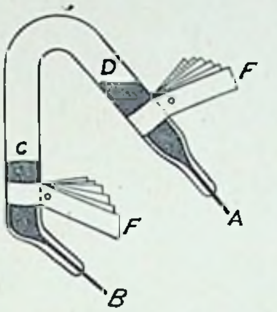


Fig. 2.
Mercury vapour arc lamp.
FF = Copper cooling fins. CD = Mercury reservoirs. AB = Leading-in wires.

employed this type of source, employing a spark of length 6–10 mm. The spark has an advantage over the mercury arc, which I shall discuss a little later, in that it emits light of shorter wavelength and greater intensity—for instance, using aluminium terminals, wavelengths of between 1,852 and 1,693 Ångstrom units have been obtained, whereas the shortest line present in the mercury arc is 1,849 Å.

Then, too, if a short spark from a coil taking 90 amps. in the primary is made use of, as in the experiments of Lenard, the energy of the spark exceeds 1,000 watts, which is in excess of the power of many carbon arcs. Hughes found that it was extremely difficult to obtain reliable results when the spark was used as source, and considers the mercury arc the most useful for experiments in photo-electricity.

Artificial Sunbath.

This apparatus is now familiar to many under the name of an "artificial sunbath," and consists of a tube of transparent fused quartz, containing mercury in reservoirs located at its ends. The apparatus is evacuated as completely as possible, and connected to a supply of direct current by means of metal contacts sealed in the tube, and making contact with the mercury reservoirs. On tilting the tube, thus joining the two mercury reservoirs, an exceedingly brilliant arc is struck, which is very rich in ultra-violet light. A diagram of the lamp is given in Fig. 2. If it is desired to run the lamp on alternating current a specially designed three-electrode lamp must be employed. A useful range of lines from 2,300 Å to 5,790 Å is available, the line 2,540 Å being particularly useful by reason of its great intensity and situation well in the ultra-violet.

Arc *v.* Spark Illumination.

If we desire to obtain light very rich in the extreme ultra-violet lines we can employ the discharge in hydrogen at a pressure of from 1–5 mm. The discharge is but faintly perceptible to the human eye, as the spectral lines which it contains are beyond the range of human vision. Hull and St. John found that if the light from such a discharge, after passing through a fluorite plate, was allowed to fall on a polished zinc plate the photo-electric effect produced was 250 times as great as that produced when the mercury lamp was used as the source of light.

It is also possible to employ the ordinary carbon arc lamp with a considerable measure of success, as this contains lines in the ultra-violet down to 2,400 Å, and it has the additional merit of being within the reach of most experimenters. With this point in view I hope to be able to publish a constructional article dealing with the carbon arc at an early date.

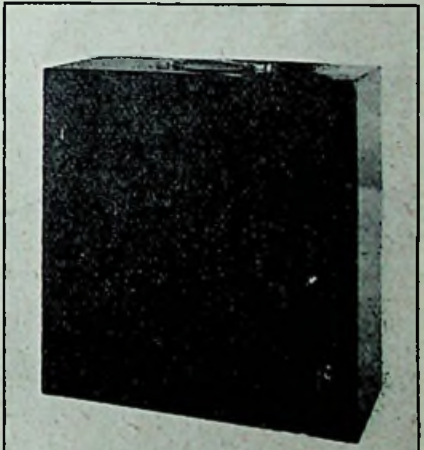
Early investigators assumed that the ratio of the photo-electric current to the light intensity could be regarded as constant, that is, the current increases proportionally as one increases the intensity of illumination.

In order to test the correctness of this supposition, Griffith, in 1907, carried out experiments in which he was able to vary the intensity of the light in the ratio of 1 : 126, and arrived at the result that the photo-electric current was not directly proportional to the intensity of illumination. Since, however, these experiments were carried out at a pressure of several millimetres, the results are not entirely a safe indication of the true state of things.

From the investigations of Richtmyer we can safely conclude that the current is directly proportional to the intensity. He placed a sodium cell in a blackened wooden box and allowed light from an incandescent lamp of 16 candle-power to fall upon it. The intensity was varied by interposing between the lamp and the cell sheets of writing paper, or by varying the distance of the lamp. It is interesting to note that a second series of experiments, employing a carbon arc as source, gave the same result, which would thus seem to have been found to hold over a wide range of light intensities (approximately 0·007 foot-candles to 600 foot-candles).

Further experiments along similar lines carried out by Dember indicate that at very high intensities of illumination there is a slight diminution of the photo-electric current as compared with the light intensity, but again there was a small pressure of hydrogen in the potassium cell, which may be a possible explanation of the discrepancy observed, though Kemp, working with potassium hydride cells, which, of course, are not completely evacuated, found that the variation from proportionality was not more than 7 per cent. over a very wide range.

Finally, we must consider the dependence of the velocity of the photo-electrons, if any, on the intensity of the light.



The Baird Company's Portable Televisor, listed at £20. This instrument is suitable for connection (in place of a loud speaker) to any wireless set which is capable of giving powerful loud-speaker reproduction of ordinary broadcasting.

Lenard was the first to show that a variation of the intensity of the light from a carbon arc in the ratio of 1 : 70 had no effect on the velocity of the emitted photo-electrons. Further conclusion was given to Lenard's result by the work of Millikan and Winchester, for the eleven metals which they experimented upon in a high vacuum, the source of light employed being the spark.

(*Continued on page* 26, *col.* 3.)

(*Concluded from page* 11.)

of slanting parts OP_1, H_1P_2, H_2P_3 . . . and of horizontal parts P_1H_1, P_2H_2, etc., and is more faithful to the original than the record OH_4 of Fig. 4. There is still, however, the tendency to round off abrupt changes.

Determination of Best Dimensions.

Such examples could be multiplied as much as we wish, and, in fact, as television proceeds, this aspect of the subject will certainly be of such importance that many examples will be worked out. However, for the moment, sufficient examples have been given to indicate how the dimensions and shape of the scanning slit tend to produce distortion.

Although it is dangerous to generalise from a few simple examples the principal feature which emerges is that the necessity for having the slit of finite magnitude tends to prevent abrupt changes of light intensity in the original from appearing in the reproduction. Further

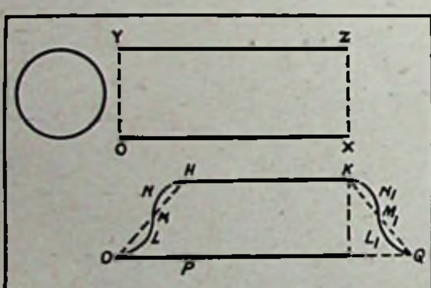


Fig. 6.
Record given by a circular slit.

abrupt changes occurring within distances equal to, or less than, the width of the slit will not be recorded at all. Hence the width of the slit determines the fineness of the grain of the reproduction.

So far we have discussed only one dimension of the slit and that is the width in the direction of motion. The discussion of the length of the slit in the other direction need not affect us here very much, for it is obvious that this dimension should also be small to allow of as good definition as possible. Further, we have considered a very simple shape for the slit, the rectangular shape. Discussion and calculation become somewhat complicated when we depart from this simple shape. Without attempting to make any calculations, the simple case of Fig. 2 is given again in Fig. 6, where the aperture or slit is circular instead of rectangular. The end conditions are modified to give curved lines $OLMNH$ and $KN_1M_1L_1Q$ instead of the straight lines OH and KQ of Fig. 2.

This preliminary discussion should be sufficient to dispose of the loose talk of dividing a picture or scene into dots, for it now appears that the practical method of strips introduces peculiarities of definition which are ignored when discussing the partition into dots. The distortion thus introduced by the magnitude and shape of the scanning slit is not too serious a matter, although it is a necessary evil, and much attention will undoubtedly be given to this subject in the future to allow of more and more faithful reproduction.

There is one other criticism of television which requires to be answered in some detail, and this also arises to some extent from the loose " dot " method of considering the subject, and that is, that for perfect television one single wireless transmission would absorb almost the whole available space in the ether, leaving no room for the ordinary wireless services. I shall deal with this aspect in a future issue of this Journal.

So far, however, enthusiastic supporters of television need not be discouraged by the criticism already answered above. I hope that a case has been made out to show that many of the criticisms lose their significance when the conception of dividing a picture into dots instead of into strips has been definitely abandoned. Then the criticisms which put forward such huge figures as millions of dots, and millions of signals per second, do not appear too bad, because when we consider the practical strip method, our conception involves numbers which are not nearly so terrifying. Further, we need not be deflected from our present methods of performing television which are of a mechanical nature, although naturally we must not close our eyes to the possibility of other methods such as the cathode ray method. However, at present there does not appear to be any hope of such methods being developed.

* * *

(*Concluded from page* 25.)

The famous experimenters, Elster and Geitel, varied the intensity by means of an iris diaphragm, and used a cell containing sodium-potassium alloy. Great precautions were taken as regards insulation, and the experiments yielded results which confirmed those of previous workers.

Taken in conjunction with the results of a number of other workers, we can conclude with safety that the velocity of emission of photo-electrons is independent of the intensity of the light.

It is this fact, together with the proportionality of the current to the intensity, which has made possible the employment of photo-electric cells in television, since any departure from this law would result in the transmission (and consequent reception) of currents which were not true representations of the light and shade values of the televised object or scene, and our televisor screen could then not be expected to reproduce faithfully the televised object.

THIS TELEVISION

By NOËL SWANNE

"THIS television . . ." began Marjorie.

"What about it?" I enquired.

"Well, hadn't you better do something, or buy something?" she said.

"I usually do," I replied.

"Do what?" she asked.

"Buy something," I sighed sadly.

"Don't be a fool," she retorted. "In these days, when science is bringing all the world to your feet, when daily we progress, when our far-flung Empire . . ."

I rose to my feet and saluted.

". . . our far-flung Empire is, as it were, on our own doorstep. When . . . when . . . well, what I want to know is, will our crystal set do it?"

"Do what?" I asked.

"This television," concluded Marjorie, as she had begun.

It is no good arguing with a woman. It is no use trying to explain, especially when you know nothing about the thing you set out to explain. Therefore I put on my hat and drifted round to the club to seek information. I tackled Jones, who knows all about ohms and volts and things.

A Frightful Thought.

"This television . . ." I began.

What he replied was something like this:

"Photo-electric selenium imposed upon a jelly produces a synchronised thermionic resistance equal to an irradiated vitamin, and proportional to the ultrasonic dilution of an apothecary."

There were a lot of verbs and adverbs and things which I have forgotten in his speech. I murmured, "Yes," and fled.

I looked up another man, whom I knew was sober.

"This television . . ." I began.

"It's got to be stopped, laddie," he boomed at me. "It won't do. This fellow Baird ought to be sent to some island somewhere. It will be positively horrid. Good Lord! Just fancy yourself at the Savoy, the missus at home, listening in to the band, and then some silly ass switches on the televisor thing, and shows up table after table. Look what a fool you would feel as you dived under the table-cloth—and you would jolly well have to dive if you wanted the missus to swallow the late-at-the-office tale. My opinion is . . ."

But I had fled.

On the way home I called in at my dealer's. He was emphatic. He hadn't got one. Didn't know when he would have, but he could do me a nice little line in . . .

I fled again.

Mournfully I came home.

Marjorie was reading.

I coughed.

"This television . . ." I began.

"In this book," said Marjorie, waving a magazine at me, "it says that television is only at the experimental stage. I remember what happened when you experimented with a soldering thing and an aerial. I know we covered it up with a new mat, but . . . never again. I am disappointed."

"I am so sorry," I said, cheering up.

"I am disappointed. I had expected so much. I had pictured happy evenings together watching the screen of life. I had built on it . . . darling . . . I am so unhappy."

Marjorie came over to my chair and ruffled my hair. The magazine slid artlessly from her fingers, and remained open on my knee. I glanced at the turned-down page, and the prominently pencilled portion about a wonderful bargain in winter furs.

I knew I would have to buy something.

* * *

[Photo by courtesy of G.E.C. (U.S.A.)

"PROPS" OF TELEVISION DRAMA.

When WGY, the American pioneer in radio drama, presented the first play by television three portable "cameras" or television transmitters were used, one each for two characters in the drama and a third camera for "props" and hands. Because of the present limitations of the art, only the faces of the actors could be shown. This picture shows the "props" camera and the two people whose hands were reproduced. Under the direction of Mortimer Stewart, action was put into the performance by introducing the hands of a man and of a woman, using revolvers, cigarettes, keys, rings, mask, and numerous other things. The play was J. Hartley Manners' "The Queen's Messenger," written thirty years ago and familiar to theatregoers. The play was presented exactly as offered on the stage.

(Concluded from page 21.)

perfect television face. I could have believed that I was looking into a mirror at her, only the image was in pink and black, due to the glow of the neon lamp.

Undoubtedly television as produced by Mr. Baird is ready for the home—if, as Mr. Baird assures me, it will be possible to obtain as good results over the radio as were shown to me when the transmission was over a hundred yards or so of land-line. And if, as Mr. Baird assures me again, the television mechanism in the £20 sets is the same as that in the £40 set I saw, which contained also a loud speaker and other elaborations.

Broadcasting of such clear images of faces is certainly a worth-while proposition. When I am listening to Mr. Baldwin I can hardly take my eyes from his mobile face: Mr. Churchill's expressions add much to his words: and who would not like to watch the life-size, living image of the face of every person broadcasting to them—even the mystery announcer?

Great Britain's television boom is coming a little later than America's, but now that it is here it will spread, and grow, and stay, for it has a foundation of slow work and definite achievement.

Is the Travelling Spot essential to Television?

By JOHN B. SHREWSBURY

EDITORIAL NOTE.—*In publishing the following article we wish to make it clear that we accept no responsibility for our contributor's views. We print the article solely because it is controversial, in the hope that it will arouse some discussion in our correspondence column. Out of this article and subsequent controversy something useful may emerge.*

THE electro-magnetic theory of light would on first thoughts make the fact that wireless telephony has preceded television somewhat surprising. There is a difficulty to be overcome in television, however, that does not exist in telephony.

This is the relative position of the various points reflecting light. Hence the use of the travelling spot. Can this difficulty be overcome in a different manner?

If light is the result of a periodic disturbance of the ether, and if alternating electric charges are accompanied by corresponding changes of state or vibrations of the ether, and if the charge be varied periodically and with sufficient rapidity, we have a vibration at each point analogous to that which occurs in the propagation of light.

Is it possible therefore to use electro-magnetic waves directly without making use of light for transmission?

Compare Electro-magnetic Waves with Light.

Let us compare these electro-magnetic waves with those of light. Hertz detected reflection from walls and subjected the electro-magnetic radiations to most of the experiments which can be performed with light rays. The electro-magnetic waves can be reflected, refracted, and focused in a similar manner to the waves of light. There is no room here to follow his experiments, but with his vibrator consisting of plates to which brass knobs were attached so that when the plates were oppositely electrified a spark passed, he was able to detect the reflection and interference of electro-magnetic waves. He showed, moreover, that a zinc sheet screens off the electro-magnetic action of the vibrator. He even detected reflection from various obstacles around the room. Such non-conducting substances as glass and paraffin can reflect the electro-magnetic waves.

As therefore by means of a lens an image can be obtained by focusing the rays of light reflected from the object on a suitable screen, so possibly an image may be obtained if a right lens is used to focus the reflected electro-magnetic waves.

Calorescence and Fluorescence.

The next thing is to secure a suitable screen and to translate the waves into light waves.

Now light waves are reduced to the same category as waves of electric polarisation; the only quality of the latter required to constitute the former is sufficient rapidity of alternation. The long electro-magnetic waves emitted by a condenser undergoing oscillating discharge are in reality the same in kind as the short ethereal waves which affect the retina.

Long heat waves may be converted into waves sufficiently short to affect the eye and may thus be rendered visible. By concentrating the non-luminous radiations by means of a condensing lens at the focus of which a piece of platinum foil is placed, the foil can be raised to incandescence and emit light.

Such a process is known as calorescence and its reverse is fluorescence, as when ultra-violet rays falling on a dilute solution of sulphate of quinine exhibit a bright blue colour.

It seems that we have here an analogy to the practical use made of the rectifying crystal or the valve in wireless telephony. As these are used in order to transform the electric oscillation in the wire to a wave-length appreciable to the ear, so a similar device is necessary in television if the aim is to dispense with the motor, rotating wheel, and travelling spot of light.

By what means the reflected electro-magnetic waves are to be focused, of what nature the lens must be, and what screen is to be used, must be left to research. It is possible to anticipate the line that would be followed, and once such rays can be focused on a screen and the wave-length shortened the rays would become visible and in proportion to the power of the reflection of the electro-magnetic waves. Thus an image would be secured. When this had been achieved, amplification, as in telephony, would make broadcasting possible.

We must now consider how the relative position of the rays emitted is to be preserved. Again the similarity of light and electro-magnetic waves offers a suggestion, and perhaps the fact that they are not absolutely identical, a solution.

Image Projection.

When a lens throws an image on a transparent screen the rays from the various tones or colours will follow parallel paths until they reach the eye. On the screen in a cinema, for

(*Continued on page* 48, *col.* 3.)

The Story of Chemistry

Part II

The Wonderful Atom

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

AS announced last month, at the head of Mr. Shearcroft's first article, it is our intention to give our readers information on all the various branches of science which have made television possible. To this end we commenced in our last issue this series of articles on Chemistry, a branch of science of vital importance to television. In this article our contributor tells our readers some of the wonders of the atom.

IN a previous article we saw that the chemist pictures matter as consisting of heaps of different little particles, called molecules, which are held together in any specimen by some force of attraction.

The differences which we observe between different substances are due to the differences which exist between the molecules which compose them. All molecules are made up of the tinier particles, called atoms, of which there are only ninety-two different kinds. This implies that our complex world is simply a matter of permutations and combinations of ninety-two different atoms, the atoms of the elements.

Notable Discoveries.

We all know the enormous number of football coupons which we should have to fill in to make certain of twenty-four correct results, and so we can let our minds gently stagger at the possibilities presented by ninety-two atoms. Fortunately, as we shall see, something else comes into consideration to simplify the process. Atoms do not just join up anyhow, and in any number. There are rules and regulations about the business which make our task very much easier than it would be were chemical combinations a mere matter of chance.

Anyway, our attention becomes focused upon the atom, and in trying to find out how it does work, the chemist and the physicist have made many notable discoveries. At first they were impressed with the stability of the atom. It appeared to take part in chemical actions, some of which might be shattering explosions, and to come out of the turmoil unchanged and, as it were, smiling. Throughout the last century the idea grew that the atom was the indestructible, ultimate particle of matter.

Then, suddenly, disaster fell on this idea. In the 'nineties of the last century Henri Becquerel found that a substance with which he was experimenting gave out some unexpected rays. He could take photographs with these rays, although light had never been anywhere near the original substance. M. and Mme. Curie tracked down another and much more vigorous ray-giver—the element radium.

At about this time much attention was being given to "rays" of one sort and another, and this new source was very thoroughly investigated. It is a long story told in full, but to be brief, it was discovered that some of these so-called "rays" were simply streams of little particles, shooting away from the ray-giving substance. That was bad enough, but worse was to come, because further work showed that the streaming particles came from atoms. The indestructible, ultimate particle, was found to be splitting up!

It was also discovered that these *radioactive* substances gave out a mixture of "rays." Some of them were very similar to the well-known X-rays. They were very *hard* X-rays. These, of course, were not material particles, but were a form of wave motion transmitting energy, and were called *γ-rays*.

(In passing it should be noted that to-day we are none of us too clear as to what we mean by matter and non-matter, and that in recalling elementary memories we may easily be trapped into dogmatic statements which are too rigid for the modern physicist.)

Now the Electron.

Another set of rays, called *α-rays*, were positively charged particles. They were fairly big particles in this region of dwarfs, being of the same order of size as the atoms of the elements. They were shot out of the radioactive atoms with velocities o over ten thousand miles a second! Even then, they were brought to rest after passing—shall we say bumping?—through an inch of air.

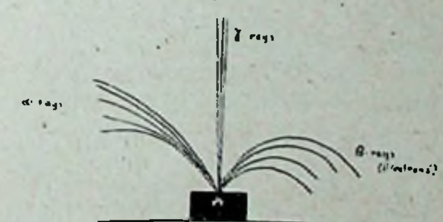


Fig. 1.
DIAGRAM OF ARRANGEMENT TO SHOW COMPLEXITY OF "RADIATIONS."
The radioactive substance is placed in hollow in block of lead, so that only a narrow pencil of "rays" escapes from the opening. When the space above is subjected to the influence of an electric or magnetic field the γ-rays pass on unaffected. The α-rays are deflected in one direction and the stream of electrons in the opposite direction. The "rays" are detected by suitable instruments.

There still remained a third set of rays, which were streams of negatively charged particles. These particles were in a terrible hurry, rushing along at speeds of over one hundred and sixty thousand miles per second. It is a meaningless speed as far as human experience is concerned, but it is approaching that of light. Seated on one of these particles you could travel from the earth to the sun—over ninety million miles—in under ten minutes.

We must pass over much of what followed. Most delicate instruments were invented to watch these particles, or rather to watch their effects. Particularly we must confine our attention to the fastest moving particles. Experiment identified them as ELECTRONS, the negative particles which had previously been found in the course of physical examination of various "rays."

Atomic Formation.

Then the physicist and the chemist combined forces, and the electron, acting like a material particle, capable of bumping into other particles, and being deflected out of its course, was proved to be just a *little bit of electricity*—the atom of electricity, if you like so to call it. A mass of research has taught us much about what the electron can do. Moving about inside a wire it makes what we call an electric current. Later we shall see its direct connection with television, but we must get back to the chemistry side of the question.

The chemist had to settle down, in the light of these discoveries, and revise his picture of the atom. From it streams of particles were being evolved, and so no longer could it be considered either the ultimate particle nor could it be pictured as structureless. Much speculation was followed by rigid experiment, from which emerged the generally accepted view that all atoms consist of a central

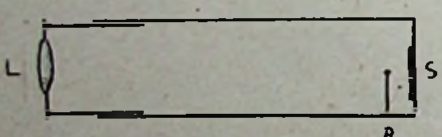


Fig. 2.
SPINTHARISCOPE.
Certain substances, when bombarded with the "rays" from radioactive material give out little flashes of light. In this pocket instrument a fragment of radioactive material is mounted on rod R, in front of small screen of suitable material S, which can be viewed by the lens S, mounted in sliding tube. A continuous shower of tiny sparks is seen on S.

nucleus, around which are arranged electrons.

Electronic Arrangement.

But we know practically nothing of what the electron really is. Recently Sir Oliver Lodge has suggested that the electron is a hole in the ether, which is supposed to fill all space, but many of us are not very sure that there is such a thing as the ether, and at that we must leave it for future research to settle.

There is no general agreement as to how these electrons are arranged round the nucleus. The physicist prefers a scheme in which the electron revolves round the nucleus in orbits much as the planets revolve round the sun. This allows him to suppose that electrons can jump from one orbit to another, on which possibility he has worked out some beautiful explanations of difficult phenomena. The chemist finds an arrangement of the electrons in more or less fixed places round the nucleus more suited to his needs, and at present the only thing to do is to take the view best suited to individual needs, and hope, again, that the future will clear up the confusion.

The nucleus has also received attention, and has been discovered to consist of a mixture of electrons, and still smaller particles of positive electricity, called PROTONS. So we get a picture of the atom as a mixture of "bits" of negative and positive electricity—electrons and protons. A step farther, the molecules are made up of atoms, and any portion of matter is made up of molecules. Hence it follows that all matter is just a mixture of positive and negative electricity—and, if Sir Oliver Lodge is right, then matter is just like the Irishman's definition of a net—holes joined together.

An Electric Current.

It is necessary to stress the sizes of these particles, if only to keep our thoughts straight. Here I thought I would be clever. I took a large piece of drawing paper, and with a very fine nib made the tiniest dot I could. The diameter of this I measured, intending to let this dot represent the nucleus of an atom, and then put other dots at appropriate distances to represent the positions of the electrons. My measurements placed the first electron dot several fields away from my study!

This mighty little atom is mostly empty space, as is the solar system, and yet it is a system which resists any and every force which humanity possesses. It will split up under certain conditions, of its own sweet will, according to its own rules and regulations, but we are quite unable to affect that splitting-up process, or *disintegration* as it is called, in any way whatever.

Here, then, we see matter composed of a multitude of electrons, the properties of which have been studied very carefully. We know the size and the weight of an electron. At present it is the lightest thing known. About eighteen hundred electrons are equal in weight to the weight of one hydrogen atom. Streams of them represent an electric current.

From our point of view, possibly the most interesting application of electrons is the part they play in photo-electric cells. Certain substances, when subjected to the action of light, give off a stream of electrons from their surfaces. It is rather a

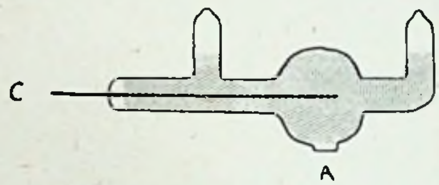


Fig. 3.
SIMPLIFIED DIAGRAM OF PHOTO-ELECTRIC CELL.
The inside of glass tube is silvered, as indicated by shading, and a coating of metallic sodium or potassium deposited on this lining. The light enters through the clear window A, and the electron current flows to the cathode C. Such a cell will give a current of 10^{-8} ampere, with a 60 c.p. lamp placed 6 inches in front of it. Methods of amplifying this current can be arranged.

wonderful process, and the whole story is not known. It seems as if the electron was able to accumulate energy from light, until it possesses enough to tear itself away from the main body. Possibly it goes off with something of the sensations of a retired profiteer who has built a mansion on the Surrey hills.

Photo-Electric Effect.

The photo-electric cell consists of a suitably prepared glass tube, which is either very thoroughly exhausted or filled with some suitable inert gas. Then a deposit of the photo-electric material—the metals sodium, potassium, and calcium are commonly used—is placed on a silver lining to part of the tube. When light falls on this prepared surface a stream of electrons leaves it, and can be detected as an electric current. The current can, of course, be used for any purpose we require, such as the variation of another current. This particularly is the case in television, where the photo-electric cell is subjected to different light intensities, to which it responds by variations in the stream of electrons emitted.

(*Concluded on opposite page, col.* 3.)

TELEVISION IN AMERICA.

By Our New York Correspondent

THROUGHOUT the United States of America television is creating a furore which compares in its intensity to the wave of enthusiasm for wireless which overspread the States when broadcasting first made its appearance.

Numerous stores are marketing television discs and components, and it is reported that several tons of aluminium sheeting have been disposed of to enthusiastic amateur television constructors for the making of television sets.

Synchronising Difficulties.

A number of stations are actually sending out television images, although no complete televisors are actually on the market, the difficulty being that a solution to the synchronising problem has not so far made its appearance in the States. Synchronism has been accomplished in the experimental demonstrations hitherto given by means of synchronous motors driven by alternating current supplied by a common source of supply, a common A.C. power supply driving the motor at the transmitter and the motor at the receiver. This, of course, depends for its functioning upon the provision of a common source of A.C. power, for transmitting and receiving. It is therefore scarcely a commercial proposition.

In the very elaborate experiments carried out by the American Telephone and Telegraph Company synchronising was accomplished on a separate wave-length carrying an alternating current frequency which, after amplification, was used to control the speed of an A.C. synchronous motor, and thus gave synchronism without the use of a wire connection. The apparatus involved was of enormous complexity, and required the use of an army of experts.

In the later demonstrations given by the General Electric Company the problem of synchronism was simply ignored, and the receiving motor was kept in some approximation of synchronism by manual adjustment of the receiver. This entails extreme agility on the part of the operator, and even with the greatest skill it is impossible to maintain synchronism except for a few seconds at a time, so that the method is quite out of the question for anything except purely experimental work.

OF late there there has been much publicity regarding television developments in America, and many of the accounts have been either exaggerated or lacking in accuracy. In this article our New York Correspondent gives us the plain facts of the situation in America as it is to-day.

The activity in the States is greatest among the large electrical corporations. The American Telephone and Telegraph Company and the General Electrical Company lead the way. The American Telephone and Telegraph Company have demonstrated recently the transmission of the image of a man standing upon the roof, illuminated by sunlight, to a different floor in the laboratory, thus showing the possibility of transmitting an object without the use of artificial lighting. It should, however, be noted that this feat was anticipated by nearly two months in England.

The General Electric Company have been extremely active in keeping their name before the public, and have demonstrated recently what was widely advertised as " the transmission of a play by television." What was actually transmitted was simply a face, the actors being transmitted successively, and only one face was visible at any time on the receiving screen. The receiver and transmitter were in adjacent rooms in the same building, although the signals were, it is claimed, sent by land wire to a station three miles away and then transmitted back again by wireless.

Each actor spoke his part, his face appearing on the television screen, and he was then replaced by another actor, only one face being seen at a time.

The statement that a play had been transmitted misled many into thinking that an actual view of a stage scene could be seen.

(*Concluded from opposite page.*)

These variations can be made to impress their effect on a transmitting apparatus.

This action is quite different from that of a selenium cell, in which the electrical resistance of the selenium varies with the intensity of the light which illuminates it.

This photo-electric effect is related to the wave-length of the light used and the material used in the cell. Thus, for example, ordinary visible light affects the metals mentioned above, but has no action whatever upon a metal such as zinc. If instead of visible light we use the short-waved light—ultra-violet light—then electrons are emitted. There appears to be a critical wave-length for each photo-electric substance.

Here, however, we are merging into that interesting borderland of chemistry and physics, and lest we be accused of poaching we must return to our own preserves. Thus far, however, it was necessary to go. The chemist lives his life with atoms and molecules, and he must know as much as possible of the bricks with which he has to build his own temple. Knowing those bricks, we can now enquire how they join up to form molecules, how molecules interact with one another, or split up into other molecules, in the gentle daily processes which go on continuously around us, or in the explosions which startle us from time to time.

N.B.—The subject-matter of this article is dealt with more fully in the following books :—

The Story of the Atom : Shearcroft.
The Structure of Matter : Cranston.
Light-Sensitive Cells, Chap. II, *Wireless Pictures and Television :* Thorne Baker.
Practical Television, Chap. IV : Larner.
Light-Sensitive Devices, Chap. IV, *Television :* Dinsdale.

TELEVISION DEMONSTRATIONS IN ROTTERDAM

Visit of The Prince of the Netherlands

By The Demonstrator

IN our October issue we reproduced a photograph of the Baird Company's stand at the Rotterdam Exhibition. Televisors were on view there throughout the period of the Exhibition, and towards the end of it demonstrations of television were given to members of the Dutch public. In the following article our contributor describes how the Prince Consort of Holland witnessed a demonstration.

THE closing of the International Industrial Exhibition at Rotterdam was officially performed by the Prince Consort on September 30th. His Royal Highness, on entering the British Section, was welcomed by the principals, and then straight away visited the stand of the Baird Television Development Co., Ltd.

The model of the first televisor engaged attention, and then without further warning H.R.H. and suite entered the curtained chamber which formed the demonstration room. Happily, the images of the stereoscopic instrument were at their best, and "Stooky" looked solid and real awaiting examination.

Successful Demonstration.

Taking the basket arm-chair, with his companions standing around him, H.R.H. gave immediate evidence of his interest in television, and all discussed the images and Mr. Baird's work and its advance. Following the mechanical motions of the dummy's face, lively enthusiasm was shown when the living face responded to the orders of the demonstrator. The sitter, who promptly moved profile, opened his mouth, rolled his eyes, showed his teeth, smiled, frowned and laughed, and said good-bye, finally bowing and so displaying the middle parting of his hair as bidden by the handphone used by the demonstrator. Appearing gratified by the proceeding, H.R.H. took the phone and asked if he could see another face.

Mr. W. C. Fox, who was superintending at the stand, immediately took the place of the sitter at the transmitting televisor. On announcing the image the demonstrator referred to the transatlantic transmissions, and the fact that Mr. Fox's face was one of the first transmitted across the Atlantic. All discussed this historic fact, and then H.R.H. asked Mr. Fox to show his pocket handkerchief. The appearance of the white fabric was quite dramatic and might have been rehearsed, for it concluded a most successful television demonstration.

On leaving, H.R.H. shook hands with the demonstrator and asked that Mr. Fox should be presented to him. In conclusion H.R.H. signed the visitors' book, and so headed many of the leading names of Holland whose signatures testified their presence amidst the hundreds of the people who visited these demonstrations.

* * *

Thoughts Before the Televisor

By The Sitter

PERHAPS it is contradictory to say that I have sat before a prince and yet not seen his highness, but, strange to say, 'tis true. Furthermore, I sang to him and did my best to impress the words of the appropriate song, "Here's a Health unto His Majesty," but I am afraid my efforts were unavailing because I could unfortunately, or fortunately (a matter of opinion), not be heard but only seen. Perhaps I had better explain myself.

After having performed to a possible 1,000 people or more, I suppose I can be excused for having no nerves, but I must admit I woke up when I was informed suddenly but quite calmly by the demonstrator to seat myself in my little cabin, for the Prince Consort of Holland had arrived. A minute or less after I had ensconced myself within the precincts of the transmitting room the familiar voice could be heard over the line: "Move the dummy's eyebrows." As I carried out the instructions I looked at Stooky's face and he, as usual, had a most benign smile which is perpetual. Caring not for prince nor beggar, he smiles; a most optimistic person is Stooky. My wandering thoughts were again cut short, and Stooky's smile abruptly changed into a broad laugh. I wonder if the prince laughed too.

"Remove the dummy, please, and will you take his place?"

Quickly I removed our friend and seated myself in his place.

The orders were rapidly given, and amid a host of mixed thoughts and wonderings I performed to the best of my ability. Was I in the right position? Could my eyes be seen? Didn't I roll them? I frowned, I laughed, sang as aforesaid, and hoped that the results were, as they had previously been, successful; but I was not to be kept in suspense for long. "Now can you bow?" the last order, and the demonstration to His Highness was over, and I learnt that it had come up to all expectations, the parting down the centre of my head that hundreds and hundreds of folk in Holland had seen was seen by their Prince.

Bridging Space
(Part V)

By JOHN WISEMAN

In this series of articles the fundamental principles of electricity and wireless are being explained in the simplest possible language. Last month Mr. Wiseman introduced the thermionic valve. In the following article he continues his explanation of the way in which the valve functions.

IN our introduction to the valve in Part IV. of this series we traced, step by step, how the flow of electrons in a valve takes place between filament and plate, and it was mentioned that the actual thermionic current depends really upon the vigour with which the electrons are swept away from the filament. We left off at the stage where the grid had been introduced and briefly touched upon its influence to the electron flow. The importance of this feature cannot be stressed unduly and it behoves us, therefore, to examine closely the grid action and then see in what way it acts to enable the valve to function as an oscillator.

Before dealing with the "how it works" side of the valve, however, I realise that there are many readers who would like a little information as to "how it is made," and in deference to their wishes the few notes below are appended.

Electrode Materials.

The filament is a length of wire generally made as long as possible consistent with strength, although actually it is thinner than the average human hair. The material from which this filament is constructed has varied considerably since the first valves were made, and as its primary function is to supply an emission of electrons the larger we can make this for a given surface area the more efficient becomes the valve. Tungsten impregnated with thorium is one form of filament, and then in other valves we have a core of metal (sometimes platinum) whose surface is coated with a thin layer of the oxides of the rare earths. The use of these filaments gives what is termed the "dull emitter" valve, that is to say, it functions as an electron giver at a comparatively low temperature and in consequence is very economical in low tension battery consumption.

What is called the "plate" of the valve varies in shape with different makes, as was shown in last month's illustration of the internal electrode construction of three valves. It is usually made of nickel and, since it surrounds the filament, acts as the electron collector. Between the plate and filament we have the grid taking the form of a spiral or a zigzag network of fine molybdenum wire. The size of the grid mesh and its relative position with reference to the other two electrodes produces varying influences upon the electron stream, but that is a point outside the scope of our present investigation.

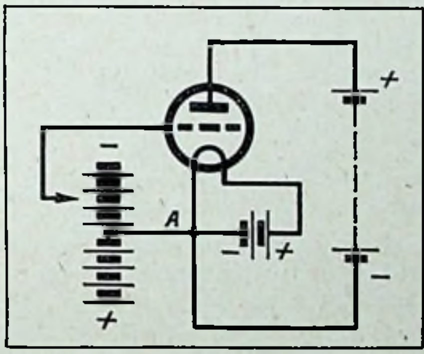


Fig. 1.
A simple valve circuit.

The Final Stages.

These three electrodes are assembled and held in a glass "pinch" and leads from them are ultimately taken to metal pins in a moulded cap. Before this is done, however, the assembly is welded into a glass bulb, the inside of which is exhausted of all gas, and the exit tube fused to a seal. Since the vacuum inside a valve should be as perfect as possible, any occluded gases in the metal electrodes themselves must be removed. By a special process, therefore, the metal parts inside the valve are made red-hot, the heat being sufficient to volatilise small pieces of magnesium attached to the plate at the time of assembly. In volatilising, the magnesium combines with whatever residual gas is inside the bulb and perfects the vacuum, incidentally giving to the inside of the bulb that well-known silvered appearance.

Making Matters Clear.

This brief note will serve to show how the valve is constructed and we can return to questions of operation. To make matters clear, we will assume that a valve is connected up to batteries in the manner shown in Fig. 1. Both plate and filament have their own batteries joined in the usual manner, while the grid battery has its centre point joined to the negative filament leg. By tapping the grid lead on either side of the centre point we can impress positive or negative voltages to the grid with reference to the negative filament leg, it being borne in mind that this point *A* is always taken as the datum level for voltage reckonings. According to the various grid and plate voltages applied, so we shall have different electric fields produced across the space plate-to-filament, and a physical conception of the

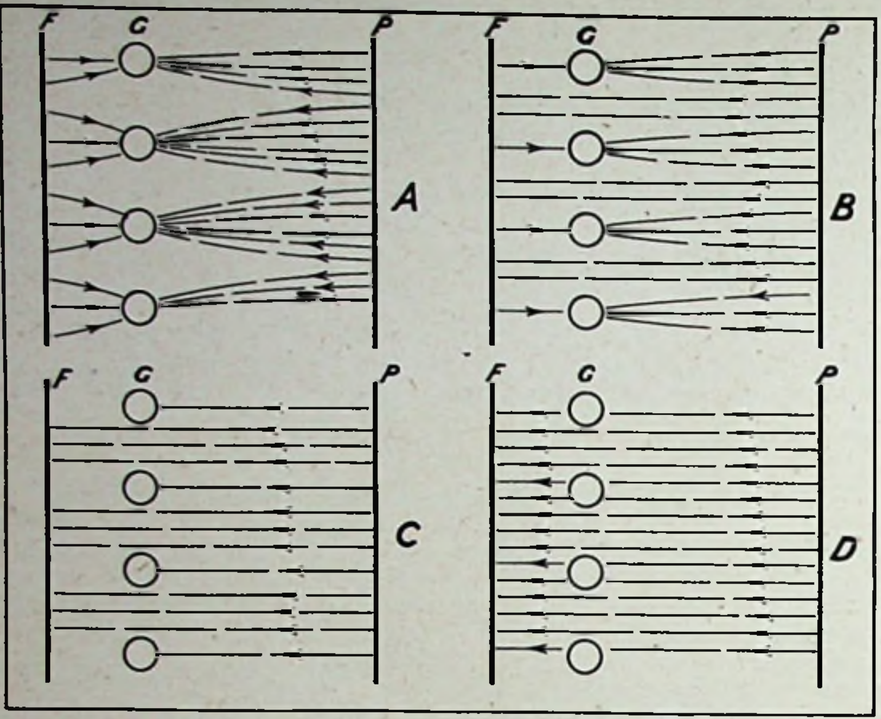


Fig. 2.
Illustrating the various effects produced when different voltages are impressed on the grid of a valve.

action going on is best gained by an examination of the composite diagram Fig. 2.

Assuming that the positive plate voltage remains constant, let us vary the grid voltage. Imparting a large negative voltage to the grid produces a field somewhat as indicated in Fig. 2*A*, lines of force from both the plate and filament finishing on the grid owing to its high negative potential, and producing the condition where no electron flow can take place from filament to plate, or in other words, the plate current in the external circuit is zero. Reducing the magnitude of this negative grid voltage to, say, a condition slightly negative with reference to the filament alters the field to that of Fig. 2*B*, and since a small number of lines of force can now pass from plate to filament owing to a reduction in the grid's " barrage action " a small plate current takes place.

The Next Step.

The next step is with grid voltage zero, and obviously the conditions between the electrodes inside the bulb is altered to that of Fig. 2*C* where the plate current has now assumed moderate dimensions. Still further continuing our alteration of grid volts, we can make the grid positive and the condition illustrated in Fig. 2*D* is reached. This constitutes a large plate current, a positive potential of the grid nullifying the negative space charge effect around the filament (see Part IV.). In examining these diagrams it will be appreciated that the arrow heads and lines represent the direction and the position of the lines of force and the electrons are actually moving in the opposite direction to the arrows, owing to their negative charge.

It can be seen, therefore, that the grid to some extent shields the space charge from the plate, although the shielding is reduced when the grid mesh is coarse in character. From its closer proximity to the filament, however, it must exert a very powerful influence on the dense portion of the filament cloud, the electrons being drawn out when the grid is positive and impelled in the direction filament to grid. The greater proportion of these electrons shoot through the grid interstices and are collected by the plate. Hence a given voltage imparted to the grid has a greater influence on the electron stream than the same voltage imparted to the plate, and it is from this fact that we can make our valve amplify or increase in intensity any voltage variation and make it reproduce greater effects in the plate circuit.

A Family of Curves.

According to the initial voltage given to the plate, so the grid voltage variations will give different effects, and if we plot curves showing the plate current for varying grid voltages with certain definite plate voltages they will take the form illustrated in Fig. 3. These are known under the name of characteristic curves, and a set such as that illustrated is called a " family." No doubt readers have seen similar curves on the leaflet of instructions to be found inside valve cartons and they are useful for predetermining voltage data in order to produce certain valve working conditions. There is not time to deal with this interesting side of the valve question at the moment for we must investigate the valve action as far as generating oscillations is concerned in order to appreciate how the wireless waves are sent out from the transmitting station.

Mechanical Analogies.

We have seen previously (Part II.) that a closed circuit consisting of a coil and a condenser (inductance and capacity) has a certain natural period of oscillation depending upon the electrical constants of these two components. This vibratile electrical circuit has its mechanical analogue in the pendulum of a clock or the balance wheel of a watch. If the reader cares to open up and examine a clock working with a pendulum, or even his own pocket watch, he will see that both the pendulum and balance wheel are sustained in vibration by properly timed impulses transmitted from the mainspring through the escapement mechanism, the actual timing of these impulses being accomplished by the moving member itself. A reference to Fig. 4, which illustrates a lever watch escapement, will serve as a self-explanatory diagram as to its working. In a similar manner, the closed

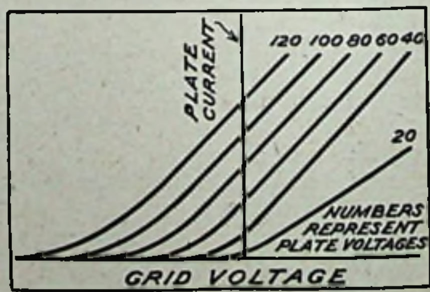


Fig. 3.
A family of characteristic curves.

(*Continued on page* 44, *col.* 1.)

OPTICAL ELEMENTS: LENSES AND LENS SYSTEMS

Part IV

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

This month our contributor tells us, in his usual popular style, something about the defects to which human eyesight becomes heir to, and describes also how, by the use of suitable lenses, these defects can be corrected.

EVERYONE is familiar with such simple forms of lenses as are found in magnifying glasses, reading glasses, spectacles, &c. Such lenses are generally round discs of ground and polished glass with either flat or curved faces, which can be divided into two classes by inspection, viz.: (1) Lenses which are thicker at the centre than at the edge, and (2) Lenses which are thicker at the edge than at the centre.

Those of the first class are known as positive or converging lenses, because when held in sunlight, say, they converge it to a real focus; whilst those of the second class are known as negative or diverging lenses because they cause parallel rays to diverge as from a focus. An image thus produced is virtual only; it cannot be photographed directly. Fig. 1 shows the action of a converging lens in a beam of parallel rays, or plain waves.

The plane-fronted waves, moving from right to left, fall upon the lens, and, since it is transparent, pass through it. In doing so, however, that part of the wave which passes along the axis of the lens, since it has to travel through a greater thickness of glass, is retarded with respect to that part of the wave which travels through the annular rim of the lens, at which the thickness of the glass is very small. The result is that each plane circular wave, cut out of the incident waves * by the mount of the lens, emerges from the lens in the shape of a watch glass or calotte with its hollow side in front—i.e., as part of a hollow sphere with its centre at what is known as the *principal focus* of the lens—the point to which parallel rays are converged. Each emergent wave then as it proceeds contracts to the focus and, passing through it, expands.

In the case of a negative lens, Fig. 2, each plane disc, cut out of the incident waves by the lens mount, in passing through the lens is retarded more by the edge of the lens than by its centre, at which the axial thickness of the glass is now least. The emergent waves are thus cupped, as in the case of the positive lens, but with the bulging or convex side forward, so that, as they progress, they expand continuously and their curvature becomes less. The virtual focus from which these waves diverge is known, too, as the principal focus.

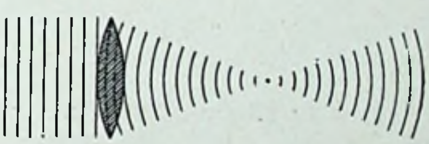


Fig. 1.
Optical Action of a Converging Lens.

Wave Diagrams for Lenses and Curved Mirrors.

It is interesting to compare the diagrams Figs. 1 and 2, for lenses with those given below for concave and convex reflectors.

In Fig. 3 the waves from a distant source fall upon the mirror, so that the edge of each wave-disc cut out suffers reflexion before the centre of the mirror comes into action. Each reflected wave, therefore, is hollow-fronted, just as in the case of those emerging from a converging lens, and like these is brought to a real focus.

Fig. 4 shows the corresponding diagram for the convex mirror. In this case the centre of each incident wave is reflected first, so that after reflexion the edge is found behind. The waves therefore diverge as in the case of the negative lens.

Lenticular Correction of Defective Eyesight.

We have in previous issues of this journal dealt at some length with the subject of optical reflecting elements, both plane and curved. We will now go on to consider—at first in a very elementary way—the subject of lenses and combinations of lenses such as occur in most optical instruments; and to begin with, because of its simplicity and importance, we cannot do better than consider the optical action of the human eye itself, and the correction of its various refractive defects by means of spectacles.

We are assured, upon evidence that is rapidly increasing from year to year, that man has enjoyed upon this earth at least 10,000 years of continuous civilisation, and yet there is practically no evidence that lenses were ever used for the correction of defective eyesight until about the year 1300*—10,000 years of continuous civilisation to produce a pair of spectacles! For reading and similar purposes men and women before the invention of spectacles became in effect blind very soon after middle age. The Roman patrician had to engage a slave to read to him.

* Strictly speaking, the incident waves, both in Figs. 1 and 2, should have been shown extended both upwards and downwards before striking the lenses, as has been done in Figs. 3 and 4.

* There is in the British Museum a rough lens-shaped piece of quartz, or what is now often referred to as Brazilian pebble, discovered by Layard in his excavations in Assyria. In spite, however, of Sir David Brewster's opinion, it is now generally conceded that this specimen must have been made for ornamental rather than for optical purposes.

The human eye, so far as its optical action is concerned, is often likened to a photographic camera, and the analogy is sound. In the camera in normal adjustment all objects at a

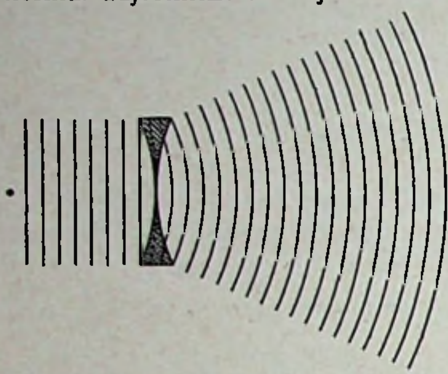


Fig. 2.
Optical Action of a Diverging Lens.

considerable distance away are in sharp focus, because the photo plate is then adjusted in the principal focal-plane of the lens.

When it is required to photograph objects near at hand, one of two methods is adopted to bring the image on to the plate again. In the first of these the lens is racked out to increase the distance between the lens and the plate, whilst in the second method a weak auxiliary lens, mounted in a cap, is placed in front of the ordinary lens to increase its power, and thus lessen the distance between the lens and the image.

The same problem occurs in the case of the eye. The length of the

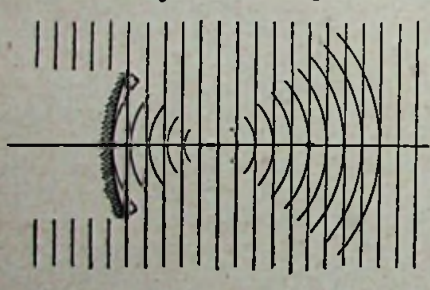


Fig. 3.
Optical Action of a Concave Reflector.

eyeball is fixed. In the normal eye at rest distant objects are seen in sharp focus. For reading or near vision the eye is said to accommodate. What, in effect, happens is that the power of the eye-lens—the crystalline lens—is increased as a result of an act of the will. This increase results directly from an increase in the axial thickness of the lens, its front surface becoming more prominent or bulged.

The more usual defects of the eye are known as *presbyopia*, *hypermetropia*, and *myopia*, or, in other words, old age, long-sight, and short-sight. Fig. 5 shows diagrammatic sections of three eyes when at rest—i.e., with all accommodating power out of action. In the first of these, which represents the normal eye, it will be seen that parallel rays are brought sharply to a focus upon the retina at the back of the eye. In the second diagram the eyeball is shorter than in the case of the normal eye, with the result that the parallel rays striking the lens converge to a point behind the retina, and hypermetropia or long-sight results.

This condition of the eye is corrected by fitting it with a positive or converging spectacle lens, of such a power that when assisting the eye-lens the converging rays inside the eye are brought to a focus sooner, as shown in dotted lines, and on the retina. A sharp image of a distant object is thus secured in the case of long-sight.

The third diagram shows a short-sighted eye, that is an eye in which the eye-ball is longer than in the case of the normal eye, with the result that parallel incident rays are brought to a focus too soon, so that it occurs in front of the retina. This defect of the eye is corrected by the use of a negative or diverging lens, to lessen the power of the eye-lens and thus increase the distance behind the lens at which the image of the distant object is formed. The image is thus brought on to the retina, and the myopic or short-sighted eye corrected.

Fig. 6 shows the same three eyes as are shown by Fig. 5, but with the eye-lens in each case adjusted by an effort of accommodation to work at its maximum power. The front surface of the eye-lens is shown in its "at rest" position, that is, as it is shown by Fig. 5, by a dotted line, and in its fully accommodated position by the full line. The nearest point which an eye can focus on the retina in its latter condition is known as the near-point, or *N.P.*, whilst the farthest point which can be focussed by an eye "at rest" is known as the far-point, or *F.P.*

Fig. 6 then shows (1) in full lines the effect upon near vision of the defects considered, and (2) in dotted lines the effect upon near vision of the spectacle lenses which, as shown by Fig. 5, are necessary for the correction of distant vision. Let us consider, first, the state of affairs as shown by the full lines of the diagrams—i.e., of eyes fully accommodated but without spectacle-correcting lenses.

The *N.P.* of the normal eye is shown to be in a vertical plane, usually at a distance of about 10 to 12 inches.

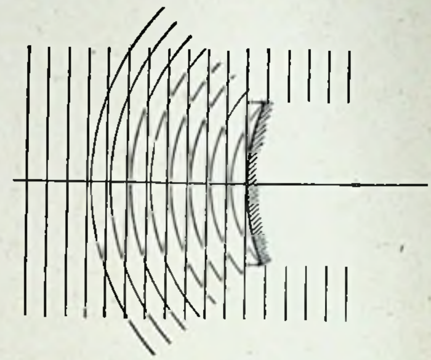


Fig. 4.
Optical Action of a Convex Mirror.

For the long-sighted eye, owing to the shortness of the eyeball, the plane of the *N.P.* has receded to a plane which may be so far away that a page of print placed in it, although perfectly well defined, may be seen so small as to be unreadable.

In the case of short-sight the abnormal length of the eyeball permits of an object being brought up to the first of the three planes shown under "near-points," before its image begins to fall off in definition. But the nearer the eye the greater the apparent size of the object, so that

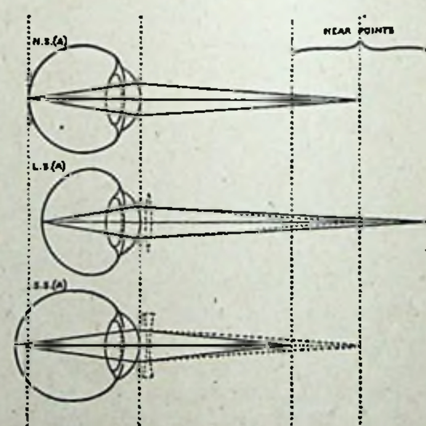


Fig. 5.
Three Typical Eyes in the "At Rest" Condition.

our diagram tells us that the short-sighted eye has a distinct advantage over the normal eye, and still greater over the long-sighted eye, in that it can see objects well defined at a less distance away, and therefore more magnified. The price it has to pay for this is the imperfect seeing of distant objects.

The effect of the interposition of the lenses necessary for the correction of distant vision is shown by the dotted lines drawn to the right of the eye in the two lower diagrams.

No correction of the normal eye, of course, has been necessary; it is our standard. In the case of the

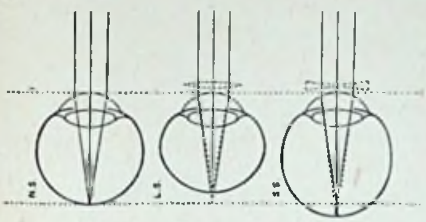


Fig. 6.
Three Typical Eyes in the Fully Accommodated Condition.

long-sighted eye the introduction of the positive lens increases the effective power of the eye-lens, with the result that an object must now, if the full accommodation of the eye be maintained, be brought up from the outer plane to the middle plane to keep the image on the retina in sharp focus. In other words, the introduction of the correcting lens has given to the long-sighted eye the same *N.P.* as that of the normal eye.

In the short-sighted eye, similarly, the introduction of the negative correcting lens shifts the plane of the near-point from the first to the second or "normal" plane. The three eyes have now got the same *F.P.'s*, and the same *N.P.'s*, and, therefore, normal vision.

These diagrams, therefore, show how in practice young eyes, with a full range of accommodation power, can be corrected for both distant and near vision by a single pair of spectacles. With the advance of age the power of accommodation falls off, owing to a decrease in the elasticity of the eye or crystalline lens, with the result that in all cases the *N.P.* recedes. This occurs in the normal eye, so that even if correcting lenses are not required for distant vision they are required for near vision. This condition of the eye brought about by age is known as presbyopia.

Only the simplest and commonest defects of the eye have been dealt with—those which can be corrected with the simple lenses we are considering.

Finding the Position and the Size of the Image of an Object projected by a simple thin Lens.

If the image of an object *o*—a candle, say—is projected by means of a pinhole *A*, in a sheet of tinfoil, we know that wherever the image *i* may be picked up on a sheet of paper, the size of this image (length) divided by the length of the object will be equal to the distance *v* of the image divided by the distance *u* of the object. The magnification *M* is equal to i/o, that is to v/u. If we then replace the tinfoil, as in the lower part of the figure, by a lens *L*, the image will be formed at a distance *v* from the lens, which depends upon the power of the lens, but at whatever distance *v* it may be, it will be found within the angle α, as in the case of the pinhole projection, and its magnification will be equal to v/u. Let us suppose, further, that parallel light from the right comes to a focus at F_1, and parallel light from the left at F_2.

If then we wish to find the image point *B*, corresponding to the terminal point *A* of the object *o*, it is only necessary to draw two rays from *A*, one *AD* parallel to the axis, and then through the point F_2, the other through F_1 to *E*, and then parallel to the axis. These two rays will intersect in a point *B*, which is the image of the point *A*. A straight line *AO* passing through the centre of the lens, assumed to be thin, will also pass through the point *B*. From the diagram thus drawn some simple fundamental equations can easily be deduced.

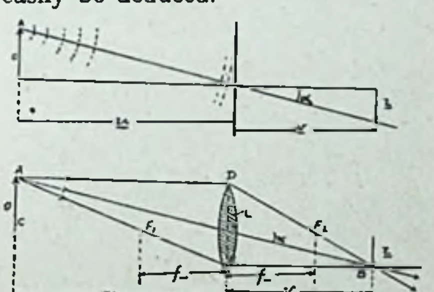


Fig. 7.
The Positioning of the Image produced by a Thin Lens.

First the magnification *M*, as already pointed out, is obtained from

$$M=\frac{i}{o}=\frac{v}{u}\ldots \quad (1)$$

Again, since *OE* is equal to *i* and *OE* to *o* we have

$$M=\frac{i}{o}=\frac{OE}{o}=\frac{f}{u-f}\ldots \quad (2)$$

Also—

$$M=\frac{i}{o}=\frac{i}{DO}=\frac{v-f}{f}\ldots \quad (3)$$

By combining (2) and (3) we get Newton's equation:—

$$(u-f)\,(v-f)=f_2\ldots \quad (4)$$

(*Continued on page 48, col. 3*)

BOOK REVIEW

TELEVISION. By ALFRED DINSDALE, A.M.I.R.E., Editor of *The Television Magazine*, with a foreword by Dr. J. A. FLEMING, M.A., D.Sc., F.R.S. Pp. 180+20. Published by Television Press. 5*s*. net.

IN a refreshing and stimulating foreword to this book, Dr. Fleming, referring to the present state of television, says: "Television now in 1928 is very much in the same stage of progress as wireless telegraphy was about the year 1900 or 1901. But it may not take nearly so long to bring it to practical perfection because many of the problems involved have been already solved."

Many there are who will read this book and will wish to become active participators in the rapid progress predicted by Dr. Fleming. But if the book only serves to stimulate a lively (and, we hope, *active*) interest in the subject of television, it will have served a useful purpose. For was there ever an issue more clouded by doubt than the question "Is television possible *now?*" The author tells us just how far television has progressed at the present day (up to August, 1928, to be precise) without being too technical and certainly without indulging in wild flights of imagination.

Starting from the almost accidental discovery of the light-sensitive properties of selenium, the history of television is unfolded stage by stage. A not undue proportion (some 30 pages) is devoted to the purely historical side, which covers familiar ground.

Then follows a carefully written description of the fundamentally important properties of the photo-electric cell, such important "offshoots" as the photo-electric valve amplifier of Zworykin not being omitted.

The image-forming device, or neon tube, receives a scanty three pages, and we think deserves more prominence; and on page 55 we should certainly query the statement that the degree of illumination produced by a neon lamp is strictly proportional to the current, without further explanation. Much depends on the particular arrangement of the electrodes and the working voltage.

Mention is made of Holweck's cathode-ray tube, and in this connec-

(*Continued on page 46, col. 3*)

When London was Gassed

By SHAW DESMOND

Author of "Ragnarok," (a story of the Coming World War), "Passion," "Gods," "Echo," etc.

When Shaw Desmond recently published his novel, "Ragnarok," it attracted the attention of the press to an unusual degree, over half a hundred newspapers alone giving it lengthy notices. One of those most interested was Mussolini himself, who, in Rome recently, expressed to the novelist his opinion of the views set forth. Shaw Desmond also received communications from leading authorities, including an air-marshal, expressing their deep interest. It may be stated that since the publication of the book many of the inventions foreshadowed therein have become accomplished facts, and in his present effort, "When London was Gassed," it may be said that almost the whole of it could take place to-day, as written.—[EDITOR'S NOTE.]

A GROUP of men stood around a table at the headquarters of the British Aerial Control in Whitehall, the new department instituted in the 'thirties for the supreme control of the aerial fleets of the Empire. The Great War had been long since forgotten.

These men were looking at a map. Some of them white-haired veterans; others, those young eager men who, since the realisation by Europe that the future of Europe hung upon the air ("air-hung" as the Kipling of the period had written), had replaced the gouty, slow-thinking veterans of an older day. Upon that map little flags stood up, some of them white, some green, some blue—but far away up there in the north-west an ominous block of red flags clustered.

"It is from there it will come," said one of the older men.

"And without warning," said the clever-looking, bald-headed, youngish man near him. "No declarations of war to-day. It'll come hurtling out of the blue."

"And we with ten millions of people in our care here in London," said the first speaker. "My God! What is to become of us all?"

"God knows, and only He," said the bald-headed man with a reverence unexpected. "But tell us again, Heathcliff, what you have found out about the Northland." He turned to the bronzed young fellow near him, the boy (for he was not much more) with the golden wings on the left breast which showed him to be one of the new Air Flotilla Leaders.

SHAW DESMOND, the author of this article.

"It is very simple, Sir," the youngster replied. "All Northland has gone into the air. They've scrapped everything to help them to do so. Ships. Destroyers. Tanks. Even large fighting units of soldiers and sailors. Yes, even airmen themselves."

"But what nonsense is this?" asked the original speaker, who happened to be Prime Minister of England. "Airmen? But you say they *have* gone into the air."

"Yes, Sir," said the youngster. "But when I was—er—spying I heard some of their chiefs say that in the warfare that was coming it was not necessary to risk a single life—at least not in the early stages. They are using pilotless planes, *tels avions* the French used to call them in that old war of 1914."

"But," said the Prime Minister impatiently, "they can't direct these *tels avions*, or whatever you call 'em, thousands of miles without pilots?"

"Oh, yes, they can," said the boy with assurance. "They can steer them by wireless. The French themselves did this—only over short distances, of course—so long ago, Sir, as 1921 on their trial grounds at Villacoublay, outside Paris. They can send them any distance through the air, and when they get them over their objective they can stop their machinery by wireless and send them crashing down to discharge their poison gas contents."

"Damnable! Damnable!" said the white-haired head of the British Government.

"Damnable, but fact," said Winstanley, the baldish man. "We are up against facts, and if we hadn't forgotten the lessons of the World War of 1914, we should have reckoned with them before. Heaven knows we've had enough warning. Those Northlanders have been preparing steadily all this time, and they were frank enough to tell us that one day they would set Europe once more by the ears. We've had warning enough."

"But they signed that League of Nations Pact at Geneva in 1928," said another speaker.

"League of Nations! Pah!" said Winstanley, laughing. "I am a realist. We have all been playing a game at the League table—heads I win, tails you lose—the oldest game in the world. League of Nations!" And again he laughed.

"What's that?" said the Prime Minister suddenly, as he looked at a plain glass screen which stood on the wall across the end of the big room. It was the television screen.

All the heads turned as with one movement to gaze at the white screen.

They saw clouds passing over it, and between the clouds tiny black specks like birds hurtling through them. And then the specks had disappeared.

"Look, oh, look!" He said it boyishly, like a child who had seen something interesting.

And then, outside, the men assembled had seen a sort of silver fish come whirling down out of the blue June sky to crash in the road outside, and to burst with a thud. Then another.

A soldier in khaki was walking up Whitehall. He stopped for an instant to look stupefied at the hole in the asphalt where the second fish had struck near him, and then he had dropped his cane and had begun to beat the air with his hands, laughably. It was as though he were playing a part. Then he had fallen face downwards and was biting at the ground.

Torpedo Fish.

A stout woman, carrying a leather handbag, a few yards away, stopped to stare at him, and then she, too, was beating the air with her hands in a sort of scrabbling motion, turning around and around. Then she, too, had fallen on the pavement and was striking feebly at the stones.

"They can do without my plaything."
"But London can't," said Heathcliff quietly.

"Must have been 'planes," said young Heathcliff, the boy with the wings on his breast. He had turned a little way from the screen to look out through the window near him and to gaze up into the sky. Then his figure had tautened.

"My God! what's that?" asked the Prime Minister.

The answer came shortly enough. It came from the youngster as truth is said to come from the mouths of babes and sucklings:—

"*Tels avions*" was all he said.

And now the people in the street were fleeing up towards Trafalgar Square to get out of the way of the terrible torpedo-fish. And as they went two more had come down with whirling tails to burst with that dud sound like the bursting of a big paper bag filled with air. But they were no duds. They were carriers of death. Carriers of death to ten millions of people herded together in the largest city on earth, the hub of the greatest empire the world had ever seen.

The square was filled with thousands of people who now poured into it out of the Strand and St. Martin's Lane. They were pouring out of Piccadilly Circus and Leicester Square to escape the *tels avions* which had fallen there, fallen out of a clear sky, without warning—bolts from the blue, indeed.

Into the square they surged, thousand upon thousand, until they stood in huddled masses about the plinth from the top of which Nelson, as always, looked out indifferent with his single eye. They poured over the plinth itself. They fought together to scramble up as though it were a place of refuge from the Hidden Death, from that *gas* which was to be the arbiter of Britain's and Europe's fate.

In a Descending Spiral.

So far no fish had fallen in Trafalgar Square. The excited cries were dying down as the refugees began to feel, however thoughtlessly, however illogically, that it was a place immune from the terror of the June skies. And then a howl of anguish went up as the crowd stared into the skies to watch half a dozen great fish, their sides silver-shining, as they circled over the square.

Around and around they went in a sort of descending spiral, and then first one and then another seemed to collapse on itself and came down into that mass of flesh and blood to tear great holes through it and to burst with that dead "phut-phut" which was the presage of the gas-scattering.

The hands of that helpless mass went up, beating the air above their heads, and then as by a miracle, great spaces showed themselves in the mass as the people went down suffocating in the gas.

The Flying Death.

Those on the outskirts now broke away from the flying death, trying to find refuge in the buildings about, bursting in doors, and seeking to get down into the cellars where they believed they would be safe.

The half circle of offices of the great shipping companies, at the first onset of the crowds into the square, had closed their doors. But now a human avalanche hurled itself against the America House building, smashing in the great doors as though they had been tinder, and pouring down into the cellars despite every effort of the officials to stay them.

A big doorkeeper in the Cunard building had foolishly sought to hold up the stampede of crazed humans, who now were but maddened animals. In a moment he was down and being trampled to death under the onrushing hordes. Down into the underground passages they poured, down into the Hampstead Tube, and into the lifts. And when the lifts were at the bottom of their shafts, the crowd, helpless to stop itself, burst through the protecting lift doors and fell down the hundred foot chasm, wave on wave.

Wave on wave they surged over the edges of the pit shafts, until they had piled them to the very top with dead and dying.

The Horror of Whitehall.

And what took place that June day in London town in the efforts of the crowds to escape from the flying fish will never be told to the full, for those who witnessed it in its supreme horror did not live to tell the tale themselves.

Young Heathcliff saw something of this as he sped in his car through the London streets.

For he was the first of all that group of men to realise what was happening, and almost before the second fish had fallen in Whitehall he had jumped down the great stairs of the Aerial Control Building, had climbed into his car, and was driving hell for leather towards North London.

He could not make headway up Whitehall with the crowds now pouring upwards into Trafalgar Square, so he quickly turned his car in the other direction, sweeping past the House of Commons down the Embankment, where apparently no fish had fallen. Here at least the ordered life of a great city went its accustomed course.

Policemen on·duty at all traffic points. The trams running along as though nothing had happened. The boats on the river peacefully tooting their way up and down. For London seemed to be a city of watertight compartments. The horror of Whitehall and the square had not yet penetrated to the Embankment.

Past the astonished and indeed angry policeman who tried to stay his wild passage. Past the end of Blackfriars Bridge, and at sixty miles an hour up Queen Victoria Street. Past the Mansion House and Bank, and then to the left down Princes Street, hearing behind him as he sped the thud of another of the fish—the first to fall in "the City."

Then he was in the City Road and fairly set for Queen's Road, Finsbury Park, where he knew was the one man who could save London.

Professor Ian MacWhirter was about as unlike the popular idea of a scientific man as any man could well be. He was a youngish, good-looking Scot, with a shock of reddish hair tumbling over his forehead and into the big glasses which he was wearing as he bent over a lens in the corner of his laboratory when young Heathcliff entered.

"Those Silly Asses."

Heathcliff was sweating like a bull. Heathcliff was a hot and dusty and, if truth be told, a very dirty Heathcliff from a spill in turning out of the City Road at forty miles an hour. But he was here. As he said exultingly to himself: he was here!

He was cool enough.

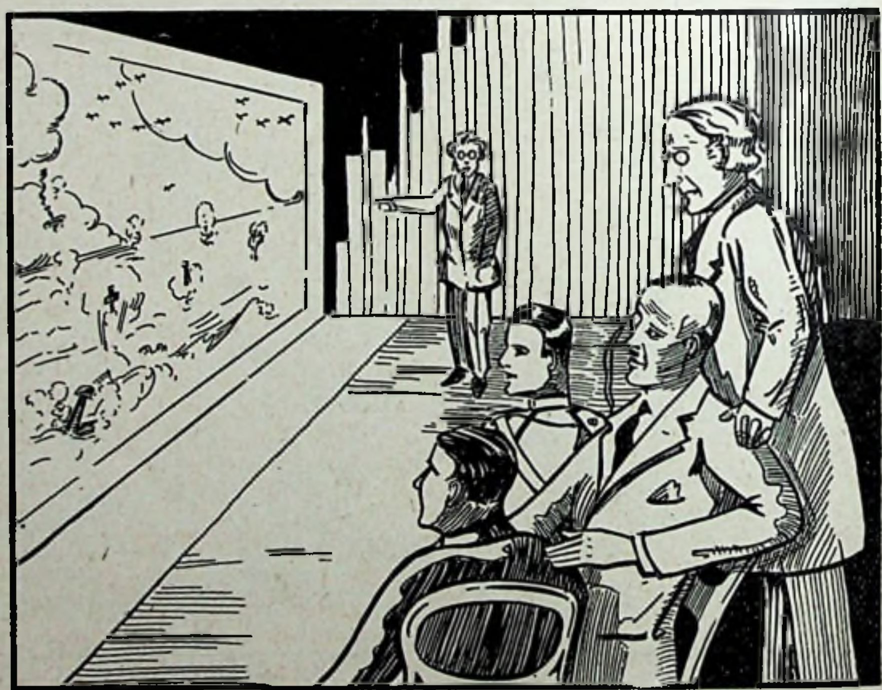
"It's happened," he said to the Professor who had gone on with his observations.

"I thought it would come," said MacWhirter, as coolly as though he had been expecting something for a long time.

"The silly fools wouldn't listen to you, Sir," said Heathcliff, "and London's for it. Two *tels avions* in Whitehall, and the first in the City as I came into Princes Street to get here."

"Well, what about it?" asked the Professor lifting his eye from the lens.

"I know those silly asses at Whitehall wouldn't listen to you, Sir," said young Heathcliff irreverently, "but damn it all! we can't let ten millions of people be poisoned because you won't offer your services once more."



MacWhirter had, indeed, given England her "eyes."

An Inventor's Lot.

"But I did offer my services. I told them that with my new invention, added to the older televisor and noctovisor, one could see, literally, round the world by night or day—and they laughed at me. Damn 'em! They laughed!"

Professor MacWhirter seemed at the moment a very angry professor despite all his coolness.

"Well, they, or others, once laughed at the inventor of the televisor itself, Baird. So you are only going through what others went through."

"But, they didn't tell him it was only a 'plaything,' damn 'em!" said MacWhirter, once more what Heathcliff called "going up into the air." "Well, they can do without my 'plaything.'"

"But London can't," said Heathcliff quietly.

MacWhirter stared at him, swore a little under his breath despite all his scientific detachment, and in a moment was putting on his coat. In another he was speeding by the side of Heathcliff back to Whitehall.

That was a nightmare ride. For in what ultimately appeared to be the First Wave of the flying fish, there was neither let nor stop. Fish after fish came plunging over and down upon the doomed city, guided inexorably by the Northland wireless, itself an extension of the principle of "positional-wireless," which had first been used long years before to give aeroplanes and ships their position at sea or in the air.

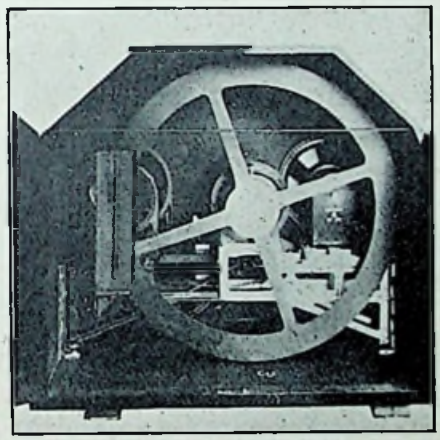
Fortunately for England, "the stormy petrel of Europe," as the Northland was known, did not possess the invention of Professor MacWhirter which at night made the earth's surface as plain to the eye as in broad daylight. It was in itself an extension of the principle of Baird's original noctovisor, through the medium of which, as long back as 1927, that pioneer of television had shown people sitting in total darkness in a room in London to scientists sitting in a room in Leeds.

London's Inert Mass.

Both Heathcliff and MacWhirter had adjusted their gas masks ere leaving the Queen's Road. Again and yet again they were compelled to make detours in their effort to break through London's now frenzied and helpless, because unmasked, millions. For as every expert had long before realised, at the time when the aerial manœuvres over London in the August of 1928 had shown the impossibility of preventing aerial attack upon London's helpless inert mass, no man could propose putting gas masks upon millions of people. Little children, thousands of whom were to die this night in this First Wave from the Northland, could not be masked. And as for their elders, not one in a thousand had provided himself with such an appliance.

"Where's the Screen?"

At last MacWhirter and Heathcliff found themselves in the room which the latter had just vacated—the room of the Aerial Control, now the very nerve-centre of the British Empire. This time, at least, the men about the table had not laughed at the Scot or called his invention a "plaything."



Interior view of the top part of Baird televisor shown in our cover illustration. The complete dual instrument, as illustrated on the cover, is listed at £150.

It was Winstanley, a courtier born, who took upon himself the task of pacifying the outraged Scot.

"We've made a mistake, Professor MacWhirter," he had said in the suave voice for which he was famous. "The winsome Winstanley voice," as it was known.

"We did not know. We did not realise," said the Prime Minister haltingly.

"Well, ye realise now," said MacWhirter implacably.

"Yes, we do, Professor," went on Winstanley in those smooth explanatory tones. "And we apologise."

MacWhirter looked fiercely at the man before him as though he would snap his head off, and then a little wintry smile crept into his face. But all he said was:—

"Where's the screen?"

The Battle Won.

Winstanley knew the battle was won.

Out of the bag which he carried he took an instrument, which he instantly began to connect up with the great television screen that stretched itself across the end wall, and which was one of the thousands of television screens now to be found in nearly every house in England. By now (for it had taken them many hours to cross London) the shadows were drawing down outside, and Heathcliff knew it was to be one of those moonless nights in which the blackness only seems to be accentuated by the stars.

"We're blind," said Winstanley, looking out at the descending night. "Blind! Blind! Blind!" He said it with a growing access of passion. "Give us eyes, MacWhirter."

"Och, aye!" said the Scot. "Wait a wee bit."

"But we can't wait," said Winstanley impatiently. "Those Northlanders won't wait. They're only waiting for night to send over a cloud of their new warplanes to complete the work of the *tels avions*. We know that through our spies. Heathcliff there will tell you. If we wait, we wait for death."

"Yes," said Heathcliff. "Their plan is to send wave on wave of poison gas over London until the city's millions are obliterated, and all the directional centres, and especially the Aerial Control, are paralysed. They believe that if they strike at London they strike at the heart of the Empire, and they mean to make a clean job of it."

"Oh, for eyes! Give us eyes!" said Winstanley, getting up from the table to watch MacWhirter's preparations impatiently.

"Wait a wee bittie," said the imperturbable Scot. "You weren't in such a hurry a while ago."

An Empire's Fate.

To this turning of the iron in the wound no man there made any reply. For each one of them knew that the fate of London and probably that of the British Empire lay in the brain of that single shock-headed man doing something with his hands in the corner.

"If we can see 'em," said Winstanley, "we can bring 'em down. If we can't see 'em, we are at their mercy. But we must see them, not when they are just on us, but when they start—and you say your new invention can do this."

"Wait a bit, now," said the Scot going on with his work.

And then a great white light had burst upon the glass screen, upon which appeared as though they were in a train and unrolling itself backwards to them as if they were passengers, the English landscape around London, but as bright as if it were seen in daylight. For the noctovisor extension was "the eye that sees everywhere."

Past the eyes of the onlookers tore the Surrey and then the Sussex landscape with its white chalky downs. And then the belt of the sea. And then, quick as thought, the whole of the European continent was streaming towards them and they were rushing across it, then with a trembling adjustment they were over a city of strange cupolas and spires—a city semi-Oriental.

A Famous Capital.

It was the famous capital of the Northland.

And then they were outside the city on the great screen, and there came upon the screen a circle of blinding lights moving amidst great hangars. And around the hangars thousands of midgets bustled, preparing something.

Already the Aerial Control was sending its messages out to the defenders of London. Already the "Channel Fliers," as they were known, were making ready. And as each warplane rose from the ground, and squadron on squadron formed itself in the night skies over the Northland capital, ready for its swoop on London, the defenders were informed. MacWhirter was giving England her "eyes."

And now the men in the room had formed a semicircle about the screen upon which they were staring intently. As the first Northland squadron wheeled and shot through the night skies upon its mission of death to form that Second Wave which was to complete the paralysis of the city, the screen picked it up.

As the squadrons came screaming across the continent at the four hundred miles an hour which was then the ordinary speed of the warplane, the screen picked them up and held them inexorably. And for every mile they flew, calculations were being made by the Aerial Control for dealing with them at the precise spot which had long before been decided upon.

Blinding Searchlights.

That spot was the English Channel, still a strip of water to protect the island-kingdom. It had ceased to be a barrier. It had, instead, become a grave.

(*Continued on page 46, col. 2*)

Another Scientific Adventure

By W. C. FOX

In our April number Mr. Fox described, in a very interesting article entitled "A Love of Scientific Adventure and Where it Leads," many highly exciting and absorbing experiences which his penchant for scientific novelties has brought him in contact with. In the following article he describes very vividly his latest experience in connection with television.

FORTUNATELY no one can predict the future, otherwise I should never have gone to Holland and found myself——. But I go too fast; what I found is the end of the story and has to do with my inability to make speeches in public.

When it was suggested to me that I should spend the summer by taking full charge of the television stand at the Netherlands Industrial Exhibition at Rotterdam I cheerfully accepted the position, for it offered a chance of seeing Holland from the ground. Having seen a lot of it from the air the new viewpoint was attractive, and there might be adventures attached to it.

On a perfect evening in July a tiny steamer carried me out of the Thames on to the placid, mirror-like North Sea, and the next morning I was watching with a thrill of enjoyment the busy shipping activity on the Maas outside Rotterdam.

Soon Busy.

It was not long before I also was busily engaged at the exhibition trying to fathom the mystery of the Dutch language, interviewing interpreters, and attending to the hundred and one matters that arise in connection with an exhibition stand.

Very soon things settled down and the period before demonstrations were given quickly passed. When the transmitter and receiver arrived fresh difficulties presented themselves. No one knew the English and Dutch for all the technical electrical terms about which information was necessary, but diagrams, dictionaries, and determination on both sides cleared all the knots and the apparatus was soon running. There was one trouble. Everyone wanted to see the demonstrations at once, and the only complaint heard was from one or two people who were kept waiting a few minutes.

(P. & A. Photo.)

A DIFFERENT SORT OF SCIENTIFIC ADVENTURE—A TELEVISION WEDDING!
One of the features of the Radio World's Fair in New York City was the wedding by radio and television of Robert W. Philysson, of Winnipeg, Canada, to Miss Bessie Simpson, of New York. The bride was in the Crystal Studio at the Fair; the groom was at a remote control point, and the minister was at his home in Yonkers, N.Y. Receiving sets and loud speakers at the three points of the triangle brought the "I Do's" and three televisors brought to the Fair the facial expressions of preacher, bride, and groom.
Photo shows the first couple to enroll for the Radio Television wedding, Robert W. Philysson and Miss Bessie Simpson.

In this way the last day of the exhibition drew near and it was announced that His Royal Highness the Prince Consort would attend to give it an official closing and would come to the television stand for a demonstration.

The great day arrived. Suddenly it seemed there was a clatter of swords (all Dutch policemen seem to wear swords), and an inspector of police announced that the Prince had come.

Having inspected the exhibits he passed directly to the demonstration chamber, and I had time to look about me and feel thankful I was not called on to play a prominent part. Such meditations, however, were abruptly terminated by my being called into the chamber, where the Prince requested me to sit in front of the transmitter. In a haze of nervous anxiety I stammered out an appropriate reply and hurried off to the transmitter situated some distance away. Stumbling over the doorsill, I fell rather than sat down before the apparatus. There was a pause during which I wondered if my tie was where it should be, or playing its usual trick of wandering off towards my right ear.

"Please make a speech."

"Will you please turn profile? Yes—a little more," said the well-known voice of the demonstrator via the loud speaker. I did so, and followed up with other movements according to request. Then came a pause and "Will you please make a speech."

To have used a feather to knock me over would have been like using a steam hammer to crush a fly, and my look of blank dismay, surprise and horror must have come out on the receiver particularly well, for sounds of undoubted amusement came over the line and from the loud speaker. Gathering my scattered wits together, I started as all nervous persons do with considerable hesitation, praying the while that some-

(*Continued on page* 44, *col.* 3.)

(*Concluded from page* 34.)

oscillatory circuit can be sustained in current oscillation if properly timed voltage impulses are applied, and the valve with its associated apparatus functions in the capacity of an impulse timer.

Another Similar Case.

For those readers musically inclined, let me cite one more analogy for this vibrating circuit, namely, a violin bow. The force and velocity of the bow are essentially constant, but the peculiar friction between the bow and the violin string enables the string to absorb more power from the bow when both string and bow are moving in the same direction than is given back to the bow by the string when the motions of both bow and string are in the opposite direction. The muscles of the arm actuating the bow constitute a source of continuous power, but it is obviously impossible for an arm muscle to supply directly power to a string vibrating, say, at a frequency of a thousand times per second. The arm supplies energy to the bow at an essentially constant rate and it is the reactions between the bow and the string that serve to utilise this power to maintain the string in a state of rapid vibration.

The Simplest Case.

So much for the analogies which will help to impress the actual oscillating and maintaining process in the reader's mind, and we should now be in a position to approach our electrical problem in a frame

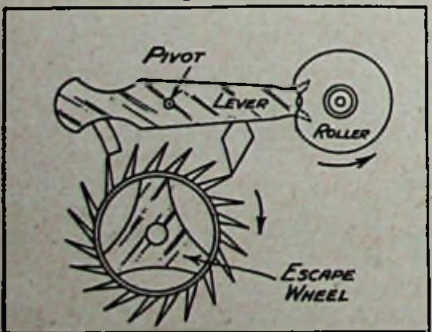


Fig. 4.
A mechanical analogy explaining the action of an oscillating valve.

of mind conducive to a thorough appreciation of its action. Taking the simplest case of a valve connected to an external circuit for producing and sustaining oscillation, we can examine that shown in Fig. 5. Anyone familiar with wireless circuits as applied to ordinary receiving sets will recognise that it contains the essentials of a valve receiver employing magnetic reaction, and when connected to an outside aerial is a source of considerable annoyance to nearby listeners if the user deliberately or unwittingly operates the set so that it oscillates, energises the aerial, and therefore becomes a miniature transmitting system.

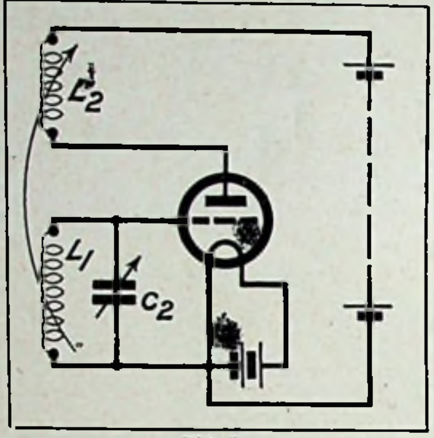


Fig. 5.
A simple oscillating valve circuit.

We see shown in schematic form an oscillatory circuit $L_1 C_1$, joined between the valve grid and filament, while in the plate circuit is another coil L_2 coupled magnetically (that is, the lines of force in one coil can influence those in the other coil) to the first coil. Under normal circumstances we can assume that the $L_1 C_1$ circuit is lightly damped, or in other words, the total resistance in the circuit is of small magnitude. If this condition was not met the circuit would not oscillate any more than our pendulum or balance wheel would operate if there was too much friction at the bearings. We have seen that if this circuit is set oscillating by some means the number and magnitude of the complete cyclical operations is a function of the resistance in the circuit.

Actually, the energy originally imparted is absorbed by the resistance, and if there is no external energy supplied to the circuit the oscillations will decrease in the manner we have seen previously—damped waves. How can we reimburse this circuit with energy to make up for the loss and in what way are the energy impulses applied so that the oscillations are sustained? This will have to form the subject-matter for next month's article, for it has a bearing on one of the most important applications of a thermionic valve.

(*Concluded from page* 43.)

thing might break down, but nothing did. Nor did the floor open and obligingly swallow me up. Remembering that I could see no one gave me a slight measure of confidence and enabled me to be coherent.

After my brief address there was another pause, and then a voice which I did not recognise, but afterwards learned was that of the Prince, asked me to show my handkerchief. I did so promptly and again my face gave me away, for it faithfully showed my relief at not being asked for another speech. This concluded the demonstration, and going back to the stand I had my third surprise, in that I was presented to the Prince, an honour which I felt my small part in the demonstration scarcely deserved.

Some hours afterwards I realised I had had another scientific adventure in that I had shared in the first television demonstration given to royalty.

(*Concluded from page* 22.)

London and Daventry. But there are also great difficulties, because most of the people in foreign countries do not understand the languages which are used in other countries. But in contrast to this television is indeed international. **There are no frontiers of language to separate the nations—you see with your eyes, and every man can understand sight.**

The invention of television will bring all nations together in a way that could never previously be imagined. When you see on the screen of your apparatus first the person or persons speaking in other countries, and later when you see the important events happening in all countries—then you will really be able to make acquaintance with all sorts of important events in all other countries. Therefore I think that television is an even more important invention than broadcasting, and I follow with the greatest interest all the stages of development. Mr. Baird's first public television broadcast will be one of the greatest moments in the history of this invention.

Invention and Development

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.

Selenium cells. No. 294108. (Convention date, July 16th, 1927.)—H. J. Küchenmeister seeks patent rights for a selenium cell of the condenser type illustrated in Fig. 1. The sensitive material is applied along an edge *h*, which is formed by laying the two sets of conducting sheets *a*, *b* crosswise. The surfaces *c*, *d*, which meet in the edge, are provided with a sensitive layer near the edge, so that the cell may be influenced by light from more than one direction. Detailed considerations are given to the use of the cell in the reproduction of sound from a film record.

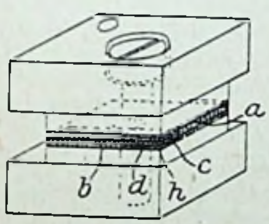
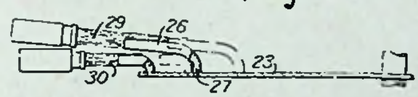


Fig 1.

Patent No. 294719. (Granted to S. G. S. Dicker and Philips, Gloeilampenfabricken (Holland).)—In Kew cells having a liquid dielectric for use in photo-telegraphy or television the conductivity due to the impurity of the liquid is kept down by causing the liquid to flow through the cell. It is suggested that a fixed quantity of liquid should be made to circulate through the cell and be subjected to a purifying process.

The use of internally reflecting rods or tubes has been the subject of more than one patent recently. In *Patent No.* 294267 J. L. Baird employs such tubes for receiving or transmitting light (by internal reflection within the tubes) from different directions. In Fig. 2 the exploring disc 23 is represented in section with a number of sets of light-transmitting devices 27,

Fig. 2



which latter may be openings in the disc or mirror reflectors. Each set of holes is arranged in the familiar spiral formation, and when the disc is rotating, light rays passing through the holes are bent within the tubes 26 into substantially different directions, 29 or 30, according to whether the tubes are working in conjunction with one set of holes or the other.

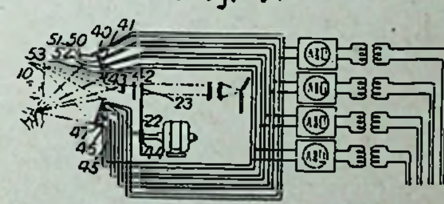
When finer picture detail is sought after recourse must generally be made to multiple exploring systems. That is to say, several different areas of the object are explored separately and simultaneously. Baird's patent just dealt with, and the two patents which follow, are examples of this.

Fig 3.

A modification of the usual type of scanning disc is the subject of *Patent No.* 295653 (Convention date, August 16th, 1927), by L. Szenyovszky.—The object or image *a* (Fig. 3) is explored by two rotating discs mounted on the same shaft and revolving in opposite directions, and having slots or rows of holes 1, 2 crossing each other at a constant angle. The slots 1 are in the form of arcs of a circle; slots 2 are cut straight. It will be noticed that the slots are in a similar relative position at a number of positions represented by *a*, *b*, *c*, *d*, so that a corresponding number of identical objects or images can be simultaneously explored to obtain colour or stereoscopic effects.

Another form of multiple scanning disc is described in No. 293308 (Convention

Fig. 4.



date, July 2nd, 1927, Electrical Research Products and H. E. Ives), whereby a number of light beams are made to scan separate areas of an object 10 (Fig. 4) simultaneously. 22 is the scanning disc having apertures 23 provided with light filters arranged radially and producing a number of scanning beams having different wave lengths. These different beams impinge on the object along adjacent paths and are reflected to light-sensitive cells 40, 41, 42, 43. The cells are either inherently selective to different wave lengths, or are rendered so by placing light filters 50, 51, 52, 53 in front of them. A second group of cells 44, etc., may also be used, the modulated currents from each pair being sent to line to operate a multiple electrode glow discharge lamp at the receiver.

(*Concluded from page 7*)

Separate Transmitters.

The next stage will be to obtain televised images of two people speaking or singing in concert. It would not be necessary for the two sitters to be placed before one transmitter. Two separate transmitters might be used if they are geared together so as to run exactly in step. Two separate but geared receivers might also be used and the images brought into one field of view by suitable prisms.

If a single object the size of a human face or a little larger can be fairly reproduced at a distance by the use of radio waves as a means of transmission, and if that can be accompanied by vocal or speech transmission as well, so that we can both see and hear the speaker, it seems to me that new life might be given to ordinary wireless broadcasting.

The spot-scanning method of transmission, aided by a microphone near the sitter, gives absolutely perfect synchronism between the motions of the vocal organs and the sounds. In fact, **television even as it is at present by Mr. Baird's system could give a lesson on lip-reading at a distance.**

The Value of Sight.

Moreover, the comprehension of a speaker's words is much assisted when we can see the speaker's face reproduced, because we all unconsciously do a little lip-reading in listening to a visible speaker.

Eminent judges on the bench have laid it down that in reading a patent specification it should be read with a "willing mind," that is with a genuine effort to understand its meaning and not merely a desire to find fault with it. Perhaps the same advice might be given with regard to television. To use a hackneyed phrase, it is in its infancy, but it is at any rate an infant which is alive and not merely a lifeless model of one.

It is desirable to conclude with the remark that the writer of these lines has no interest whatever of any sort, kind or description in the commercial aspects of television or of any proposals to employ it as a public service, but is simply and solely interested in it as a scientific and technical achievement.

(*Concluded from page 42*)

Those watching saw the Northland squadrons as they tore above the waters of the Channel suddenly check. And then from the waters below there had burst into the upper regions a ring of powerful searchlights blinding the pilots of the Northland planes, ringing them so that they could not escape.

A Chain of Bombs.

And as they fluttered helplessly for a moment seeking to escape those long white fingers of light that sought to hold them, those in that Whitehall room saw swooping down upon them from above squadron on squadron of the defending planes, which had been waiting in the upper regions at a great height, their pilots wearing the now universal oxygen mask which enabled them to remain aloft in those rarefied air-strata.

In vain did the Northland planes seek to mount to get on terms with the defenders. As they rose, they were struck with the chain-bombs with which the British planes were furnished, bombs which showed their direction in long trails of greenish light. In vain did the Northland commanders seek to draw away. As they turned to fly back to the continent from which they had come they were struck remorselessly down by the defending planes.

Bursts of light showed where in the night skies they met their end, to come smashing down into the safe waters of the Channel to discharge their poison loads harmlessly in the blue waters—loads which, brought down on land, would have spread death over the English countryside.

In that fight over two hundred of the enemy planes perished, only a remnant getting back to the Northland capital to tell the story of how the brain of a single man, working alone, had saved the capital of the British Empire.

MacWhirter had, indeed, given England her "eyes."

(*Concluded from page 37*)

tion it would have been helpful to have had the method suggested by Campbell-Swinton discussed, and the difficulties of operation emphasised, in view of the theoretical importance underlying the idea.

As might be expected, however, some considerable portion of the book is devoted to methods of mechanical exploring, for this is the only method which has hitherto yielded results of any worth. A due place is given to American and Continental workers, but the chief interest centres round the Baird system, which is undoubtedly the most successful of any yet demonstrated. Considerable light is thrown on the practical methods developed by J. L. Baird, and the very recent work is brought right up to date.

The chapter on synchronising is particularly valuable. Here (as, indeed, throughout the book) apt and simple analogies serve to clear up such difficulties as "isochronism" and "synchronism." The Ranger tuning-fork method, the phonic drum and synchronous motors all receive a due share of attention.

Throughout the book it is not only the principles but also the actual methods, where known, which are explained. For example, the difficulties to be met in the wireless link are frankly and authoritatively discussed, and we are glad to see that the old misleading conception of dividing a picture into so many thousand dots has been dropped in favour of the idea of strips.

Fig. 35 seems to need some further explanation; otherwise the diagrams and illustrations are well done and are distinctly helpful to the reader.

By clearness of expression the author certainly holds the reader's attention, and I have no hesitation in recommending the book to the wider public which needs an authoritative exposition to fill in the gaps in the mental picture occasioned by newspaper reports and technical journals. The book is evidently not intended as a work of reference; nevertheless an index would have been extremely useful.

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

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.*

46, Howard Road,
Walthamstow,
E.17.
October 7th, 1928.

The Editor,
"Television."

Dear Sir,

For some months past I have been reading reports by alleged "experts" that some radical development is necessary in television before the public should take a serious and general interest in it.

When, therefore, I visited on September 26th the public demonstration studio of the British television system I expected to see the human head as a blurred image resembling a turnip with blobs for mouth and eyes. Actually I saw a well lighted, animated, and recognisable image which was sufficiently large and clear to show every movement and play of expression.

On leaving the studio I could not but wonder why I had been so misled, and why such an apparently definite attempt has been made to strangle at birth Britain's lead in this most fascinating new science.

Yours faithfully,
G. H. Gill.

Bonnington Hotel,
Southampton Row,
London.
October 2nd, 1928.

The Editor,
"Television."

Dear Sir,

Just a short letter from an American in regard to Mr. Adcock's views.

Several years ago I conceived what I thought at the time to be an original idea for obtaining power from light by heterodyning the waves through two prisms to disperse into colours set exactly opposite each other, the colours to interfere and the resulting wave to be picked up by resonance circuit near by.

Later, realising that the power would be small, I thought of using the resulting wave for short-wave radio transmission.

I built a device but never got it finished, as vernier control must be very fine for these experiments. I later heard it said that the Bell Telephone Laboratories had done similar work, as also had other researchers.

I may say I am not working on this now as my interest has turned to other fields.

Here are a few useful "tips" to experimenters. A very fine control can be cheaply made by using two geared speed counters in series. That is, attach the worm or drive spindle of the second to the recording or gear spindle of the first, which will give in one American make a 10,000 to 1 control. There is backlash, however, so a friction drive radio dial compounded might be better.

Now as to light "hetro." Can some expert on spectrum work find two elements of which the bands of part of their spectrum is the necessary number of wave-lengths apart, and, if so, can he make a gaseous mixture of same inside a vacuum tube of some sort in circuit with a short-wave radio receiver? I've been told it cannot be done. But I think it might be done.

Yours faithfully,
Charles Gardner, Jr.

P.S.—These ideas really grew out of an incident described many years back of supposed electric shock obtained when a boy and a man flashed sunlight from hand mirrors, and one with the silver unbacked met the rays exactly. This was described in the magazine by a reader. The magazine is now called *Science and Invention*, but was then, I believe, the *Electrical Experimenter*. It is edited by Hugo Gernsback.—C. G.

COLOUR MUSIC AND TELEVISION.

43, Shoobridge Street,
Leek, Staffs.
October 1st, 1928.

The Editor,
"Television."

Dear Sir,

I submit the following as being a subject likely to interest many of your readers, and possibly the Baird Television Company. I am not as yet acquainted with the difficulties that will be encountered with the reception of coloured television, and write on the assumption that we may reasonably hope that it, having been shown to be possible, will in the near future be incorporated in the regular television transmissions.

If it is possible to transmit moving coloured objects of any hue, little difficulty, if any, would arise in the transmission of colour music.

The possibilities of an art of light have been deeply investigated, notably by Professor Rimington, A. B. Klein, and others, and it is maintained that fundamental principles exist upon which a form of colour music, somewhat akin to the acoustic music we already possess, will ultimately be developed.

A few individuals who, like the writer, have constructed various types of apparatus for the production of this new music have caught glimpses of a veritable wealth of æsthetic pleasure lying dormant, and can appreciate the numerous avenues of possible development. The main reason why colour music has not been developed as a sister art to the acoustic would appear to be that, until recent years, means have not been available for its production, and even now the apparatus required is too expensive to become popular. Recent years have seen a considerable increase in the æsthetic appreciation of colour harmony, and with the advent of coloured television the development of an art of light should receive great impetus—elaborate instruments capable of producing the most beautiful colour compositions imaginable could be broadcast.

The introduction of the time and other elements of music into colour harmony renders existing laws extremely flexible, and they are entirely inadequate, practically all the elements that go to make up acoustic music as produced by an organ could have their counterpart in colour.

The writer's own device automatically produces colour music when connected to a piano, and aims at producing colour effects as closely allied to the accompanying acoustic as possible. I will not discuss here the arguments advanced against such a combination except to say that the large amount of successive contrast that occurs in colour music renders scientific accuracy with regard to the wavelength of colours forming harmony unnecessary, and also it is not essential that the whole field of vision should be filled with colour to enable us to receive æsthetic impressions.

It does not seem too much to assert that no person is living whose sense of colour music is sufficiently developed to justify an opinion that it is impossible to combine the two arts. To most experimenters, and these have included eminent composers and artists, some affinity is apparent; to the writer the greatest difficulty seems to be in endeavouring to combine age with youth, discrepancies are bound to occur between an art centuries old and one that is but an infant, possibly the future will see a type of acoustic music developed solely with a view to producing harmonising effects of light and sound. One thing, however, is certain. Colour music, even though restricted to the size of a television screen, would convey to most observers inexplicable æsthetic pleasure. To condense matters, then, we have the following: (*a*) Investigation has proved that fundamental principles exist upon which an art of light may be built. (*b*) Various types of instruments for its production are in existence. (*c*) Progress is retarded by the lack of psychological knowledge from which laws may be formulated. (*d*) Such knowledge will only be gained when a considerable number of persons have witnessed colour music sufficiently to express an opinion of value. (*e*) Coloured television offers a means of conveying this new music to the multitude. (*f*) Colour music is a subject worthy to rank among those to be broadcast by television.

Yours faithfully,

PERCY SIMPSON.

[Our contributor, Shaw Desmond, described in a recent article a demonstration of music in colours which he attended in Philadelphia, and the General Electric Co. (U.S.A.) are at present working on the idea.—ED.]

B.B.C. DECISION.

ROMFORD, ESSEX.
October 18th, 1928.

THE EDITOR,
"TELEVISION."

DEAR SIR,

I note with considerable surprise that the press announce that in the opinion of the B.B.C. television has not reached a state of perfection such that they feel able to afford broadcast facilities.

I was one of those who was fortunate enough to witness a demonstration of the Baird televisors at Olympia, and I must be one of the many thousands who entirely disagree with the decision of the B.B.C. The demonstration which I saw proved beyond all doubt that the Baird system of television has not only reached a very high degree of perfection, but the entertainment value of the present B.B.C. programmes would be enhanced immeasurably by the simultaneous broadcasting of television and speech.

Yours sincerely,
H. T. D.

ST. ALBANS, HERTS.
October 19th, 1928.

THE EDITOR,
"TELEVISION."

DEAR SIR,

In common with a number of friends who have for some months awaited television broadcasts, we learn with much satisfaction that, despite the decision of the B.B.C., Mr. Baird is shortly to start television broadcasting on his own account. We wish him every success.

Yours faithfully,
JOHN WALTERS.

EDGBASTON,
BIRMINGHAM.
October 19th, 1928.

THE EDITOR,
"TELEVISION,"

DEAR SIR,

I have been expecting the broadcasting of television for some weeks. It was even rumoured in this area that Daventry (5GB) was to be used for the purpose, using Chelmsford (5SW) to relay the transmissions for the benefit of the colonies; and now I read with disappointment that the B.B.C. are doing everything they can to delay the broadcasting of television. When will Savoy Hill realise the real wants of the listener?

Yours, etc.,
"ENTHUSIAST."

EALING WEST.
October 18th, 1928.

THE EDITOR,
"TELEVISION."

DEAR SIR,

Last week, for the first time, I saw a demonstration of television at Selfridges. I do think that the picture could have been better, but what I saw has proved to me that Mr. Baird's television has certainly reached a stage of development to warrant the commencement of experimental broadcasts.

I cannot see why the B.B.C. should place an experimental station for still picture transmissions and not to television—a vastly more interesting thing to my mind.

Yours sincerely,
K. R. HARRIS.

(*Concluded from page* 37).

Finally:—

$$\frac{u}{v}=\frac{CF_1}{F_1O}=\frac{u-f}{f}$$

Dividing each side of the equation by $1/u$

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}\ldots\ (5)$$

This is the same equation, allowing for the difference in the sign convention, as that which occurs on p. 26 of the August issue of TELEVISION.

A set of equations which we shall find very useful in our future work.

(*concluded from page* 28).

instance, the picture is enlarged by the lens of the projector, but once the screen is illumined no further enlargement takes place. When the light rays reach the eye then the lens of the eye reduces the picture and focuses it on the retina.

Now suppose a subject, for instance a theatrical performance taking place in a specially prepared studio, to be "illumined" by rapid oscillatory discharges so that the electromagnetic waves are reflected and focused through a lens which refracts such waves, on a screen or disc which is the analogue of the microphone. Amplified and radiated after screening to obtain parallelism of the rays, could they be received and give a clear image without distortion or blur? That is the problem which if solved will give immediately the television which would be within the reach of almost every home. The field for research which it opens is an interesting one, although for the present the travelling spot device is the best solution possible.

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