NEW YEAR GREETINGS TO ALL

6D MONTHLY

Television

The Official Organ of the Television Society

VOL. 1 JAN. 1929 No. 11

EXPERIMENTAL

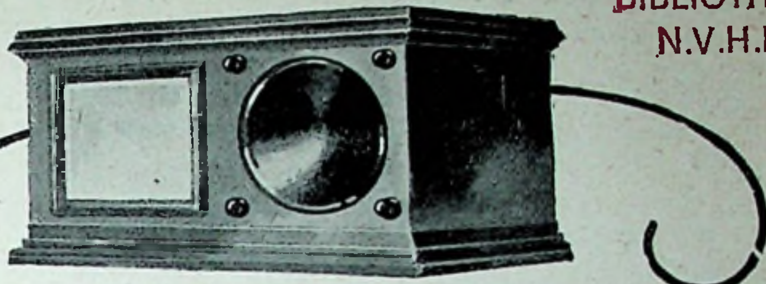
TELEVISION PROGRAMMES

NOW BEING

BROADCAST

TWICE WEEKLY

THE WORLDS FIRST TELEVISION JOURNAL



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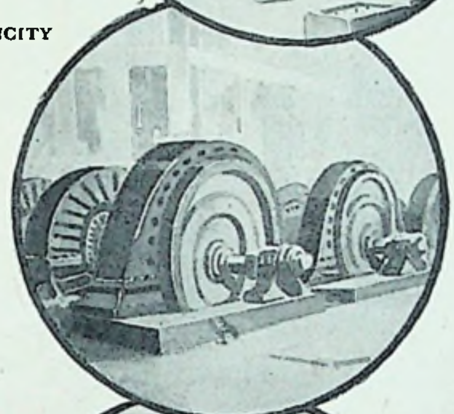

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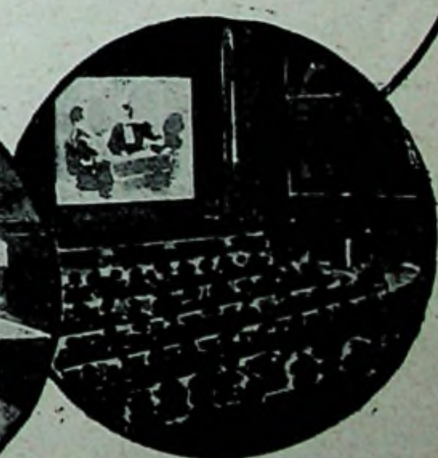
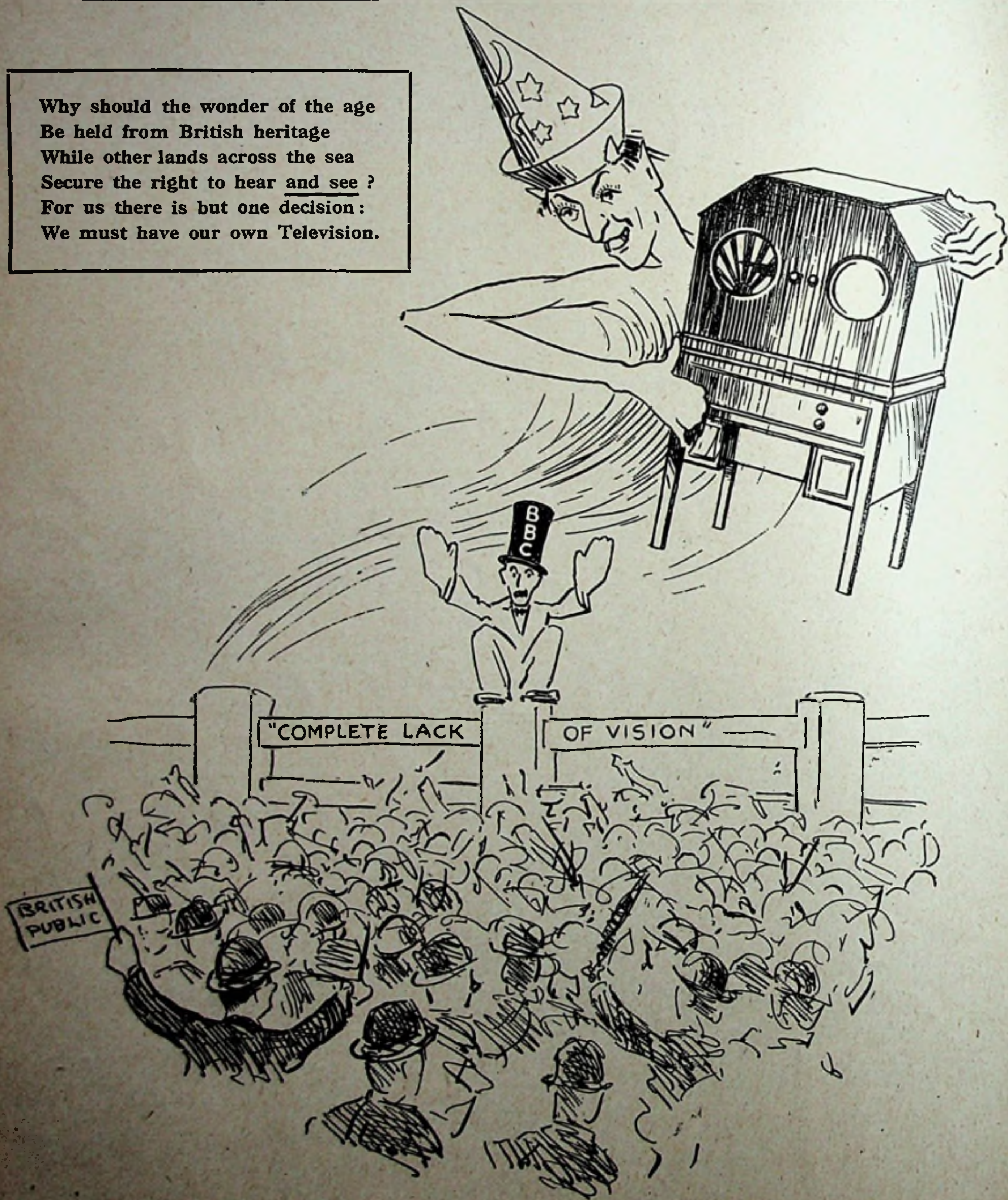


CHEMISTRY

CINEMATOGRAPHY

"THERE ARE NONE SO BLIND—
as those who will not see."

Why should the wonder of the age
Be held from British heritage
While other lands across the sea
Secure the right to hear and see ?
For us there is but one decision :
We must have our own Television.



Television

THE WORLD'S FIRST TELEVISION JOURNAL

The Official Organ of The Television Society

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Vol. 1] JANUARY 1929 [No. 11

EDITORIAL

TELEVISION BROADCASTS.

For some considerable time the Baird Company has been broadcasting television signals at irregular intervals, for the purposes of their own experiments. As announced elsewhere in this issue, however, regular transmissions, in conjunction with music, singing, and speech, have now been inaugurated. These transmissions are still purely experimental in character, and are sent out twice weekly, on Tuesday and Saturday nights, between the hours of midnight and 1 a.m.. As announced at the December meeting of the Television Society, the wavelengths used are 200 and 250 metres.

* * *

It is from such small beginnings that great things grow.

* * *

On other pages will be found photographs of members of the Baird Concert Party who appear before the television transmitter whilst their various turns are being picked up by the microphone. Readers whose wireless receivers are capable of tuning down to the wavelengths used and who live within range of the experimental station will find a very attractive programme which is well worth listening to.

FRENCH STATIONS.

On another page we give a brief account of the interest in the Baird system which is being taken abroad, together with some interesting photographs of Radio Toulouse, one of seven French broadcasting stations which have made arrangements to broadcast television, using the Baird system. Just as we go to press we learn the names of five more of the French stations at which television transmitters are rapidly being installed. These are Petit Parisien (Paris), Radio-Bordeaux S. Ouest, Radio-Lyon, Radio-Agen, and Radio-Béziers.

* * *

WIRELESS DIFFICULTIES.

On other pages of this issue will be found references to an article from the pen of the chief engineer of the British Broadcasting Corporation. We have said before, and we repeat, that we have the greatest admiration and respect for Captain Eckersley's technical ability. As chief engineer of the B.C.C. he has done great work in the past, and will no doubt do even greater work in the future.

* * *

But some of Captain Eckersley's public statements are frequently confusing, misleading, and misin-

Editorial & Publishing Offices:

The Television Press, Limited,

26, Charing Cross Road, London, W.C.2.

Telephone: Regent 6437.

SUBSCRIPTION RATES, 7/6 PER ANNUM, POST FREE.

MSS. and other material for Editorial consideration should be accompanied by a stamped addressed envelope, and should be typewritten.

formed. In the article referred to above he makes certain statements concerning wavelengths which are so confused that they might mean anything. We seem to gain the impression, however, that the idea he had in mind when he wrote was that "all available wavelengths within the broadcast waveband are in use. There is thus no possible hope of ever being able to allot wavelengths for the broadcasting of television, so the whole idea ought to be discouraged." If Captain Eckersley really means that, then we are afraid his career of usefulness to the B.B.C. is ended. There is no such thing as finality in this existence. There can be no standing still; we must either progress or retrogress.

* * *

FOR the benefit of our non-technical readers we will endeavour to unravel some of the mysteries of "wavelengths" and "wavebands," and add a suggestion which we commend to the attention of Captain Eckersley in particular, and wireless technicians in general.

* * *

WIRELESS communication between one place and another is carried out through an intangible medium which, for want of a better term and more information about it, is called the "ether." Scientists are not in agreement that this medium exists, but as *something* conveys wireless signals from one place to another, the ether explanation is generally accepted. It is further agreed that ether permeates everything and everybody. It is a part of us. It extends throughout the entire Universe.

* * *

A WIRELESS transmitter sets up vibrations in the ether, and in order to avoid interference between stations every transmitter has its own particular number of vibrations per second, or, expressed differently, its own wavelength. Captain P. P. Eckersley would have us believe that finality has been reached in this direction.

AS far as broadcast transmitters are concerned, the present technical methods of operation are such that, in addition to the fundamental period of vibration, a large number of other vibrations are superimposed and let loose into the ether. In other words, a present-day broadcasting station takes up more room in the ether than it is entitled to.

* * *

BROADCASTING is conducted between certain upper and lower wavelength limits, the intervening region being known as the broadcast waveband. Both in the United States and in Europe this waveband, as at present subdivided, is fully occupied by broadcast stations.

* * *

IN England there is a standard of measurement known as a foot. It may surprise many of our readers to learn that this standard can be seen mounted in the wall on the north side of Trafalgar Square. A foot-rule, like the broadcast waveband, has a beginning and an end, and the intervening space can be divided up into twelve divisions, which we call inches. It is impossible to divide a foot-rule into more than twelve inches. But it can be divided into twenty-four sections, which we call half-inches. To achieve further division a change of ideas and terms is all that is necessary.

* * *

WHAT Captain Eckersley is saying, in effect, is that because, *under present technical methods and conditions*, the broadcast waveband is fully divided up it cannot be subdivided again.

* * *

MUCH has been written about the necessity for the invention of some totally new principle before television can become an accomplished fact. It seems to us that the time has come for some totally new principle to be discovered in connection with *wireless*, so that the present overcrowding in the ether may be relieved.

IN days to come the present methods of modulating broadcast transmitters will come to be regarded as extremely wasteful, from the point of view of the waveband required. But Captain Eckersley appears not only to be entirely satisfied with this unsatisfactory position; he even, apparently, wants to perpetuate it.

* * *

WHAT is now required is some new method of modulation which will enable a broadcast station to operate on its assigned frequency without spreading widely on either side of it. The problem cannot be impossible of solution. It has already been partially solved in the case of the transatlantic wireless telephone service, which operates on a system which takes up only half as much room in the ether as a broadcasting station.

* * *

WHEN it comes to a discussion of the problems of Television we suggest that Captain Eckersley leave entirely alone a subject which is completely outside his sphere, and devote his capable attentions instead to this pressing problem, the solution of which will confer a lasting benefit not only upon himself but also upon his Corporation and the public.

* * *

TELEVISION is here, in a form suitable for presentation to the public. The public demands it, and will inevitably receive it. Television technicians have done their share. It is now up to the wireless technicians to find a way to open up the ether and make room for this new service which must be provided. Those who attempt to stand in the way will simply be pushed aside by the irresistible tide of progress.

* * *

IN the minds of Captain Eckersley and other wireless engineers the word "Television" will henceforward convey a new meaning and significance.

The Power Behind Television

By SYDNEY A. MOSELEY

WHEN the history of television comes to be written, as indeed it is being written now, the name of Oliver George Hutchinson will be emblazoned therein, as the one great power who translated the new science from a big idea into big business.

Geniuses are reputably uncommercial. John Logie Baird is somewhat of an exception in this case, for a more level-headed man it is impossible to meet, but he will be the first to admit that without the vision, the extraordinary energy, the intense belief and thorough-going business mind of this man Hutchinson, television in Europe—certainly in England—would not have advanced to the position it occupies to-day.

The Gods were in a happy mood when they threw John Baird and Oliver Hutchinson together.

Baird, a roving genius, whose ideas chased each other with such rapidity that he had no time—indeed if he had inclination—to convert them into practice; Hutchinson, of inexhaustible energy, a fighter to the last ditch. Pioneers of science are usually left high and dry when it comes to "cashing in," but Capt. Hutchinson has proved himself to be a loyal colleague all through. Once realising, as he did spontaneously, the germ of Baird's television idea, he seized upon it, and wrestled with a world of skeptics, astonishing a centre which one used to think had no more room left for surprise—the City! Later, London was the first to pay tribute to the business genius of the young Irishman who had smiled at their sneers, and disarmed their hostility as and when he met it.

For the last three years Capt. Hutchinson has "lived" television. His associates will tell you that he talks of nothing else, and exhibits that unceasing restlessness which has carried him safely over the most difficult hurdles, and which is carrying him and his Corporation unresistingly towards a triumphant finale. It is one thing to be inspired; it is quite another thing to commercialise that inspiration.

CAPT. O. G. HUTCHINSON.

When there was hardly a soul in London besides Mr. Baird who believed in the possibilities of television, Capt. Hutchinson, realising the need for a big organisation through which the new science must be developed, induced two of the soundest men in the City to come on his Board. Lord Ampthill and Sir Edward Manville are names to be conjured with. If you see either of these honoured names in association with any enterprise you may be sure that there is a solid and sure foundation which has justified them giving that enterprise the hall-mark which their names carry.

To tell of the early obstacles that were deliberately placed in the way of this pioneer's work, or to recall the rebuffs offered to the pioneers themselves — men who were simply asking to be allowed to develop a wonderful new science, would take too long; but probably it may be a piquant task for the future historian to include a chapter of these early intrigues and blind opposition.

Such a chapter, indeed, would enable the reader better to appreciate the fighting spirit of the Managing Director of the Baird Company, a spirit that was for ever undaunted, a determination that did not falter even when faced with almost heartbreaking reverses.

The position of television to-day in England, and in Europe generally, is such that the subject of this short character-sketch can afford to look back with placidity and pride on work nobly done.

And the tributes that reach London in regard to the work accomplished for the science shows that Capt. Hutchinson's reputation has become world-wide.

The World-Wide Influence of the Baird System

New Companies being Formed Abroad

Great Interest Displayed

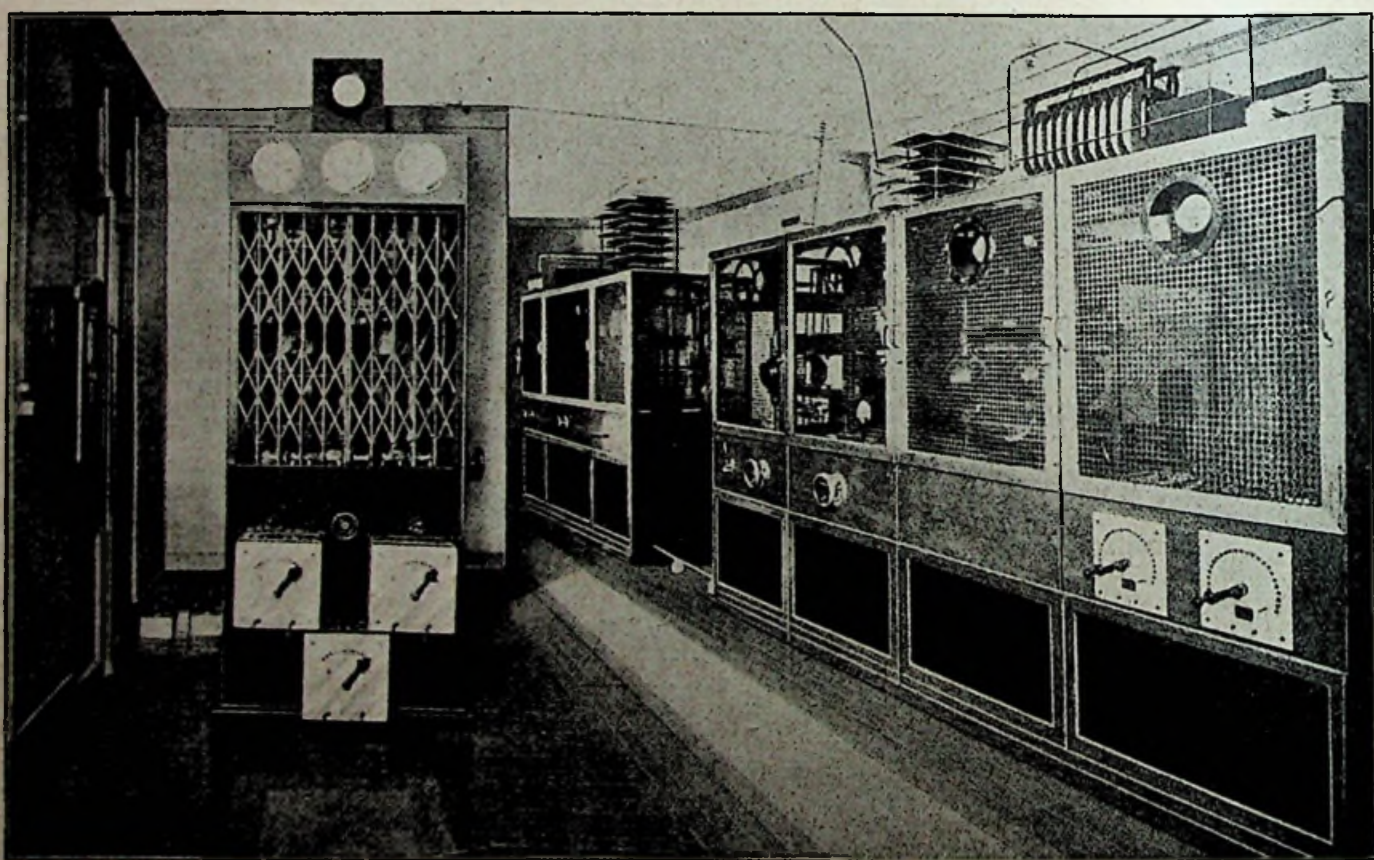
FROM its very inception this magazine has consistently urged our readers to SUPPORT BRITISH INVENTIONS. We have done it for good reasons, some of which are referred to elsewhere in this issue. History shows us that any product of merit, whether man or machine, if not appreciated and exploited in the country of origin, is very soon snapped up by foreigners whose vision is not clouded by the dust stirred up locally by petty squabbling over the merits or demerits of the product in question.

This British Invention.

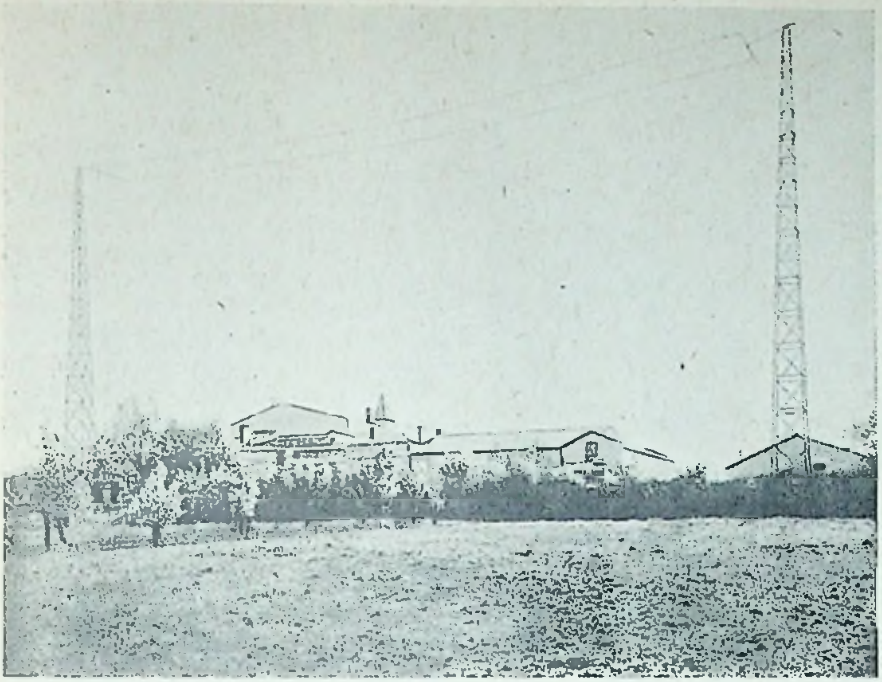
And so it is with television. This is a British invention which has been developed in this country to a point where it is now a commercial practicability. No one would argue that it is yet perfect; there is no such finality in human affairs or in human activities. But the Baird system has progressed far in a short space of time. The capabilities of the apparatus have already been described in these pages, and need not be reiterated here.

The important point is that **Britain is beginning to lose ground in the application of this new invention.** While the air here is full of bitter wrangling and controversy, fostered largely by "interests" hostile to television, foreign countries are busily and quietly *acting*.

Two large companies have already

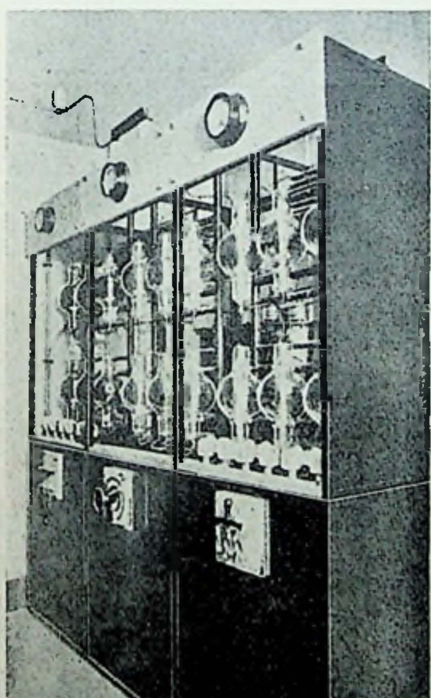


The arrangement of the transmitter at Radio-Toulouse, which has an output power of 8 kw., and broadcasts on a wavelength of 390 metres. This is one of seven French stations which, we learn, have decided to broadcast the Baird system of television.



An exterior view of Radio-Toulouse, showing the masts and aerial. The station is situated three kilometres from Toulouse, on the plateau of Balma, which is 180 feet above the surrounding plain. The aerial is 180 feet long and 100 feet high.

been formed in America to exploit television based on the fundamental principles of the Baird system. These companies are busily engaged



One of the power amplifiers at Radio-Toulouse.

in preliminary organisation work, and will, we understand, shortly be in a position to commence active trading, in conjunction with a regular television broadcasting service through a number of broadcast stations scattered throughout the United States.

It is understood also that in France a company called the Compagnie Générale de Télévision (Procédés Baird) has been formed, with offices in the building of the newspaper *L'Intransigeant*. A photograph of these premises is reproduced here.

Activities in France.

The broadcasting station situated on the roof of the building will be used for broadcasting television, and will be one of seven French stations which have already adopted the Baird system of television, and are proceeding to erect television transmitters immediately. Radio-Toulouse, photographs of which appear here, is another of the seven stations.

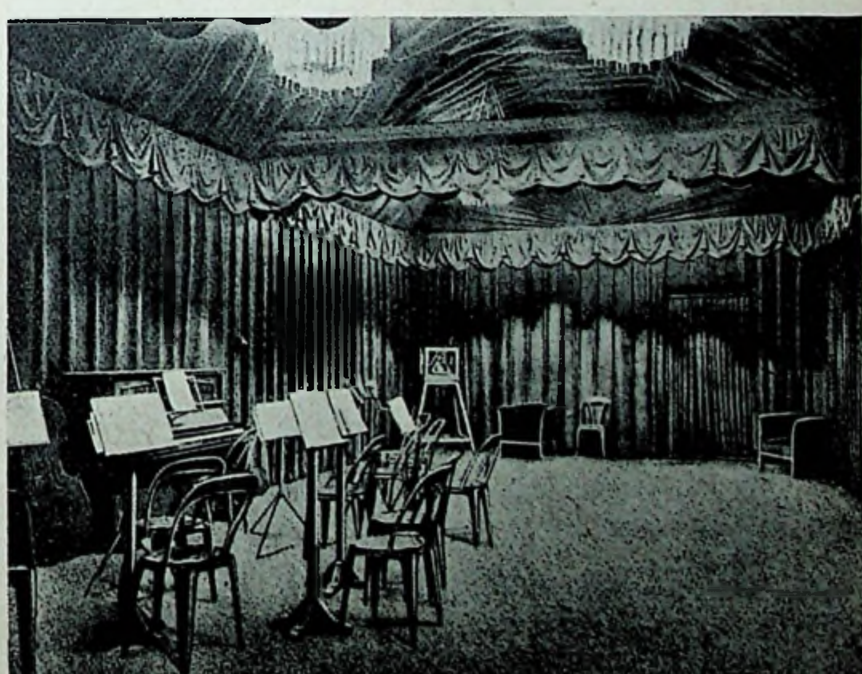
In Holland, the government has already given the Baird interests permission to broadcast television through the powerful government station at Scheveningen.

On the Continent.

Just as we go to press we learn that the Baird International Television, Ltd., have definitely made arrangements covering two other continental countries. We believe that the output power of the stations concerned is sufficient to make their signals readily receivable in this country.

Several other European countries are exhibiting the liveliest interest, and sending their representatives over to London to investigate the Baird system.

The Baird International Co., which is handling these negotiations, has also, we understand, made great progress towards arriving at agree-



The large studio at Radio-Toulouse.

A distinguished group of visitors representing large radio interests in France and Belgium, who have recently been investigating the Baird system of television. They expressed the opinion that the system is commercially practicable.

ments with many other countries still further afield.

Overseas.

In the case of Argentine, an agreement has been arrived at for the formation of a company.

Negotiations are in progress with interests in South Africa.

Baird engineers with a complete transmitting plant are already at work in Australia, as the result of an invitation from the representative of a powerful group who recently visited London. It is understood that an Australian company has now been formed which will operate throughout Australia.

Antipodes too.

New Zealand has also sent a representative to London, and rapid progress is being made towards the formation of a company in those distant islands.

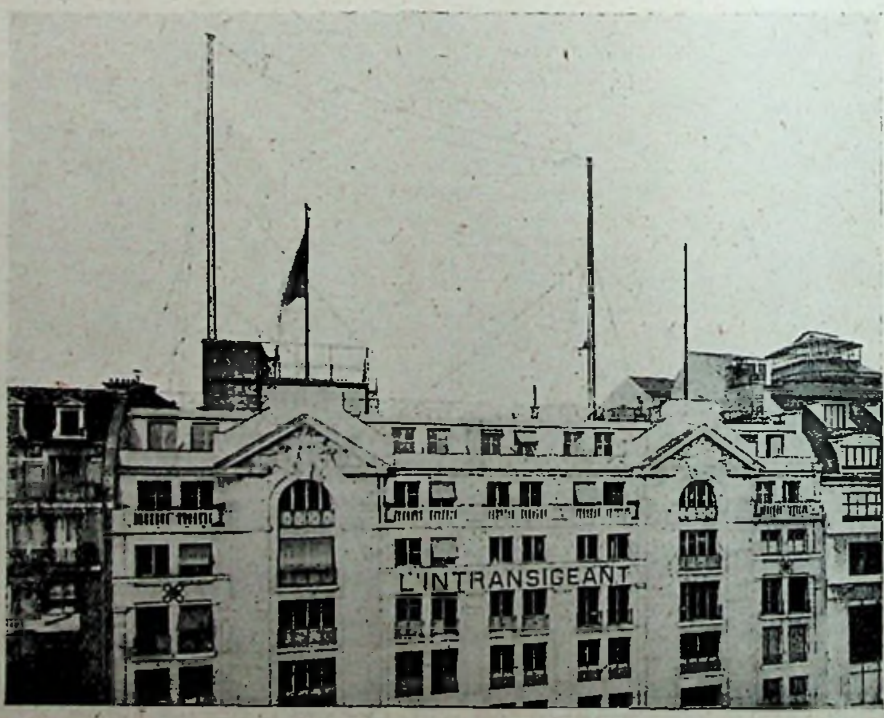
Such, in very brief review, is the position abroad. What of the position in this country? True, there is in Great Britain one company whose energies are devoted to the development and exploitation of the Baird system of television. But before effective development, which the public can appreciate, can take place, broadcasting facilities are necessary, and these, for the time being, have been denied, with the exception of the private experimental transmissions which are being carried out twice weekly by the Baird Company. These transmissions are only available to a restricted few who live within range of the experimental station.

Abroad, in the countries mentioned, nothing like the same difficulties have been placed in the way of granting broadcasting facilities as has been the case in this country. The controlling bodies, whether governmental or otherwise, have in all cases either granted facilities or promised them as and when required, and this happier attitude on the part of those in control is largely responsible for the ease and rapidity with which agreements are being reached overseas.

Very soon these countries will be broadcasting television, and their inhabitants will be looking-in while they listen-in.

Will Britain, the country of origin of television, be the last country in the world to enjoy the benefits of a television broadcasting service and reap the rich harvest of a new industry?

It looks like it, unless we SUPPORT BRITISH INVENTIONS.



The Paris station and offices of the Compagnie Générale de Télévision (Procédés Baird).

Review of the Present Position in Television

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

In the following article our contributor puts a searchlight on the position of television in this country. He recalls the early days of wireless broadcasting and describes how the first transmissions, which we could receive in this country, came to be made from Holland. Will history repeat itself in the case of television?

A BOMBSHELL has fallen on the British enthusiasts for television, and this has come from a source of the highest repute—the British Broadcasting Corporation. No suitable facilities are to be provided by them in these islands for the broadcasting of television, and this decision has been arrived at in spite of the fact that many aspects of the subject have been already discussed in the public press, so that these have presumably been under the notice of the B.B.C.

This body cannot be said to be out of sympathy with the broadcasting of optical effects, for they are proceeding vigorously with the transmission of still pictures on the Fultograph system. In this connection they are in harmony with practice in various other countries, but these other countries do not necessarily consider that the broadcasting of still pictures excludes that of television at present.

Post Office Favourably Disposed.

The disappointment at the B.B.C. decision was all the more poignant as hopes were raised when it was learned that the Post Office considered that a trial should be given to television broadcasting. However, this recommendation from such a high authority was not accepted by the B.B.C., and we are now in the condition that we must employ other expedients and arrange to receive from foreign broadcasting stations which *will* give television programmes. This state of affairs will apparently continue until the B.B.C. has witnessed a further demonstration of television which comes more nearly up to certain standards that they have set up, whatever they may be.

The early days of broadcasting of speech and music before the foundation of the B.B.C. are thus called to mind, when many enthusiastic wireless people in England used to listen to programmes from Holland. These Dutch programmes increased rapidly in popular favour, and it was not long before steps were taken in this country to provide our own programmes. These steps were of a national character at that time, and the largest wireless companies in the country together found the capital to start the British Broadcasting Company, and it was only quite recently that this company was abolished to give way to the present semi-Government corporation.

History Repeats . . . ?

Are we to have a complete repetition of these proceedings with television? It certainly looks as if we are starting on precisely the same lines. **It will be sad if again we are to allow our British public opinion to be formed initially by foreign programmes.** It is recognised throughout the whole world that television must soon be as powerful a service to mankind as the present broadcasting of speech and music, and the British public should not allow its conservatism, or that of some of its officials, to prevent its taking part in the moulding process, during which the new subject will be adopted to applications apparent to, or convenient to, those actively engaged on it. It is absolutely certain that the British methods of application will have considerable influence on the whole future of television, and thus it is highly inadvisable to remain inactive as a nation during these preliminary phases.

It is impossible to believe that the present condition of stalemate in Britain can continue for a long period. However, the present setback must be faced, and we must attempt to employ the period of delay to the best advantage.

Powers of the B.B.C.

A question which might reasonably be asked is why the decision as regards the future of television should be in the hands of the B.B.C., when this corporation has powers only in a very limited field of wireless. The higher authorities in control of the whole of communications in this country might have been appealed to, but we must remember that the Post Office referred the matter to the B.B.C. There is a sound problem of policy behind this, for the British method for conducting broadcasting, to have one central body in control, has been highly successful in the case of speech and music. There will also be most certainly an ultimate central control of television broadcasting, and it may be reasonable to consider that broadcasting of all forms should be under one authority.

From the point of view also that television broadcast may be of greater interest when accompanied by speech and music, it seems reasonable to have both at the same time and thus under one control. As the B.B.C. has a monopoly of acoustical broadcasting, even if another body were created to deal with television broadcasting a most attractive feature of the latter would be lost. Thus, as the B.B.C. declines to co-operate in providing facilities for broadcasting television at present, one of the most attractive sides of the subject is denied us.

Turning from the purely broadcasting aspect of the subject, the lack of suitable facilities for transmission of television is a very serious matter at the present moment, when there is so much to be done. The B.B.C. does not think that the art is sufficiently far advanced to justify a trial of broadcasting. In expressing this view they have their minds obviously on their function as the responsible authorities on the entertainment feature of broadcasting. Accepting this position at the moment, though not agreeing with it, it is obvious that the B.B.C. wants further progress before they will agree to its use for entertainment. The subject is exceedingly complex, and all possible help is required. **The B.B.C. can give very great assistance in providing transmission which can be employed for experimental purposes.** There are many amateurs in this country who would like to experiment on television, and all facilities should be provided for them.

The Amateur's Part.

Naturally such facilities may at times be obtained by the most enthusiastic amateurs who apply for a licence to transmit, but there are many amateurs who could not contemplate the expense of fixing up their own transmitting station. Much useful work can be performed by amateurs on receiving apparatus, and for this purpose a central transmission station is essential. The B.B.C. would perform a national service by reviewing the situation from this aspect, and by providing such transmissions at suitable times and on suitable power and wave-lengths in conjunction with music, singing, and speech.

During the last few months there has been much controversy on television in this country. This has been brought about because Mr. Baird made claims that he was performing satisfactory television. As his methods were known in a general manner to the technical world, there was an outcry against him from certain directions, and it was definitely stated by some critics that on his methods it would be impossible to make progress towards perfection. However, owing to the recent demonstrations given by Mr. Baird, a considerable change has been apparent in the criticisms, for it is not easy to keep on condemning, when it is obvious that actual television is being effected.

Unfortunately the criticisms have not died down completely, so that we must continue our examination of the statements made by the remaining critics. The chief remaining point that must be dealt with is that the Baird system is mechanical and depends on the actual motion of parts.

There is still considerable misapprehension about the whole subject, particularly on the fundamental problem which relates to the method employed to divide the whole scene into a large number of parts. We all agree that the number of parts employed to depict a single scene determines the definition, and it is advisable to have as large a number of parts as possible.

As each part must be scanned about sixteen times per second to give apparent continuous motion, it is assumed that the Baird method, which is mechanical, cannot deal with either the quantities or speeds which are involved.

"The Same Old Conclusion."

Then the same old conclusion is drawn that there is a missing link somewhere, or that some entirely new discovery is essential, or that we must look for entirely different lines of attack, such as the cathode ray method. It is quite possible that an opinion of this kind held by some people in authority was a contributory cause leading to the adverse decision by the B.B.C.

Thus, although there are still criticisms to be answered, their nature is different, and instead of stating that television is impossible under any circumstances, it is now stated that Baird's mechanical methods can deal only with small scenes and that they can never hope to deal with scenes as large as those of the cinematograph. Well, we are progressing to have changed the tone of criticism thus far, and I shall once more express my view here that **there is nothing inherent in Baird's mechanical methods to prevent full success being obtained with them.** Having made this statement, it is advisable to go into some detail to show the reasons for making it.

With the mechanical method for scanning a picture or scene a typical case is the use of a spot of light which is made to fall on all parts of a picture in turn, and this is accomplished by having a rotating disc with a number of holes at different distances from the centre, these holes being staggered so that succeeding holes scan neighbouring strips of the picture. The disc rotates about sixteen times per second, which is a reasonable mechanical speed when compared with other ordinary speeds. This speed corresponds to less than one thousand revolutions per minute, and many engines and electric generators have much greater numbers of revolutions.

There is not a vast amount of

The Baird Company's Concert Party and Engineers, photographed in the sight and sound broadcasting studio in Long Acre. Experimental transmissions are now sent out regularly twice a week.

power required to drive such a disc at this low speed, as the disc can be made of very small weight and it can, if necessary, have the best possible bearings. Thus there can be no legitimate criticism levelled against a mechanical device of this nature, for it is merely of the type of machine with which the general public is very familiar.

In such a typical case the necessity for the rotation of the disc sixteen times per second is to give the appearance of continuous motion. Misconception arises in many minds in attempting to visualise how a large scene can be scanned at such a low speed of rotation. It is usually concluded that as the size of the scene is increased, or as the definition is improved, the speed of rotation must increase. This is not necessarily the case, nor is it necessarily the case that the dimensions of the rotating parts must be increased enormously so as to make the mechanical method unwieldy.

Referring to Fig. 1, a typical case is shown where the light proceeds from L through one or other of the holes h, h_1, h_2 of the disc D to fall on the scene S_1, S_2, S_3, S_4. The holes h, h_1, h_2 are at different distances from the centre of the disc, so that the succeeding holes scan neighbouring strips of the scene S_1, S_2, S_3, S_4. Further, the distance apart of the holes h_1, h_2 obviously has some relation to the size of the scene. Thus if we have a large scene, and *if there is no optical manipulation* such as the use of lenses and mirrors, the distance apart of succeeding holes along the diameter must be equal to the width of the scene S_1, S_4. Then under such conditions, if the scene is large, and if we have a large number of holes, thus desiring great definition, the critics must conclude that it is obvious that the size of the disc must be increased.

Alternatively, to keep down the size of the disc we might have two or more complete series of holes and increase the speed of rotation of the disc two or more times. Although the critics do not say so, and in fact their criticisms are usually of a very general nature, this is really the point where criticism is levelled at the mechanical methods of television.

Closer consideration, however, shows that we have a relation between the diameter of the disc, the number of holes, the size of the holes, and the size of the scene. If the size of the scene is increased something must be done with the other factors, and it is automatically assumed that we must increase the number of holes and the dimensions or speed of the disc. It is in circumstances such as this where the inventive genius is different from the average working engineer. The former knows that there is usually at least one way out of difficulties of this kind, whilst the latter assumes that he has come up against an impregnable position, and, further, he occasionally adopts a superior attitude towards anyone who suggests that the position is not impregnable.

Mr. Baird is of the former class, an inventive genius, and he knows much about the superior attitude of engineers who have no such inventive powers.

Before referring to one method in which he has solved the problem just mentioned it should be noted that if the size of the scene S_1, S_2, S_3, S_4 is increased, it is not absolutely necessary to increase either the size of the disc or its speed of rotation, for it is a typical case, to show how wrong conclusions can be drawn. Those who wish to study how Mr. Baird has overcome this problem are referred to his invention, which he calls the optical lever, a most ingenious device, a description of which is in Mr. Dinsdale's recent book on television.*

This discussion should make it obvious that there is nothing to prevent mechanical methods such as Mr. Baird's from scanning scenes of any size and with any desired definition, and that there is no reason at present to deviate from such methods. Instead of requiring enormous speeds of rotation, or moving parts of enormous sizes, which is the general conclusion of the critics, the real crux of the situation is in the sensitiveness of the photo-electric cell. This, in fact, is the crux of television scanning, *no matter whether we use a mechanical method or a method such as the cathode-ray tube*, and I hope to elaborate this point of view in a later issue of this journal.

Photo-electric cells have been

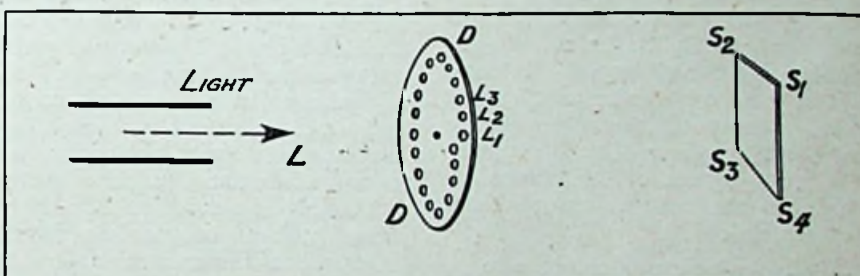


Fig. 1.

quite possible to have an optical arrangement at S_1, S_2, S_3, S_4 in place of the scene, which is of comparatively small dimensions, but of such a nature that it covers optically the whole of the actual scene.

Then if we wish to increase definition we must increase the number of holes in the disc, and make them smaller and closer together, the relationship then being maintained with the size of the optical system S_1, S_2, S_3, S_4 instead of with the size of the actual scene. Then we are brought to the critical point that as the size of the holes is diminished the amount of light is cut down and thus the magnitude of the photoelectric current, which is in my opinion the real controlling factor of television scanning. I shall refer to this later, but this is a very different conclusion from that drawn by the critics of mechanical methods.

This discussion is given merely of known for some considerable time, but they are still insensitive; or, in other words, the current obtained when light falls on them is exceedingly small, and a large amount of amplification is required. From the history of technical development in recent years, and particularly when we remember the progress that has been made with thermionic valves, we may confidently expect to have very large improvements in such light-sensitive devices.

In conclusion, it is hoped that the decision of the B.B.C. will be reviewed at a very early date, and that they will at least provide facilities for transmissions of an experimental nature in the sense that amateurs may be assisted and encouraged to devote their energies to television.

* Obtainable from Television Press, Ltd., 26, Charing Cross Road, W.C.2, price 5/6, post free.

The Story of Chemistry

Part IV

Molecular Architecture

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

HAVING assigned to each elementary substance a symbol for its atom, and having used these symbols to picture the molecules formed by combination of the atoms, the chemist is able to represent chemical actions by the use of what are called *equations*. Here, instead of writing the words, he uses the formulæ for the molecules.

Thus, for example, hydrogen and oxygen combine together to form water. We picture molecules of hydrogen and molecules of oxygen coming together under suitable conditions, and undergoing disruption. This break-up of the molecules is immediately followed by the union into fresh groups of the atoms of which they are formed. In words then we can write:

Hydrogen+Oxygen combine to produce Water

and in symbols this becomes:

$$2H_2 + O_2 \rightarrow 2H_2O$$

It is unfortunate that such an expression should have been called an "equation," for this term implies equality, whereas the fundamental point about a chemical change is the inequality. The things produced must be entirely different from the things with which we start, which is obviously the case in the above example.

Indestructibility of Matter.

The only equality in the above chemical action is that the total quantity of substance with which we begin is equal to the total quantity of substance with which we end. ***Nothing is ever created or destroyed in a chemical action.***

This is also implied in the above equation by the extension of the meaning of the symbols. *H* stands not for hydrogen, but for *one atom of hydrogen*, and it will be seen that on the left hand side of the above equation we have two atoms of hydrogen, combined together as one molecule, and that on the right-hand side we also have four atoms of hydrogen—two in each water molecule. This explains why the simpler form, thus—

$$H_2+O_2 \rightarrow H_2O$$

is not used. Here we have two oxygen atoms on the left, and only one on the right, which would indicate a loss of matter. Note that we write the formula for a molecule of hydrogen, a molecule of oxygen, and a molecule of water. We believe that we start with molecules, and so we write our equations as true as possible to our belief. We have a difficulty here because we do not know what the molecular formulæ for some of the elements are.

Combustion of Magnesium.

Thus, in the action which takes place when a piece of magnesium burns, we know that the molecules of magnesium react with the oxygen of the air, and produce a white powder, magnesia, or magnesium oxide. This substance has the formula *MgO*, *i.e.*, consists of one atom of oxygen united with one atom of magnesium. Now, if we wish to write the equation for this reaction we have, in words,

Magnesium+Oxygen → Magnesium oxide.

We do not know what the molecule of magnesium is, and so the conventional procedure is to write the symbol for the element, which gives us as a start the equation

$$Mg+O_2 \rightarrow MgO$$

There is something obviously wrong here, as the equation indicates the destruction of an atom of oxygen, and so we revise it or balance it thus:

$$2Mg+O_2 \rightarrow 2MgO$$

When we read this equation we just remember that "$2Mg$" is not intended to represent two solitary atoms.

Atomic Weights.

It will be recalled that each of the atoms was distinguished by having a weight different from every other atom. These weights have been determined. So small are they, however, that the ordinary units lead to confusion. A hydrogen atom weighs0·000,000,000,000,000,000,000, 001,6 gram! For atomic weights it is therefore customary to select the hydrogen atom, which is the lightest, as the unit. The oxygen atom weighs sixteen times as much as the hydrogen atom, and thus its atomic weight is said to be 16. A list of the atomic weights of the commoner elements is given below.

TABLE OF THE COMMON ELEMENTS

Name	Symbol	Approximate atomic weight	Name	Symbol	Approximate atomic weight
Aluminium	Al	27	Lead . .	Pb	207
Antimony.	Sb	120	Magnesium	Mg	24
Argon , .	A	40	Manganese	Mn	55
Arsenic .	As	75	Mercury .	Hg	00
Barium .	Ba	137	Nickel . .	Ni	259
Bismuth .	Bi	208	Nitrogen .	N	·14
Bromine .	Br	80	Oxygen .	O	16
Calcium .	Ca	40	Phosphorus	P	31
Carbon .	C	12	Platinum .	Pt	95
Chlorine .	Cl	35·5	Potassium.	K	139
Chromium	Cr	52	Silicon .	Si	28
Copper .	Cu	63	Silver . .	Ag	·08
Fluorine .	F	19	Sodium .	Na	123
Helium .	He	4	Strontium.	Sr	88
Hydrogen.	H	1	Sulphur. .	S	32
Iodine. .	I	127	Tin . .	Sn	19
Iron . .	Fe	56	Zinc . .	Zn	165

The symbol for any atom is extended to include this information, thus

H stands for one atom of hydrogen weighing 1.

O stands for one atom of oxygen weighing 16.

Cl stands for one atom of chlorine weighing 35·5.

Cu stands for one atom of copper weighing 63.

A simple extension gives us the weights of molecules on the same scale. Thus, a water molecule contains two hydrogen atoms each weighing 1, and one oxygen atom weighing 16. Therefore the water molecule weighs 18 on the scale where the hydrogen atom weighs 1. A sulphuric acid molecule weighs 96 ($H_2SO_4=2+32+64$).

All this information we may read into an equation. Thus

$$2H_2+O_2 \rightarrow 2H_2O$$

which means that

4 of hydrogen+32 of oxygen produce 36 of water.

It will be noticed that as all these weights are related to the weight of a hydrogen atom as unity, it does not matter what units we use to measure actual quantities of reacting substances, the proportions will be the same. For example:

4 tons of hydrogen with 32 tons of oxygen will produce 36 tons of water,

and

4 oz. of hydrogen with 32 oz. of oxygen will produce 36 oz. of water.

The Value of Equations.

Therefore, on our equations we can base numerous calculations; for the equation tells us not only *what* substances react and *what* substances are produced, but it also tells us the *proportions by weight* of all the substances concerned.

The chemical equation is the most useful implement which the chemist possesses when he is writing of his subject. It supplies a mental picture of the inter-molecular reactions which take place. It supplies definite information as to the quantities concerned. It must be stressed, however, that the equation is not the result of sitting down and making any old formulæ balance. No equation can be written until the particular reaction which it represents has been studied in detail, and the quantities of the substances concerned determined.

If, however, we are unable to carry through such a series of determinations as this demands, there is no reason why we should not be able to read the correct meaning into the equations with which the chemist so freely sprinkles his writings, and use them for our own calculations. In future articles we shall have frequent examples on which to practise.

Having learned how we can shortly picture the molecule by means of formulæ, we may now pass on to a consideration of the architecture of the molecular world, which will lead us to a realisation that most of the substances in the universe can be grouped into a comparatively small number of classes. Each class is characterised by a particular style of architecture.

THIS is the fourth of our contributor's articles on the story of chemistry, written in simple everyday language. Last month he told us something of what goes on inside a molecule. This month he deals with the construction of molecules, or unit parts, showing what they consist of in the cases of different substances, and how they are built up from elementary atoms.

In the first place this classification was based on striking likenesses, perhaps not obvious at first sight, but becoming prominent with closer study. As an example we may take the liquid known to early chemists as *oil of vitriol.* This was a syrupy liquid and, as far as outward appearance goes, entirely different from another equally well-known liquid, *spirits of salt.* It would seem that in order to know much about these two substances it would be necessary to consider them solely as individuals. Even if the chemist determines the elements of which they are made, the result is of little help; in fact, it only adds to the number of things which have to be learned about these two substances.

Yet when these two liquids are closely examined it is found that in spite of their apparent outward differences they are very closely related. They both react on the purple or violet colouring matter contained in plants and turn it red, in the same way that vinegar turns the purplish pickling-cabbage into the red pickled-cabbage. When metals are added to these liquids in both cases there is a "breaking out of an air," as the ancient chemists called it. In later phraseology there is an "effervescence" and the evolution of an inflammable gas, which we recognise as hydrogen.

Similar Substances.

These dissimilar substances have likenesses—oil of vitriol, spirits of salt, and vinegar can be put into one class in view of these likenesses. Now if we remember that each of these substances is but a collection of molecules "heaped" together, we can go a step further, and say that the molecules are alike in some respects. Molecules are made of atoms, and therefore likenesses among molecules can only be attributed to two things. If molecules are alike then either the atoms which they contain are alike or the arrangement of the atoms must be upon some plan which renders them similar. Kind and arrangement of atoms is the only possible variation, as far as chemical properties are concerned.

The chemist can tell us what atoms are contained in the molecules of these three substances which have been chosen as illustrations. Oil of vitriol contains sulphur, hydrogen and oxygen atoms. Spirits of salt contains hydrogen and chlorine atoms and vinegar contains carbon, hydrogen and oxygen atoms. With such variation then it is to the method of arrangement that we must look for the similarity.

Action of Acids.

In the architecture of the molecules of these substances we can expect to find some common structure. These three substances are classed as acids, and we have already noticed that when acted upon by metals they evolve hydrogen. There are many hundreds of substances which by virtue of their properties are classed as acids, and each of them exhibits this property of readily giving up hydrogen under appropriate circumstances. With the above simple cases the hydrogen is evolved by the simple process of adding metal to the diluted acid. No strenuous effort is necessary to get the hydrogen out of the acid.

Let us just picture what this means—thinking of one molecule of oil of vitriol (or sulphuric acid, to use its modern name), we get a picture of a molecule containing seven atoms—two hydrogen atoms, one sulphur atom, and four oxygen atoms. That information comes from the results of careful analytical processes. This group of atoms cling together, and many millions of them form a drop of the acid.

Affinity.

Our molecule of acid would exist as such in a bottle for centuries unchanged, but it is not content, it is not "happy"; it wants to make a change. Let it come in contact with a metal and the conditions for such a change are achieved. An "eruption" takes place. On a molecular scale something akin to the break-up of a sun and its attendant planets takes place. The two hydrogen atoms are torn from their partners, and, left alone, go off together as a molecule of hydrogen, while the remaining five atoms enter into a partnership with the metal.

Similar things occur with other acids. In the molecule of all acids there seems to be a weakness of some kind in the attachment of the hydrogen atoms, for hydrogen atoms are found in all acids. Therefore, we picture the architecture of an acid molecule as consisting of two parts—the hydrogen atoms loosely held in the molecule, and readily exchanged for certain other atoms, and the rest of the molecule.

Acid Radicle.

Thus an acid molecule becomes (loosely held hydrogen) × (the rest of the molecule), where the multiplication sign indicates whatever we mean by affinity. The rest of the molecule is usually called the *acid radicle*, and in this way we may write a kind of general formula for all acids, thus:

$$H.R$$

where H stands for the loosely held hydrogen or *available hydrogen*, to use the technical term, and R stands for the rest of the molecule, the acid radicle.

This statement of the architecture of the acid molecule makes it possible for us to comprehend in one sweeping generalisation all those hundreds of compounds in the class of acids. If X is an acid, then whether we have seen it or whether we have not, we know how its molecule is built up, and we know that it will have the properties of such a molecular structure.

When we know the kind of atoms within its molecule and their number, we can so write its formula as to indicate its acidic nature. Thus nitric acid contains nitrogen, oxygen, and hydrogen, its molecules containing one atom of nitrogen, three of oxygen, and one of hydrogen. To signify that this substance is an acid we write its formula $H.NO_3$, although it is customary to omit the full stop. Similarly HCl, H_2CO_3 and H_3PO_4 are the formulæ of acids.

Television – First with the News

PROMISES WILLIAM J. BRITTAIN

MOST thrilling of the coming uses of television is news-spreading.

Two developments are taking place in to-day's newspapers. One is towards greater speed.

Newsletters, centuries ago, reached outlying towns with "news" weeks old.

When the *Times* and *Daily Telegraph* were the bright papers of their day speed used to be attained by correspondents writing their copy in the train on their way back to the office.

Reuter, starting by sending stock prices by pigeon-flight, soon built up a telegraphic news service which encouraged newspapers in their craze for speed.

Now, of course, wireless messages—often wireless telephone messages—are superseding cablegrams for special work, and aeroplanes are superseding special boats and trains.

Newspaper editors always have died young, of course, but soon they will have to be machines with brains to last a month.

And the other development is partly a matter of speed, for pictures enable the reader to get a grasp of a news event far quicker than by reading half a column description.

Pictures are becoming more and more important in every newspaper.

When I joined the *Daily Mail* shooting out a man to a story was the first consideration. A photographer went if the story was a good one.

Two years later the photographer frequently was sent without a reporter.

These two growing needs in newspaper work—greater speed and letting pictures tell the story—are exactly covered by television.

Instead of offering a single glimpse as photographers do, television will let its subscribers see all the time.

And the speed—Einstein says nothing could travel faster. Developing plates in motor-darkrooms scurrying towards the office has hardly a chance against the pace of television images flying over at 186,000 miles a second.

I am looking forward to the time when other people besides the B.B.C. will be able to appeal to the public over the radio.

In a few months, if B.B.C. plans mature, the public will be given descriptions of news events—not just football matches, but unexpected, surprise events—by trained wireless reporters.

How much more thrilling it will be when television reporters go flying off to crash scenes and the like.

They probably will have broadcasting apparatus that can be fitted into a fast motor-car.

With all the ingenuity of cinema news men they will angle for best positions and "shoot" the scene. Lookers will see the event as they see it.

There is no need to go on imagining—you can do that. Five minutes spent looking forward to television news possibilities will surprise you.

Although newspapers are by no means doomed television will offer some day the first news service which really can be called "hot."

THOSE ACCUMULATORS

How to keep them charged—without worry

By W. C. FOX

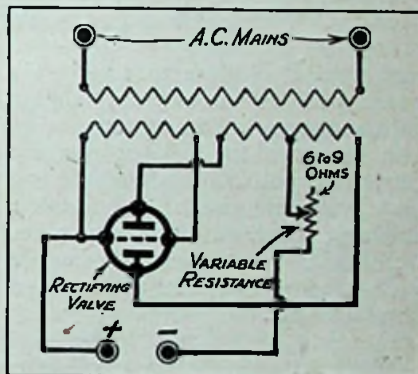
One of the greatest bugbears of wireless reception is the upkeep of batteries. With the advent of television broadcasting, in addition to sound broadcasting, the accumulator problem will become even more acute. In the following article a method is described whereby accumulators can be kept constantly charged without the least trouble or bother, and without the arduous business of carrying them to a charging station. With the apparatus described, all the valve filaments can even be lighted directly from the mains, thus eliminating accumulators entirely.

HOW to recharge one's accumulators with the minimum of trouble and the maximum of certainty is a question that has worried many accumulator users, particularly if the electric light mains available are A.C.

As a matter of fact, alternating current is to be preferred, for one can take just what is required for the purpose, without having to waste useful energy in the form of heat in resistances.

The simple rectifier described here was chosen out of the many types available because it is practically fool-proof, is quite cheap, simple to construct, has no chemical or other troublesome elements to look after, works absolutely silently, and requires no attention. Furthermore, it can be switched on and left, secure in the knowledge that if for some reason or other the mains supply is cut off the accumulator will not be discharged. When the supply comes on again charging will go on as though nothing had happened.

In fact the unit is so accommodating that it can be left permanently



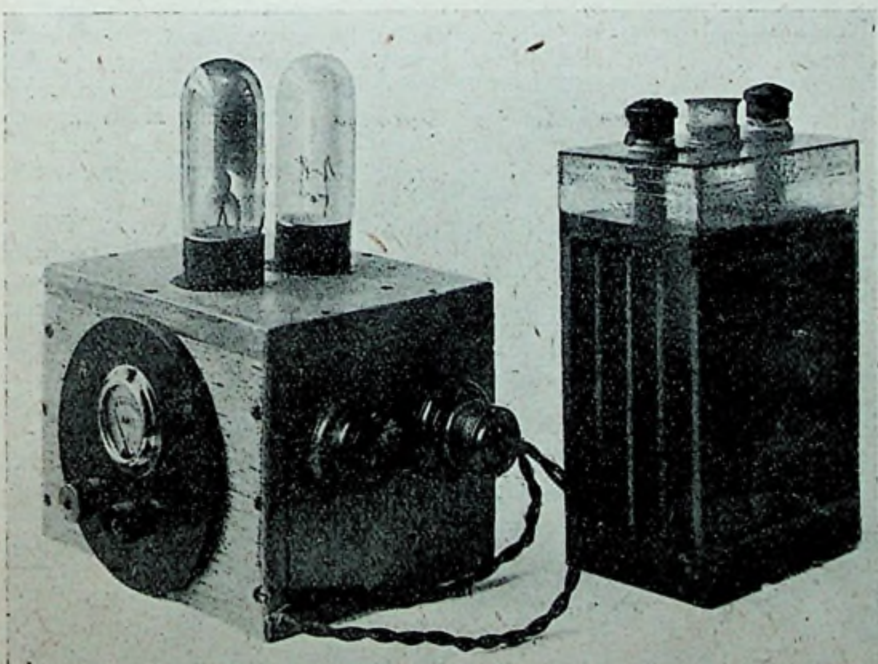
Resistance method of limiting output.

connected to the accumulator and switched on when required, while if one is using it in connection with a wireless set, and does not overdo reaction, the accumulator can be "on charge" while the set is working, with but the slightest mains hum being noticeable.

So much in favour of the system.

On the other hand it is not possible to use two or more mercury arc rectifiers in parallel to increase output, and the valve is to a certain extent susceptible to the influences of outside open circuit magnetic fields; but as valves of suitable output for most amateur purposes are available, and in the case of the present unit it operates quite satisfactorily beside a fairly heavy-duty choke in a large H.T. mains eliminator, both objections seem to be more theoretical than practical.

The unit gives 1·3 amps. at six volts, and is quite sufficient to keep a six-volt 30 amp.-hour accumulator fully charged even when it is used for



The rectifier with 2-volt 20 amp.-hour accumulator beside it. The baretter is the clear valve at the back. There are also shown the plug connection to the mains, switch, and output terminals with ammeter above them.

Back of rectifier, showing ventilation holes and nick in base to permit entry of air.

long periods of time to supply the wants of L.S.5 valves and similar current-thirsty pieces of apparatus. The baretter method of limiting current output was used because it is practically automatic in operation, and at the same time acts as a red warning lamp if anything goes wrong with the accumulator, and a short develops—i.e., the filament in the baretter, normally invisible, becomes red hot and visible. The small amp. meter between the output terminals is not necessary, but acts as a useful indication of the current going to the cells.

If it is of the centre zero or polarised type it will show in the case of the baretter lighting up whether the accumulator has been reversed when joined up, or has developed an internal short.

The main requirements to build such a unit are a mains transformer and a mercury-arc rectifier valve. The latter can be purchased from Messrs. Philips Lamps, Ltd., 145, Charing Cross Road, W.C.2, to give outputs of 1·3 amps. or 6 amps. at six volts. Suitable mains transformers are procurable from Messrs. F. C. Heayberd, 9, Talbot Court, E.C.3, whose Suprecision transformers are built expressly to work with these valves.

Having decided upon the output required, one has to decide whether to use baretter control of output or simple resistance control in the negative lead, for the transformer will have to be ordered accordingly. In the former case, the baretter is placed in series with the two separate windings supplying the plates in the rectifier valve, and the negative lead is taken from the centre tapping on the baretter resistance.

With the resistance method of limiting output the secondary of the transformer is tapped at its centre and an adjustable resistance is put in the lead. This resistance has to be adjusted to suit whatever accumulator is put in circuit, whether it be a 2·4 or 6 volts.

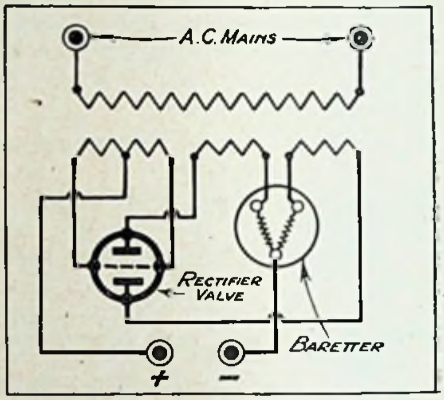
The difference in the transformer windings for these two methods is clearly shown in the accompanying circuit diagrams.

The items can be mounted open, on a baseboard (and be it noted the valve and the baretter are fitted with ordinary valve sockets), with terminal strips, or the whole can be built up into a neat box, care being taken to have plenty of holes for ventilation purposes; for although the transformer gets barely warm, if shut up in a wooden box there is a risk of it being baked, by reason of the heat insulation properties of the wood, when left in operation for a lengthy period.

The whole unit can, if thought necessary, be screened with a metal box, but so far the writer has not found any such screening necessary, or observed any disturbance due to the operation of the unit near wireless and television sets.

As to cost, 50s. would more than cover the cost of all components to make up the 6 amp. unit, while the 1·3 amp. unit costs at the outside 35s.

With regard to the writer's unit, photographs of which are reproduced

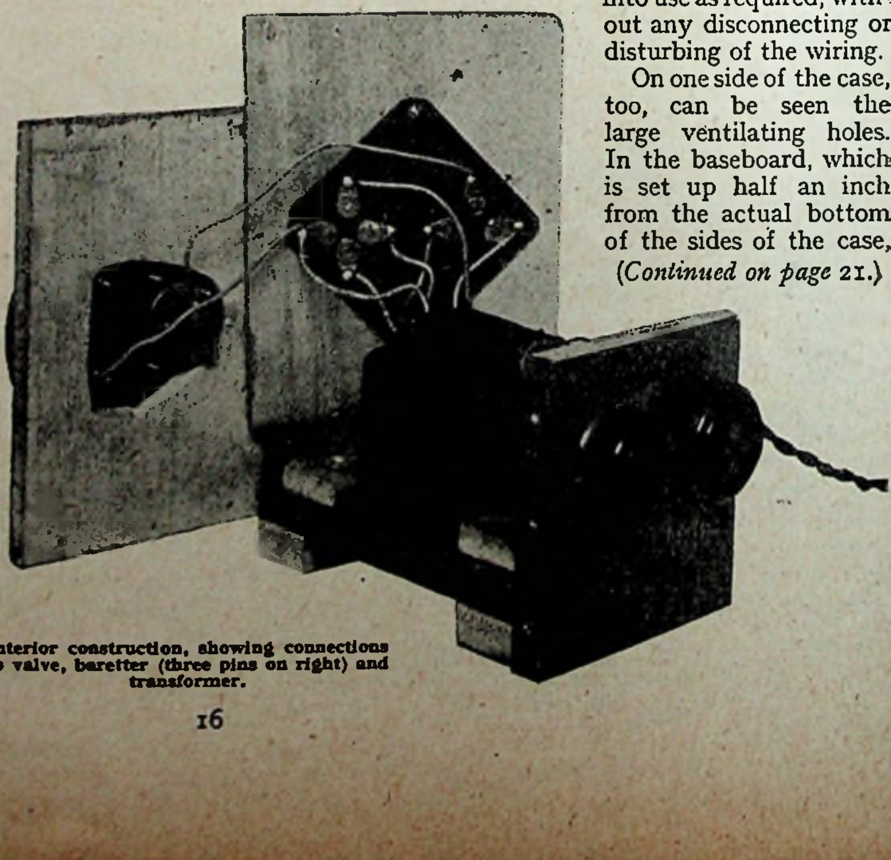


The baretter method of limiting output.

here, a switch, plug, and cord will be noticed on one side of the case. These were fitted because the L.T. charger and H.T. eliminator stand side by side on a shelf and are permanently hooked up to a special mains supply. A small tumbler switch on each enables either to be put into use as required, without any disconnecting or disturbing of the wiring.

On one side of the case, too, can be seen the large ventilating holes. In the baseboard, which is set up half an inch from the actual bottom of the sides of the case,

(Continued on page 21.)



Interior construction, showing connections to valve, baretter (three pins on right) and transformer.

CATHODE RAYS

By H. WOLFSON

The following article continues to a logical conclusion the examination which our contributor made last month of electrical discharges through gases.

Amongst television workers in various countries much attention has been given for some time to the possibility of utilising cathode rays for television purposes, instead of mechanisms. So far, no practical success has attended these efforts, but it will be interesting to learn exactly what cathode rays are, and how they are generated.

LAST month we discussed briefly some of the phenomena which accompany the discharge of electricity through gases. The most important of these from the point of view of the present article occurs when the pressure of the gas in the tube is one-millionth of an atmosphere, at which pressure the passage of an electric discharge through the gas causes a brilliant fluorescence of the glass walls of the discharge tube.

We must stop a moment and consider exactly what is the significance of the term "one-millionth of an atmosphere," in order that we shall have a clear picture in our minds of the state of affairs existing in the tube. As many of my readers are aware, a gas is composed of a large number of molecules, the size of which is extremely small. These molecules are considered to be perfectly elastic, and free to move in any direction. They are moving rapidly about the vessel in which the gas is contained, and their path is determined solely by the collisions which occur between the molecules.

Definition of Low Gas Pressure.

It is quite evident that the molecules will be constantly striking the walls of the containing vessel, and it is the number and frequency of these impacts which determines the pressure of the gas. When, however, the gas becomes rarified (by which we mean that the greater part has been pumped away), the number of molecules which are left in the vessel is comparatively very small. The number of impacts per second on the walls of the vessel is therefore considerably diminished, and we say that the pressure is low.

In the case under consideration the number of impacts per second (or the number of impacting molecules) is one-millionth of the number at the ordinary atmospheric pressure.

A closer examination of the molecules of gas present in the discharge tube will reveal several facts of interest and importance. Since the atmosphere is composed of a mixture of nitrogen and oxygen, with traces of other gases which are of little importance to our present investigation, it is evident that there will be present in the rarified gas of the discharge tube molecules of these gases.

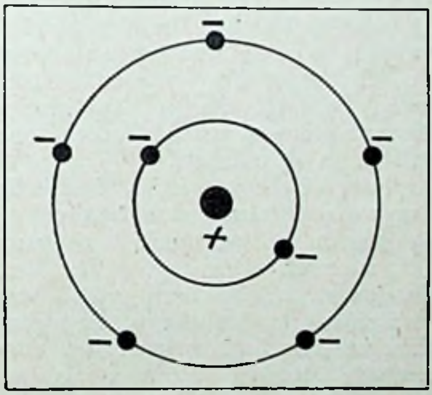


Fig. 1.
The author's conception of an atom.

Now the molecules of oxygen and nitrogen are diatomic; that is, each molecule is a combination of two atoms. These atoms are built up in a most remarkable way, from positive and negative electricity; or in more scientific language, from protons and electrons.

Our conception of an atom is shown in Fig. 1, which represents the nitrogen atom. Around the central nucleus, which is positively charged, are rings of electrons. The maximum number of electrons in the first ring is two, while the maximum number in successive rings is eight. Now it has been proved that the number of electrons which are rotating round the nucleus of the nitrogen atom is seven, which is expressed by saying that the atomic number of nitrogen is seven.

Composition of an Atom.

Thus we see that the first ring will contain two electrons and the second ring five electrons. The number of electrons in the outer ring corresponds to the valency of the element, and the valency determines the number of atoms of an element which will combine with other atoms to form a compound. An atom of nitrogen would be most likely to combine with an atom which had three electrons in its outer ring, so that a complete ring of eight electrons could be formed.

It is not necessary that I should discuss this fascinating question further for the purposes of this article, so that I must leave the full discussion of the structure of the atom to a later article.

When an electric discharge is passed through the tube, some of the atoms become ionised, by which we mean that an uncharged or neutral atom becomes charged, either positively or negatively, as the case may be. The mechanism of this ionisation is thought to be that the atom suffers a shock due to the discharge, and loses one electron from its outer ring. Loss of a negative charge implies that there will be now an unbalanced positive charge in the nucleus, and this will result in the atom as a whole assuming a positive charge. We then speak of the charged atom as a positive ion. Similarly, some atoms may seize an electron when it is knocked out of the outer ring of some other atom. These atoms will have an unbalanced negative charge, and are spoken of as negative ions.

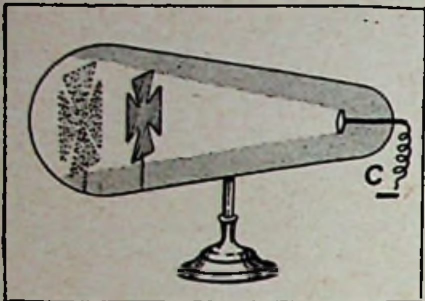


Fig. 2.
The Maltese Cross experiment, which demonstrates that cathode rays cast shadows.

As soon as ions are formed in the tube they will be immediately attracted to the electrode having an opposite charge, thus the electrons and the negative ions will be attracted to the anode, or positive electrode. In traversing the space between the two electrodes, however, collisions will occur between the streams of charged particles and the uncharged atoms of gas present in the tube. If the projectile or colliding particle is an electron, the only effect will be a diminution in the speed of the electron, since the mass of the electron is very small in comparison to the weight of an atom of, say, nitrogen (actually the ratio of the masses is 1 : 25,620); and therefore its momentum, which is the product of mass and velocity, will be comparatively small.

The momentum of the negative ions, on the other hand, is considerable, since the mass of the negative ion is very little less than the mass

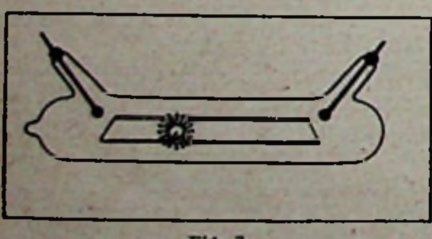


Fig. 3.
Another experiment which helps to illustrate the mechanical effects of cathode rays.

of the nitrogen atom. When, therefore, a collision occurs between a nitrogen atom and a negative ion the equilibrium of the nitrogen atom will be upset by having an electron knocked out of its outer ring. This phenomenon is known as *ionisation by collision.* The positive ions formed will fly to the cathode, and some electrons will attach themselves to other atoms to form more negative ions.

This ionisation process must be imagined as a progressive one, and we see that in a very short time (actually, of course, merely a fraction of a second) there will be present in the tube an enormous number of electrons and positive ions. Owing to their negative character, the electrons will be immediately attracted to the anode, and since this stream of particles originates from the cathode, they were called *Cathode Rays.*

Discovery of Cathode Rays.

When first discovered, the nature of cathode rays was somewhat obscure, and Goldstein (in 1876) stated that they consisted of transverse ether waves inside the tube. Sir William Crookes, on the other hand, came to the conclusion (in 1879) that the particles were neither solid, liquid nor gaseous, but consisted of "ultra atomic-corpuscles much smaller than the atom, which appear to be the foundation stones of which atoms are composed." This would suggest that we had here a fourth state of matter, which took the form of radiation.

Most of the properties of cathode rays were first announced by Crookes, to whom we owe much in the way of scientific discovery. The first action of cathode rays which was observed was that they caused glass and other substances, such as calcium sulphide, barium platinocyanide, etc., to phosphoresce. Screens formed of one of these substances have been employed to reproduce the image at the receiver of the television apparatus of several workers, where the neon lamp of the Baird system is replaced by a cathode ray tube.

Cathode Rays Cast Shadows.

Then, too, it has been shown that cathode rays cast shadows, and the classical Maltese Cross experiment will be known to many of my readers. This experiment consists of producing cathode rays in a tube fitted with a Maltese Cross made of mica. It is then noticed that a shadow of the cross is cast on the end of the tube opposite the cathode (Fig. 2). The inference to be drawn from this experiment is that the rays are emitted in straight lines at right angles to the surface of the cathode, and not in all directions as is the case with ordinary light. Further proof of this is obtained by moving the cross to various positions in the tube, when it is observed that the shadow of the cross is still well defined. An analogous case is

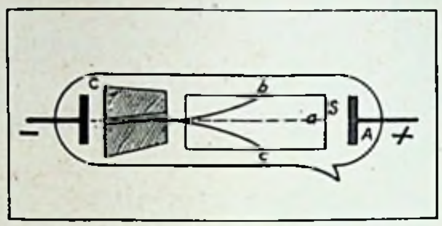


Fig. 4.
Illustrating how the rays can be bent by the application of a magnetic field.

the continuous discharge of a stream of bullets discharged at a target from a number of parallel machine guns, where the phosphorescence is represented by the holes made in the target.

Cathode rays produce heat in bodies upon which they fall, and if the cathode is made hemispherical, the rays may be brought to a focus, or concentrated, so that a piece of platinum foil placed at the focus of the cathode rays is heated to redness.

Mechanical Effects.

An interesting experiment which gives us further help in elucidating the nature of cathode rays, deals with the mechanical effects of the rays. If we fix inside the tube a pair of parallel glass rails (Fig. 3), on which a wheel with mica vanes is free to rotate, it will be observed that on starting the stream of cathode rays the wheel will travel

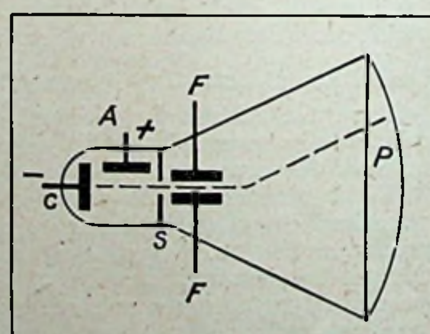


Fig. 5.
Diagrammatic sketch of a cathode ray oscillograph.

away from the cathode. On reversing the polarity of the electrodes, the wheel moves in the opposite direction. From this result we must infer that cathode rays are actual material particles, and not, as Crookes supposed, transverse ether waves.

Hertz proved that the rays, when passed through a gas, modify it so

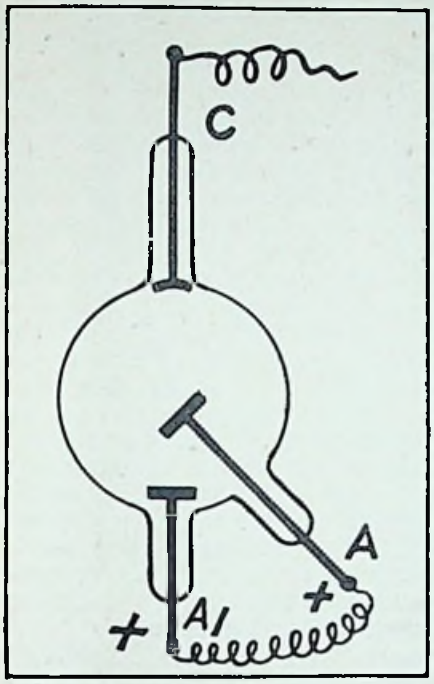


Fig. 6.
An early form of X-ray tube.

that it becomes a conductor of electricity. If a potential is applied between two plates of metal placed inside a cathode ray tube, it will be found that the maximum potential difference which can be maintained between the plates is considerably less when the cathode rays are passing through the gas. This would indicate that the gas in the space traversed by the rays has become conducting.

Perhaps the most important property of cathode rays is their behaviour when subjected to a magnetic field. If a mica screen having a transverse slit is fixed near the cathode, and a phosphorescent mica screen is placed along the tube as indicated in the diagram (Fig. 4), it will be possible to trace the path of the rays without difficulty. When a horseshoe magnet is placed under the tube, so that the magnetic field is at right angles to the path of the rays, it will be found that the rays show a deflection which indicates that they are negatively charged. We shall see a little later how this behaviour of the cathode rays under the influence of a magnetic field has been applied to television by a number of workers.

It is interesting to note, in passing, that the speed of the cathode rays is of the order of 20,000 miles per second, and that since the rays consist of electrons, the mass of which is very small, we have in cathode rays an extremely fast moving weightless beam, which we can control either electrically or magnetically.

Cathode Ray Oscillographs.

Use has been made of specially designed cathode ray tubes in the study of the waveform of alternating currents, under the name of the cathode ray oscillograph. This consists of a cathode ray tube shaped as shown in Fig. 5, and having both electrodes close to one end. The stream of cathode rays then passes through the aperture in the screen *S* placed near to the anode, finally falling on the phosphorescent screen *P*, at the opposite end of the tube. On applying the current under investigation to the two plates *FF*, there will be a field produced which will deflect the beam of rays according to its value at each moment. If this is varying, as in the case of alternating current, there will be traced out on the screen the actual waveform of the current.

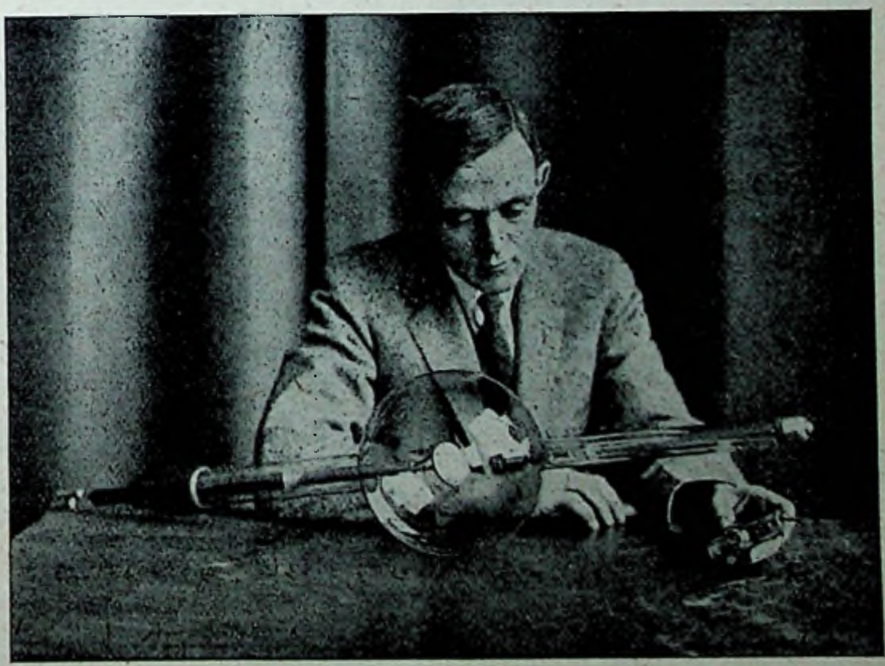
One other important property of the rays which I must discuss deals with the action of cathode rays on objects which they strike. It was in 1895 that Prof. Röntgen accidentally discovered that an unexposed photographic plate which had been lying near to a cathode ray tube, though still in its original light-proof wrapper, had been affected just as if it had been exposed in the ordinary way.

He decided that the phenomenon was in some way due to an unknown penetrating radiation, present in the discharge tube, which had been previously overlooked. Since he was by no means clear as to the nature of the radiation, he called it " X-rays," and the name suggested as a provisional term has persisted to this day, though a number of people prefer the term Röntgen rays, as being more suitable, since we are now in a position to appreciate their nature, and as commemorating for all time the name of their discoverer.

X-rays differ from cathode rays in certain vital points. They are not deflected by a magnetic or electric field, and can pass through much greater thicknesses of solid substances than is the case with cathode rays. The rays differ from light, too, for they are not refracted or bent, in passing from one medium to another.

Opacity of Metal to X-rays.

The opacity of a metal to X-rays depends directly on the atomic weight of the metal. For instance, aluminium, with an atomic weight of



A large Coolidge X-ray tube, photographed beside one of the smallest tubes (in left hand of figure).

27·1 is comparatively transparent; while lead, whose atomic weight is 207·2, is almost opaque to the rays. The same rule applies to compounds. Thus lead glass is opaque and soda glass fairly transparent to X-rays. Advantage is taken of varying degrees of opacity of flesh and bone in the use of X-rays for surgical purposes.

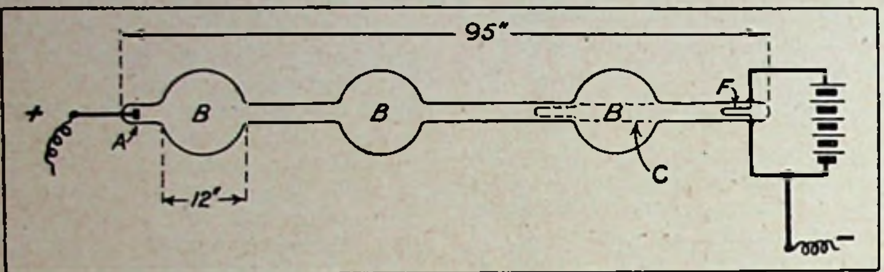


Fig. 7.
Sketch of one of the latest and largest triple cascade Coolidge X-ray tubes, built to operate on 900,000 volts.

What are these X-rays, and what have they to do with the subject of cathode rays? If we consider the type of tube used to generate X-rays we shall be more in a position to answer these questions. Fig. 6 illustrates diagrammatically the focus tube used for this purpose, and invented originally by Mr. Jackson, of King's College, London. The cathode *C* is a concave aluminium disc, and the anode *A* consists of a round piece of platinum foil placed at the focus of the cathode, at the same time being inclined at an angle of 45° to its axis. It is usual to make provision for an auxiliary anode A_1, placed diammetrically opposite to the cathode. After exhaustion through a side tube, which is then sealed, a discharge is passed through the tube.

Action of X-ray Tube.

You will realise that cathode rays will be generated, and the stream will be focussed on to the platinum anode. Under the fierce bombardment with the cathode rays, which you remember are electrons, the anode sets up ether waves, or pulses, due to the sudden pulling up of the fast moving electron stream. Each individual electron, when it strikes the anode, is responsible for a pulse or ripple, the energy of this ripple depending on the suddenness with which the electron is stopped.

Since the speed with which the velocity of the electron is reduced to zero increases with increasing evacuation of the tube, we see that for a more penetrating radiation, that is one with a higher frequency and higher energy per pulse, we must have a very low vacuum. This is expressed in technical language, by saying that the tube is a hard one.

The rays excite fluorescence in many substances, such as precious stones, and chemicals like barium platinocyanide. Like light waves and the waves used in wireless, they consist of ether waves, but their wavelength is much smaller than that of light, being of the order of 0·00000001 metres! Expressed in terms of frequency, we have the astounding figure of 1,600 million million vibrations per second.

Before proceeding to a brief discussion of the television systems in which the use of cathode rays has been suggested, I thought it might prove of interest to my readers to hear a little concerning the latest developments in cathode ray tubes.

For some time past Dr. D. W. Coolidge, of the General Electric Co. of America, has been carrying out research with tubes in which the potential difference employed was 300,000 volts, and in his latest tubes he uses potentials of the order of 900,000 volts.

The method which he employed to make success possible was the outcome of the Coolidge X-ray tube which he had developed some time before. The main idea underlying this is to employ a heated filament as a cathode, in place of the ordinary cold cathode. We see then that there will be a plentiful supply of electrons as soon as the cathode filament becomes heated, before the enormous potential is applied to the electrodes. In Fig. 7 I have endeavoured to give readers some idea of the design of tne latest triple cascade tube for 900,000 volts.

The overall length of the tube is 95 inches, while each of the three bulbs (*B*) is 12 inches in diameter. The filament is shown at *F*, and this constitutes the cathode. The anode is shown at *A*. In order to prevent the puncturing of the glass by the high-speed electrons, an internal copper tube is arranged as a screen. The window through which the electrons issue is of metal 1/10,000 of an inch thick, but so made as to withstand an air pressure of 100 lb. per square inch. The X-rays which are produced when the cathode rays generated by this tube strike a solid target are as penetrating as the rays emitted by radium. There are a number of wonderful effects associated with this tube, of which I can only make brief mention.

Effects of Gigantic X-ray Tube.

Acetylene gas is transformed into an unknown yellow solid; animal life is killed after a few seconds' exposure to

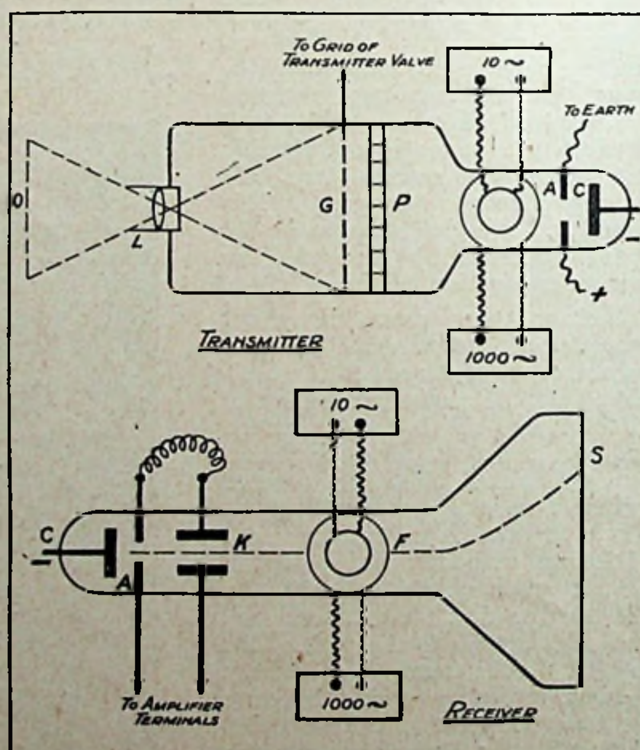


Fig. 8.
Mr. A. A. Campbell Swinton's scheme for employing cathode rays for television purposes.

the rays; and crystals of the mineral calcite glow with a red heat, and remain a glowing mass of incandescence while being actually perfectly cold; furthermore, the rays from this giant tube have a bactericidal action greater than any other known form of radiation.

We must now consider the various schemes which have been suggested for the employment of cathode rays in television systems. One of the earliest methods was the outcome of the work of Mr. Campbell Swinton, who made use of cathode rays at both transmitter and receiver. Fig. 8 shows the idea underlying the scheme, but for full details reference should be made to the original Patent Specification.

Campbell Swinton's Suggestion.

In the transmitting tube there is placed a lens, *L*, which focusses light from the object on to the gauze screen *G*, behind which is placed a network of photo-electric cells, *P*. The cathode rays stream from the cathode *C* through an aperture in the anode *A*, and are subject to two magnetic fields at right angles to one another, these fields being produced by coils *F*, which are connected to valve oscillators producing frequencies of 10 and 1,000 per second. The anode is connected to earth, while the gauze screen is connected to the grid of the transmitter.

At the receiver a similar arrangement is employed, but of course the photo-electric cells are omitted. The anode *A* is connected to one terminal of the amplifier, while one side of the two-plate condenser *K* is connected to the other terminal of the amplifier. The cathode rays are thus precontrolled by the electric field due to this condenser, which field varies in intensity according to the light impulses impressed upon the photo-electric cells at the transmitter. The rays are then subjected to two magnetic fields at right angles, which correspond to those at the transmitter. By this means the beam of rays is made to sweep across the receiving screen (*S*) in synchronism with the scanning beam at the transmitter.

Belin and Holweck.

MM. Belin and Holweck use a system of vibrating mirrors as the scanning mechanism of their transmitter, and a specially designed cathode ray oscillograph is used at the receiver. This tube works on the heated cathode principle mentioned in connection with the Coolidge tube, and in addition is fitted with a plate and grid and a concentrating coil. The action of the grid is to vary the number of electrons which reach the screen in accordance with the current variations from the transmitter. In order to cause the spot of light on the fluorescent screen to move over the whole surface of the screen two electromagnets are fitted at right angles to one another outside the apparatus, and these are supplied with current of frequency, 500 and 10 respectively, which corresponds with the frequencies of the two vibrating mirrors at the transmitter, which are used for scanning purposes.

Similar arrangements have been suggested by a number of other workers, but nobody has yet succeeded in demonstrating true television by this method.

Thus we see that, in spite of adverse criticism, Mr. Baird's method still remains first and supreme in the field, despite the statement that nothing short of the speed of the electron in the cathode ray tube would suffice for television purposes.

Those Accumulators.

(*Concluded from page* 16.)

are other large holes, while a large nick in the side, already drilled, permits air to pass under the baseboard, and so through the holes and past the transformer.

There is one other point. If at any time it is desired to light all the valve filaments direct from the mains a suitable large electrolytic condenser, known as the TOBE, can be purchased, together with the necessary heavy-duty chokes, from Messrs. Heayberd, to convert the charger into an L.T. eliminator.

A word of warning. Having built and installed your eliminator, don't expect its mere presence to be sufficient to keep your accumulator fully charged. Use it. It won't harm for using, nor will it wear out quickly. The valve has a useful life of at least 1,000 hours. Also, don't fear for your electric light bill by using it. It takes very little more current than it puts into the accumulator, and in any case will be found to be by far the most satisfactory way of keeping accumulators fully charged.

APPARATUS RECEIVED.

From the British General Manufacturing Co.. Ltd., we have received for test one of their L.F. transformers. This instrument is generously proportioned and heavy, extremely well finished, and shrouded by a highly polished, cleanly, attractive looking, and efficient shield. Provision is made to earth this shield.

On test in a broadcast receiver we found its performance to be excellent. On trying it out in a television amplifier (where distortion immediately becomes apparent to the eye) we found that we could detect no appreciable signs of distortion.

From Messrs. Gambrell Radio, Ltd., we have received a safety device known as the Gam-brell Twin Fuse Unit for use in mains receivers. The fuses are designed to blow at 1 amp., thus protecting both the house lighting supply and the radio and associated instruments. The unit is very well made, and the arrangement for fitting in the fuses (which are of the cartridge type) is extremely neat.

We commend this unit to the attention of constructors.

A Television Record.

According to a recent newspaper report, a wireless amateur in Johannesburg, named McCormick, claims to have established a record for television reception. He states that he received pictures broadcast from New York.

The distance between New York and Johannesburg is approximately 7,000 miles.

WGY's Television Broadcasts.

According to information received from the General Electric Company, of Schenectady, N.Y., WGY's television broadcast programmes are now being sent out one hour later, from 4.15 to 4.30 a.m.,G.M.T. These transmissions are also sent out simultaneously through one of WGY's sister short-wave stations.

The Latest.

Discontented Visitor: "In your advertisement you said one could see the sea from your house."

Landlady of the Future: "So you could if you'd brought your televisor!"

Who's Who in Television

Sir EDWARD MANVILLE

AND

LORD AMPTHILL

READERS of this journal are already familiar with the technical side of television, and with the details of the career of Mr. J. L. Baird, the Scots inventor, who was the first to achieve success in the international race to attain practical television. Other personalities have also been dealt with from time to time in these pages.

Little has been heard, however, of the courageous pioneers who gave their names and energies to the furthering of the business side of television. These pioneers are Sir Edward Manville and Lord Ampthill,

LORD AMPTHILL.

Chairmen respectively of the Baird Television Development Co., Ltd., and Baird International Television, Ltd.

Sir Edward has many interests other than television. He is chairman of the Daimler Co., Ltd., and several other prominent companies. He is also consulting engineer to many local authorities and companies for electrical undertakings at home, in the Colonies, and in foreign countries. He has established a reputation for his determination to regain for Britain her lost prosperity.

Lord Ampthill, after a long and distinguished Army career, filled several public posts of importance, notably Governor of Madras and Viceroy and Governor-General of India. He is also a very prominent Freemason, occupying the high office of Pro Grand Master of Grand Lodge of England, a position in Freemasonry second only to that held by the Duke of Connaught. Like Sir Edward Manville, Lord Ampthill has several business interests other than television, and, again like Sir Edward, he is determined to improve the status and prospects of British industries.

Both men are to be congratulated and esteemed for their courage and foresight in associating themselves with television, the basis of a new and gigantic industry, an industry which may well outgrow the wireless industry in its size, scope, and importance. Both men are determined to carry out the spirit of the slogan which we printed on the cover of our last issue—SUPPORT BRITISH INVENTIONS.

If everyone in this country will live and act up to that spirit, Britain will reap all the rewards which must necessarily follow her retention of this new industry. The introduction of a new industry means, amongst other things, more work for our unemployed, and the creation of new wealth. These benefits may

SIR EDWARD MANVILLE.

easily slip from our grasp unless we speedily wake up and realise the position. In contrast to the general apathy exhibited in this country towards the latest British invention, we give on another page some details of the interest in television which is being shown by other countries who are more alive to its possibilities.

Given the support of a few more such far-seeing and patriotic pioneers as Lord Ampthill and Sir Edward Manville, the seed sown by television may yet be harvested by this country.

Light: The Essential of Television
Part V.

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 normal daylight and artificial light, since the light sources are concealed (that is, they are not in the line of vision), it may be said that all objects seen either by the eye or the televisor reflect either direct or diffused light; this depends upon the surface of the reflecting medium, whether it has a glossy or matt surface. Glossy reflecting surfaces are not at all desirable; they serve no useful purpose, except in the application of artificial light, to redirect the rays from a light source in any desired direction. In normal daylight an object can be better seen under diffused light, when the rays from the sun are passing through white clouds. The light, however,

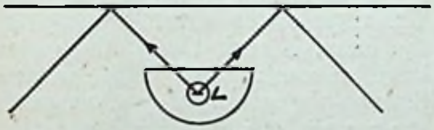


Fig. 1.

is more or less directional, since the intensity varies, the governing factor being the position of the sun in the sky.

The difference between direct and diffused reflected light should be thoroughly understood; this applies more particularly to artificial light. The effect, in practice, is often different to that which has been anticipated. Let us consider Fig. 1 for a moment. Here we have an entirely concealed light source, *L*, located in an inverted bowl type fitting. The ceiling from which the unit is suspended is painted with white enamel of a high reflection factor.

Assuming the light rays to follow the directions indicated by the arrows, it will be found that light sources, at the points of reflection, have been produced on the ceiling. If one, walking about the room in which the unit is located, looks at the ceiling, various light sources can be seen as different angles of reflection and incidence are made between the lamp filament and the eye. These direct reflected light rays are re-reflected from other bright surfaces, such as polished sideboards and mirrors. Such light sources produce curious shaped shadows; shadows which appear to be part of objects, so that the latter appear distorted.

Eliminating Shadows.

The shadow produced by one direct light source cannot be eliminated by the installation of another source. Let us consider Fig. 2. Here we have a light source, *L*, which is illuminating a square object. The shadow zone is indicated by the dark space next to the object, on the opposite side to the light source. At first sight it may be assumed that if another light source is fitted at the same distance from the object, and at the same height as the other source, the shadow will be eliminated. The obvious inference is that it will require the same intensity of light and angle of incidence to neutralise the shadow as it does to produce it.

This does not work out in practice. If another light source were fitted, as illustrated in Fig. 3, the result would be to produce another shadow as shown. The intensity, or density, of the first shadow is decreased, and both shadows, although lighter than the first one, will both be of the same density. It has been assumed that the light sources are bare sources, such as would be obtained from ordinary tungsten filament gas-filled lamps with clear glass bulbs.

The shadows can be eliminated by

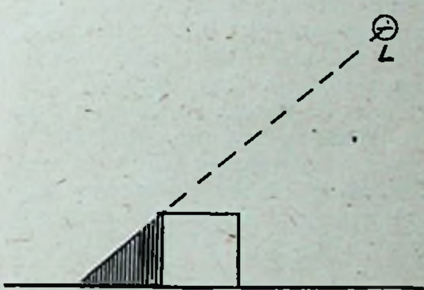


Fig. 2.

the use of a diffusing medium. White colour-sprayed lamps, for instance, will diffuse the rays from the filament. The effect is illustrated in Fig. 4. The rays from the filament, *F*, pass through the glass and, encountering the matter held in suspension (the colouring material), they are split up and reflected in various directions. The reason for this is

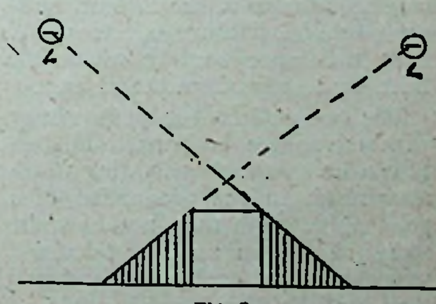


Fig. 3.

that many surfaces are presented to the rays at different angles; the reflection, then, is in many directions. It should be noted, however, that, although the shadows are eliminated, the shape of the object cannot be determined by the eye or the televisor. The edges facing the observer would appear flat. The outside shape would be seen, but only in contradistinction with the various reflection

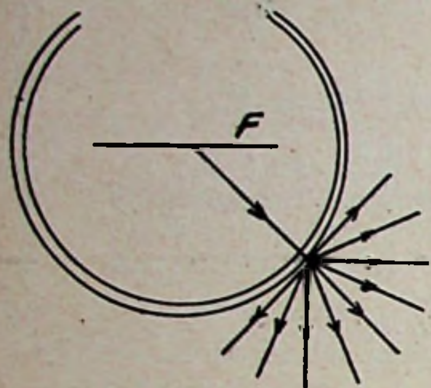


Fig. 4.

factors of other objects at the back of the object under discussion.

We have discussed the effect of two forms of lighting: dense shadows and apparently distorted objects through direct light, and loss of shape through direct diffused light. It is obvious that neither is of use for television purposes. It should be remembered that, as with a camera, the whole of the light rays from objects which form a scene or setting are convergent.

Convergent Light Rays.

There is, however, a difference in the effect. In a camera, for instance, if a very wide scene is to be taken in, a wide angle lens is used, the effect of which is that objects in the centre of the plate are not seen in their true perspective; they appear to be too far away. In normal daylight, when light intensities are high, the televisor may take in the central objects. Under artificial light, however, special lighting effects would have to be produced to enable the televisor to reproduce the objects.

The camera-televisor analogy may with advantage be carried further. It can be shown that lighting which may result in the production of a good photograph may not be quite so suitable when used for television purposes. It should be remembered that good lighting should enable all objects to be seen in their three dimensions; detail should be seen quite as clearly with artificial light as with normal daylight. By detail is meant the carved or embossed features of objects which demand light of the correct quality, intensity and direction to bring out the right values in light and shade.

Let us consider Fig. 5. This is reproduced from a photograph of a figure in fancy dress, and it is considered to be a fine example of the photographer's art. (We will discuss the system of lighting this figure later in this article. It is the *effect* of the lighting that we are concerned with at the moment.)

Fig. 5.

The extreme contrasts in light and shade on both sides of the figure should be noted. The left-hand side contains quite a lot of detail in the shape of creases, but the right-hand side appears flat. The creases exist in the material seen on the right, just as they do on the left; they cannot, however, be seen.

Again, the shape of the pom-poms on the right can be clearly seen. They are black, but not dead black. The tops appear light because a certain amount of light is being reflected from a more or less glossy surface. On the left-hand side of the figure the pom-poms do not appear to have shape. They appear flat; yet they are exactly the same as those on the right. From this it will be seen that, with two different coloured materials, we have different effects under the same intensities of light.

The reason is that the photograph was taken in a room by means of one light source which was capable of producing light of various intensities. It is obvious that the intensity of light on the right of the figure is higher than that on the left. The light on the left is reflected diffused light; on the right it is direct diffused light from the same source.

Lighting Effects.

It would appear that for television purposes the illumination on the right is too well diffused; it should be slightly directional to bring out the shadows of the creases. The intensity is right because the shape of the pom-poms can be seen. Referring to the left of the figure, the direction of the light is right, but the intensity is too low. Increasing the intensity will have the effect of projecting more light on the pom-poms and their shape will be seen.

The method of illuminating this figure is illustrated in Fig. 6. An arc lamp, *A*, is located behind a screen, *S*. The screen is composed of several layers of muslin fitted on a frame. The angle of the screen, relative to the lamp, is such that, although a large percentage of light passes through the screen on to the figure, the remainder is reflected from the ceiling at points *CC*1; the ceiling is this peculiar shape. At *C* the

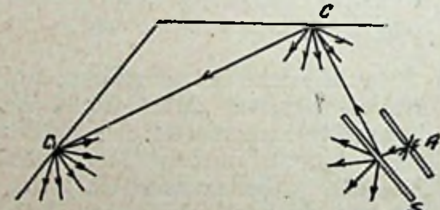


Fig. 6.

intensity of the light is higher than at *C*1, the reason being that, although the reflection factor is the same, the losses through reflection are considerable.

As an example, let us assume that a light source is projecting light upon a piece of white paper which

(*Continued on page* 29.)

The Television Society

Report of December Meeting

Professor Cheshire on "Tuning Forks"

TELEVISION DEMONSTRATED

THOSE members attending the December meeting of the Television Society held at the Engineers' Club, Coventry Street, London, W., on Tuesday, Dec. 4th, had an opportunity of seeing what real television is like.

A televisor was fitted up on the premises, and for an hour before the lecture, and also at its close, the Baird Company broadcast a special transmission by wireless from their laboratories at Long Acre.

This was the first time many members had seen real television, and their comments on the action of the B.B.C. in refusing facilities for broadcast purposes must have made many ears burn at Savoy Hill.

The images received were remarkably good, showing every detail from high lights to deepest shadow.

A number of persons took part in the transmission, and those present at the Club looking-in were able to say whether the person appearing was grey-haired, fair-haired, or dark, and recognise many other details of appearance.

Chairman's Remarks.

Calling on Professor Cheshire to give his lecture on "Tuning Forks, How they Talk and What they Say," DR. TIERNEY, the chairman, said most of them were familiar with a tuning-fork as the implement the piano tuner carried in his pocket, or as was used by the village parson in the village hall on gala nights, equally to the annoyance of everyone.

From a scientific point of view the tuning-fork was of very much greater importance, and it was now fast becoming an instrument of precision, in matters appertaining to instruments for measuring wave-length and wave motion, and that again had an important bearing on work in connection with wireless.

Professor Cheshire was going to give them a general outline of the importance and theory of tuning-forks, especially in relation to wave motion, and he had much pleasure in asking him to give his lecture.

Professor Cheshire's Lecture.

PROFESSOR CHESHIRE said the title of his lecture might make it appear that his subject was a very humble one, but in spite of that it dealt with a subject of the greatest importance to the student of Nature and Nature's ways. In short, his lecture was intended to serve as a simple experimental introduction to the study of wave motion, a subject which was becoming of greater importance every day.

The study of wave motion began most naturally in experiments with water waves and ripples across the surface of a pond. During his years of teaching he had often lamented the fact that it was not possible to take a class of students down to the side of a pond, in order to carry out experiments on the surface of the water, for it was surprising what an extraordinary number of the basic facts of wave motion could be demonstrated simply by a few experiments in a pond, or failing that—a bath.

In the lecture theatre they tried to represent these experiments as nearly as possible in a basin of mercury, but a direct recourse to water waves and ripples was preferable.

It was unfortunate, however, that the subject of acoustics had fallen on evil days, for there seemed to be a tendency for it to play a less and less important part in the subjects dealt with at schools and colleges. In his opinion it was worth teaching, and should be taught if only to serve as an introduction to the study of wave motion. Possibly, some day, someone would endow a Chair of Wave Motion at one of our universities.

He had chosen the subject of tuning-forks because they enabled us to carry out a number of very beautiful experiments and helped us to proceed to a knowledge of waves and wave motion in general.

The facts he proposed to demonstrate were fundamental facts in sound, heat, light, and electricity. The modern invention of wireless—and its offspring, Television—had given an enormous impetus to the study of wave motion. Every schoolboy now basked in the ether of space, and was familiar with such terms as "wave-length," "frequency," "amplitude," "vibration," "heterodyne," and a number of others relating to wave motion.

The Study of Wave Motion.

The study of waves and wave motion could most conveniently be divided into three parts. In the first place they could deal with wave producers, then proceed to consider how and by what means waves once produced were transmitted from one place to another, and finally they could discuss wave receivers. A familiar instance of that was the reproduction of vocal sounds which were originated by the action of the vocal cords acting in collaboration with certain resonating cavities.

The sounds were transmitted in all directions by the air, and, finally falling on the drum of the ear, were identified as musical sounds.

He proposed to deal first with the tuning-fork as a producer of waves, and for that purpose he had brought a number along with him. There was, of course, the ordinary familiar waistcoat pocket tuning-fork, which was struck on any hard object (most brutal treatment), and then placed on some wooden surface to make its note audible.

Having produced and sounded the fork, Professor Cheshire then showed six special tuning forks. The largest of these was a 50 chronographic fork made by Koenig. Such forks were no longer made, he explained, and probably never would be made again with the same perfection. Koenig worked in a room kept at a constant temperature, and each fork he produced was tested and calibrated with reference to a special 64-fork, which acted as a pendulum for a standard clock, and thus had its frequency constantly checked.

Standard Forks.

The resultant forks were so accurate that they became a standard for chronographic work all over the world. A 50-fork was so called because the blades vibrated 50 times a second.

As against the 50-fork Professor Cheshire produced a tuning-fork scarcely half an inch long, which he called the baby of the family. Between these extremes he had four forks which when sounded together produced a perfect major chord.

Reverting to the large fork, he sounded it by drawing a violin bow across both prongs. It produced a deep, scarcely audible humming note. Picking up the baby fork, he mentioned that it produced a high-pitched sound, which was to a certain extent a test of age. The older ones present would probably not hear it, but the younger ones should. The note produced was very shrill indeed, and about the pitch of the note of the squeak of a bat. The fork vibrated about 10,000 times a second, and gave a note which was about an octave below the upper limit of audibility. A healthy youth with good normal ears should be able to hear 20,000 vibrations a second, which was the upper limit of audibility.

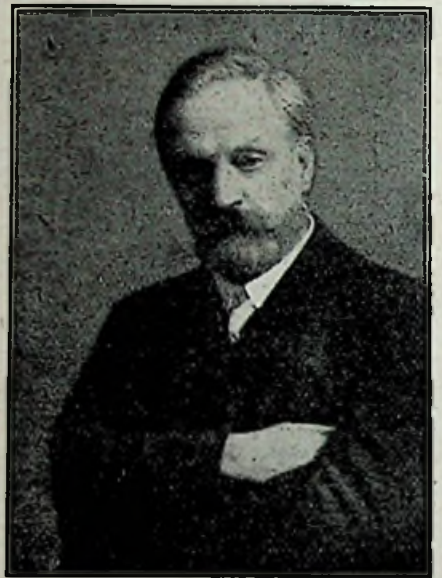
The four intermediate forks when sounded together gave a perfect major chord of wonderful purity and beauty.

Professor Cheshire then dealt with what a fork did when it was speaking, and by means of a strip of steel held in a vice showed that as the length of metal vibrating was shortened one came to a point where it gave a note. Further shortening raised the pitch of the note. The strip showed, too, that as it was shortened its vibrations became more and more rapid.

This indicated that in the case of a tuning-fork the musical pitch was governed by the rate of vibrations of the blades, which in its turn depended on their length.

To prove that the tuning-fork when sounded *did* vibrate, a ping-pong ball suspended on a string was held against one of the fork blades. When the fork was sounding it was periodically struck away from the blade by the vibrations.

Apparatus to record fork vibrations was next illustrated by lantern slide.



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

In this apparatus the fork was clamped rigidly in a horizontal position. On one of its blades was fixed a light pointer. Beside it, independently fixed, was another pointer—a time marker—which each half second was moved by a combined clockwork and electric movement a short distance from left to right, and *vice versa*, as the case might be. Both these pointers bore on a smoked glass plate which was slowly pushed forward.

When the fork was vibrating its pointer traced a wavy line on the plate, and beside it was the line traced by the half-second pointer with a sharply defined kink at each half-second. The two together enabled one to determine the number of vibrations of a fork per second.

Lantern slides of these smoked plates were shown.

The first one showed both blades vibrating together, and proved that the blades did not move left and right in unison, but moved to and from each other.

Other slides showed the vibrations of the four forks of the major chord and the separate vibrations were of the order of 8, 10, 12, and 16, and gave the relative frequency of 4, 5, 6, and 8, which was true for any major chord. In the same way octaves were related to one another in the proportion of 2 to 1.

Pendulum Analogy.

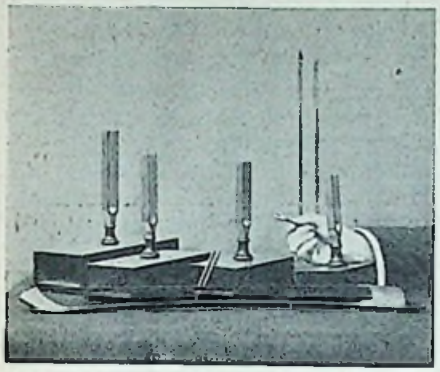
When vibrating, a tuning-fork acted exactly as a pendulum did and followed the same laws, i.e., the blade was moving fastest when passing the centre line, and came to rest to the right or left of that line before starting a fresh vibration. Also, however big or small the vibration of a given fork, the blades always took the same time to complete one vibration.

Under such conditions it was easily understandable that it would be extremely difficult to say where a vibrating blade would be at any instant of time. Fortunately there was a method of doing it. The full swing of the blade was taken as the diameter of a circle and on it were marked the points where the blade touched at the extreme left and right of its vibration. If it was desired to see where the blade was at any given twentieth of a second, for example, the upper and lower halves of the circle of reference were divided into twenty equal parts and the segments joined—upper and lower—by vertical and parallel lines. Each line by its intersection with the horizontal line coincident with the track of the pendulum gave the position of the blade at that fraction of time.

Going back to the traces of fork vibrations on the smoked glass with the half-second pointer marks behind it, it was obvious that such a combination formed a very accurate means of dividing and recording minute portions of time.

An Amusing Experiment.

In an interesting aside Professor Cheshire mentioned that he had often tried to get spiders to come down their webs and attack pieces of stick or leaf that he entangled in their webs, but it was not until he used an ordinary common C tuning-fork that he was successful. When he struck such a fork and put it in a spider's web the animal immediately rushed out and attacked it. When



A group of tuning forks (ranging in frequency from 50 to about 10,000) used in the course of the lecture.

it touched the cold steel, however, its surprise was great, and it promptly leapt off and either sat down to think things out or fell like a stone to the ground.

Considering the subject of overtones, all musical instruments not only had a fundamental vibration, but also overtones or *harmonics*, as they were called.

When a fork started to sound there was just the suspicion of the presence of an overtone, but it was immediately damped out by the resonator to which the fork was attached, and one got the pure note.

It was possible, however, to get the overtone by bowing in a special way.

Overtones Demonstrated.

Professor Cheshire illustrated the overtone by bowing the fork very low down on the limbs of the blades, and then showed a smoked plate tracing of the vibrations.

In this there was imposed on the main vibration of the fork an additional ripple which in the case of the first harmonic went about six and one-third times as fast.

The fundamental was caused by the ends of the fork vibrating independently of the main portions of the blade, and to prove this Professor Cheshire used the 50 chronographic fork.

Making it sound the harmonic and the fundamental together, he picked it up from the table by grasping the centre of the blades. While the fundamental immediately ceased, the overtone continued for some time.

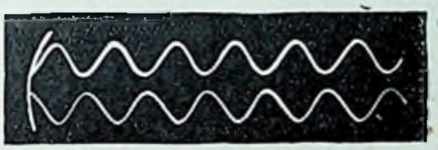
In the case of the second overtone the vibrations were seventeen and a fraction times as fast as the fundamental.

As everyone knew, sound waves were transmitted by the air, but, although we could not see them, it was possible to secure photographs. Two lantern slides were then thrown on the screen, of a rifle bullet travelling at a velocity of 2,000 feet a second.

The air waves were clearly visible, and in conjunction with the black body of the bullet appeared very like a bird's-eye view of a tug on the Thames. There was the clearly marked bow wave and stern wave, while immediately behind the square end of the bullet were a number of broken ripples corresponding to the churned-up, frothy appearance of the water at the stern of a boat.

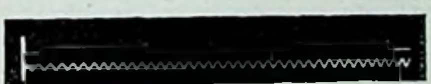
To demonstrate the principles of resonance, Professor Cheshire had two balls of equal weight hung on

TRACES ON SMOKED GLASS OF TUNING-FORK VIBRATIONS.

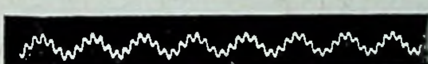


Two-prong trace of 50 fork.

Simultaneous traces of a fork (fundamental) and its octave.



Trace of 50 fork, side by side with trace of half-second time marks.



Fork giving simultaneously fundamental note and first overtone.

separate strings of equal length and about six feet apart. Joining them at a point a few inches from their point of suspension was a light rod.

One ball, when started swinging, gradually transferred its motion to the second ball. This built up its length of swing from rest to a maximum. While this was taking place the first ball gradually came to rest, and actually stopped, by which time the second ball had attained its maximum motion. The process was then automatically reversed, the first ball building up its length of swing, while the second gradually lost it. The process, explained Professor Cheshire, would continue for some hours before both balls came to rest. The transference of energy took place through the rod.

The first pendulum in its swing delivered a slight push to the second, and was practically driving it, because the second pendulum was always a quarter of a phase behind. When the first came to rest a reversal of the process took place, and the second pendulum began to drive the first.

That was the simplest possible mechanical experiment of the principle of resonance or the tendency of one body of a given frequency to start in vibration other bodies with the same frequency. It was the principle on which all modern wireless tuning and reception depended.

In another experiment to illustrate this point a violin, a long thin deal rod, and the movement of a musical box were used.

The musical box when playing in the air was almost inaudible, but when it pressed against one end of the deal rod and the violin body pressed against the other end, the sound vibrations travelled along the rod, caused the violin body to resonate, and the musical box was clearly audible.

DR. TIERNEY, thanking the lecturer, said they had all listened to a very fascinating lecture on an apparently simple subject.

Chronographic apparatus (home-made) for obtaining fork-traces and frequencies.

When they began to look into it, however, they realised that waves and wave motion played a very important part. If the knowledge was applied to everyday problems the day might yet come when it would be possible to build lecture halls and government institutions in which people could actually hear what was said on the platform! The moment one began to understand waves and wave motion one could then begin to coördinate one's knowledge to some practical application from which we should all derive benefit.

A very hearty vote of thanks having been passed to Professor Cheshire, Dr. Tierney announced that the next lecture would be given on Tuesday, Jan. 1st, by J. Cameron Rennie, Esq., M.I.E.E., B.Sc., who would speak on "Exploring Devices."

The secretaries desired it to be known that it was proposed to hold a members' evening and conversazione in May, and suggestions as to the types of apparatus and demonstrations would be welcomed.

Members, too, would be interested to know that experimental television transmissions by wireless were to take place from the Baird Laboratories in Long Acre from midnight till 1 o'clock on Tuesdays and Saturdays on a wave-length of 200 metres.

A very hearty vote of thanks was passed to the Baird Company for the demonstration of television which they had arranged for the benefit of members attending the meeting.

Miss D. K. Caffrey and Miss C. M. King, the two young ladies who appeared before the televisor, and who were seen by television by members of the Society who attended the meeting on December 4th.

The Television Demonstrations.

Members at the crowded meeting of December 4th availed themselves of the opportunity to visit the demonstration room, where a Baird dual commercial televisor was installed.

A programme of wireless vision was maintained for each hour announced, but the audition portion of the instrument was tuned to 2LO due to the present impeding conditions, and this unfortunately did not serve for the full purpose of the demonstration, other than as evidence of the remarkable purity of the loud - speaker combination and the absence of interference.

Television was never better demonstrated, the images being perfectly well received, showing a noticeably stereoscopic effect and a perfect reproduction of high lights and tones scarcely expected to be possible.

Members who had witnessed previous demonstrations were loud in their praises regarding recent developments and all were charmed with the ladies, so naturally visible, who took part in the programme at the distant Long Acre studio.

The lecturer of the evening, Professor Cheshire, C.B.E., A.R.C.S., F.I.P., remarked, as he inspected the demonstration, that television had passed the Rubicon, and he was overheard to say that the last demonstration he saw did not suggest to him that he would wish to see the lady he loved presented to him by the televisor; but this demonstration certainly made him wish to see his wife by television.

Members were invited to test their apparatus at midnight, when the first of a series of experimental test programmes would be put on the ether for one hour by the Baird Company.

The wavelengths used are 200 and 250 metres.

It is hoped that these tests will afford members an opportunity to obtain data helpful to all concerned. Members will use these transmissions to test apparatus that they propose to display at the May exhibition of members' work to be held at the Society's rooms.

All interested in the formation of group centres in their district may have a copy of the memoranda relating to Group Byelaws (now passed by Council) by applying to the

Hon. Secretaries,
Television Society,
95, Belgrave Road, S.W.1.

Lectures are being arranged by the Society and by others, and it is hoped that members will notify the secretaries of these events in their districts so that members residing locally can be posted in order to help the formation of centres. If members will wear their badges (which can be had at a cost of 1s. from the head office of the Society) these lectures will promote the fellowship of local members.

A complete list of members is being prepared for the printers, and all who have not completed their subscription are invited to do so now,

Miss C. M. King sitting before the televisor.

so that the list may be as complete as possible. Readers desirous of becoming members should forward the application form, printed in this issue, duly filled up, without delay, so that their membership may be completed for the list.

ANNOUNCEMENTS.

The next meeting of the Society will be on January 1st, at 8 p.m., Engineers' Club, Coventry Street, W.C.2, when J. Cameron Rennie, Esq., M.I.E.E., B.Sc., will lecture on "Exploring Devices." Members' friends will be admitted by signing the visitors' book.

The subject of the lecture has been slightly touched on in certain back numbers of the Journal, which, by special arrangement with Television Press, Ltd., members can have at half price from the publishers.

For the meeting of the Society to be held in February, it is proposed to depart from the usual formal lecture. Instead, it is hoped to have a number of "lecturettes" each lasting about a quarter of an hour and dealing with some aspect of television. Where possible experiments will be shown to illustrate the principles involved, and a short discussion will follow each item on the programme, in which members are invited to take part. By this means it is hoped the members of the Society will get to know one another better. The success of the arrangements will, however, depend very largely on the support given by the members themselves both in providing suitable experiments and in initiating and following up the discussions so as to make them of real value.

Those members who have live ideas or who can offer experiments or apparatus dealing with some particular line of investigation along which they have been working, are asked to communicate as soon as possible with the lecture secretary. It is desired to issue a short summary of the evening's programme in time for distribution at the next meeting in January, so that this summary may be available for members wishing to take part in any of the discussions.

The secretaries have recently received a number of letters of constructive criticism on the work and development of the Society. We welcome such letters as indicating that the majority of our members are keenly alive to the importance of "team work" and that they realise that the influence and prestige of the Society depends very largely on individual effort. Some of the suggestions received have already been acted upon. The lecture secretary is now actively engaged on preparing a lending library of lantern slides dealing with every aspect of television. A list of members is also in course of preparation, and when this is printed it is hoped members will be able to get in touch with one another more easily. For those engaged on actual research in television problems, the widely scattered references to papers make their work none too easy. The Society hopes to be of assistance to its members in this way before very long.

If you have constructive criticism to offer, please write.

W. G. W. MITCHELL,
J. DENTON,
Joint Hon. Secretaries.

Light: The Essential of Television.

(*Continued from page* 24.)

has a reflection factor of 85 per cent. This means that 15 per cent. of the light will be absorbed in reflection. In other words, after reflection, the intensity will be but 85 per cent. of its original value. If this reflected light is reflected again from another surface the value after reflection will be 62·25 per cent. of its original value. This explains very clearly why the left-hand side of the figure is so dark in comparison with the other side.

From what has been said it would appear that almost every scene or setting transmitted under artificial light will call for different treatment from a lighting point of view. This is because, in any scene, one has objects of different reflection factors. Dark objects (these have poor reflection factors) must be illuminated to a higher intensity than the lighter objects. That is, the intensity of the light projected upon them must be higher.

(*To be continued.*)

Forthcoming Lectures on Television.

During the Fête at the Polytechnic, Regent Street, W., Jan. 1st to 5th, exhibits of apparatus; also lecturettes at 3.30 and 8.30 p.m. by J. Denton, A.M.I.E.E. (Joint Hon. Sec., Television Society), with lantern slides and experiments.

Luton Wireless Society, Hitchin Road Boys' School, Luton. Lecture (illustrated by lantern slides and experiments) by J. Denton, Jan. 10th, 1929.

Lectures on television, illustrated by lantern slides and experiments, will be given at the following places by A. Dinsdale, A.M.I.R.E., the Editor of this journal:—

Jan. 9th.—Wadhurst Hall, Wadhurst, Surrey, at 8 p.m., before Popular Entertainments.

Jan. 18th.—The Barn Theatre, Oxted, Surrey, at 8 p.m., before the Oxted and Limpsfield Literary Society.

Jan. 23rd.—The Lounge, The Esplanade, Bridlington, Yorks., at 8 p.m., before the Literary and Philosophical Society.

Jan. 29th.—Picton Hall, Reference Library, William Brown Street, Liverpool, at 8 p.m., before Corporation Libraries.

Jan. 31st.—St. Polius Room, Windermere, at 3.15 p.m., before the Lecture Association.

Vision in Television

By The Technical Editor

In the following article our Technical Editor deplores the lack of vision of certain of those in authority in this country in matters relating to television. In contrast to the position here, he gives some indication of the state of affairs in America, which country he recently visited.

SCIENTISTS believe the ether to be that something through which radio communication is maintained. Its existence cannot as yet be proved in law. This may in some measure explain the apathy of politicians towards television.

I assume politics are a pleasant pastime, but to my mind they are not nearly so interesting as a newly applied science. Present circumstances, however, compel me to devote attention to the political side of television, although, of course, the technical side is my particular sphere, and I do not feel that it is necessary for me to apologise for so doing owing to the political difficulties which are being placed in the way of this wonderful British invention; an invention which, in my opinion, is destined to play as great a part in Empire communications as the cable and the oral wireless have already.

The Man in the Street.

It is a very commonplace criticism of the man in the street that he does not think for himself and takes his views ready made — as instance *Punch's* well-known joke about the gentleman trying to explain to his wife that he has been delayed at the office while a picture of him sitting in the Savoy Hotel appears before his wife's eyes above her telephone receiver.

But in justice to this down-trodden being (the man in the street), it is only fair to point out that the same accusation may be levelled against those who in a greater or lesser degree are set in authority over him.

The process of thinking is an interesting one, and one of its characteristics is that a very simple fact often deserves a lot of thought, and as an example of one of these facts I give the following statement: **"There are fourteen stations broadcasting television in the United States of America to-day."**

This is quite a simple fact and quite interesting, but when we start to think about it the implications are almost staggering. Television has been developed to a practicable stage in England by a Scotsman, and this fact has not been hidden under a bushel. All who take an interest and a pride in their country have had this information available to them, and those set in authority over us have had ample time to assure themselves of the genuineness of the claims that have been made.

It is at all times equally clear that if television could be accomplished it would be a matter of supreme importance both commercially and nationally. But the position that we are in to-day is that apart from the few meagre facilities which have been granted by an experimental licence for transmissions after midnight, there is no broadcasting of television in this country, and, be it noted, not a single government broadcasting station has been offered for the use of this great British invention, whereas *"There are fourteen stations broadcasting television in America to-day."*

Mr. A. Calkin, baritone, whose voice and features are broadcast twice weekly from the Baird experimental station.

Some months ago I ventured to urge on the authorities controlling broadcasting in this country, the necessity of broadcasting television in the interests of science, and other pens far more able than myself have developed these arguments. Let us be quite clear as to what we mean.

B.B.C. a Licensee.

The B.B.C. was granted by the Postmaster-General a licence for a period of ten years, commencing on the first day of January, 1927, to establish and maintain throughout the British Isles broadcasting stations for the broadcasting of news and matters of interest to us. The Corporation has refused to broadcast television on the grounds that it is not good enough. **By what standard is it not good enough?**

The B.B.C. has been set up to act as a national authority, and as such must take a national view of everything that its interests touch. On the grounds of scientific research and national interests there is absolutely no justification for withholding the broadcasting of television in conjunction with music, singing, and speech. I have said before, and I repeat that one of the most useful factors in developing a new science

(*Continued on page* 34.)

Sydney A. Moseley Tells the World!

I'LL tell the world, first of all, that I wish it the happiest of New Years. . . . Furthermore, I'll say that owing to the festive season I shall abjure subjects controversial—except to say that supposing all of us had been given facilities to *see* as well as hear Christmas and New Year greetings from famous folk—but there you are, my attitude is one of peace and goodwill to all men—including the men of the B.B.C. One can't go much further!

This magazine, TELEVISION, not being published daily with "h'extra speshuls," I must perforce pen these lines before Smithfield is all dressed up with turkeys and rosettes (first prize, Gadzooks Poultry Show), and when the problem is what presents to buy and where to find the money to buy 'em.

So that, don't expect the very latest possible, such as "Abdication of the B.B.C," "Baird Crowned King of Edinburgh Castle," "Television to Timbuctoo." Yet such are the omens that I would not be surprised at almost anything—*anything good*, that is.

For seemingly we have established our point—which is reasonable and not to be combated—namely, that *television should be given a fair public trial.* Unless I read public opinion wrongly and the force that is usually behind it, this trial cannot be long delayed. I imagine that Master Eckersley would be discreetly missing from such an Open Event—which would have to be free from all the inglorious glamour that surrounded a similar event of not so long ago.

I will wager that ere these lines are published the optimism I have expressed from the first will have been justified—*we shall be broadcasting television.*

Indeed, I shall, for the purpose of these notes, take all this for granted and look ahead a bit! Once having been given the opportunity of putting television over—even a restricted service—we shall go from strength to strength. The circle of lookers-in must extend and, the irony of it, television will result in popularising some of those talks which in the past have created more hostile criticism than anything else in the B.B.C. programmes!

* * *

Why and how will television achieve this? you will ask. Well, the average listener does not like to be spoken *at*; television, by enabling the speaker to be seen as well as heard, will create that feeling of intimacy between the speaker and listener which, in my view, is vital to the success of a talk. This need of beholding the artist is equally pronounced so far as music is concerned. You have only to watch the varied effects that different artistes, with the same quality of voice, have on audiences. The facial expression apart from the voice counts. The voice is never enough.

In talking, the lack of sight is particularly inimical. I am certain that the reason why some excellent B.B.C. talks have "flopped" is by reason of the listener's inability to concentrate on what is being said. Here is a test. Take an audience at a public meeting and have a well-known speaker address them. His force of personality will hold even those members of the audience who least of all follow his arguments. Watch the rows of uplifted faces even during a speech of utter boredom—as I often have—and you will realise how potent is the sense of sight, how it helps the least mentally disciplined to concentrate.

Now get this audience of listeners to turn away from the speaker; let them turn right round so that, although they are still able to hear what is said, they no longer have a vision of the speaker. The effect would be instantaneous; the speaker's grip would at once slacken so that his golden words—had he any to offer—would fall on deaf or otherwise distracted hearers.

You would have thought that all it needed was a little imagination on the part of the B.B.C. to realise how potent a force in its favour is the advent of television—even to such wireless "fans" as I am! To me wireless still retains all its mystery and marvels. I am yet thrilled at the sound of a voice which emanates from some distant centre.

Not everybody, however, either wishes or is able to retain this freshness, this constant anticipation of wonderment.

Novelties—even the novelties of wireless—soon wear. Living in an age of miracles, fresh discoveries occasion no heartbeats—even those of a momentary order. Tell the people you can *touch* by wireless and they will soon want to know how it is you cannot smell in the same manner. It seems so simple! I imagine, however, that the fascination of television will not wane so soon.

It has astonished me to hear the expressions of wonderment from the lips of those who have been privileged to see the early demonstrations at Long Acre, Olympia, and Selfridges. I find women—especially imaginative, intuitive, instinctive women—get the right angle.

> "My, but it's marvellous! Don't you see the endless possibilities of it?"

More than one wife of a distinguished public man has uttered these words on beholding television for the first time.

If these people, who affect indifference to, or who are genuinely disinterested in, broadcast talks, could *see* the moving features of the speaker a new interest would be aroused. It is inevitable that the two wireless sciences of sight and sound should be co-ordinated. It is merely childish to imagine that because some people at Savoy Hill are satisfied with what they already have that the world of listeners is going to be content as well—and that a far-reaching invention is to go a-begging because some ever-so-contented individual ordains that changes are distasteful to him.

Recent events (and I confess again that so sure am I of my ground that I am anticipating as I write) do much towards re-affirming our belief in the ultimate fairness of the British sense of equality. The little group of B.B.C. officials who came to decide the fate of television—which had been decided beforehand by the chief technician among them—and looked at each other for guidance and seemed to regard the whole thing as a huge joke—must have felt immensely secure behind the bulwark of their remaining eight years' monopoly.

"And that's that!" signified their attitude on leaving. The end of television—or, at any rate, *British* television.

They were never more mistaken in their lives. Abroad, these mysterious things may happen, but when a British inventor has some epoch-making thing to offer, and when a British Board of Directors feel they have not had a fair deal, truth and justice will prevail, monopoly or no monopoly—B.B.C. or no B.B.C.

You see, then, that the frivolous and Christmas mood in which I opened these notes has slowly but inevitably evaporated. The fact is, the subject is far too serious to be lightly dealt with, even in these festive times. When I set out on this new undertaking I vowed that, so far as I was concerned, there would be no stone left unturned until the only jury I recognise—The British Public—gave its verdict on this twentieth century wonder.

We have succeeded against all sorts of incredible opposition to remove the case from a packed jury, and I am satisfied. The appeal is still before the Greater Court, but I am as confident as it is possible to be of the result. By next Christmas television will be in every household and we shall all be wondering what the fuss was all about.

Yes, sir, a Happy New Year!

* * *

"My Young Friend."—Latest.

Under the heading "Television Developments" my young and modern friend, Norman Edwards, of *Popular Wireless*, writes:—

> "A curious calm has fallen upon the relations of the B.B.C. and Baird Television. Mr. Sydney Moseley, the versatile publicist, who is chivalrously sponsoring the television cause, and is usually decisive in his views of the B.B.C. policy towards television, shows a surprising reserve lately."

Alas! this time he was a bit too previous.

Hitherto his television news has been merely a year or so late. If he had waited till TELEVISION for December was out he might have revised his views on my "surprising reserve." I have an inkling, somehow, that he has now repaired his error.

Let him be assured that it is not so much a matter of reserve as of "reserves." I am storing up quite a nice little packet of ammunition in readiness. If and when it is necessary to fire it, he and others who have dealt unfairly with us will then have some little idea of what Armageddon is like.

Meanwhile, the calm may become curiouser and curiouser; but when it does break—my! when it *does* break . . . .

* * *

And Another!

Here is Capt. Eckersley again, true to the dignity of his official position, ever desirous of taking a fatherly interest in the development of science, and revealing that generosity of spirit which is so natural between one engineer and another:

"Well done, Baird!" you can hear him say, "I have a brother who knows something about television. And you have licked him and my friends in America to a frazzle. Go ahead! Keep the foreigners out. You are streets ahead as yet, and you are going to get a straight deal. Put it here, John L. You may not have achieved all that you are going to achieve, but, by gum! as one Britisher to another, we are going to give you all the encouragement we can. What would you like? 5XX or 5GB?"

"Did Eckersley really say that," the simple-minded reader will enquire. "How jolly decent of him. Judging from his voice over the wireless (and we have had good opportunity of judging that) that is exactly what you would have expected from him."

"Did he really say that?"

No, sir, he did not, but he did say this, in that friendly disposed journal *Popular Wireless*. (How they *all* try to help.) "And television: Is it crude now? No one can deny that it is very crude compared with the cinema. Crude in reproduction, crude in the amount that it will show. But will it be improved? My own view is that along the lines of mechanical scanning, as used by Baird, it cannot improve; quantities beat it. Even if that problem is surmountable it requires such a large number of (effectively) wavelengths that by wireless it is hopelessly unwieldly. Any technician will say the same. Television is in the state of an interesting laboratory experiment. Has it ultimate service value? Of course, if it can show us events in our own homes as they happen. Are its economics sound? At present they are not, and never will be until the whole problem is attacked from some as yet undisclosed but quite different angle."

Thus this super-optimist follows in the wake, with due humility as

(*Continued on page* 37.)

Television and the Amateur

By Major ARCHIBALD CHURCH, D.S.O., M.C.

General Secretary, Association of Scientific Workers.

Wireless provided the amateur with what is probably the greatest and most popular hobby ever known. Our contributor points out not only what the amateur has done for wireless, but also the educational benefits (from the scientific aspect) which wireless has conferred not only on the amateur, but on the public generally. What wireless has done, television will also undoubtedly do, and in greater measure.

WONDER is the parent of curiosity. Curiosity is the necessary precursor to intelligent interest, without which there can be no understanding.

Television is the greatest wonder of our age of wonders. It has already aroused the curiosity of large numbers of people, a curiosity which is reinforced rather than weakened by their familiarity with the instruments by means of which sound is broadcast and received. They will not be satisfied until they know more about it, until they have more than a nodding acquaintance with its technique, and a much greater understanding of the principles underlying it.

Achievements of Education.

Whatever its defects may be, modern education can take credit for having created a thirst for knowledge. And while it is probably true that many possessors of sets for the reception of sound waves propagated by the B.B.C. are concerned only with the quality of the programme, it is also true that there are many thousands of "listeners-in" who are interested in their sets as sets and are constantly experimenting with them in the hope of improving the quality of the reception.

In no small measure it is due to the experiments of these enthusiastic amateurs that such great improvements have been made in wireless receiving apparatus. In addition to the improvements they have made themselves, their activities have acted as a stimulant to manufacturers.

This intelligent interest in wireless has another important aspect. Children, brought up in homes where there are wireless sets, are provided with a new outlet for their curiosity. Quite early in their lives they become familiar with the meaning of terms which a comparatively few years ago were mere abstractions, definitions to be acquired solely for examination tests.

A New Terminology.

Dry-batteries, accumulators, induction coils, capacities, telephone receivers, and other apparatus which the majority of children of former generations seldom saw outside the school-room or laboratory, are now among the commonplaces of life. The terminology of electro-magnetism, including the distinctions between volts, amperes, microfarads, henries, no longer present difficulties to them. Without much trouble they can be initiated into the mysteries of electrons. They are handling in their own homes the things with which such terms and conceptions are associated.

If television were being broadcast in this country, as it is in others, the range of interest for our people would be enormously extended. For its intelligent understanding television demands acquaintance with the principles underlying wireless and, in addition, a knowledge of optics, particularly the functions of prisms and lenses, the physiology of vision, the photo-electric cell, the study of the nature of light, and mechanics. Apart from their bearing upon television itself, the importance of these studies cannot be over-estimated. They are associated with an almost endless variety of other applications of science.

Mr. P. T. Hobson, pianist, who broadcasts twice weekly from the Baird experimental station.

Once the fundamental principles underlying television are grasped, and the British public share with some of the peoples of the continents of Europe and America the advantage of having television sets in their own homes, and television transmission is a regular feature of broadcasting programmes, tremendous advances in the art are certain to be made.

There is still abundant scope offered by television for further invention and for the development and improvement of the existing process. Possibly no original invention has ever before opened up so wide and so fascinating a field for the exercise of inventive ingenuity. As a brain-stretching hobby it possesses no equal. Therein it possesses a very special value as a cultural instrument.

It cannot be expected, however, that people will buy television receiving sets until authority is given for television transmission to become a regular feature of our daily round of interests. For all practical purposes the enthusiastic amateur in this country is denied the opportunity to play a part in the progress of this new invention. All progress, therefore, must depend upon the efforts of Mr. Baird and his few assistants and collaborators in this country, or upon developments in other countries.

This is a most unsatisfactory state of affairs. It is putting an enormous burden of responsibility upon one man. That he has borne it so far, that he has succeeded in keeping this country ahead of any other as regards television by the almost daily advances he is making, is at once a measure of his genius and undaunted spirit.

Target of Attack.

The position is made worse by the fact that not only has the Baird Company, at the instance of the technical officers of the B.B.C., been refused facilities for broadcasting television, but the Baird television process has been the target of frequent attacks and misrepresentations in the press, almost entirely by persons who have not witnessed a demonstration of television for years. In connection with the decision of the B.B.C., it is distinctly unfortunate that its chief technical officer had committed himself to an expression of opinion unfavourable to the Baird process before the B.B.C. experts witnessed the recent demonstration upon which they assert their adverse decision was based.

In the circumstances the public has every justification for doubting the good faith of the B.B.C. Firstly, thousands of individuals have been able to see demonstrations. They are in a position to judge for themselves the value of a television receiver. Secondly, it is doubtful if any person would buy such an apparatus unless he or she were given a demonstration of its performance. Thirdly, any broadcasting facilities granted could be provisional, and the public made aware of the fact. If, after due trial over a fair period of time, the Baird Company had not satisfied the possessors of receiving sets—and they, after all, would be the persons mainly concerned—then facilities could be withdrawn.

What would happen then to the Baird Companies is fairly obvious. It certainly appears to be ridiculous to encourage the public to buy special sets for the reception of reproductions of photographs while they are discouraged from purchasing sets for the reception of images of living objects.

As Dr. Fleming stated in a recent article: "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." It is surprising that speakers, singers and instrumentalists who broadcast have not realised the potentialities of this new invention.

It would be interesting to know what degree of perfection the B.B.C. demands before it is prepared to provide facilities for the broadcasting of television. At present easily recognisable life-like images of a sitter can be received. Every movement of the head as a whole, or any feature, is faithfully reproduced.

Leaving entirely out of consideration all possible advances on this present position—and there are likely to be some amazing developments soon—is the B.B.C. of the opinion that what can already be supplied will not satisfy the public's requirements? What is just as important, has the B.B.C. an alternative process to the Baird mechanical process to offer the public? If not, and public opinion is focussed on its arbitrary grandmotherliness, how long does it consider the continuance of its monopoly in its present form will be tolerated?

"Three Serving Men."

There are thousands of the King's subjects with three serving men, "What and Why and How," ready to serve television as they served broadcasting in its infancy, to wonder at it, to play with it, to interest themselves in it and find out enough about it to assist its healthy growth. To deprive them of the opportunity is to retard the infant's progress. Until there was broadcasting there was very little intelligent interest shown in wireless.

The first efforts at broadcasting were nearly as crude as some of the apparatus hurriedly requisitioned for its reception. It is due to the enthusiasm of the early wireless devotees that sound is now reproduced with such perfection in our receivers. *They* created the demand for better, wider range sets, and a higher standard of efficiency for valves, coils, loud-speakers, etc. *They* stimulated further research and invention. It was *their* interest which built factories.

Vision in Television.

(*Concluded from page* 30.)

and a new art is that plenty of criticism by laymen of its achievements should be available.

It therefore follows that if the B.B.C., through its chief engineer, persists in its present attitude towards broadcasting television, the Postmaster-General, whose engineers have already pronounced in favour of television being broadcast, will be obliged to reconsider the licence granted to the B.B.C.

Nobody who has seen a recent demonstration of the Baird system of television could possibly agree with the statement made by Captain P. P. Eckersley, A.M.I.E.E., in the December issue of *Popular Wireless*, where he says "That along the lines of mechanical scanning as used by Baird it (television) cannot improve —quantities beat it . . ." "Are its (the Baird system of television) economics sound? At present they are not and never will be until the whole problem is attacked from some as yet undisclosed, but quite different, angle." It is quite obvious that a man so prejudiced should not be called upon by the organisation he represents to decide whether regular television broadcasting in conjunction with music, singing, and speech should commence. Furthermore, *just because Captain Eckersley is technically qualified to act as Chief Engineer of the B.B.C., it by no means follows that he is qualified to deliver himself of a technical criticism of television.*

If the B.B.C. had given facilities for the broadcasting of television and then were criticised for "wasting time" they would have had a perfect reply to their critics, i.e., that they were anxious to keep this country in the forefront of development in television and had deliberately adopted this policy in view of the severe competition from America.

There is already a precedent in short-wave broadcasting. The B.B.C. only commenced regular short-wave broadcasts under pressure of public opinion, which did not relish the fact that other countries were getting ahead of Great Britain in this respect.

It is safe to say that television in this country is still ahead of the art and science in the States, but lack of foresight in official quarters is a terrible handicap to further progress here. If those set in authority over us are men of vision they will also be men for television.

The Story of Electrical Communications

PART I.—LINE TELEGRAPHY.

By Lt.-Col. CHETWODE CRAWLEY, M.I.E.E.

(Deputy Inspector of Wireless Telegraphy, G.P.O.)

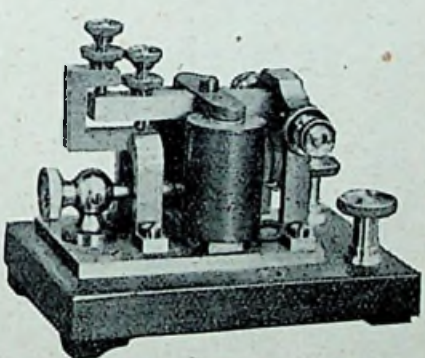
Television is the latest and fastest means of communication known to man. It is also a form of electrical communication. It will be interesting at this stage, therefore, to consider the history of the development of electrical communications generally—an enthralling subject which makes extremely fascinating reading. In the following article, the first of a series, our contributor deals with the invention and early development of line (or wire) telegraphy.

TELEVISION is the very latest development in electrical communication, but in studying the present we must not neglect the past. Mr. Hilaire Belloc rightly says: "Upon a just presentation of the past depends all our concrete judgment of the present." There are some who think otherwise and fondly imagine that they can appreciate the present without the trouble of studying the past. But they are wrong, and it is the hope of helping towards a concrete judgment of the present that must excuse this short—but, let us hope, just—presentation of the past. The subject is enormous, but even a bird's eye of an enormous subject must have some value, however small.

Morrison and Baird.

The electric telegraph may reasonably be taken as the earliest form of electrical communication, just as television may reasonably be taken as the latest; and as we can start with a Scotsman in the latest, so, too, can we start in the earliest. The later pioneer's name is well known to us all, but unfortunately we are not so sure of the earlier. However, even if he was not a Scotsman, he certainly wrote a paper in the *Scotsman's Magazine* in the year 1753, suggesting for the first time that messages might be sent by electric currents. This famous paper, which was signed with the letters C. M., is generally believed to have been written by a Greenock surgeon called Charles Morrison, one of that gallant band of what the professionals call the amateurs.

It is a very remarkable fact, well worth the attention of readers of "Television," that most of the pioneers of electrical communication were amateurs. The work of development fell mainly to professionals, but the amateurs undoubtedly carried off the palm of pioneering enterprise. The professional, if he admits that fact at all, will often say that the amateur became a pioneer because he was incapable of seeing the difficulties in his path. Very well then, we will even leave it at that half truth, but let us note down the fact as the first lesson learned in our "presentation of the past."



A standard Post Office morse sounder.

Sömmering.

Morrison's suggestion in 1753 was that the electric current should be conveyed by a series of parallel wires, one for each letter of the alphabet, the current in each wire actuating a bell which signified a particular letter. But it was not until 1809 that another amateur, Sömmering, a medical student at Gottingen, actually demonstrated the possibility of telegraphic communication. He, too, used a wire for each letter. The wires led into a glass box full of acidulated water, each one was lettered, and the letter being signalled was indicated by the bubbles produced in the water by the current in that particular wire.

On August 6th, 1809, Sömmering telegraphed a message by this means over a line 724 feet long. Such was the birth of the electric telegraph, though as a matter of fact this particular apparatus was never put to practical use.

Gauss and Weber.

It was not until 1832 that the next great advance was made, and again at Gottingen. This more practical telegraph was constructed by Gauss and Weber, and took advantage of an epoch-making discovery which was made since Sömmering's time—viz., the deviation of a magnetic needle by means of an electric current. Messages were passed over a line of 1,000 yards, and looking back now it seems surprising that this experiment should not have opened up at once the way to commercial telegraphy, as it is obvious that the whole alphabet could have been built up by a combination of the deflections of the magnet. But that was not to be; the apparatus was relegated to a magnetic observatory, and for five years there was peace—the calm before the storm, which burst out in 1837 and has been raging ever since.

In what might be called the invention of practical telegraphy, which dates from this year 1837, many names might be mentioned, but four in particular tower above all others—Wheatstone and Cooke, of England, Morse, of America, and Steinheil, of Germany.

Steinheil.

Of these Steinheil alone was a professional. He was a pupil of Gauss and Weber and as such must be ranked with the experts. His invention, though based on that of Gauss and Weber, embodied original points. It consisted of an apparatus for making a ribbon of paper move by clockwork, marks being made on the paper by a pen which was brought into contact with the paper by the action of an electro-magnet.

Wheatstone and Cooke.

Wheatstone was employed in a music-seller's shop in London, and Cooke, like Morrison, was a doctor, but both were what we would now call scientific "fans." Before long, Wheatstone blossomed into a professor at King's College, and carried out his experiments in the cellars of the college. Luckily he met Cooke, who was not only a scientific "fan," but what is so useful to a genius like Wheatstone, a first-class business man.

Between them they developed into a practical proposition the principles of Gauss and Weber, and in 1838 installed the first practical telegraph in England, on the London and Blackwall Railway. Four line wires were employed, the signals being given by the deviation of magnetic needles, and a relay, the invention of Wheatstone, was brought into use for the first time. The line wires were not at first carried overhead, but were laid in wooden grooves. So long as the wood kept dry all was well, but when it became wet the insulation broke down and the system became useless.

Eventually a double-needle instrument was designed with the object of reducing the number of lines to be maintained, and from this instrument the Single Needle, so well known on railways, was gradually developed. Wheatstone also invented the A.B.C. instrument in which currents from a hand magneto generator were caused to move a pointer over a dial bearing the letters of the alphabet. This apparatus was easily worked up to a speed of 15 telegrams an hour, and has only recently been superseded by the telephone in many village offices.

Morse.

Morse was a gifted American painter and sculptor, and did not even become a scientific "fan" until he was over forty years of age, when on a return voyage from England to America in 1832 he met an electrical expert in Professor Jackson. He witnessed some experiments carried out by Jackson on board the ship, and the good seed was sown. Morse at first knew nothing of electricity, but he sought the assistance of men who did, and by 1837 he had spent most of his money, but had constructed his first practical telegraph apparatus.

The ideas embodied in this apparatus are included in instruments still in use. About this time Morse went into partnership with Vail, a young American engineer who had helped him in his work. Morse brought his invention over to England but, like others we know of, received little encouragement here, and in 1840 was in sight of starvation. But he weathered the storm, and in 1843 erected the first telegraph line in America, between Washington and Baltimore, a distance of 40 miles. After eight years of poverty, fortune was achieved, and at the age of fifty-three his name was known all over the world.

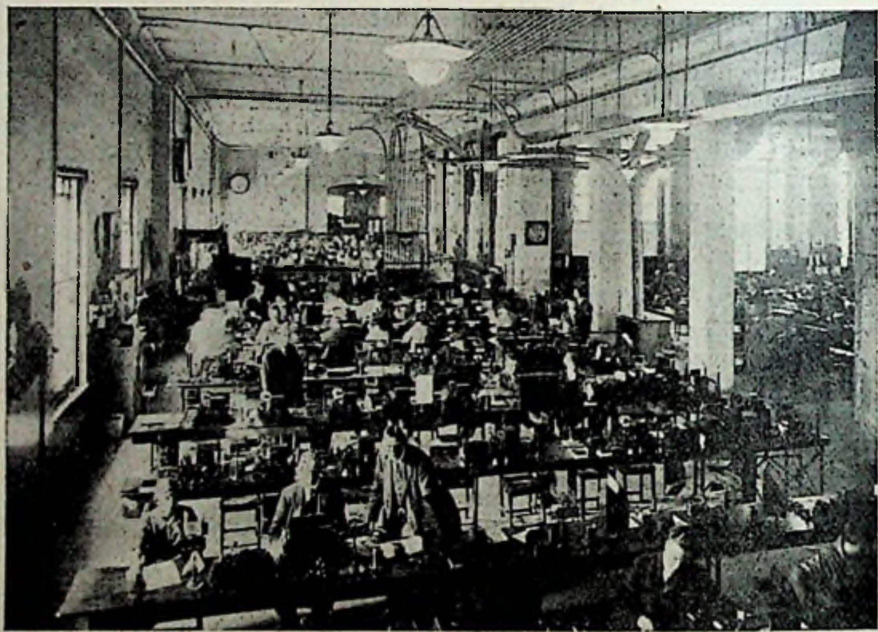
It is now nearly a hundred years since Morse invented the dot-and-dash system of signalling, which, in spite of all the developments in telegraph working, is still the basis of the universal telegraph code.

By 1850 it was clear that the telegraph had come to stay as a new means of communication, and we must now pass on from the pioneer stage to the modern stage of commercial practice.

The Needle Instrument.

For many years transmission was confined to sending messages in the morse code by means of a hand-worked signalling key, and this arrangement is still, of course, used, but only on circuits where the volume of traffic is small. For other circuits, automatic sending of one sort or another has now been universally adopted.

At the receiving end, non-recording apparatus was at first supreme, but is now confined to unimportant circuits with little traffic. The first non-recording instrument to be used extensively was the Single Needle instrument, which is now obsolete except on railways. It consists of a magnetised needle swung at its centre in a coil of wire. When the current from the line passed through the coil in one direction the needle swung to the left, which represented a dot; when the current was in the opposite direction the needle swung to the right, which represented a dash. In its later design this instrument became a simple and most efficient piece of apparatus with a working rate of up to 30 telegrams an hour.



A part of the Central Telegraph Office in London.

The Sounder.

The needle instrument was supplanted in the Post Office service by the sounder, which has had such a long life and such an extensive vogue that it must be familiar to many readers of TELEVISION. It consists of an electro-magnet which can attract an armature fixed to a lever which is pivoted and moves between two stops. When the current from the line passes through the electro-magnet the lever is pulled down against the lower stop and remains down as long as the current is flowing. When the current ceases the armature is released, and a spring pulls the lever against the opposite stop. If a sending key is introduced into the circuit we have the means of sending or ceasing the current at will, and can send the dots and dashes of the morse code, a dot being made by pressing down the key and immediately releasing it, and a dash by holding the key down for the space of time required for making three dots. With skilled operators the sounder is good for 60 telegrams an hour.

It should be noticed, as the writer found to his cost in the war, that a wireless operator, used to reading wireless morse signals in a telephone, is perfectly useless on a sounder until he has had considerable practice, as the sounder signals are quite different from the buzzing telephone signals. In fact a wireless operator can read a flashing lamp much better than he can a sounder, though he may never before have used his eyes for reading signals. The sounder is the best, and the last, of the non-recording instruments so far as line telegraphy is concerned, and we must now pass on to recording instruments which have been descending upon us like a shower of meteors for the last quarter of a century.

Sydney A. Moseley tells the World
(*Concluded from page* 32.)

you notice, the powers of those inevitable crabbers who have throughout the chequered history of science declared that this was impossible, and that was impossible, but only to be scoffed out of court in the course of time. Captain Eckersley is talking the uttermost rubbish when he attempts to give technical reasons why television along the present lines is impossible. Why hasn't he the common sense to ask the man who really knows, Mr. Baird? Simply because it would be entirely alien to his vanity to sit at the feet of his masters.

One would like to enquire what credentials Captain Eckersley has to pose as an expert on television?

WANTED—A DEATH RAY

By NOËL SWANNE

MY study door flew open with a bang.

Hastily I dropped the copy of "The Mystery of Hellwell Grange" on the floor, and looked thoughtful.

It was Marjorie.

"I say, old dear," she began, "it's frightfully interesting. Mrs. Jones was there. You should have seen her hat! We are all going to keep it up. You will make another list out for me, won't you? That pimply-faced Brown girl was there, too. I wonder why she ever goes anywhere. You'll help, won't you."

"Oh . . . yes . . . yes . . . oh, yes . . . certainly . . . of course . . . was she . . . what with?" was my comprehensive reply.

"It's our wireless tea-club, of course," explained Marjorie.

"Of course, yes . . . wireless tea—oh, of course," I struggled.

"It's Mrs. Elkington Smythe's idea, really. She said that once you understand the technical side of things it all becomes so much more frantically interesting. I do wish she would not wear green, it clashes so with her complexion. She has got Professor . . . er . . . somebody or other to come along next week, and we are all to do experiments."

"Oh, yes, but about my help?" I inquired.

"Well, you see, Professor . . . er . . . somebody or other made out a list of all the things we need," explained Marjorie. "I know I had one. Perhaps I posted it with that letter of yours. Anyway, you will just make me out another one, won't you, dear? That is the best of having a clever husband."

I kicked "The Mystery of Hellwell Grange" under the chair.

"Oh, yes," I said. What else was there to say?

* * *

"My wife wants to build a wireless set," I explained to the dealer.

"Three valve?" he asked.

"Three-three, I expect," I smiled back.

Probably he came from Scotland, for he did not smile until I was leaving the shop, and, looking at the bill I paid, I am dashed if I am clear as to what he was smiling at.

* * *

"What are they all?" asked Marjorie, as we unpacked the parcel.

Well, I knew she did not know, so I went ahead with confidence.

"That is a thermionic. That is a conductance. That is a Henry or a Watt. You connect this to the aerial through a variable valve and side-track it with hysterics. This gives the grid a bias, and so it runs sideways. The high tension is lower than the price."

"How very intriguing," said Marjorie. "I don't think I quite understand it, but after Professor . . . er . . . somebody or other has explained, it will all be very plain, I expect."

"I should say so," I agreed.

* * *

The study door flew open with a bang.

Hastily I dropped the copy of "The Blood of a Druid" on the floor, and looked thoughtful.

It was Marjorie.

"I say, old dear," she began, "it was frightfully interesting. Professor . . . er . . . somebody or other had a cold, and could not turn up. Mrs. Elkington Smythe had brought along Edith Volkers. She writes all the gardening stuff for "Little Women's Weekly." She was priceless about bulbs. I never knew there was so much in it. You must get me some bulbs, dear, at once. Our home will be a garden of flowers."

"What about all those wireless things I bought?"

"Oh, Mrs. Smythe was great about that. You see we were all so frightfully sorry about that Brown girl. She is in bed with measles—and with all her own pimples; it is too bad. So we packed up all the wireless sets and sent them along to her to cheer up her lonely life. Now, do run off and get those bulbs before the shops close."

"But I paid . . ." I began.

"Surely," said Marjorie, "I can have one little bulb."

Her violet eyes looked velvety, and wet like the underneath part of a frog.

* * *

Can anyone tell me anything definite about that death ray? I want to get even with Mrs. Elkington Smythe, and I want to put that pimply-faced Brown girl out of her misery.

Bridging Space

(Part VII)

By JOHN WISEMAN

In this, the seventh of our contributor's series of articles in which the fundamental principles of electricity and wireless are being explained, the process of modulation is fully described; i.e., the process whereby sound waves are transformed into electrical impulses, which are superimposed upon a wireless wave.

THE steps which we traced last month in our "Bridging Space" series were most important, for we were able to see how a complete control of the working of the valve and its associated apparatus as a generator of oscillations is secured by making certain relatively simple adjustments. From this point we have to ascertain in what manner the continuous waves, once generated, are made to serve as the medium for transmitting not only the music, singing, or speech, from the broadcasting studio, but also the televised picture.

In order to make this phase of our investigation as clear as possible, we will follow the same course as has been adopted in the other articles, namely, to introduce the study with what may be regarded as a more everyday occurrence and which works on analogous principles. Let us for the moment, therefore, turn our attention to the ordinary telephone used for transmitting speech from one point to another.

Sound Waves.

Sound, as we know, is transmitted through air by a wave motion due to movements of the particles of the air backwards and forwards in a line with the direction in which the sound is travelling. This contrasts with wave motion in water, which is caused by an up-and-down motion of the particles of water, or at right angles to the direction in which the wave progresses. Every different sound needs a different motion of the air particles for its conveyance, and if the characteristic motion of any sound can be impressed upon the air particles at any place, that sound will be produced.

The Ordinary Telephone.

Now when we speak into the mouthpiece of an ordinary telephone transmitter, the air waves set up by our voice impinge on a thin plate or diaphragm which is housed inside

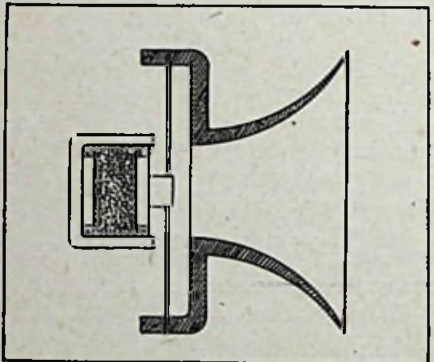


Fig. 1.—Cross-sectional drawing of an ordinary carbon microphone.

this portion of the complete telephone instrument. The diaphragm in the form of a metal disc secured rigidly around its rim, follows the air movements and bends in and out in a manner corresponding to the to-and-fro motion of the air. Without going into undue details of construction, it is necessary to note that behind this diaphragm is a box partially filled with a number of small carbon granules, see Fig. 1, and the actuations of the diaphragm are imparted to these granules, increasing or decreasing the compression already existing.

Carbon granules are a conductor of electricity, but the degree of conductivity in a case like this naturally will be governed by the amount of mechanical pressure existing between the granules. If, therefore, a current of electricity had been passing round a complete electrical circuit, of which this transmitter formed a part, the change in the contact resistance of the carbon would cause a variation in the magnitude of the current. Our current variation, therefore, is in accordance with the diaphragm movements, which in turn are according to the air waves actually set up by the speaker's voice.

A Reversed Process.

Obviously, the next step is to find some means of reversing the process at the receiving end of the line, that is, to reconvert the electrical variations into sound waves which will affect the ear. The medium for this is provided by the telephone receiver, the bare details of which are shown in Fig. 2. Here we have another thin metal diaphragm kept in a state of strain by the attraction of a permanent magnet. The varying currents produced in our line or circuit are made to pass through a

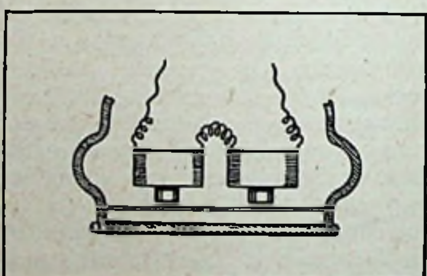


Fig. 2.—Cross-sectional drawing of a telephone receiver.

pair of small coils so that the magnetic field produced in the coils is superimposed upon the existing magnetic field. The current alterations produce a magnetic field varying in accordance with the original air-waves, and the varying magnetic attractions on the plate cause it to reproduce air waves similar to the original ones.

Suitable Substitutes.

This is very briefly the action of our ordinary telephone, but with wireless transmission we must face the fact that there are no wires to act as a medium for conveying a steady current upon which are superimposed small variations corresponding to the speech. What then can we use as substitutes for the wire and steady current? Obviously, space will have to serve as the medium to enable us to dispense with the wire, while the continuous oscillations generated by the valve and sent out from the aerial as undamped waves will step into the breach to serve in place of the previous steady current. These waves of constant amplitude become the carrying medium for our speech currents, and hence the familiar name of the "carrier wave." At first this might seem a trifle puzzling, but if we ponder over the details very carefully it will become quite simple.

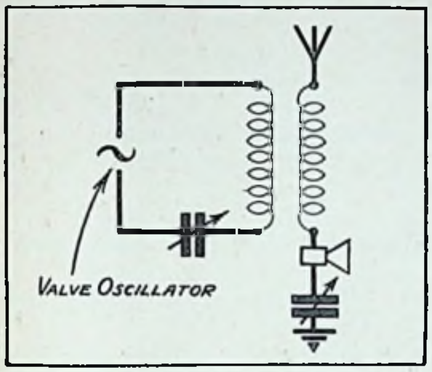


Fig. 3.—Circuit diagram of a wireless transmitter showing the simplest possible manner of connecting a microphone to modulate the transmitted wave.

Song, speech or music is made up of notes of varying frequency and the band of frequency covered extends roughly from 50 to 10,000 cycles per second and is known as the acoustical range. Our wireless waves, however, have frequencies reckoned in hundreds of thousands, as witness the fact that a 300-metre wavelength corresponds to a frequency of 1,000,000 cycles per second, and so long as this wide divergence exists between carrier frequency and acoustical frequency, our transmissions can take place. For the purposes of explanation, let us take the simplest case, for, as has been mentioned previously, we are dealing essentially with principles.

A Simple Case.

Assume that our valve and its associated apparatus are generating continuous oscillations and that these are transferred to the aerial by means of a coupled circuit so that continuous waves are sent out into space, see Fig. 3. To retain our simplicity we can actually place our microphone (telephone transmitter) in the aerial itself as shown, and provided there are no sound waves actuating the diaphragm, the aerial resistance remains constant and hence our transmitted waves are of equal amplitude. Now imagine that a vibrating tuning fork is placed in front of the microphone. The particular note emitted will cause vibrations in the microphone diaphragm, which in turn alter the resistance of the carbon granules, and since nothing else is undergoing a change, the variation in resistance of the aerial circuit must of necessity alter the amplitude of our high frequency carrier waves.

Modulation.

To illustrate this diagrammatically, turn to Fig. 4. At *A* we have the continuous wave depicted when the microphone is not being acted upon, while at *B* is shown the current alteration brought about by the change in microphone resistance. Obviously, the action shown at *B* is superimposed on that of *A* and the result is that given at *C*. The frequency of the aerial current must remain the same since it is dependent upon the valve oscillator energising the aerial, but the amplitude of the wave now varies according to microphone displacement. The dotted curve shown in diagram *C* corresponds to that of *B* and it is seen, therefore, that the *frequency* with which the aerial current *changes* from maximum to minimum and back to maximum, is the same as the frequency of the microphone displacement, which, of course, corresponds to the emitted note of the tuning fork.

This is a particularly important point and must be thoroughly understood, for the process whereby our actual signal currents are imposed upon the previous steady wave is our means for transmitting the signal itself from the aerial. For the purposes of illustration, we have taken the simplest possible case, and although the practical details will vary, the principles involved are similar for all cases of wireless

(*Continued on page* 42.)

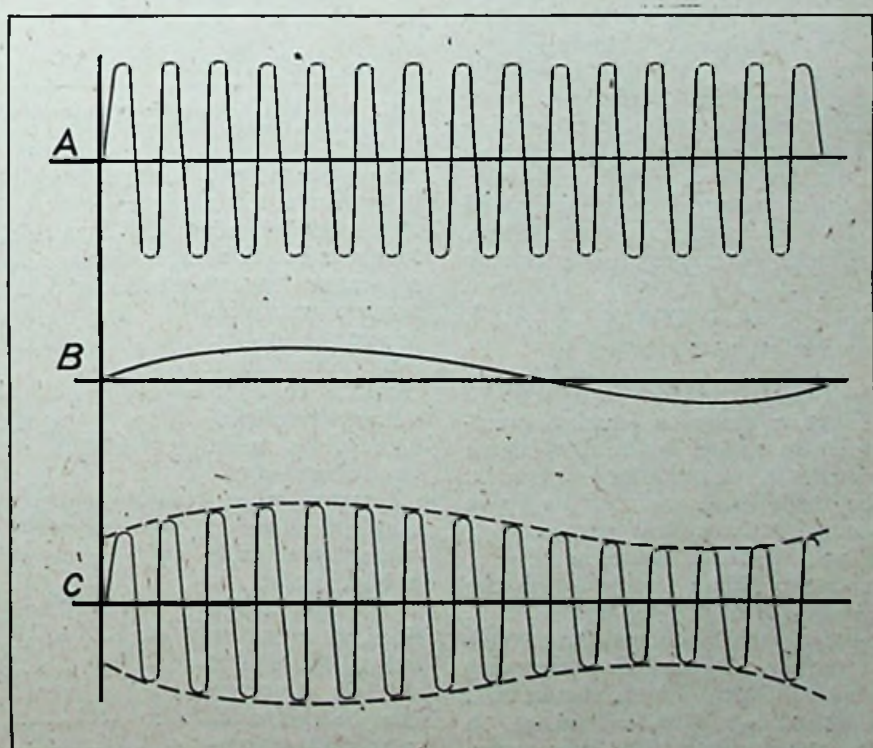


Fig. 4.—How the wireless wave is modulated.

Simple Two-Lens Optical Systems

Huygenian Eye-Pieces and Telephoto Lenses

Part VI

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

This month our contributor devotes his article to giving his readers information on the determination of the focal length of lenses, leading to the calculation of lens systems, or combinations, for various optical purposes.

As we have already indicated in a previous article, the action of a lens may be looked upon in two ways—one physical and the other geometrical. By the first of these the power of a lens is associated with the curvature impressed by it upon light waves passing through it, whilst by the second method the lens is looked upon as an annular prism which bends rays to or from a point on its axis.

In practice, strange to say, the use of the curvature method is almost entirely limited to what, for want of a better term, we may call "spectacle" optics. The unit of power in this case is called a *diopter* (sometimes written dioptre) and is that of a lens with a focal length of one metre.

Implicitly, then, the system is based upon the definition of unit curvature as that of a sphere with a radius of one metre. The dioptrical power of a lens expressed numerically is, therefore, equal to the reciprocal of its focal length in metres. Thus, spectacle lenses specified as having powers of 1D, 4D, 0·50D would have focal lengths, respectively, of 1, $\frac{1}{4}$, and 2 metres.

Determining Focal Length.

Since a metre is equal approximately to 40 inches, the focal length in inches of an x diopter lens is $40/x$. The three lenses referred to above would thus have focal lengths of 40, 10, and 80 inches, respectively.

Positive and negative lenses are indicated as usual by + and − signs. A −20D lens (read as "a minus twenty diopter lens") is a diverging lens with a focal length of 2 inches, whilst a +20D lens (read as "a plus twenty diopter lens") is a converging lens of 2-inch focus.

The "diopter" system is generally used by oculists for the prescription of spectacle lenses.

Equivalent Refracting Surfaces and Equivalent Lenses.

So far we have dealt with thin lenses only, lenses so thin that the refractions of rays which in general

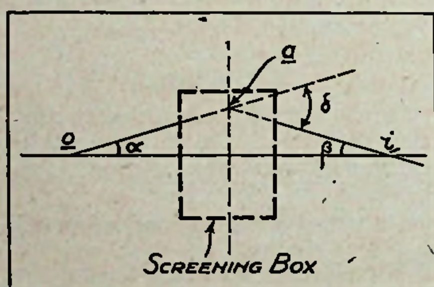


Fig. 1.—Diagram showing the derivation of an equivalent refracting plane for a lens system.

take place at two surfaces may be looked upon as taking place at one only, and that a plane. When thick lenses, or two thin lenses with an axial separation, have to be considered, this assumption can no longer be made. We must have recourse to equivalent refracting surfaces and equivalent lenses.

Suppose, for example, that in Fig. 1 we have inside a box, shown in rectangular broken lines, an unknown optical system which, however, can be shown to refract a ray passing through o at an angle α, into a ray passing through i, at an angle β.

Then whatever number of refractions may actually have occurred at lens surfaces, they are all obviously equivalent to a single refraction, through the angle δ, as shown at the point a, obtained by producing the incident ray and its corresponding emergent ray backwards until they meet. The point a is thus an equivalent refracting point for the rays shown.

If the angular aperture of the system be small, as assumed, then the equivalent refracting points for all pairs of rays passing through o and i will occur in a plane transverse to the axis of the system, defined as the *equivalent refracting plane or surface.*

Knowing the position of this plane with respect to the points o and i, the focal length of a lens to produce at i an image of o, equal in size to that given by the unknown system, can be calculated. Such a lens is known as an *equivalent lens.*

In Fig. 2 the application of the equivalent lens is given to the solu-

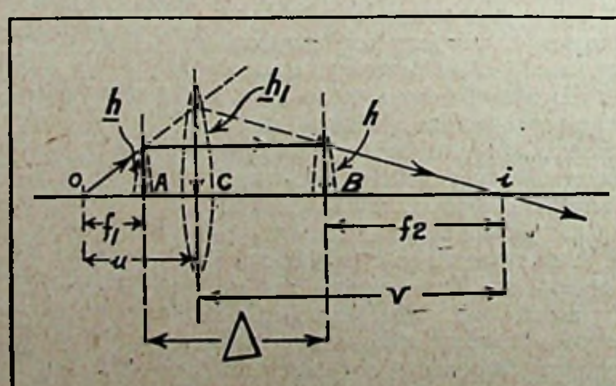


Fig. 2.—Solution of magnification problem by use of equivalent refracting surface.

tion of a simple problem. An object *o* is placed in the focal plane of a lens *A*, with a focal length f_1. A lens *B*, with a focal length f_2, and at a distance Δ from the lens *A*, produces an image *i* of *o* in its focal plane. What is the magnifying

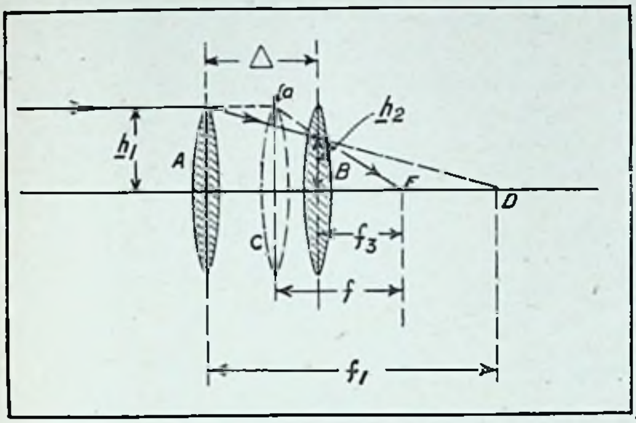


Fig. 3.—Ray diagram for two separated lenses imaging a distant object-point.

power of the system—i.e., the ratio *i/o*?

A ray is drawn from *o* to *i* as shown. Between *A* and *B* this ray is, of course, parallel to the axis, since *o* is the focal point of the lens *A*. We then find in the way already shown the position *C* of the equivalent lens—the magnification *i/o* must equal *v/u*. But from a consideration of similar triangles—

$$(1)\ \frac{v}{h_1}=\frac{f_2}{h} \text{ and } (2)\ \frac{u}{h_1}=\frac{f_1}{h}$$

Dividing the first of these identities by the second we obtain—

$$\frac{v}{u}=\frac{f_2}{f_1}.$$

Thus the magnification of the image, i.e., the ratio *v/u*, remains constant for all values of Δ. If, however, the object *o* is an extended one less and less of it will be imaged in the plane of *i* as Δ is increased.

In the periscope, an optical system at the upper end of a vertical tube is adjusted to transmit parallel bundles of rays to a similar device at the lower end of the tube, the final magnification being thus rendered independent of the length of the tube.

Two Lenses with an Axial Separation.

One of the commonest and, therefore, one of the most important optical elements in optical apparatus generally, is that of two lenses separated axially. The compound microscope is a familiar example of such an arrangement. The objective may, for many purposes, be looked upon as a single thin lens, separated axially from a second thin lens—the ocular lens.

In Fig. 3 let an incident ray, parallel to the axis, strike the first lens *A*, with a focal length f_1, at a height h_1 from the axis. After refraction the ray strikes the second lens *B*, with a focal length f_2, at a height h_2, and finally comes to a focus at the point *F* on the axis of the system. If now the emergent ray through *F* be drawn backwards, as a dotted line, until it intersects the incident ray, similarly produced, at a point *a*, and a perpendicular be dropped from this point on to the axis, we shall obtain the position on the axis which the equivalent lens *C* must occupy. With a focal length equal to *f* it will give at the point *F* an image of the distant object equal in size to that given by the combined lenses *A* and *B*, separated by the distance Δ. *The length f is therefore the equivalent focal length of the system.*

To find an algebraic expression for this focal length we will first find the value of f_3, which is known as the *back focal length*, since it is the distance between the last lens face of the combination and the focus *F*. The necessary equation is given on page 26 of the August issue of TELEVISION. The light waves as they strike the lens *B* are converging to a focus at *D*, so that their curvature must be equal to the reciprocal of the distance of *D* from the lens *B*, i.e., to $1/(f_1-\Delta)$, and the focal length of this lens *B* is equal to f_2, so that we have—

$$\frac{1}{f_3}=\frac{1}{f_1-\Delta}+\frac{1}{f_2}$$

$$=\frac{f_1+f_2-\Delta}{f_2(f_1-\Delta)} \quad \ldots\ldots\ldots (1)$$

$$\text{but } \frac{h_1}{h_2}=\frac{f_1}{f_1-\Delta} \text{ also } \frac{h_1}{h_2}=\frac{f}{f_3}$$

$$\text{so that— } \frac{f}{f_3}=\frac{f_1}{f_1-\Delta} \quad \ldots\ldots (2)$$

and interpolating the value of f_3 from (1) we obtain :—

$$f=\frac{f_1}{f_1-\Delta}\times\frac{f_2(f_1-\Delta)}{f_1+f_2-\Delta}$$

$$=\frac{f_1f_2}{f_1+f_2-\Delta} \quad \ldots\ldots (3)$$

which gives us the equivalent focal length of the combination in terms of the focal lengths of the two lenses, and their separation. By inverting the two sides of the equation we obtain the power equation :—

$$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}-\frac{\Delta}{f_1f_2} \quad \ldots\ldots (4)$$

which expressed in words reads: The equivalent focal power $\left(\frac{1}{f}\right)$ of a combination of two lenses is equal to the sum of their focal powers $\left(\frac{1}{f_1}\text{ and }\frac{1}{f_2}\right)$ less the product of those powers $\left(\frac{1}{f_1f_2}\right)$ multiplied by the axial separation of the two lenses (Δ).

Examples.—The Huygenian eyepiece, so much used in microscopes and telescopes, is often made up in what is known as the 1-2-3 type. This means that if the eye-lens has a focal length of 1, the separation is 2, and the focal length of the field-

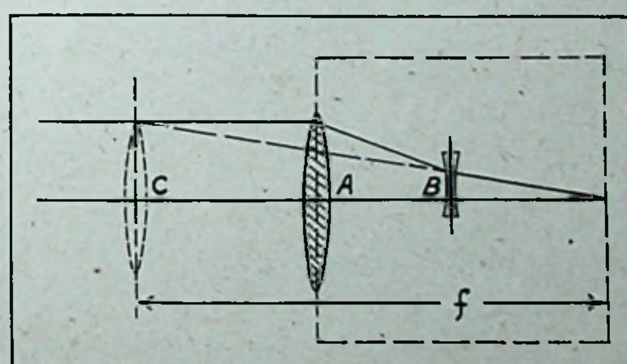


Fig. 4.—The optical action of a telephoto lens.

lens 3. Let us take these as expressed in inches. Then we have by (3) above—

$$f=\frac{1\times 3}{1+3-\Delta}=1\tfrac{1}{2}\text{ inches.}$$

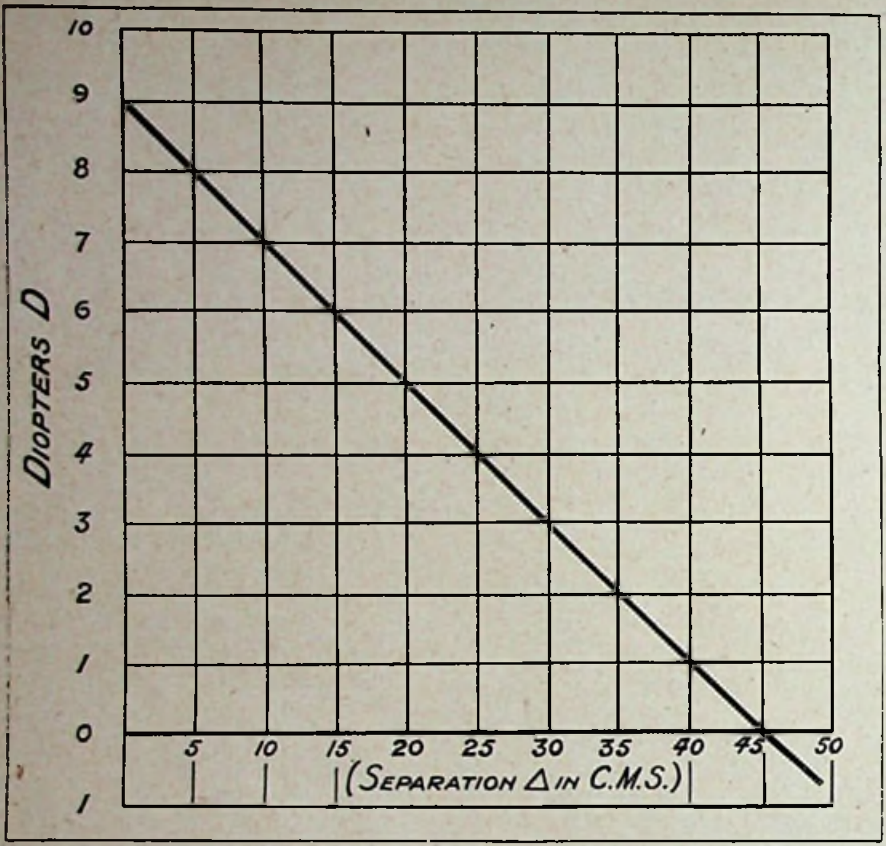


Fig. 5.—Graph for combination of two lenses, +5 D and +4 D, with variable separation.

The eyepiece of two lenses is in this case equal to a single lens of $1\frac{1}{2}$ inches focal length.

In another slightly more difficult example, shown by Fig. 4, let $f_1=10$, $f_2=-2$, and $\Delta=9$. (The negative sign for f_2 means that the lens B is concave and therefore of negative power). In this case—

$$f=\frac{10\times-2}{10-2-9}=\frac{-20}{-1}=+20$$

and the back-focal length (f_3) is by (1) above equal to 2 inches.

Now imagine such a combination built into a camera as indicated in broken lines, Fig. 4. The focussing screen would be at a distance of 2 inches only behind the lens B, but the size of the image of a distant object would be equal to that given by a single lens of 20 inches focus! Whilst the overall length of the camera would be about a foot, the magnification would be that of a camera, fitted with a single lens, 20 inches or more in length. A telephoto lens is, therefore, an optical system devised to give a large-scale picture with a short and manageable camera.

By turning such a system round it will be found that the back-focal length, with suitable powers and separation of the two lenses, may be made much greater than the equivalent focal length. Such a combination is used in one form of dissecting microscope. The great back-focal length allows of the free use of the hands for teasing out tissues, etc., on the stage of the microscope.

As an example of the value of the "diopter" system we will plot the values of the equivalent powers of a combination of two lenses, one D_1, with a power of +5 diopters, and the other, D_2, with a power of +4 diopters, the separation Δ changing gradually from zero to about 50 cms. (The focal length of the first lens is 8 inches, whilst that of the second is 10 inches.) Let D be the equivalent power of the two lenses combined, for any value of Δ, then equation (4) can be written in the form of the linear equation —

$$D=D_1+D_2-D_1\,D_2\,\Delta\;.\;.\;.\;(5)$$

When $\Delta=0$, i.e., when the two lenses are close together, $D=5+4=9D$. When D is equal to 0, D_1+D_2 must be equal to $D_1D_2\,\Delta$, i.e.—

$$\Delta=\frac{D_1+D_2}{D_1\,D_2}=5+4\Big/20$$

$$=0\cdot45 \text{ metres.}$$

A straight line drawn through the two points ($\Delta=0$, $D=9$) and ($D=0$, $\Delta=0\cdot45$ m.) gives the graph of equation (5). This curve shows that as Δ increases from 0 to 45 cms., the power of the equivalent lens falls from +9 to zero, whilst any further increase in Δ results in a negative equivalent lens.

Bridging Space.

(*Concluded from page* 39.)

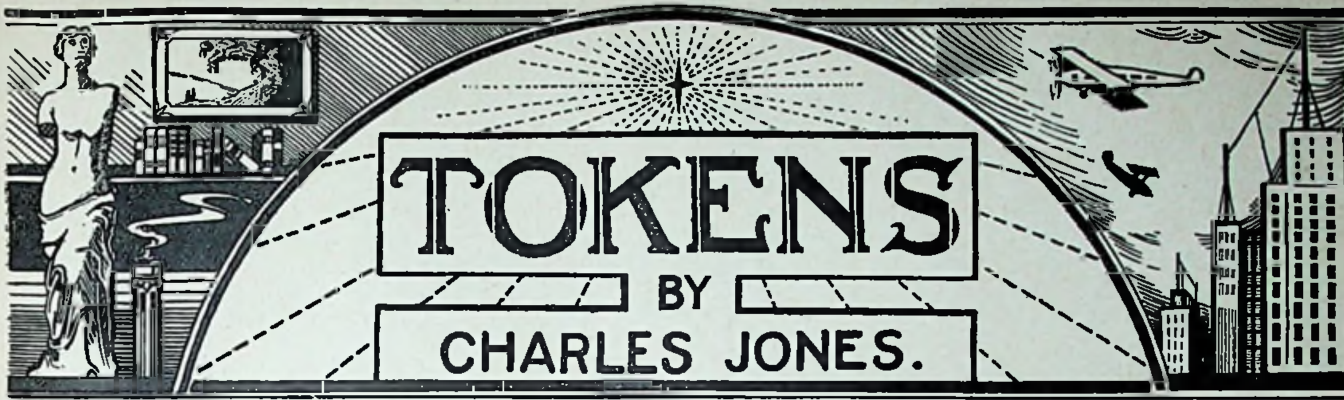
transmission. The actual aerial current is said to be modulated and the high frequency is known as the carrier frequency, while the superimposed signal frequency is called the modulating frequency.

Similarity.

It will be seen that we vary the strength of the oscillations sent out in just the same manner as we vary the strength of the current in the ordinary wire telephone circuit. With waves broadcast into space as regular as any electric current in a wire, the modulation is made possible and conforms with the inflexions of the human voice or the notes of musical instruments. It is these modified waves which eventually reach the receiving station and are made to operate the receiving apparatus in a manner which will be gone into later on in the series.

The obvious drawback to the simple method of placing the microphone actually in the aerial circuit is that the maximum power available for transmission is strictly limited by the power consumed as heat in the microphone itself. To deal with the large powers necessary to bridge space over long distances it is essential to adopt quite different microphone arrangements, but as was emphasised earlier, this does not influence the actual mental picture which this series is building up stage by stage.

It will be interesting, however, to see where the main differences lie between this simple case and the more up-to-date methods used for energising the aerial at the carrier frequency and modulating this at the low frequencies. This will be deferred to next month's article so that readers can thoroughly digest the details just enunciated of what is known as "modulating the carrier wave."



THIS is an age of éclat. The world of mankind, never stagnant but fitful in movement, has plunged eagerly forward in the last few decades. The portents of quiet revolution are on all hands, so that one can sense already the refounding of politics ; the conversion of commerce from a see-saw of plunder and deprivation to a science of service ; the cleansing of religion ; the development and widening influence of art.

One can almost hear the pounding pistons of the world's machines throbbing less rythmically, and the lighter, singing note of the atomic engine taking up its high-pitched note. Of all these things they are but tokens, and yet the thunder of change burdens the air, and because of it our eyes are set towards the future, anxiously and hopefully.

There is a forward-reaching spirit in humanity which now seems crouched for a leap. After the hurry of a century of piecemeal discovery and reform and frantic devising of mechanisms, there is much to be swept away ; a litter of debris which encumbers the free motion of the social spirit of man.

Why do we feel, as it were, a coiled spring of energies in the race ? Why do we feel a purging cataclysm overtaking us ? Because, I think, we are slowly reaching what the whole life of the world has groped towards ; because man's understanding is reaching its adolescence and quickening with spiritual powers.

It is true that discovery has contributed to this end and will continue to do so ; but surely the age of mere works is passing, surely we are arriving at the age of consummations, and man, so long embroiled in the conflicts and jealousies of local civilisation, is being released for the vaster issues of world morality which his works compel him to face, and to which indeed they lead. That may appear a grandiose conclusion to link with the coming of Television, and yet it is related as the whole is to the part.

For in wireless communication and in Television we envisage, not merely pleasant devices to mitigate the smothering ennui of taskdom, but instruments also for that enveloping spread of culture which is presently to heighten the average status of men, intellectually and spiritually, as the printed word has through centuries of progress.

If Beauty is made a common possession, if the language of music and light becomes a common utterance, it will create an artificial environment, the moulding powers of which can only be guessed at. It is the thing the world is waiting for. We endured the Industrial age for it . . . Beauty, liberated by craft from the poets' page, stalking the land, the faculty of all men.

Architecture, supreme in its single instances, has failed to ramify sufficiently to sustain a sense of beauty to man in the crowd ; religion has lost the magical power it once had to do so ; politics never had a ghost's chance of being anything other than an ugly business, and art is a department of life rather than a pervasion of it.

Science, clean, sane, and sure, has the well-founded, strong loveliness of a noble edifice built upon a rock ; is full of that loving wonder and showing forth of the miracle which is the essence and the cause of religion ; is statute, school and pulpit to many men, and is now the servant of art to carry its works abroad and justify it.

It is thus that Television will take its part in all the little homes of the world . . . it will take the Royal Academy to country kitchens, and the dreams of Giotto will refabricate on the walls of dreary Suburbia. Rightly directed, as one feels by the impulse of our times that it will be, it may well bring back the heyday of Greece to a world equipped to sublimate the ideals of form.

If this should be so, if the universal canon of taste becomes purified (and it is not high-brow cant to say it needs purification, as anyone who knows South London, cheap wallpaper and china, the average hoarding and bungalow, and the epidemic petrol pump, will agree), if it should be purified, the fact would soon be reflected in the appurtenances of everyday. The mind, the unconscious, wordless, perceptive mind of the normal man, would create a revolution far more penetrating and comprehensive than any cult could achieve, however eclectic.

The time is at hand when he that hath eyes will be invited to see, and it is surely a universal thing, the search for Beauty, however misled it may have been by the limitations of locality and introversion. What a perverse yet profoundly true idea of Wilde's it was that life is the plagiarist of art ! Did not the Greeks, he asks, set up a statue of Hermes or Apollo in the bride's chamber, that when the time of her pain should come what she fashioned in the flesh should be created in the rapture of beholden loveliness ? That was the right spirit. The spell of Beauty endures only when it is woven in the eternal substance of the race.

There will always be some, perhaps, who having ears are deaf, and eyes, are blind, but Beauty so begets itself that is is very safe to say that Television (or leave out the scientific prefix and call it Vision) would fulfil as many dreams as it would give rise to.

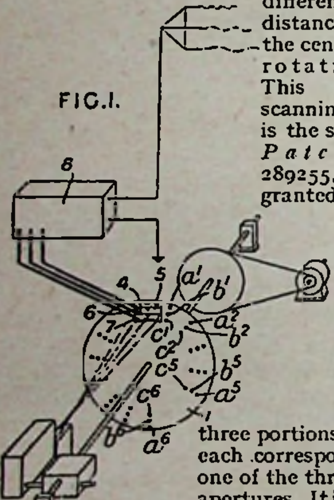
Let it select and reiterate, and life would set about catching up with a new standard.

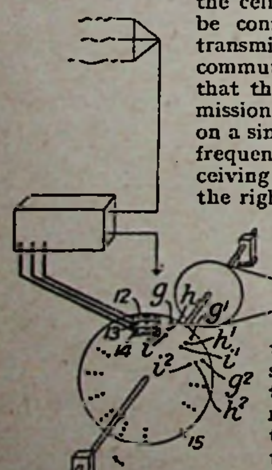
Invention and Development

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.

A NUMBER of spirally-disposed apertures, shown as a^1, a^2 . . . a^6; b^1, b^2 . . . b^6; c^1, c^2 . . . c^6; g, g^1 g^2; h, h^1, h^2; i, i^1, i^2, are arranged in a rotating disc (1 or 15) in Fig. 1, so that each set scans a portion of the picture and in so doing sweeps out an arc of a circle at a different radial distance from the centre of the rotating disc. This multiple scanning device is the subject of *Patent No.* 289255, recently granted to R. L. Aspden. In the same figure the light-sensitive cell (4) is shown divided into three portions (5, 6, 7), each corresponding to one of the three sets of apertures. It is arranged that each portion of the cell, in turn, shall be connected to the transmitter (8) by a commutator switch, so that the actual transmission can be effected on a single channel or frequency. At the receiving end (shown on the right of Fig. 1) a multiple section neon lamp (12, 13, 14) works through the same commutator arrangement. Alternatively a plate of the same size as the picture can be illuminated by light focussed from separate neon lamps.

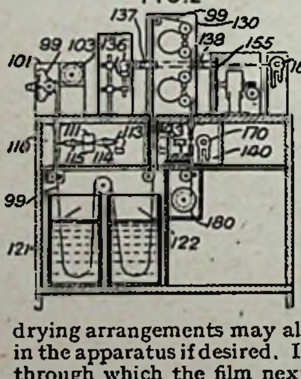
FIG. I.





An interesting application for patent rights is that made by Electrical Research Products in *No.* 297078 (Convention date, U.S.A., September 14th, 1927), and is concerned rather with the technique of television broadcasting. It is claimed that by taking a cinematograph picture film of the scene to be transmitted, and by causing the film to be developed at high speed, so that it can be utilised almost immediately to control the actual television signals, improved background details and increased illumination is obtained. Speech signals can also be impressed upon the film and be transmitted. At the receiving station a photographic process is employed so that the television picture signals may be accompanied by speech signals derived from the phonofilm. Fig. 2 shows the arrangements provided at the transmitting end, where the film (99) is made to pass from a spool (103) through the following parts until it is finally disposed of on a storage spool (180). Firstly it passes intermittently through a cinematograph camera (101); and thence through a sound-recording device (110), where its movement is continuous. The sound-recording device comprises a source of light (113), a lens system (114, 115), and a light-sensitive cell (111) controlled by the microphone currents. From here the film passes through developing and fixing tanks shown as 121 and 122 and washing and drying arrangements may also be included in the apparatus if desired. In the projector through which the film next travels, light coming from a source (136) passes through optical systems (137, 138), through the film (99), and thence through a scanning disc (155) to a light-sensitive cell (160). Immediately after this the film passes through the sound projector (140), where a source of light is shown as 143, provided with an optical system (144), through which the light passes to a cell (170). Means for disposing of the used film are provided at 180. The outgoing picture signals are controlled by the light-sensitive cell (160) and the outgoing speech signals by the cell (170).

FIG. 2



Similar arrangements may be provided at the receiver or alternatively the television picture-film signals, and the synchronising currents may be applied to a television receiver comprising a long continuous neon tube bent backwards and forwards, so that successive portions of the tube are illuminated under the control of a rotary distributor. Means may also be provided for delaying the reproduction of the sound signals in cases where the television signals, but not the voice signals, are subjected to the delay occasioned in the process of developing the film. In this case a telegraphone is employed having an endless wire on which the sound record is continuously impressed and the record erased after reproduction or a phonograph record of the disc type may be used.

In *Patent No.* 293474, issued to W. Dawson and D. M. Miller, a new form of scanning disc is described. This disc comprises a number of spark gaps or holes arranged in order on a fixed panel, and it is claimed that a more rapid effect is secured by utilising a stationary panel pierced by a large number of holes than by using a rotating disc. The spark gaps are controlled by a commutator so arranged that all the gaps but one are energised at any instant. The gaps are momentarily de-energised in turn so that the one "free" gap is thus moved at high speed along the series of holes. The principle utilised is, that an electric discharge in taking place across a gap cuts off visible light which would otherwise pass through the gap.

Means for registering a single luminous spot at a receiver with coördinates exactly the same as those at the transmitter are provided in *Patent No.* 295210 granted to Television, Ltd., and J. L. Baird. The result is achieved by the use at both sending and receiving stations of synchronised scanning discs (5) in Fig. 3 having zig-zag arranged slots (3) in place of the usual spiral arrangement of holes. At the receiving station (Fig. 4), the intersection of two luminous lines (30) indicates the position of the luminous spot (2) on the transparent map (26) at the transmitter.

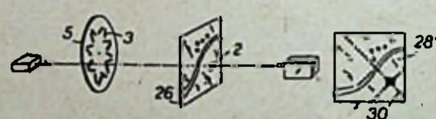


Fig. 3. Fig. 4.

THE BEST LETTERS OF THE MONTH

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

J. B. SHREWSBURY'S ARTICLE.

RIANT-MONT,
LA ROSIAZ,
LAUSANNE.
December 4th, 1928.

THE EDITOR,
"TELEVISION."

DEAR SIR,

Mr. J. B. Shrewsbury's article in the November issue of TELEVISION was considerably interesting; he wishes to use wireless waves for analysing his subject to be televised, whereas I consider that somehow or other the use of the electromagnetic property of light is the most indicated solution for television if only it replaces the photo-electric cell; I mean, of course, a light-sensitive cell.

As a result of his article I thought of an arrangement not for eliminating the travelling light spot, but to serve as a basis for the experimenting on what might be called a light-sensitive cell having no lag and using to the maximum advantage the intensity variations of the reflected light analysed by the scanning disc. The other mechanism of the now-classical television remains unaltered; this service would only replace the present light-sensitive cell.

I thought of heterodyning the light rays issuing from the scanning disc and receiving the beat frequency vibrations in the form of wireless waves whose intensity would vary proportionately to that of the original light rays. To heterodyne light waves other light waves would be required; but by the ordinary methods it seemed impossible to obtain two light frequencies whose beat frequency would be of the order of a wireless wave even of (say) one metre in length. A double heterodyne did not even offer a solution, and great complication arises if the process is to be carried further.

I then realised that the speed of light varies according to the medium through which it travels, and it occurred to me that by experimenting and finding two suitable media for heterodyning two light waves a resultant wireless wave might be obtained. This wireless wave could, of course, be made to induce a current in a suitable aerial connected to an amplifier.

I next considered the fact that white light consisted of many radiations, and in order to separate them the rays of light from the scanning disc could be directed on to a grating and thereby made to produce diffraction spectra. To heterodyne the bands of light obtained, a polychromatic light would be shone through a medium having a slightly different refractive index than the air, and this medium would be placed behind the grating (on the opposite side to that of the scanning disc), and inside this medium in very close proximity to its face next to the grating a second grating would be placed which would be of such dimensions as to produce diffraction spectra whose bands of light are diametrically opposite the first ones due to the rays of light issuing from the scanning disc. These second diffraction spectra are naturally caused by the white (polychromatic) light shining through the auxiliary medium.

If a suitable medium is obtained the beat frequency of the two light waves would be of the order of a wireless wave which could be collected by an aerial placed in the proximity and then duly amplified. If the auxiliary medium is homogeneous the beat frequency would be constant and identical for all the bands, and the intensity for each colour would add up, so that in the amplifier the intensity variations obtained would be exactly proportional to the intensity variations of the rays reflected from the subject televised by means of the scanning disc, travelling light spot, or other suitable mechanism; at the receiver a neon lamp would be actuated in the ordinary way.

Now take, for example, red and violet light rays; they have approximately a frequency of 375×10^{12} and 750×10^{12} respectively; the difference between the two frequencies is 375×10^{12}. By heterodyning in the ordinary way two shades of the same colour, I doubt whether a beat frequency as low as 1×10^{12} could be obtained, and as will be realised, this is at least a frequency 10,000 times greater than the smallest wireless wave (3 metres). From these considerations it occurred to me that by using two light-waves of exactly the same frequency (this is obtained by the diffraction through the gratings), and by altering the frequency very slightly by making one set of rays travel through a medium having a correspondingly different refractive index, a beat frequency of the order of a wireless wave might be obtained. At the present moment I do not know of a suitable medium, but it seems to me that certain gases or mixture of gases might be tried. The gases or other media could no doubt be calculated beforehand to see which is likely to prove most useful, and I shall set myself the task of doing so one of these days. Double heterodyning by using two lots of two different media could also be tried in a similar way if the simple heterodyning with only two media is not sufficiently satisfactory.

It will readily be appreciated that such or similar a system eliminates entirely the lag so disadvantageous in many photo-electric cells, and uses to the maximum advantage the small variations of light intensity reflected from the subject to be televised. This may even offer a solution to outdoor television.

I hope your readers have been able to follow my idea, and I shall be pleased to welcome their opinions and ideas on the subject; I know a discussion is a thing that all readers like, and I am looking forward to some interesting ones. I consider these discussions one of the most important items of your excellent periodical.

Yours faithfully,
E. P. ADCOCK.

CLAREMONT,
LONDON ROAD,
HORSHAM.
December 14th, 1928.

THE EDITOR,
"TELEVISION."

SIR,

In the criticisms of my article, "Is the Travelling Spot Essential to Television," in your issue of November, I am glad to see honest doubt and encouragement. At the same time, may I venture to refer to experiments which Hertz carried out, and which formed the basis of my article?

These experiments have been repeated by Sir Oliver J. Lodge, who rendered the effect of the electric oscillations more easily observable in the resonating circuit by placing a Geissler's tube in the spark-gap. When the apparatus was at work the tube was lighted up and the effect of the electric oscillations was visible even at a considerable distance.

Hertz concentrated the radiation by means of zinc reflectors bent into the shape of parabolic cylinders. The vibrator consisted of two brass cylinders each about 12 or 13 centimetres long, 3 centimetres in diameter, and rounded or terminated by knobs at the sparking ends. The cylinders were placed in the focal line of the parabolic reflector and were connected to the terminals of an induction coil which excited the oscillations. The receiver consisted of two pieces of thick wire each about 50 centimetres long. They were also placed in the focal line of a parabolic reflector and from the end of each a thin wire passed at right angles through the reflector to a sparking space at the back, where the induced sparking could be observed without obstructing the waves falling on the reflector.

With this apparatus Hertz detected reflection from various objects, and found that the laws of reflection were the same as those for light waves. He used a prism of pitch with an angle of 30 degrees and found the long electro-magnetic waves gave a refractive index of 1·69. The refractive index for light waves varies from 1·5 to 1·6. Since the wave-length of the Hertzian wave was 1 metre and that of light 200,000 times shorter, this disagreement is not evidence against the similarity of light waves and electro-magnetic waves.

This line of research seems to me worth following as it will have as important a bearing upon television as it has had on telephony. As yet we are not fully aware of the vast store of information to be obtained by making use of the electrical disturbances of the ether. One critic observes that reflected electro-magnetic waves would be too weak to be perceived. They are extremely weak, but so is the amperage of the current picked up by our aerials every day. Yet they give us telephony. It is the extraordinary sensitiveness of the ether to delicate vibrations that is worth serious study.

These vibrations can be reflected and refracted, and the telescope of the future may depend more upon the amplification of such waves to obtain greater details of the planets than the most scientific arrangement of optical lenses can give us. In fact the televisor is a wireless telescope. That is no reason why we should dispense with light waves when they are available, and I do not see why the moving picture on the camera screen should not be divided into sections and each section have its own wave-length.

Those of us who in the early days of wireless telephony cut down our coils to tune them to the transmitting signal understand the practical difficulties, but know also that they can be surmounted. Experiments might be made first of all with few sections. Each section illuminated would, by means of a photo-electric cell, be translated into a definite electro-magnetic wave of a given length. This would be received by an aerial and coil in tune with the section and be conveyed to a multiple screen of neon tubes specially designed to fit into a frame. The aerial would in fact be a cable of insulated wires and need not be of unusual area in section. The receiving screen might be of considerable size, but reduction of the picture would be secured by lenses.

It is as if newspaper pictures were magnified and then reduced to a size comfortable to the eye. Here would be some enjoyable work for the amateur, although rather expensive at first on account of the number of valves, but perhaps not more expensive than fitting up a dynamo and using power for mechanical apparatus. Moreover, country districts which would benefit more by television would find the lack of power an added difficulty and expense. Large halls such as cinemas could, of course, with their capital and engineers, build a screen which would give immediately any event of importance and any play acted on the stage.

There is a fear expressed in some quarters that the ether would be overcrowded, but there would be little danger if the selected wave bands were organised. A very definite gap might be arranged between the televising and the telephonic bands. These gaps might occur alternately so that the longer wave-lengths, with a gap, might be used for television and telephony, and also the shorter wave-lengths with a corresponding gap. With more critical apparatus, moreover, there would be less and less interference.

In any case it seems to me that the travelling spot is too limited as yet in its scope to deal adequately with large screens out-of-door events, or stage performances, and this is mainly what I had in mind on writing the article. Is there any other way? That is for your readers to discover.

Yours faithfully,

J. B. SHREWSBURY.

P.S.—I have devised a method for transmitting and receiving, using 16 sections to commence with and aerial wiring and coils covered with coloured insulation to correspond with the various sections of the transmitting screen, which is the back of a camera.

The receiving apparatus would not require more than one valve, I think, as light is more easily excited in a neon tube than the vibrating disc of a phone. (I mean one valve per section, giving 16 valves in all.) The wave-lengths starting at 900 and diminishing by 50 would reach 150 for the last section, but possibly closer wave-lengths would be efficient and even interference or overlapping might give sufficient light and shade to lessen the number of sections. It would not be very expensive to experiment on these lines.

IMAGE SCANNING.

15, ELDON PLACE,
BARRAS BRIDGE,
NEWCASTLE-UPON-TYNE.
December 2nd, 1928.

THE EDITOR,
"TELEVISION."

DEAR SIR,

In the first place I am writing to thank you for obtaining and forwarding to me a sub-constructor's licence. I was beginning to think, as the weeks rolled on and still no licence came, that my request had been overlooked. But, when the licence finally arrived, one glance at the number thereof gave me food for thought of a different character. No. 2,628 indeed. So there are over two thousand six hundred sub-constructors. Truly a bad outlook for the critics!

It is to be hoped that with such a large number of experimenters at work, some interesting facts, and even genuine discoveries will be forthcoming very shortly.

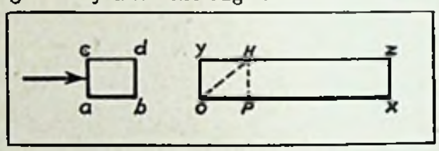
Well then, in the first place—Thank you. In the second place, I want to get down to a discussion of facts.

In the November, 1928, issue of TELEVISION Dr. Robinson contributes a really helpful paper on the facts underlying the scanning of an image. He goes into the question of the distortion which must obviously attend such a process in practice, suggesting that the idea of splitting up an image into dots is incorrect, and pointing out that the scanning proceeds in strips and continuously. In the first and second issues of TELEVISION in which a description is given of how to construct suitable apparatus for the transmission of "shadowgraphs," mention is made of an "interrupter-disc." Dr. Robinson does not take this into consideration in his paper on "Image Scanning," but surely it should be included in the scanning system?

As far as one can make out, the purpose of this disc is to divide the strips produced by the spiral disc into what Dr. Robinson would call "dots."

I have been unable to find out if the interrupter disc is supposed to rotate in the same direction as the spiral disc, or in the opposite direction. Up to now I have always assumed that it revolved in the opposite direction.

Now, as Dr. Robinson points out in his paper, if the slit *abdc* (in the figure) traverses the strip *YZXO* in the direction of the arrow, then the distortion will be of the amount *OHP* (or equal to half the area of the slit *abdc*). This distortion does not occur instantaneously, but is built up gradually until the edge *ca* reaches *O*.



If, however, one of the "teeth" of the interrupter disc traverses *YHPO* in the opposite direction to that in which *abdc* is moving, then I contend that the amount of distortion will be much reduced. The same sort of thing will occur at the other end.

I am, however, open to correction, and hope to hear more about this subject.

Personally, I look forward to the day when television apparatus will be attached to telescopes in the large observatories, thus enabling all to enjoy the wonders of the sky with the minimum of expense, and in the comfort of the fireside armchair!

With best wishes to you and TELEVISION,
I am, yours electrically,
PUSS ROBSON.

December 8th, 1928.

THE EDITOR,
"TELEVISION."

DEAR SIR,

Mr. P. Robson has raised an interesting question in his letter of December 2nd with regard to my article on "Scanning" in the November issue of TELEVISION. He refers to the influence on the definition of an image of the interrupter disc. He will appreciate that in my article there was no attempt to deal exhaustively with the influence of the various scanning devices on definition, but that my object was to show that there is a distinct difference between the "dot" and the "strip" conceptions of scanning. For this purpose simple examples were given to show that on the practical "strip" method the dimensions of the slit introduce an amount of distortion which becomes smaller as the size of the slit is diminished.

Mr. Robson would like to have more examples, worked out in detail, and he refers particularly to the case of the interrupter disc. He is correct in stating that with that method the scanning resembles the "dot" rather than the "strip" system. It would be possible to make a close examination of the distortion introduced by the interrupter disc, but in any case the latter is not likely to be employed with photo-electric cells. Again, when selenium cells are used the distortion introduced by them will be much larger from the lag of the selenium than from the dimensions of either the slit or the holes in the interrupter disc. However, without going into detail, I think that the distortion from the dimensions will be present in this case from both the slits or holes in the disc, and from the holes in the interrupter disc, and that the distortion at both ends of the strip will be at least double that which would be obtained without the interrupter disc. I do not think the relative direction of rotation of the two discs will have any influence on this form of distortion, for all that changing the direction of rotation does is to alter relative speeds, and the form of distortion discussed in my November article depends only on dimensions and not on speed.

Yours faithfully,
J. ROBINSON.

THE B.B.C. DECISION.

21, FRANKLIN ROAD,
HARROGATE.
December 7th, 1928.

THE EDITOR,
"TELEVISION."

DEAR SIR,

Did you hear the B.B.C. announcer at 7.45 p.m. this day announce Jack Hulbert as follows :—

"....Jack Hulbert will commence now as he has to get back to the theatre. You know his dancing. I wish you could see him."

I have underlined the last sentence. What about the B.B.C. decision ?

H. A. WHITELEY.

KILLOWEN,
HOLDEN ROAD,
WOODSIDE PARK, N.12.
December 1st, 1928.

THE EDITOR,
"TELEVISION."

DEAR SIR,

If Mr. John L. Baird had taken the precaution, before his name became famous, of changing this name to something ending in "stein," there is no doubt that the B.B.C. would have welcomed him with open arms.

It is a remarkable fact that only Britons meet with such cavalier treatment at the hands of British authorities.

I have already expressed disgust at the attitude adopted by Captain Eckersley, in a letter you were good enough to publish in a former number of TELEVISION, and although I have a great respect for the chief engineer's ability, one cannot help wondering what is behind this "mediæval" attitude—this opposition to a science accepted by all who matter as practicable and well on the way to perfection.

I saw a television demonstration, and how anyone can uphold that it is not yet fit for public broadcasting is beyond me.

In conclusion, I should like to assure you that public opinion is with Mr. Baird and shrugs its shoulders at the B.B.C. as at men with the type of mind as had they who were loth to abandon England's "Wooden Walls."

Yours sincerely,
EDWARD S. HYAMS.

PROF. CHESHIRE'S OPINION OF TELEVISION.

23, CARSON ROAD,
DULWICH, S.E.21.
December 15th, 1928.

THE EDITOR,
"TELEVISION."

DEAR SIR,

At the meeting of the Television Society on May 1st of this year I saw for the first time Mr. Baird's apparatus at work. My impressions of what I saw were set out in a letter to you, which appeared in the June number of TELEVISION. In that letter, after referring to the early defects of kinematography and their correction, I went on to say: "I think it is highly probable that television projection apparatus will develop on similar lines. In principle the present apparatus appears to be sound, so that commercial success may very conceivably be achieved by a careful tuning-up of its elements."

At the meeting of the Television Society on Dec. 4th last I again had an opportunity of seeing Mr. Baird's apparatus at work. I was quite unprepared for the advance that had been made. A view of a lady's head was being transmitted by wireless with a sharpness of definition which I had scarcely thought the apparatus was capable of doing. The lighting, too, from the high lights downwards, was beautifully graded, and an altogether pleasing effect secured.

Mr. Baird, upon being questioned, assured me that the apparatus employed did not in any radical essential differ from that with which the earlier demonstration had been made. The marked improvement in the result had been achieved by tuning-up simply.

There can be no going back now—the Rubicon has been passed.

Yours faithfully,
F. J. CHESHIRE.

FROM GUERNSEY.

1, DOYLE TERRACE,
DOYLE ROAD,
GUERNSEY, C.I.
December 3rd, 1928.

THE EDITOR,
"TELEVISION."

DEAR SIR,

I have taken your fine journal since No. 1. At first I thought it was just another paper which would soon break up. However, I soon changed my opinion. I believe that I am the only person in Guernsey who is interested in television. I am sixteen or rather will be seventeen years old next month, and I have had six years' real experience of theoretical and experimental wireless. During the past months I have not paid much attention to television, as I have had other duties at college, but I will be experimenting with television during the coming weeks.

I think that if I was a member of the Television Society I could get more local support.

Yours faithfully,
JOHN D. LE LACHEUR.

P.S.—I hope the B.B.C. will soon change their attitude towards television.

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JANUARY, 1929.

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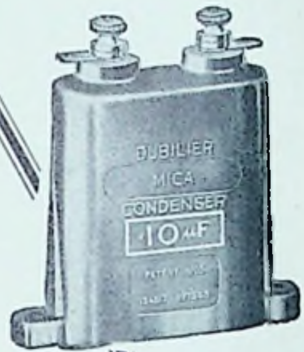

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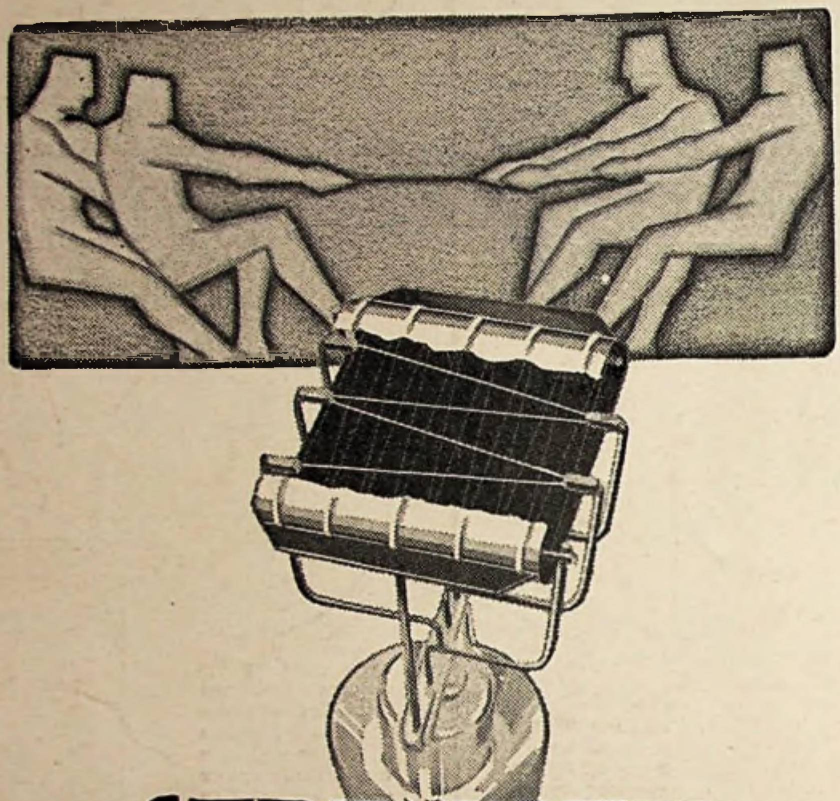

Printed by Hazell, Watson & Viney, Ld., 52, Long Acre, London, W.C.2, and published for the Proprietors, Television Press, Ltd., 23, Charing Cross Road, London, W.C.2, by The Aldine Publishing Co., Ltd., Crown Court, Chancery Lane, London, W.C.2. Address for advertisements, "Television" Advertisement Dept., 109, Kingsway, London, W.C.2. Sole Agent for U.S.A., International News. Registered for transmission by Canadian Magazine Post.