RADIO EXHIBITION NUMBER

6D MONTHLY

Television

The Official Organ of the Television Society

VOL. 2 OCT. 1929 No. 20

B. B. C.

to broadcast

BAIRD TELEVISION

Commencing September 30th.

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No. 241 (Gallery), at Olympia.

THE WORLDS FIRST TELEVISION JOURNAL

THE TELEVISION SOCIETY

The Television Society was founded on September 7th, 1927.

The Society makes its appeal to those who desire to share in the responsibility of furthering this new branch of applied science.

THE OBJECTS OF THE SOCIETY

may be summarised as follows :

(*a*) The Study of Television and its application in applied science and industry.

(*b*) To afford a common meeting ground for professional and other workers interested in current research relating to Television and allied subjects and to afford facilities for the publication of reports and matters of interest to Members.

(*c*) To encourage the formation of *Local Centres* of the Society in the Provinces, so that by social intercourse and discussion among members these aims may be more fully realised.

The present register indicates a world-wide membership.

ORGANISATION.

The Society consists of one Honorary Fellow, Fellows and Associates, and the management is vested in a Council of Fellows, including the President, three Vice-Presidents, and Ordinary Fellows.

Fellows.—Ordinary Fellows must be elected by the Council. Candidates for the Fellowship must be proposed by two Ordinary Fellows, the first proposer certifying his personal knowledge of the candidate.

Associates.—Any person over 21 interested in Television may be eligible for the Associateship without technical qualifications, but must give some evidence of interest in the subject as shall satisfy the Committee.

Student Members.—The Council have arranged for the entrance of persons under the age of 21 as Student Members.

Subscriptions.—The annual subscription for Ordinary Fellows is 20s., with an entrance fee of 10s. 6d. ; and for Associates 10s., with an entrance fee of 5s.
The annual subscription for Student Members is 5s., entrance fee 2s. 6d.

Life Members.—Life Membership may be secured at a fee of £10 10s.

Meetings.—The ordinary meetings of the Society are held in London at the Engineers' Club, Coventry Street, W.1, at 8 p.m., on the first Tuesday of the month (October to May inclusive). Notices of meetings are posted to all members about seven days before the meeting.

Full-size reproduction of the new Television Society Badge, which is available to accredited Members, and may be obtained from the Head Office, price 1s.

The official organ of the Society is " Television," published monthly by the Television Press, Ltd., 26, Charing Cross Road, W.C.2.

A memorandum for the guidance of members wishing to form a Local Centre of the Society may be obtained (gratis) on application to the Joint Hon. Secretaries, 4, Duke Street, Adelphi, W.C. 2.

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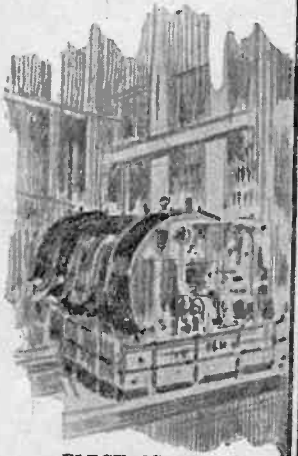

ELECTRICITY

MECHANICS

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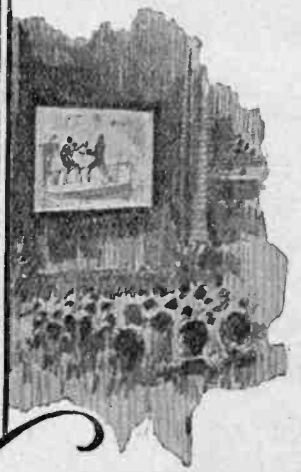
CHEMISTRY

OPTICS



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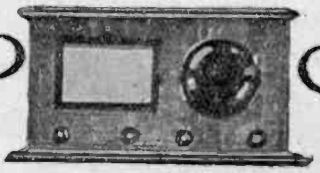

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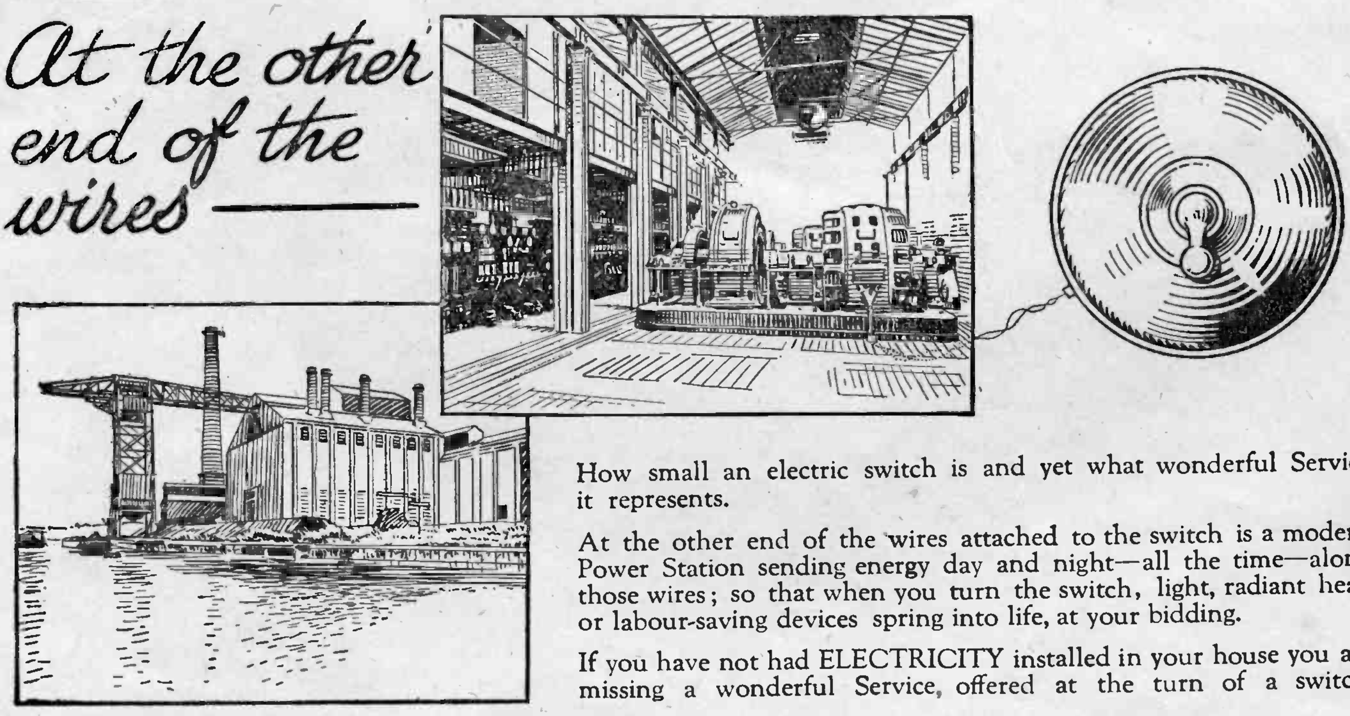

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The Official Organ of The Television Society

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Vol. II] OCTOBER 1929 [No. 20

EDITORIAL

No doubt our readers have already read in the newspapers the joint statement of the B.B.C. and the Baird Company to the effect that the B.B.C. will commence to broadcast television on September 30th. A start is being made at last, after months of protracted and frequently interrupted negotiations. We make no apology for drawing attention to the very active part which we have taken in the struggle to secure this result. We look back upon our share in the fight for broadcasting facilities, and survey the result with justifiable pride.

* * *

Television has come to stay. It has had many setbacks in the past, and may have many more in the future, but despite all troubles and difficulties, there is no question or doubt that television has come to stay. Our reason for being so definite on this point is because *this latest product of scientific endeavour provides something which the public wants.* It supplies something which broadcasting has always lacked, SIGHT.

* * *

It was because we realised this very early in the life of this magazine that, at the risk of being accused of bias, we formulated the policy which we have been pursuing. In its fight for recognition and proper facilities we have consistently and actively supported the only organisation (the Baird Company) which can supply British broadcast listeners with this priceless thing, sight. We intend to continue that policy, for we are even now only at the beginning.

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* * *

The latest offer of broadcasting facilities which the Postmaster-General made to the Baird Company, and which the latter accepted, is by no means all that one would wish. It is perhaps natural that both the Postmaster-General and the B.B.C. should disclaim all responsibility for the success or otherwise of the experiments. Nevertheless, both parties can, and we feel sure they will, do much to make success certain. However perfect the transmissions may be (within the present limits of the art) when they leave the Baird studios, much depends upon the technical excellence of the Post Office land lines to 2LO and on the adjustment of the 2LO transmitter. The unvarying technical excellence of both these factors, as demonstrated daily in ordinary broadcasting, is of such a high order, however, that we feel sure there is no cause for anxiety on those scores.

* * *

THE facilities which have been offered and accepted cannot under any circumstances be described as ideal. The experimental transmissions are to last half an hour only, and that half-hour is between 11 and 11.30 a.m., a time of day when most of us are at business. On Saturdays and Sundays, the very days when most of us do our experimenting, there are to be no transmissions. Surely something could be done to rectify this anomaly, which amounts almost to an injustice to the experimenter.

* * *

THEN there is the question of security of tenure. Nothing is so upsetting as uncertainty. Neither the Postmaster-General nor the B.B.C. guarantee that the transmissions will be continued for any definite period. Apart from the effect of this upon the domestic arrangements of the Baird Company, there is, as we have already pointed out in these pages, the effect upon the manufacturer and also upon the experimenter. Uncertainty as to the future does not encourage either the manufacturer or the customer to expend money on apparatus which may be rendered useless overnight by a decision to discontinue broadcasting television. Fortunately, however, there is a safeguard in this direction, which we will deal with presently.

* * *

BEFORE closing this subject, we cannot do better, in order to indicate the feelings of our contemporaries, than quote from *Nature* of September 21st, which expresses itself as follows: "We hope that these experiments will be successful and that television will soon take a permanent place in our everyday life. In particular, we shall be interested to know the breadth of the band of frequencies required in the ether; the trend of invention seems to be in the direction of narrowing this band very appreciably."

* * *

Constructional Articles.

NOW that television broadcasting is about to start, the Baird Company has abandoned its policy of secrecy (made necessary in the past by commercial considerations) and released full details of the Baird televisor receiver. We are therefore hastening with all speed our preparations to give our readers the constructional articles for which they have waited so long and with such commendable patience. We hope to be in a position to publish the first of these in our November issue. There is sure to be a rush for that issue, so place an order with your newsagent NOW.

* * *

News from Abroad.

FROM press cuttings and direct information received from South Africa it is clear that the television demonstrations which Lord Angus Kennedy has been giving there recently have met with the greatest success and aroused the utmost enthusiasm. Scepticism has been completely killed, and the broadcasting authorities realise that television is here, and that what remains to be done is merely a matter of negotiation and detail. In our next issue we hope to be able to chronicle further interesting news from South Africa.

* * *

A FULL report of the state of television in Germany is published elsewhere in this issue. As far as other European countries are concerned, we understand that the only reason why Baird television is not already being broadcast from several powerful stations, easily receivable in this country, is that the Baird Company, however fast they recruit men, cannot provide sufficient trained engineers to meet all the demands from abroad.

* * *

Olympia.

AS mentioned above, the television section of the Berlin Radio Exhibition is fully described in this issue. And now, the British Radio Exhibition at Olympia, which will be open this year from September 23rd to October 3rd. Readers will find us in the gallery, at Stand 241. This is immediately on your left at the top of the staircase which you will find facing you as you enter the Exhibition. You are cordially invited to call and see us at our stand.

* * *

BY special arrangement with the Baird Television Development Company demonstrations of the Baird system of television will be given under our auspices, during the period of the Exhibition, at No. 1, Hammersmith Road (entrance in Addison Bridge Place). This is opposite Olympia. Although we have secured commodious premises there is, of course, a physical limit to the number of people who can be accommodated at any given time, and we have so organised the demonstrations that every member of each party will be assured of a good view not only of the receivers but also of the transmitting studio and control room. These two features have been specially arranged for this purpose. Everything will be clearly visible.

* * *

ADMISSION to the demonstrations will be by ticket only. These tickets will be given free, but must be applied for at our stand in the Exhibition. They cannot be obtained anywhere else.

Television and Photo-telegraphy

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

One of the obstacles to the perfection of broadcast television, as our readers know, is the present congestion in the broadcast waveband. Dr. Robinson points out that, throughout the field of wireless communication, those interests which were first in the field are maintaining a monopoly grip on all the available wavebands. He suggests that, throughout the world, those interested in the latest forms of communication, television, photo-telegraphy, and facsimile transmission, should band together for the one purpose of breaking this monopoly grip and forcing the older interests to yield space for the new arrivals.

ABOUT one year ago the general public throughout the world was made aware that startling developments were being made in wireless, and that new means for converting wireless waves into intelligence were being introduced. In place of the well-known telephones, loudspeakers or Morse inkers, it was being energetically put forward that wireless waves could be made to appeal instantly to the eye, and, in fact, that it was possible to transmit pictures.

On the one hand there was photo-telegraphy, by means of which a picture could be transmitted and received as a permanent record; and on the other hand moving pictures could be transmitted and received so as to be seen instantly as they arrived. There was then considerable confusion in the public mind as to the difference between these two different methods, and this confusion has even now not been completely dissipated.

Differences Between the Methods.

Technical people had no misconception as to the differences between the methods, and they proceeded to give a lead to the general public as to the kind of reception to accord to the two new applications of wireless. There were differences in the results, in the methods, and in the relationship to the general technique of wireless. Also there was a very large psychological difference in so far as one system recorded a picture whilst the other gave actual vision of life.

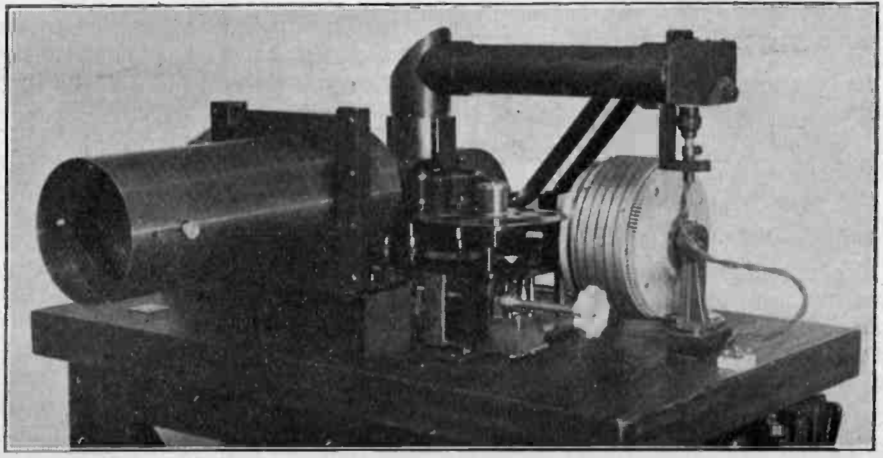
In view of the progress that has been made with both methods of optical recording of wireless communication, it may be of interest to discuss these differences at some length. In doing so it will become obvious that there are some very large features of similarity, which demand closer co-operation between the workers in the two fields, in all parts of the world.

Although it was only during last summer that the public became aware of the possibility of optical broadcasting and similar applications, much work had been done by inventors and engineers for many years previous to this. Such good progress had been made in some countries that it became essential to widen their activities, and to obtain financial assistance, which was forthcoming by the formation of public companies.

It is a very curious fact that although undoubted progress had been made both with the transmission and reception of telegraphed photographs and television, some engineers resented the steps taken to acquire financial assistance from the public; and in at least one case the statement was made that such developments should be taken completely out of the hands of the inventors, who had already done so much, and given to research organisations which already exist, such as the research laboratories of the large electrical companies. Fortunately, however, the modern world is prepared to admit that the large recognised research associations have not a monopoly of brains, and they do come to the assistance of promising inventors who are working independently. From a technical point of view the progress made during the last twelve months has justified the confidence of the public.

Mechanical Scanning.

Before proceeding further, one might be excused for referring to one other criticism of last year, that television could not hope to progress with the mechanical methods of scanning. It is a significant fact that in all practical systems of photo-telegraphy and television trans-



Close-up view of Telefunken-Karolus tele-cinema transmitter, showing optical arrangements used in connection with the scanning mechanism.

mission there is to-day only one general system of scanning the picture, and that is the mechanical method. Again, the good sense of the public has prevented criticism from delaying legitimate progress.

If we wish to transmit a picture from one place to another by wireless or by wire, we divide the picture into a number of parts and convey a signal for each part. When received, the various signals, which are of an electrical nature, are converted to optical effects, and correct arrangement of these made so as to give a correct picture.

There are thus certain essential processes for all systems of picture transmission whether still or moving: firstly, the division of the picture to be transmitted into a number of parts; secondly, the conversion of the light effect of each part into an equivalent electrical effect; thirdly, the transmission and reception of the electrical effects; fourthly, the reconversion of the electrical into optical effects; and fifthly, the correct arrangement of the optical effects into a picture. These processes are fundamental to both types of picture transmission.

The general result desired is to transmit pictures as perfectly as possible, and also, if possible, almost instantaneously. These two desirable features introduce the most important factor in optical broadcasting, i.e., *time*. Ignoring this factor, there is no fundamental difference in the principles of photo-telegraphy and television. However, when we do consider the time factor in conjunction with the perfection of the result which is desired, we find divergences in the methods applied to achieve the two distinct results.

Let us bear in mind always that there is only one ultimate object of all systems of optical broadcasting, and that is to obtain as good a picture or series of pictures in as short a time as possible.

The "Dot" Theory.

To consider the influence of time on the communication of optical effects, it is necessary to use some system of reference for the scanning of a picture. The simplest method is to consider the number of parts into which a picture is divided. When this subdivision is very extended, it has become customary to refer to the number of "dots" of a picture. This is by no means an ideal means for considering scanning, as it implies that each part of a picture or dot is separate from every other part, whereas, in fact, the picture is scanned quite continuously, so that there is usually no "dot" effect. However, for certain purposes the "dot" conception is convenient and we shall for the moment consider a picture of rectangular shape divided into 100 strips each way, thus having 10,000 rectangular parts or "dots." This is a crude subdivision, and in order to give the most faithful detail a picture should be divided into a much larger number of "dots."

High Signalling Speeds.

Suppose that we wish to transmit the picture in this form in one second. We must transmit at the rate of 10,000 signals per second, assuming that each "dot" is transmitted separately. This is a very high signalling speed, for the assumption we have just made takes us into the telegraphic rather than into the telephonic field. In telegraphy any system capable of dealing with 10,000 independent signals per second would have an immediate commercial outlet, for this is equivalent to a speed of about 10,000 words per minute, and there is no system of telegraphy to-day which comes anywhere near such high speeds.

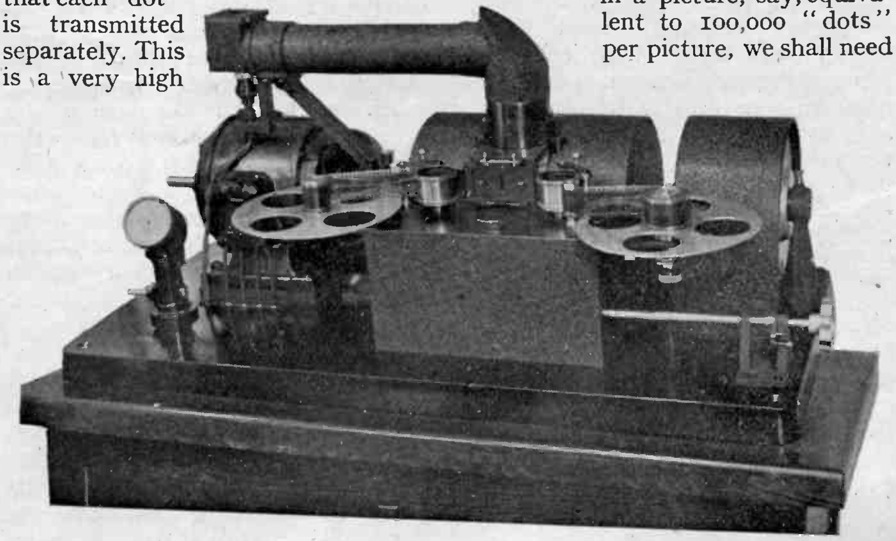
However, if we give up our assumption of the transmission of each "dot" separately, and use the practical method of scanning, we should have 100 strips to scan in one second, the width of the scanning aperture to correspond being equal to the width of the strip. In this case we approach the telephonic method of recording rather than the telegraphic, when the transmission of our picture becomes equivalent to the transmission of frequencies approaching 10,000 per second, the actual maximum frequency depending on how regular or irregular is the light distribution along one strip.

Returning to the "dot" conception again, a single picture of 10,000 "dots" could not be transmitted by telegraphic methods in one second, and to correspond to present-day practice of these methods, about 50 seconds would be required.

On the practical method of continuous scanning along a strip, it would be possible to transmit the picture of 10,000 "dots" in one second, as this would not involve frequencies higher than 10,000 per second. Now consider that we need a finer grain in a picture, say, equivalent to 100,000 "dots" per picture, we shall need to transmit frequencies approaching 100,000 if such a picture must be completed in one second, and as this is not allowed, we must take at least 10 seconds to transmit such a picture.

Thus, in order to transmit a photograph telegraphically the time factor comes in, and the greater the detail of the picture the longer is the time required.

In the case of television the problem is different, for it is essential to transmit one complete picture in a fraction of a second, say, from one-tenth to one-sixteenth of a second. The problem is different because in the case of photo-telegraphy an actual optical record is made either photo-



Another close-up view of the Karolus tele-cinema transmitter, with the optical parts removed.

graphically or photo-chemically, whereas with television a fleeting image of each picture is all that is required, each complete picture being made in a fraction of a second, the pictures succeeding each other as in the case of the cinematograph, to give the appearance of continuous motion.

Suppose that we choose 10 pictures per second, we find that the definition of the picture must be restricted to about 1,000 "dots" per picture. This is equivalent to 10,000 signals per second, or on the continuous scanning system to frequencies approaching 10,000 cycles per second.

Different Objectives.

This is where the two different methods of optical transmission by wireless choose different paths. In photo-telegraphy we attempt to have the greatest possible detail and take a comparatively long time to transmit one picture; whereas with television the time factor is fixed, as each picture must be completed in one-tenth of a second, so that the definition of the picture is sacrificed. Further progress by both methods will be towards the same end, transmitting as large a picture as possible in one-tenth or one-sixteenth of a second.

At the moment organisations all over the world are working at these problems, and were there no fundamental difficulties it is certain that the final solution would be obtained by people working along these different lines.

There is, however, a very important difficulty in the way of both methods, which is that the rate of transmitting the "dots" either continuously or separately has an unfortunate effect on wireless waves. To transmit 10,000 "dots" per second means that frequencies approaching 10,000 cycles per second are involved, and if the highest frequency is 10,000 we are liable to have all lower frequencies present. With ordinary present-day wireless this means that we must absorb in the ether two bands of frequency each about 10,000 cycles in width, so that the total frequency band required is of a width of 20,000 cycles.

Frequency Band Required.

To transmit 20,000 "dots" per second we would require a frequency band of about 40,000 cycles, and so on. In fact, in the present state of the art, there is a direct proportion between the number of "dots" per second and the frequency band which is required. Allowing ourselves to change the time from one second, we find that *to transmit a certain number of "dots" of a picture or series of pictures the time required is inversely proportional to the frequency band.*

This general law applies so long as we restrict ourselves to one method of transmission and reception. It can be extended beyond pictures to ordinary telephony or telegraphy where we might convert the law into the amount of intelligence to be transmitted instead of the number of "dots," or the definition of a picture. Thus, to transmit a certain amount of intelligence through the ether, using present-day methods, the time required is inversely proportional to the frequency band absorbed. We must in this case take into account the method of interpretation of the signals received, for obviously these differ considerably for telephony and telegraphy. For instance, if we are allowed a frequency band of 20,000 cycles, it should be possible telegraphically to transmit about 10,000 words per minute, and by the speech or telephonic method such speeds are out of all reason.

A New Law.

There is thus at present a general law for picture or image transmission which associates the definition of pictures with the time for transmission and with the frequency bands, this law applying both to photo-telegraphy and to television. Both applications are comparatively new branches of wireless, and they are both in search of permission to enter the wireless field. Being late-comers, they find that the older users of wireless have in all countries dug themselves in, and have had allocated to themselves the right to say how wireless may be used. They have made international laws and regulations, and they keep a most careful watch on the employment of the ether, which has been divided up into frequency bands, which have already been allocated for various services. The greatest apathy has been shown by these people in control with regard to the use of the optical application of wireless, and they have only grudgingly allowed experimental transmissions.

One other standpoint that has been taken up is that the maximum frequency band that can be allowed is 9,000 cycles. This regulation applies because this happens to be the band which is never exceeded by a telephony service.

It is a very difficult situation both for the new-comers with their new optical application, and for those in control of the ether. There are many other complications which cannot be dealt with satisfactorily here. For instance, certain commercial companies who already have a licence to run wireless services can and do transmit still pictures or fascimile writing on their services. Again, the protagonists of television and some of the advocates of photo-telegraphy transmission have concentrated solely on their demand for broadcasting facilities. Still another complication is the fact that it is possible to transmit optical effects along telephone lines for newspaper and other purposes, and such lines are usually in the hands of a monopoly.

A Common Interest.

The fact remains that there is no fundamental difference between photo-telegraphy and television, as regards the basis of their technical work, their ultimate technical development, or as regards the difficulties with which they are faced in all countries. Their common interests demand that they should present a united front in their attack on the vested interests of the ether. They must realise how much they have in common, what their various possible activities are, and in this connection they should realise quite clearly that the broadcasting application is not the only one, nor even necessarily the most important; and further they must work together internationally in the one common interest in furthering the means and increasing the facilities for the complete application of optical methods to the communication field.

Noctovision and the Noctovisor

By NORMAN J. NICOLSON

In our last issue we gave some information about the recent demonstration of noctovision given by Mr. Baird at Boxhill, Surrey. In the following article our contributor gives some further technical details.

READERS of a technical journal are naturally interested in publicity accorded to any new achievements which may lie within the scope of their journal. Generally speaking, however, they are far more interested to learn something about the methods and apparatus employed in the accomplishment of these advances, and thus realising for themselves the manner in which an objective, hitherto deemed outside the realm of practicable possibilities, has been brought within the boundary by the patient endeavour of some inventive genius or scientist.

Most subscribers to this magazine will have perused recent accounts relating to Mr. Baird's latest development, christened the Noctovisor; an invention providing us with an instrument by means of which, in the densest smoke or fog, lights may be located at distances upwards of several miles and their bearings accurately recorded.

Obviously a valuable application this is for ships at sea, to enable navigators when blanketed by fog to maintain their courses with a larger measure of security against collision of running their vessels ashore; and in fact the instrument was evolved with this aim in view. Having been privileged to gain an insight into the mysteries of noctovision and its offspring, the noctovisor, we shall attempt to enlighten others who are similarly intrigued in a "how-on-earth-is-it-done" sense.

It is well known in scientific circles that ether waves or rays produce different effects and require various means of reception, according to their frequency. Energy is conveyed by all of these waves and can be made perceptible as heat by using suitable detectors.

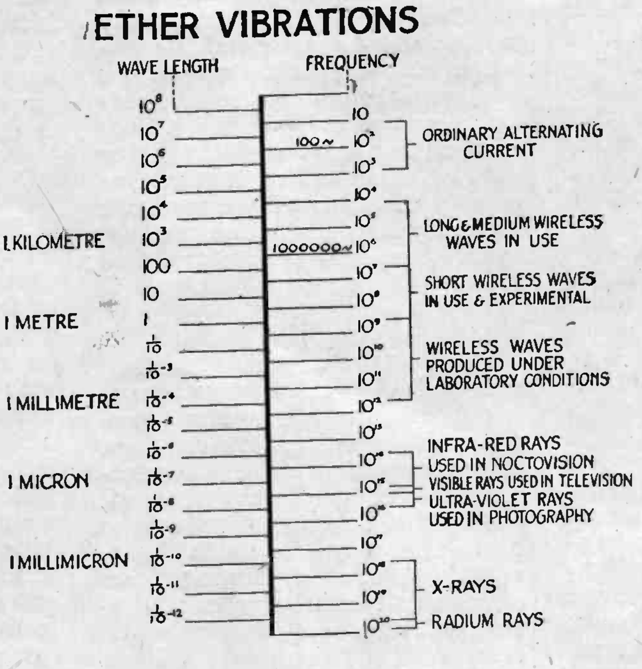


Fig. 1.

Table of Ether Vibrations, with frequency per second and equivalent wave-length in metres.

It will be noticed what a small section the visible spectrum is composed of, even compared with the infra-red; also considerable amount of unused and in some cases uninvestigated sections still remain.

In noctovision we are not concerned with those vibrations known as the visible spectrum, but with a band of rays just below, scientifically named infra-red, of which our bodies are made aware when we feel radiant heat—such as sunshine. It is these rays which warm us and make us sunburnt. In fact most of the sun's energy reaches this earth in this form. Scientists originally proved the existence by the aid of thermometers,* but although unseen their presence may be easily detected in a number of ways.

Now, the visible rays—violet, blue, green, orange, and red—are more or less easily absorbed by fog, the violet far more so than the red. Thus readers who live in foggy towns will, if ordinarily observant, have noticed that red electric signs are seen much more brilliantly on foggy occasions than are, say, blue or white signs. That is the main reason why, with road warnings and in buoyed channels, we find red the predominating illuminant. If the fog is very intense all lights are blotted out, as we know, and at sea even the most powerful lighthouses are rendered completely invisible to the eye except at very short distances, so that until the advent of noctovision and its adjunct, the noctovisor, the modern navigator was no better able to pick up visual navigational warnings under such conditions than were the early Britons able to see their countrymen's warning fires on distant hilltops.

Fog has practically no absorption effect on infra-red rays, so that, given

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*See "Invisible rays—the infra-red." TELEVISION, No. 2, April 1928.

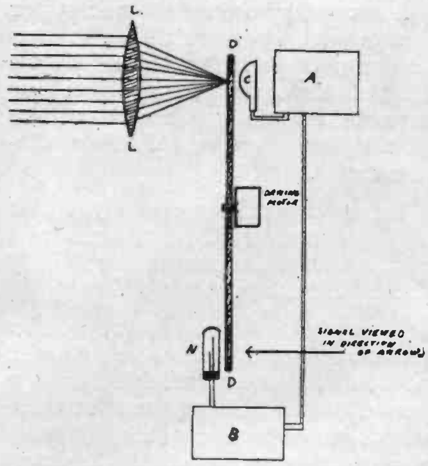


Fig. 2.
Schematic layout of Noctovisor.

some device for rendering invisible rays visible to the human eye, use may be made of such penetrative properties as they possess, to assist us in thick weather. Noctovision owes its existence to these properties and might well be termed "infra-red television," because we apply the usual television methods of reproduction, merely substituting infra-red rays for those of the luminous spectrum.

Derivation of Noctovision.

Students of etymology may possibly disagree with the designation "noctovision" as a suitable *nomen* for this discovery. Being derived from the Latin *noctes*, meaning night, and *videre*, to see, noctovision consequently is "seeing by night," which perhaps is not altogether correct, seeing that with infra-red rays we look through fog and smoke whether it is night or day. This, of course, suggests more than a suspicion of hair-splitting and is merely a thought *en passant*.

As in ordinary television, the first link between light and electricity in noctovision was the selenium cell, but for the same reason that it had to be discarded in television experiments, i.e. on account of its inertia or time-lag, so it was found useless for noctovision and has had to give way to the photo-electric cell. The earlier photo cells were also far from suitable for the purpose of responding to infra-red rays owing to their abnormal sensitivity to the blue rays. However, research workers quickly produced cells of a different type which would give their maximum response to infra-red, and these, though still capable of improvement, are found sufficiently good to achieve satisfactory results. The blue sensitive cells are the potassium kind, and in the red-sensitive category we now find ourselves with a choice of several, such as rubidium, cæsium, hydrogen, and thallofide. Our old friend selenium has almost completely receded into the background except in certain light-controlled switchgear where extreme rapidity of action is not essential.

Infra-red rays are present in most sources of illumination, and the method of separating them from the luminous portion is to place an absorption filter in the path of the light, so designed that it will only pass these rays. A thin sheet of ebonite effectively fulfils this purpose.

Mr. Baird, years ago, found that he could televise persons seated in total darkness by means of infra-red rays by the aid of his scanning devices and either spot or flood lighting, but, as with other of his valuable discoveries, the matter then became more or less shelved until the scope of its application seemed clearer. Now the principle has re-emerged from its comparative obscurity in the shape of the Baird noctovisor.

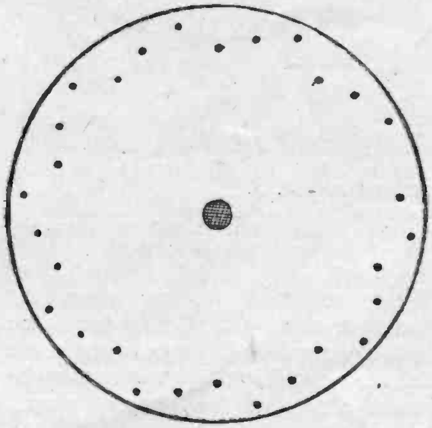


Fig. 3.
Diagram of Noctovisor disc.

Its construction is in accordance with the theoretical layout shown in Fig. 2, where L is an ordinary convex lens which concentrates an image of the radiating light point on to a perforated disc D, to the rear of which is situated a red-sensitive cell C, connected up to an amplifier A. The output of A is in turn connected to the input of an additional amplifier B, which operates a neon lamp N. The light is received at the top of the disc and may be viewed simultaneously in the screen formed by the neon at the bottom, 180° opposite to the cell mounting. There being no definite image formed, as we shall see later, it is unnecessary for the scanning direction at the receiver side to be the same as at the transmitter.

Considerations of Disc Design.

We must now study the disc itself. Before explaining the way in which this is perforated let us examine the requirements. A finely detailed picture of the light point is, of course, unnecessary, it being sufficient to know that it is there and to be able to take its bearing. What we do want is that our apertures shall be as large as possible in order to admit as much of the light, or its infra-red component, as we can to the cell, for upon the amount of ray admitted depends the range of the noctovisor's operations. So it is permissible to use large perforations and a coarsely-grained screen.

We must naturally have a continuity of apertures around the disc, and also the diameter of this cannot fall below a certain size owing to two further considerations. Firstly, one needs to be able comfortably to view the screen below, and, secondly, the neon cannot be mounted within a certain distance of the photo-cell, else, despite all precautions, the latter will pick up the quite appreciable radiation of the former and cause oscillation in the amplifiers, just as

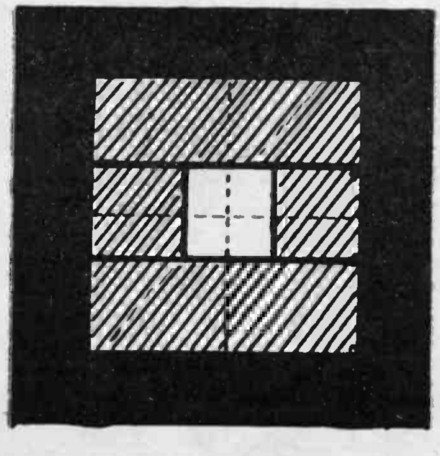
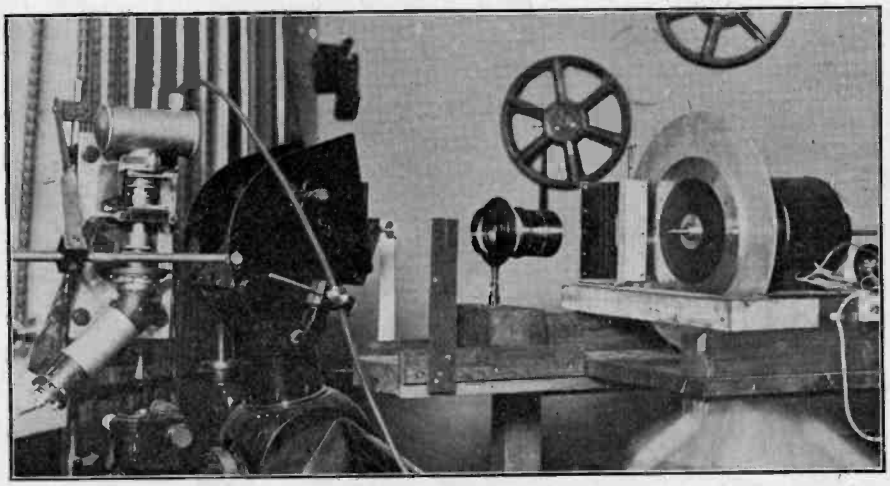


Fig. 4.
Diagram of Noctoscope viewing aperture. The spot of light is first picked up anywhere within the black frame and by suitable adjustment of the sighting controls is brought to the centre, where it is indicated as a white spot.

any amplifier will oscillate when coupling exists between its output and input.

The disc eventually decided upon as suitable (although its design is not by any means arbitrary) was a thirty-hole disc with round apertures arranged in ten series of three, as shown in Fig. 3, the diameter of each being $\frac{3}{8}$ in. Considering that the grain of our screen consists of but three strips, and each disc revolution produces this ten times, the driving-motor, in order to maintain a continuous image, need not rotate faster than 70 to 80 revolutions per minute. But another point enters here, for which allowance has to be made, and that is the low-frequency response of our amplifier. At 80 revolutions our minimum frequency, when a light signal is present, could be as low as $\frac{10 \times 80}{60} = 13 \cdot 3$ per second, and this would present a delicate amplification problem. Our disc speed then has ultimately to be governed by the characteristic of our amplifier. The writer is not at liberty to divulge circuit details of the noctovisor amplifiers, but it is sufficient to say that they contain several unique features. The neon is coupled so that it glows only when a signal is recorded. Thus the light is seen on a black background, not a pink one, as would otherwise result.

Following through the operation of picking up a light from its infra-red radiation with the noctovisor, the lens concentrates the image of the light on the disc, which scans it with its series of three holes passing the direct values of the ray on to the cell, which converts the ray impulses into electrical impulses. These are amplified and set up large current fluctuations in the neon, which can be quite easily noted by anyone looking at that portion of the disc in front of it. The whole unit is mounted on a base calibrated in degrees, and can be swivelled round and elevated to meet requirements. When we wish to ascertain the presence of a light all we have to do is to manipulate the noctovisor like a telescope until the light appears in the exact centre of the viewing screen (denoted by a vertical hair line). Consult the scale below and we have its bearing.



THE BAIRD TELE-TALKIE TRANSMITTER.

On the left is the film projector, which throws an image of the picture on to the face of the scanning disc at the right. Behind the scanning disc, and not visible in the picture, is the photo-electric cell.

Equally Suitable for Daylight Use.

If the light were stationary, as in the case of a lighthouse, its exact distance from a moving vessel could be plotted in the usual navigating manner—by triangulation. A navigator picking up a moving light in his noctovisor during fog would simply alter his course as required. A natural query to raise is whether the instrument functions equally well during fog in daylight. The answer is yes. The internal arrangements are such that the noctovisor ignores an even daylight signal and is sensitive only to points of light whose intrinsic brilliance is greater than their background of daylight. Ordinary ships' masthead lights quite easily fulfil this condition.

A secondary use for the noctovisor (but nevertheless one that has obvious potentialities) is that it might be utilised for secret morse signalling between two points where the flashing of visible lights would be a disadvantage.

Before concluding, one might hint at the future trend of progress and further beneficial innovations likely to accrue from noctovision.

It is quite a feasible proposition technically and one which would, no doubt, prove invaluable during a period of hostilities to use infra-red searchlights to sweep the skies or seas and to view, instead of the direct rays, those reflected back from any objects in the path of the infra-red searchlight. These searchlights might be used to detect aircraft, ships at sea, and even land forces at night or in fog, without conveying any warning to them that they were seen. An earlier materialisation of this idea will undoubtedly appear shortly to enable icebergs to be located in fog.

Noctovisor *versus* Direction Finder.

Doubtless many interested readers will be inclined to wonder whether the noctovisor has arrived too late, in view of the parallel service it affords to wireless direction-finding? The writer offers a decidedly negative opinion to this query. Wireless direction finders are admittedly superior over distances exceeding the limits of direct human vision, but even so, they are subject to certain freak effects, especially at sunrise and sunset, and in addition require a skilled wireless operator to manipulate the gear. The expense of a direction-finding plant also is considerable.

Within visual limits (by this is meant distance over which one can see in clear weather) there is no doubt that the noctovisor will prove a greater asset to ships than their direction finders. Equipped with this instrument, all existing lighthouses and buoys would, in foggy weather, be visible to them at their usual distances, and a navigating officer could operate it with ease. Naturally, any navigator would prefer to be guided by lights at close range than by bearings which he must trust blindly and apply in conjunction with his chart, the leadline, and the roughly calculated speed of his vessel.

Television at the Berlin Radio Exhibition

by THE EDITOR

IN the *Evening Standard* the other day "The Londoner," in his diary, deplored the apathetic attitude of British business men towards new ideas and inventions. He cited the case of two scientist-inventors who had attempted to interest British manufacturers and financiers in their work, only to be told frankly that their only chance of success was to go to Germany.

"The Londoner's" paragraph attracted my attention more particularly because I had just returned from a visit to the great German Wireless Exhibition in Berlin, where I noted an atmosphere of perpetual alertness for new ideas not only on the part of business men, but also amongst government officials.

In Germany, as in this country, the government controls wireless broadcasting, but there the resemblance ends. In Great Britain there is no visible evidence that the government is even aware that the wireless industry exists; it certainly takes no steps to help, or even co-operate with the trade. In Germany the government is so anxious to help the wireless industry that it may almost be said to father it.

Government Interest.

Every year, at the Berlin Wireless Exhibition, the Reichspostzentralamt (G.P.O.) takes a considerable amount of space which it devotes to exhibits which are calculated to assist the German wireless industry in some form or another. Last year space was allocated to the demonstration apparatus of the two television workers who were then active in Germany, Professor Karolus, of Leipzig University, and Denes Von Mihaly, of Budapest. Mihaly, although not a German citizen, has received subsidies and every other form of assistance from the German government.

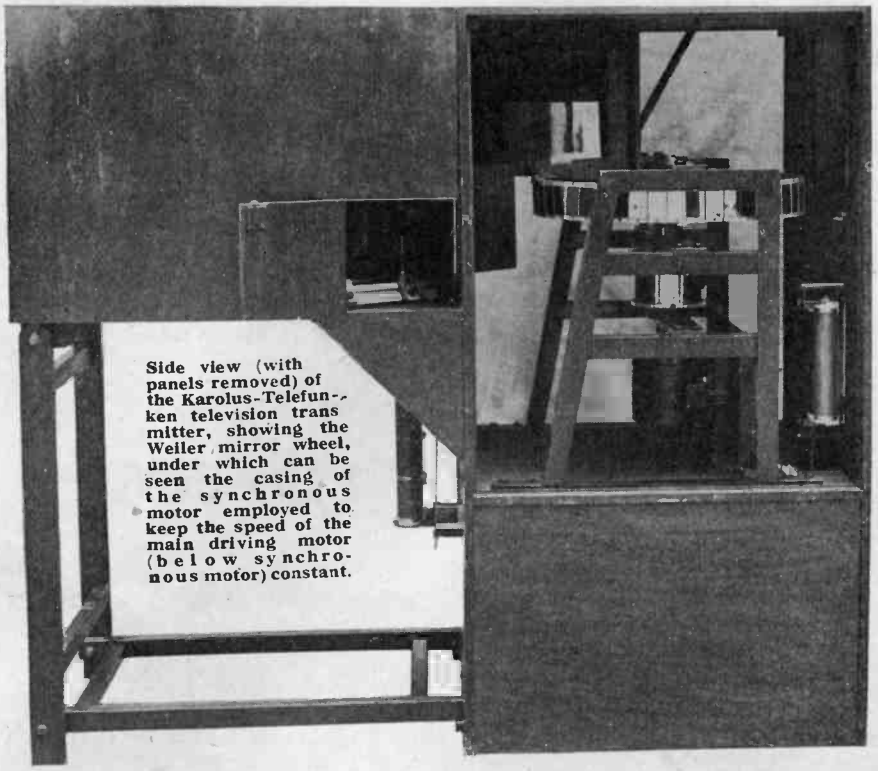
Within the last few months, as has been chronicled in the pages of this journal, a deputation of German government officials, headed by Dr. Hans Von Bredow, who is the Czar of broadcasting in Germany, came over to England to investigate the Baird system of television, with results which are already known to my readers. At this year's exhibition more space than ever was devoted by the Reichspostzentralamt to television demonstrations. In addition to the systems of Baird, Karolus, and Mihaly, the Post Office itself demonstrated apparatus.

The "Dot Theory" Again.

One of the outstanding features of all these exhibits was one which revealed that the "dot theory" of television image construction still prevails in Germany. Each exhibitor displayed a large printed card on which was given the main characteristics of his system. Amongst other particulars was given the number of "picture points" which went to form the image. The number of picture points is calculated as follows: Assuming a scanning disc containing thirty holes, and assuming that the received image is square in shape, the number of picture points is 30×30=900 picture points.

A thirty-hole scanning disc produces thirty strips in the image, and this method of calculation assumes that each strip is divided up along its length into thirty separate and distinct impulses or picture points. This falacy used to be very common in this country, and was continually employed by critics of the Baird system of television to prove that the

Members of the public crowding round one of the television demonstrations at the Berlin Exhibition.



Side view (with panels removed) of the Karolus-Telefunken television transmitter, showing the Weiler mirror wheel, under which can be seen the casing of the synchronous motor employed to keep the speed of the main driving motor (below synchronous motor) constant.

frequency band width required for television was so preposterously wide that it would be impossible to broadcast television within the internationally prescribed frequency band width, for broadcasting, of 9 kilocycles.

This dot theory originated with the early experimenters in the field of photo-telegraphy, who based their theory on the points which go to make up the half-tone reproductions of photographs, such as are printed in this magazine. The theory, as applied to television, was finally and very effectively exploded in this country by the very able articles which Dr. J. Robinson wrote specially for TELEVISION.* The Germans do not appear to be very sure whether the dot theory, as applied to television, is right or not, but they argue that it is a very convenient, if arbitrary, method of giving some quantitative indication of the relative amounts of image detail and frequency band width produced by the different systems.

The Post Office receiver gave 1,200 picture points, the Fernseh receiver (representing the Baird system) 1,800 picture points, and of the Mihaly receivers, one gave 900 and the other 1,600 points. As all three used thirty-hole discs, the difference is accounted for by differences in the dimensions, or ratio of height to width, of the received image. Dividing the Post Office figure by 30, for instance, gives 40, or a dimension ratio of 3 to 4. The Karolus system gave 2,300 picture points, representing a square picture made up of 48 strips.

Standards Chosen for Germany.

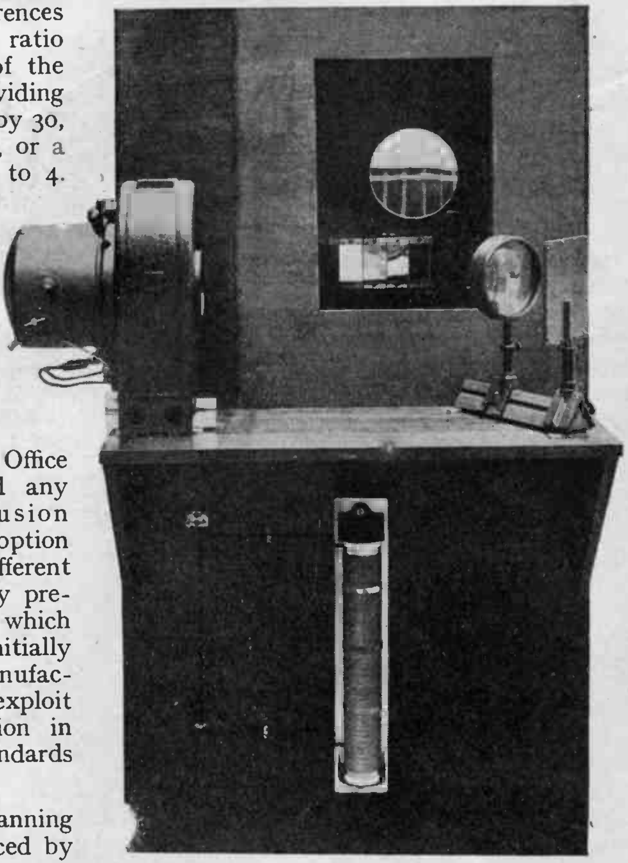
With characteristic German thoroughness, the Post Office has already removed any possibility of confusion arising, due to the adoption by rival systems of different standards, by officially prescribing the standards which must be adopted, initially at least, by any manufacturer who desires to exploit a system of television in Germany. These standards are as follow.

The number of scanning lines (whether produced by a Nipkow disc or other means) is 30. The number of pictures to be transmitted per second is 12½ (as against standard cinematograph speed of 16 per second). Horizontal scanning has been adopted, as opposed to the vertical scanning used by Baird in this country. The dimensions of the picture are to be based on the ratio 3 to 4, i.e., the picture must measure 3 units (centimetres, inches, or feet) high by 4 units wide.

The first two of these standards are based on the frequency band width available, 9 kilocycles. Worked out on the picture point basis, and considering the 3 to 4 ratio of the picture, the actual frequency, by calculation, is 7,500, or 7·5 kc.

The ratio 3 to 4 is the standard motion picture size, and has been adopted partly because it is a ratio of height to width to which everybody has become accustomed, and expects in a picture, still or moving, and partly because the German plan is to broadcast cinematograph films in the first place, during the initial experimental transmissions, and introduce actual television broadcasts gradually.

Having thus settled the ratio,



Karolus transmitter (with cowling removed) as seen from the sitter's point of view. At left is the arc lamp, at right the back of reflecting mirror and lens which directs the beam from the arc on to the mirror wheel (centre). Above the mirror wheel is the inclined mirror which reflects on to the photo-electric cell the image of the sitter. Compare these two illustrations with Fig. 2.

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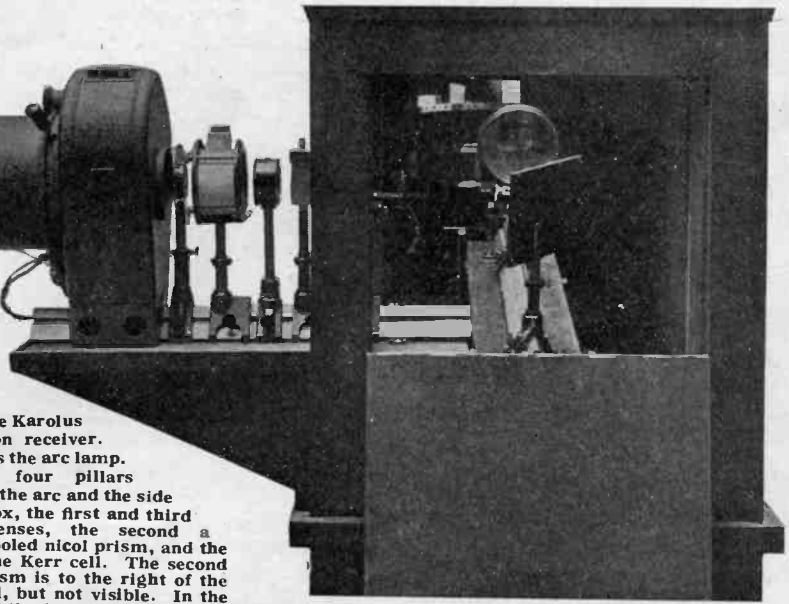
* See issues for November and December, 1928, and January, 1929.



The large Karolus projection receiver. At left is the arc lamp. Of the four pillars between the arc and the side of the box, the first and third carry lenses, the second a water-cooled nicol prism, and the fourth the Kerr cell. The second nicol prism is to the right of the Kerr cell, but not visible. In the centre of the box opening, in the foreground, can be seen the back of the inclined mirror which reflects the light beam through the lens on to the mirror wheel just visible at the top.

horizontal scanning follows almost as a matter of course, for in order to obtain the greatest detail the picture strips must run the long way of the picture; to scan vertically would mean the employment of larger holes in the scanning disc, with consequent loss of detail.

Horizontal *versus* Vertical Scanning.

For television proper, owing to the limitations imposed on television at present by the frequency band width available, little more than a head and shoulder view of one or two persons can be transmitted. Now, if you consider the human face it will be realised that the most prominent characteristic lines which go to make up the features run in a horizontal direction. That being so, they can be reproduced much more clearly if they are scanned in a direction at right angles, that is, by vertical scanning.

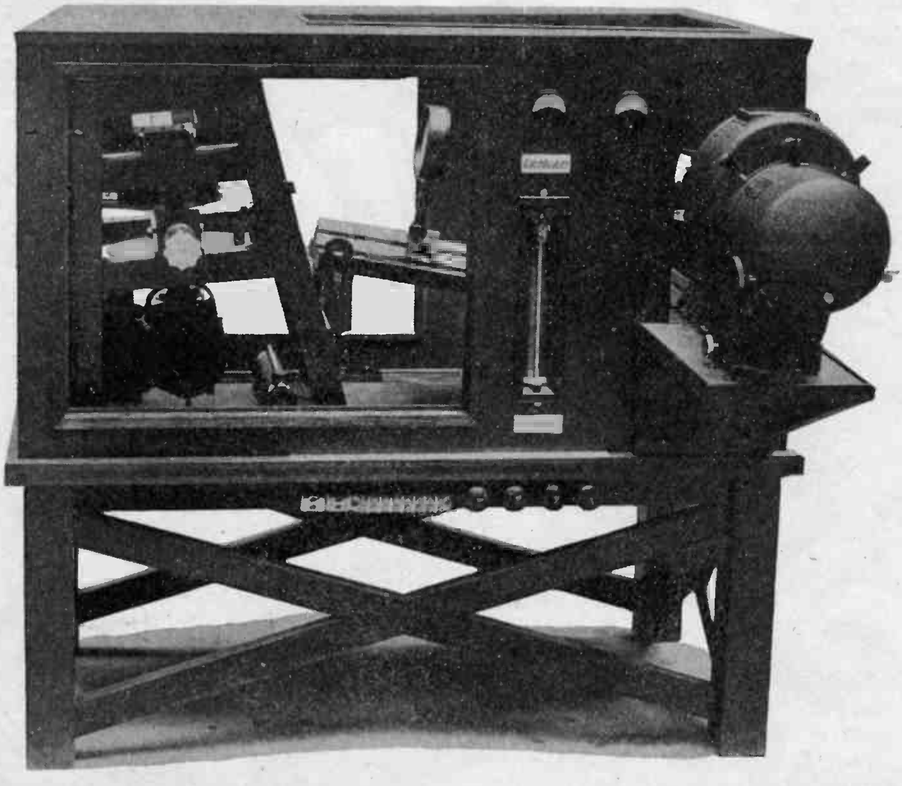
Baird states that he has found that the head and shoulders picture of a person can best be presented by a height to width ratio of 2 to 1. Of course, if the moving images of *more* than one person are to be transmitted, the 2 to 1 ratio becomes less suitable.

I had a most interesting discussion on television problems with Dr. Schroeter, of the Telefunken Company, with whom Dr. Karolus collaborates in the development of the Karolus-Telefunken system of television. As a result of this discussion, by the way, Dr. Schroeter has promised to honour our pages with a contribution on television problems.

Dr. Schroeter agrees with Baird that vertical scanning is more efficient than horizontal scanning, and drew attention to another interesting point in connection with synchronism. If the receiving motor has any tendency at all to "hunt," the movement, in the case of horizontal scanning, is to and fro horizontally; in the case of vertical scanning the movement is vertical. Now, it is a curious fact that, through long usage, we can more readily detect horizontal movement. Most movements in our everyday lives take place in a horizontal plane. We are accustomed to moving our heads from side to side rapidly. We are not accustomed to such rapid and continual movement in a vertical plane. In fact, we subconsciously oppose small vertical movements because, when we walk, our heads move slightly up and down. As a result, a given amount of hunting in a television image becomes far more noticeable and distressing in the case of horizontal scanning than it does where vertical scanning is employed. After leaving Dr. Schroeter I returned to the Exhibition and proved this for myself. It is no imaginary phenomenon, but a very real one.

The Post Office Exhibit.

Coming now to a detailed description of the various exhibits, the



A side view of the projection receiver. On the left can be seen (top) the mirror wheel, below which is the synchronising motor, and at bottom of shaft is the main driving motor. The light beam is projected from the mirror wheel upwards at a low angle through the opening in the roof of the box. Compare these illustrations with Fig. 2.

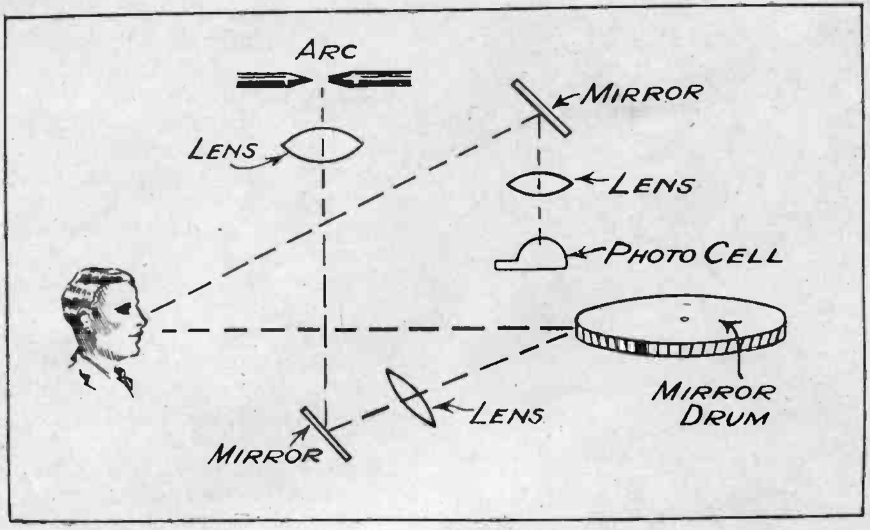


Fig. 1.
Diagram of the Karolus television transmitter.

German Post Office had a long stand divided into three compartments, all faced with large plate-glass windows, which allowed the public to see what was going on inside. In one compartment was a tele-cinema transmitter through which ran continuously a large loop of film. In the adjoining compartment was a large check receiver, on the screen of which the public could see a television reproduction of the film.

This receiver followed the design of the Baird system, but horizontal scanning was employed (as at the transmitter), and a picture was presented which was dimensioned in accordance with the 3 to 4 ratio. Instead of the usual flat plate neon tube as a light source, however, the Post Office receiver employed a rather large mercury-argon light source. This consisted of a thin glass tube bent to and fro about itself to form a grid. Between this tube and the back of the scanning disc was placed a ground glass screen to diffuse the bars of light from the grid-shaped tube. In front of the disc, nearest the observer, was placed the usual large magnifying lens.

This receiver made no pretensions to being commercial, for it was too large for home use, and the mercury-argon lamp required something in the neighbourhood of 200 watts (obtained from a large power amplifier) to operate it. The light from such a tube is bluish in colour, and the picture, though steady and good in detail, was lacking in depth and intensity of illumination.

The third compartment contained a transmitter for actual television, but it was never in operation. I was given to understand that it represented one of the Post Office's earliest efforts to build for themselves such an apparatus, and it had not proved very successful. From Dr. Bredow, with whom I had an interesting interview, I understand that another transmitter is in course of construction.

The Post Office tele-cinema transmitter, in addition to running the check receiver described above, supplied a signal which was used by all the other exhibitors to run tele-cinema receivers. In addition to the picture frequency, a separate synchronising frequency, derived from an A.C. generator coupled to the driving motor, was also sent out, both frequencies, of course, being transmitted by separate land lines. That is to say, two channels were required.

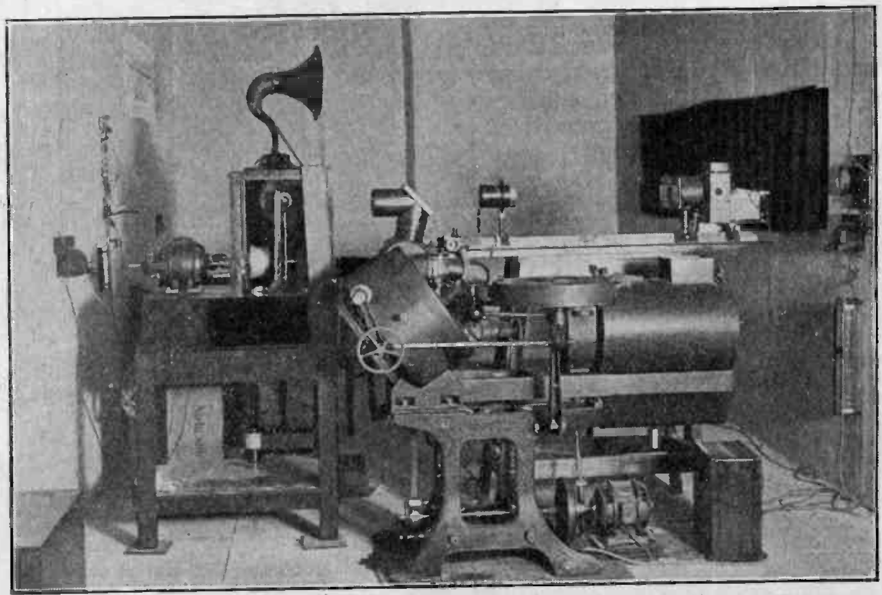
The synchronising frequency employed was 375 cycles. This was based on one synchronising impulse for each picture strip, there being 30 strips recurring 12½ times per second.

Two telephone call boxes were erected at opposite ends of the Post Office enclosure, in which a member of the public could sit and converse, by telephone, with another person seated in the other box, and see each other simultaneously. For this purpose a single scanning disc was used at each end of the circuit, so arranged that while the face of the telephonist was being scanned by a beam of light emanating from the holes at the bottom of the disc, by looking at the top of the same disc he saw there the image of the person at the other end of the wire.

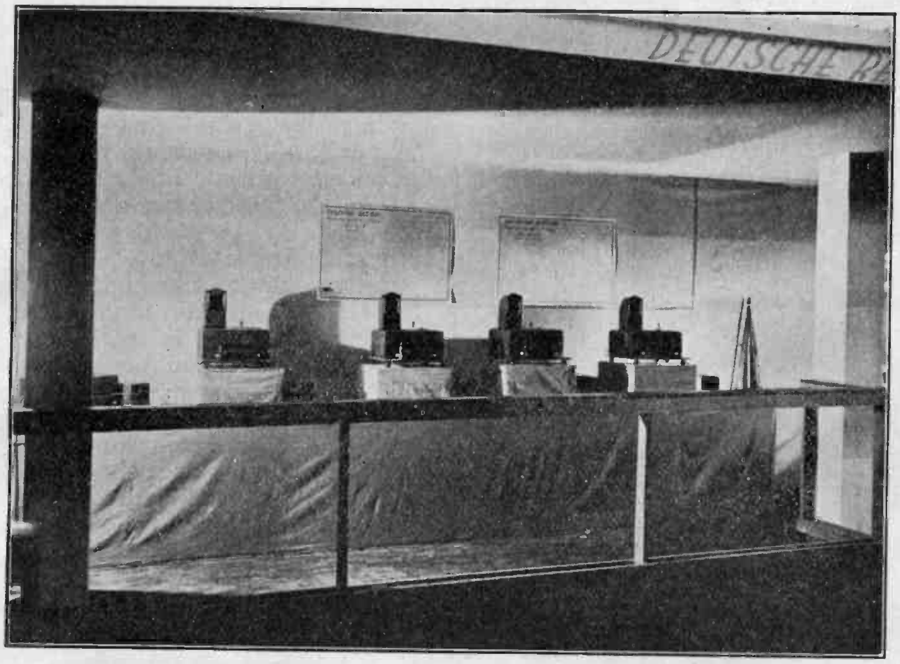
The received image, however, was not at all good, and, owing to the spotlight playing on one's face, it was difficult to see.

The Karolus-Telefunken Stand.

Proceeding further round the television enclosure, we come to the Karolus-Telefunken stand, exactly opposite the Post Office stand, and equal to it in size. The main attraction of this stand was a large television transmitter, employing for scanning purposes the well-known Weiler mirror wheel device with



General view of the Karolus tele-cinema transmitter. This was not demonstrated at the Exhibition.



General view of Mihaly's stand. The receivers shown are of the smallest type mentioned in the text.

which Dr. Karolus has been experimenting for some time. Photographs of this transmitter are reproduced here and it is represented diagrammatically in Fig. 1.

A beam of light from an arc lamp is concentrated by means of lenses to a fine and extremely intense point, which is directed on to the revolving mirror wheel. The mirrors are set in staggered formation, which imparts vertical movement to the beam, while the revolving motion of the wheel imparts horizontal movement.

One Cell Used.

The light point is reflected from the mirror wheel on to the face of the sitter, from whence it is again reflected and concentrated by means of a lens on to a single photo-electric cell. Baird uses two cells in his transmitter, but his spotlight is not nearly so intense. Instead of an arc he uses as a light source a gas-filled lamp of 900 watts rating. To the sitter the Baird spotlight is scarcely noticeable, whereas the Karolus spotlight shown at Berlin was uncomfortably dazzling.

On either side of the transmitter (which occupied the centre of the stand) were several Post Office laboratory models of receivers using Nipkow discs and neon tubes. These worked off the Post Office film transmission. The image they provided, however, left much to be desired, and the synchronism (by tuning fork) was definitely bad. Even when the discs were running in step they were continually going gradually out of phase.

To secure synchronism Dr. Karolus uses at the transmitter an electrically driven tuning fork that provides a steady alternating current which, after amplification, is fed to a small synchronous motor which, in turn, is mechanically coupled to the main motor which drives the mirror wheel. This synchronous motor keeps the speed of the main motor constant.

At the receiving end an exactly similar tuning fork provides alternating current for a synchronous motor which controls the speed of the motor used to drive the receiver mirror wheel. The weakness of this system lies in the tuning forks. Slight differences of temperature and other considerations cause their frequency of vibration to vary, and, of course, even the slightest variation of frequency is sufficient to upset the synchronism of the receiver. The system is also expensive, and complicated, inasmuch as the tuning forks require very careful adjustment.

The Karolus Receivers.

The main Karolus receivers, however, were housed in a separate enclosure in the centre of the television section of the exhibition. Two receivers were shown, one a small one suitable (in size) for home use, and the other a large one which projected the image on to a screen measuring about three feet square. Both of them worked off the Karolus television transmitter, although only one of them was to be seen in operation at any given time. The main synchronous driving motors of both receivers were fed from the same A.C. mains which supplied the transmitter driving motor, so that synchronism was assured without the use of tuning forks.

In the small receiver a thin pencil of light from the light source, a crater type neon tube, was focussed on to a small mirror wheel, whence it was reflected on to a ground glass screen measuring about four inches square. Owing to the large number of picture strips (48) the detail in the image was very good indeed,

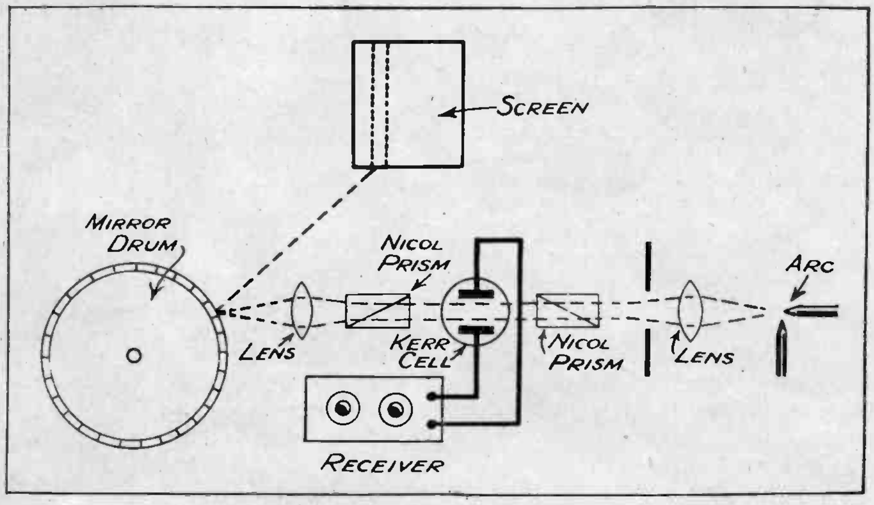


Fig. 2.
Diagram of Karolus projection receiver.

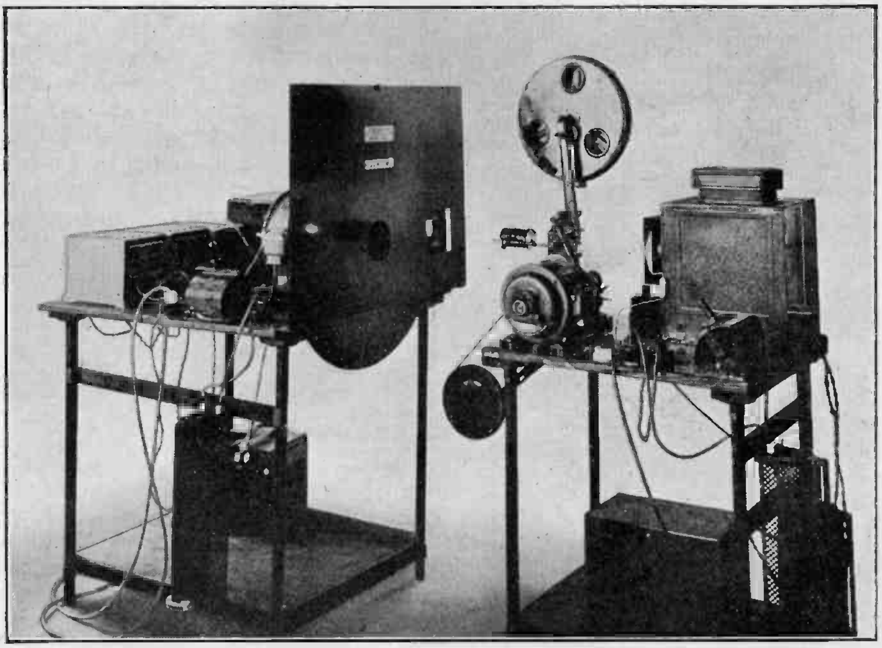


Fig. 3.
The Mihaly tele-cinema transmitter. At right is an ordinary cinema projector, which projects the moving picture on to the scanning disc (left).

but no better than Baird obtains by using, in his 30-hole disc, the very small holes which are made possible by the choice of a 2 to 1 picture ratio.

Dr. Karolus's choice of ground glass to act as a translucent screen can scarcely be called a happy one. Not only did the ground glass limit the illumination, but it caused it to be very directional—that is to say, if you stood in such a way that your eyes were dead level with the centre of the screen you could see the middle of the image quite clearly, but scarcely anything of the edges. In order to see the edges you had to move your head bodily from side to side and up and down.

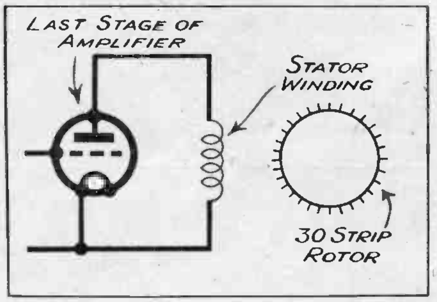


Fig. 4.
Diagram of Mihaly phonic wheel drive circuit.

Photographs of the large receiver accompany this article, and it is shown diagrammatically in Fig. 2.

Light from an arc lamp is concentrated to pass through two sets of nicol prisms between which is situated a Kerr cell. As is well known, the action of a nicol prism is to polarise light, *i.e.*, cause it to vibrate in one plane only instead of in every conceivable plane. The first prism polarises the light beam in one plane, while the second prism polarises it in the opposite plane, the net result being that the light vibrations in the two opposing planes cancel each other, and no light at all emerges from the second prism.

A Kerr cell consists essentially of two small condenser plates immersed in nitro-benzol. The light beam, polarised in one plane only, passes between the condenser plates, which are connected to the two output terminals of the television signal amplifier. The effect of these varying electrical impulses is to depolarise the light beam, so that, according to the intensity of the signal currents, more or less light emerges from the second nicol prism. In the Karolus receiver the nicol prisms are water-cooled, owing to their proximity to the intense arc light.

The varying light emerging from the second nicol prism is projected, by means of a lens, on to the large receiving screen, the surface of which is covered with very finely powdered aluminium, like a cinema screen. The detail of this large picture was very good indeed, but extremely difficult to see, as the illumination of the screen was very poor indeed. Dr. Karolus, who was kind enough personally to explain his apparatus to me, told me that I was looking

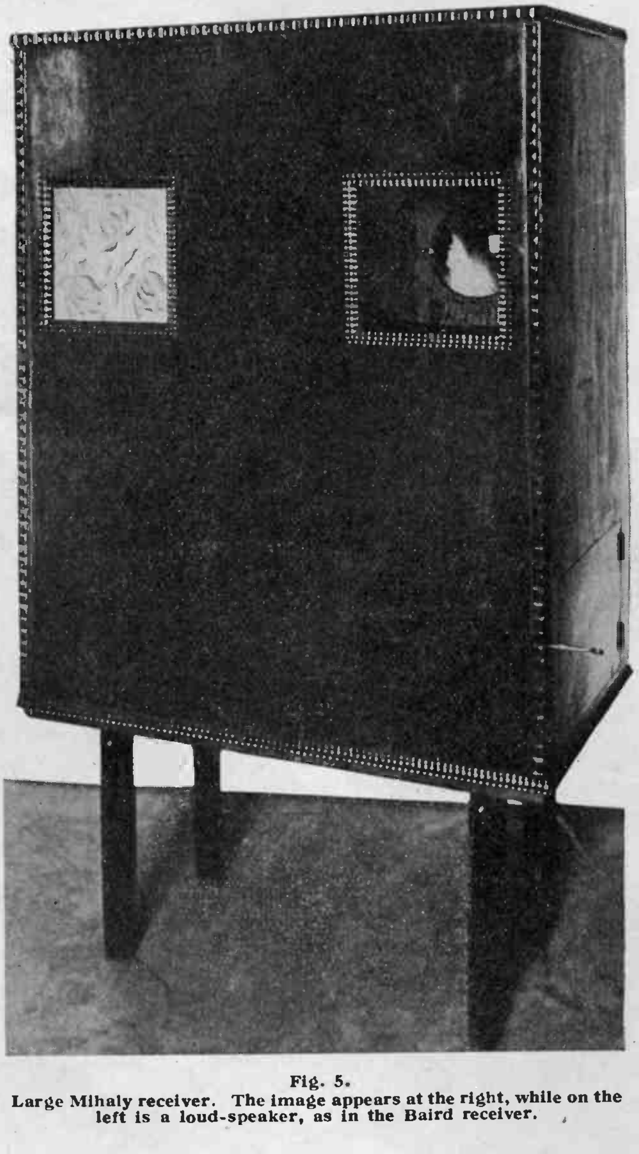


Fig. 5.
Large Mihaly receiver. The image appears at the right, while on the left is a loud-speaker, as in the Baird receiver.

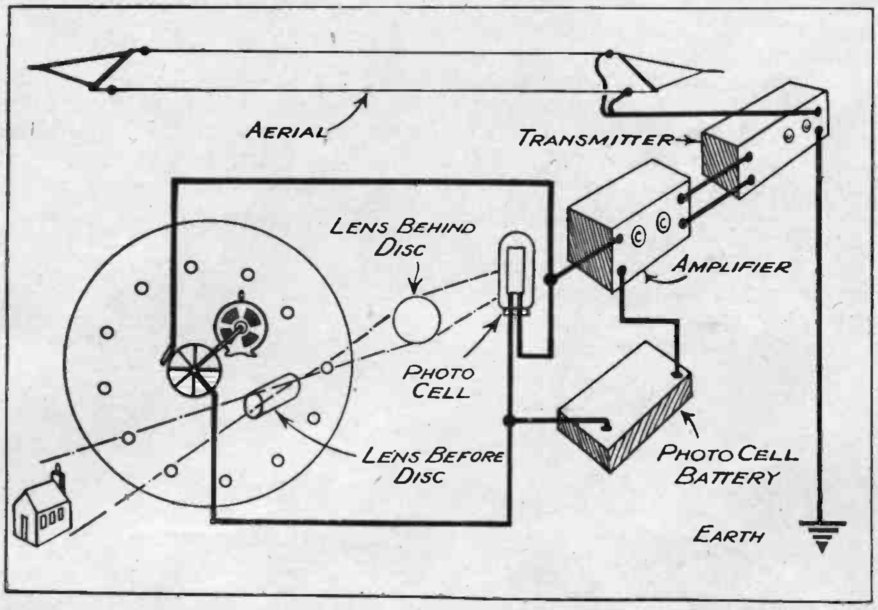


Fig. 7.
Diagram exhibited by Mihaly to explain his proposed automatic synchronising system. See text for explanation.

Fig. 6.
The Mihaly television transmitter. The photo-electric cell can be seen at the bottom of the open side.

at the large screen under adverse conditions. Although the television section was illuminated only by very subdued lights, there was still sufficient light left to be prejudicial to the Karolus projection screen. Dr. Karolus assured me that, seen in total darkness, the large screen image appeared very well indeed. Unfortunately, I had no opportunity to view it under such perfect conditions.

The Mihaly Stand.

Coming now to the Mihaly exhibits, I found the young Hungarian inventor very annoyed with those of his critics who in the past have, in the absence of authoritative confirmation or personal demonstration, doubted his many claims. Naturally, responsible scientists, journalists, and other interested persons are not prepared to accept mere claims which are not backed up by conclusive proof. In the past Mihaly has been, and still is, very widely discredited because of his disinclination to give demonstrations or produce patents which would prove the worth of his claims. Through an interpreter he expressed to me the view that his word should be sufficient, and that it was not fair to insist that he should disclose his latest methods and achievements. As a responsible editor, therefore, I can only give here such technical details as Mihaly told me about his system, and describe what I actually saw.

Mihaly worked for many years using tiny mirrors operated by oscillographs for scanning purposes. About two years ago, seeing the success which Baird was achieving by using the Nipkow disc for scanning purposes, he too turned to that means. All his apparatus at Berlin worked on the Nipkow disc principle.

New Arrangements.

Last year he was using as a light source for the receiver a special high frequency "Wolfram" lamp. This year he is using flat plate neon tubes. Only recently he was announcing that he proposed to secure synchronism by using, both at the transmitter and at the receiver, synchronous motors driven by alternating current supplied by the standard German A.C. supply net. Now, it is well known that such a system of synchronism will work very well when both transmitter and receiver are in very close proximity, but when they are remotely separated local influences affect the A.C. supplies to such an extent that accurate synchronism is impossible.

On the Mihaly stand were to be seen in operation two types of receiver, one very small, and one somewhat larger. Both are illustrated here. The very small receiver consisted of a light ebonite disc driven by a small phonic wheel, the stator of which was supplied with current from the same A.C. mains which supplied the transmitter. The number of holes in the disc was twelve. The light source was a small neon tube which, I

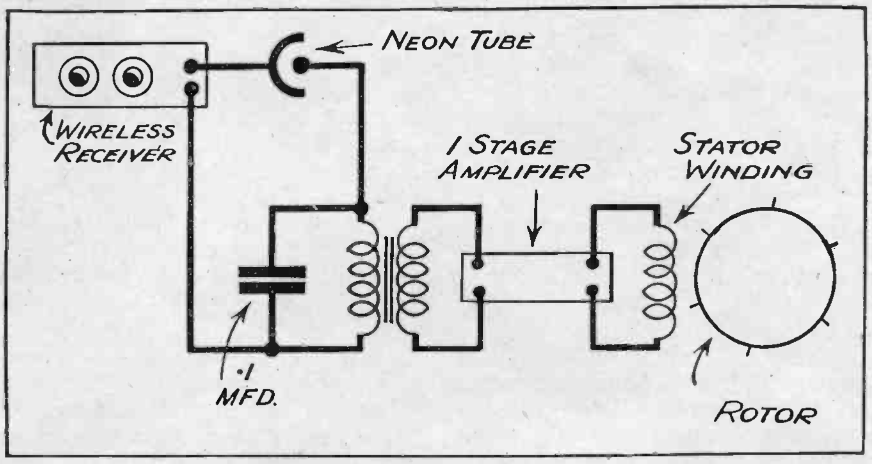
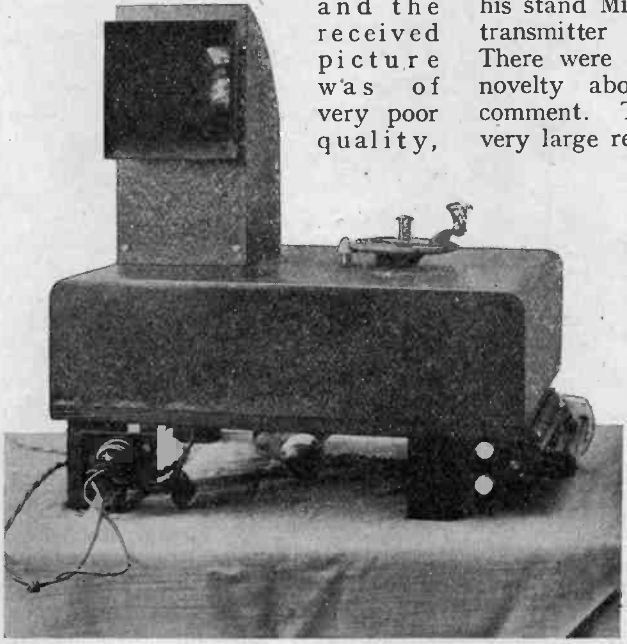


Fig. 8.
Diagram of circuit arrangements at receiver when the Fig. 7 system of synchronising is employed.

was informed, consumed only 10 Ma. This receiver was fed from a transmitter, similar to that illustrated in Fig. 3, which was located in the cellar of the building. The transmission consisted of the image of a lantern slide only, and the received picture was of very poor quality, due to the small number of image strips.


The second type of Mihaly receiver mentioned in the text. A motor of the phonic wheel type is not self-starting, so the handle (rubber band, friction-drive coupled) is provided so that the user can bring the disc up to speed when starting. The resistance for rough speed adjustment is visible at the right.

Receiver Details.

The larger receiver, somewhat better constructed, is illustrated here. The disc, in this case a 30-hole one, was also driven by a phonic wheel, used as an induction type synchronous motor, the rotor of which contained 30 iron strips. The stator was supplied from the output terminals of a three-stage amplifier, the input terminals of which were supplied by the 375 cycle synchronising current sent out by the Post Office tele-cinema transmitter. The circuit connections to the phonic wheel are given in Fig. 4.

The voltage on the last stage of the amplifier was 150-200, and the output current 30-40 Ma. In series with the stator winding was a variable 1,200 ohm resistance for rough speed adjustment. I was told that the phonic wheel would run on 8 watts, but not very well. The resistance was generally set to supply the wheel with about 12-14 watts.

The neon tube employed consumed 50-60 Ma., and was, of course, supplied by another amplifier whose input was the picture frequency sent out by the Post Office transmitter. The reproduction of the Post Office film on this receiver was quite good.

Behind a partition at the end of his stand Mihaly had a tele-cinema transmitter of his own working. There were no technical points of novelty about it which require comment. This transmitter fed a very large receiver (standing about six feet high) in a second enclosure similar to that used by Karolus. This receiver is illustrated in Fig. 5. Vertical scanning and a large neon tube were employed. The disc, measuring about three feet in diameter and containing 30 holes, was driven off the A.C. mains by a synchronous motor which appeared to be of about ¼ h.p. rating. According to Mihaly, no other means of obtaining synchronism could be employed in such a large machine.

The picture produced by this machine, as seen through a magnifying lens, appeared to be about four inches square. The brilliancy of the image was good, as was also the detail. Synchronism was assured, of course, owing to the fact that the disc was driven by a synchronous motor working off the same supply as that used for the transmitter driving motor.

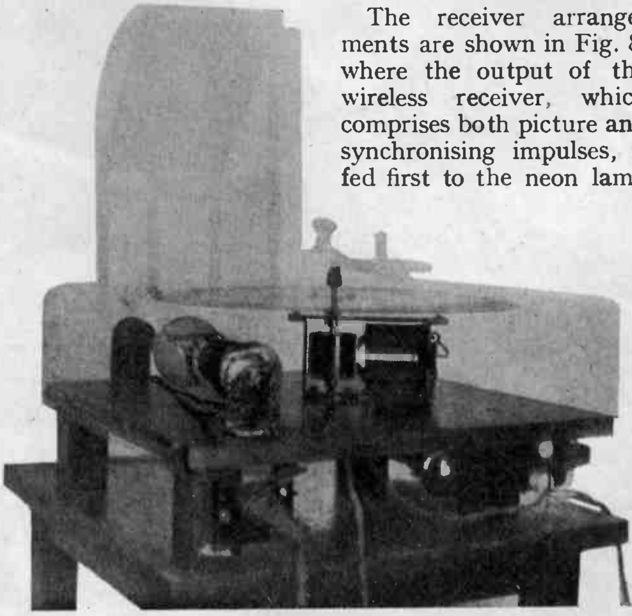
Mihaly did not demonstrate actual television, which was unfortunate. He explained that sufficient space was not left to him to install a television transmitter. However, he had two transmitters of his own in operation, one sending a lantern slide and the other a film.

His television transmitter was on view, however, and is illustrated in Fig. 6. It measures no more than about two feet long. Instead of using the spotlight principle, Mihaly told me that the person being televised sits under a floodlight, or in daylight. An image of the sitter is reflected by the inclined mirror down on to the lens, which focusses an image on to the surface of the scanning disc. Under the scanning disc is a single photo-electric cell.

Proposed Synchronising Arrangements.

Mihaly did not demonstrate automatic synchronising, but showed a diagram explaining how he proposed to accomplish it. This is illustrated in Fig. 7. A commutator mounted on the shaft of the transmitter driving motor is arranged momentarily to short-circuit the photo-electric cell six times per revolution. Such treatment is scarcely designed to improve photo-electric cells. The effect, so far as the receiver is concerned, is that six times per revolution of the disc very strong impulses are received from the transmitter.

The receiver arrangements are shown in Fig. 8, where the output of the wireless receiver, which comprises both picture and synchronising impulses, is fed first to the neon lamp and then through the low impedance primary of a special transformer. Across this primary is connected a ·1 mfd. condenser, to by-pass the


Internal view of the receiver, with phantom cover in position. The stator magnets and rotor of phonic wheel motor are clearly visible. A small knob at the front of the instrument enables the stator to be turned about the rotor for phasing purposes. The flat plate neon tube is clearly visible.

General view of the Fernseh stand.

H.F. picture component of the amplifier output.

The output of the transformer secondary is then taken to a single stage amplifier, the output of which is caused to run the phonic wheel which drives the receiver disc. I was told that a very heavy grid bias is applied to the single stage amplifier in order to rectify the synchronising impulses. Such a method of synchronism would produce a bright white strip or band either at the top or bottom of the received picture.

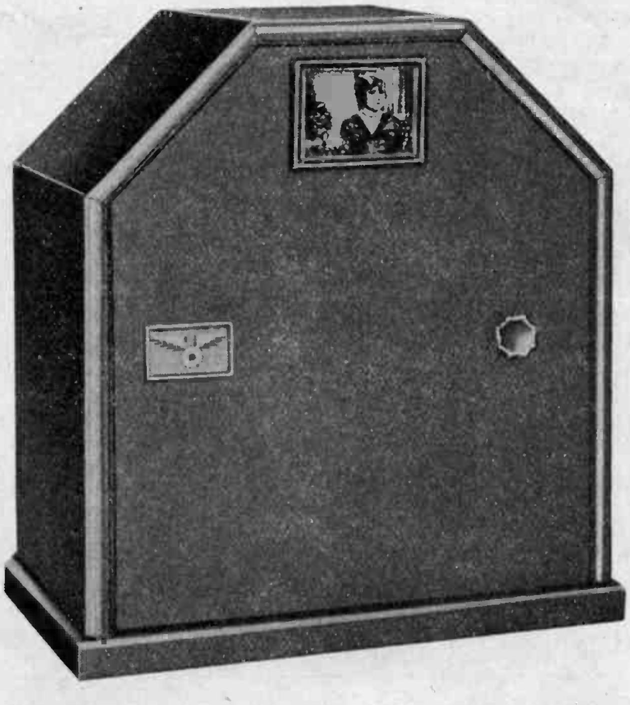
Fernseh, A.G.

Fernseh, A.G., my readers will remember, is the name of the company which was recently formed to develop the Baird system in Germany. The partners consist of the Baird International Television Company, Zeiss Ikon, Bosch, and Loewe Radio. This company, in the short time it has been in existence, has undoubtedly made rapid progress, the commercial aspect of which I will deal with later on.

Photographs of the Fernseh stand are reproduced here. This company exhibited several examples of the standard televisor which they intend to market in Germany immediately, but modified as regards the synchronising arrangements so that they could operate off the Post Office tele-cinema transmissions.

The synchronising arrangements of the model to be placed on the market will be adapted in accordance with the Baird method of synchronising directly off the broadcast picture signal itself. Details of the Baird automatic synchroniser are given elsewhere in this issue, so I need not describe it here.

These Fernseh instruments ran throughout the exhibition, without giving any trouble, reproducing the Post Office film transmission. As will be seen from the position of the viewing screen in the photograph of the instrument, the German standard of horizontal scanning has been adopted, as, indeed, it must.



The Fernseh receiver. Because horizontal scanning is employed, the image appears at the top of the disc. The knob on the right is for adjusting the synchronism.

In addition to these film reception demonstrations, television demonstrations were also given on a standard Baird portable televisor, and also on one of the larger Baird machines, incorporating a loud speaker, both of which were supplied by a Baird transmitter erected behind a partition at one end of the stand. A window in this partition enabled the public clearly to see the person being televised, and compare his or her likeness with the reproduction on the televisor screens.

The Fernseh stand was under the very able and energetic charge of Dr. Goerz, who is Chairman of Fernseh, A.G., and also technical director of Zeiss Ikon. Let me give you a little pen picture of him. After the formation of Fernseh, A.G., Dr. Goerz spent *weeks* making his first disc *with the aid of a microscope.* He took charge of the exhibition stand in his shirt sleeves (the weather was very hot). He was kept extremely busy, yet everything ran like clockwork, and he always had time for courteous conversation with all comers. He never appeared to be ruffled.

I think I can safely say, without fear of contradiction, that the Fernseh stand was the most popular in the exhibition, with the possible exception of the telephone box demonstration for which the Post Office was responsible.

Comparison of Results.

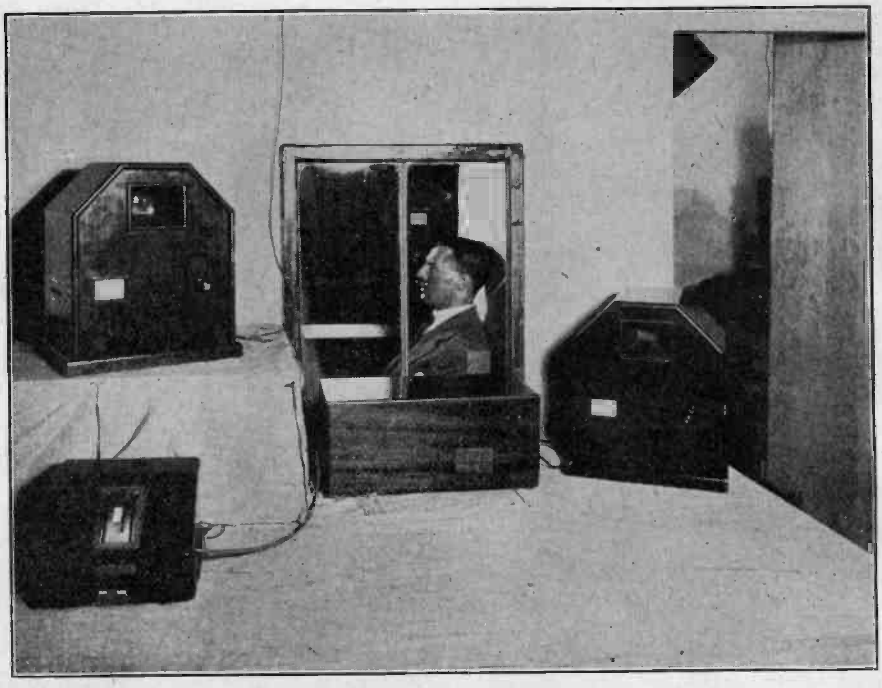
Comparisons were ever odious, but my readers will naturally be most interested to know which of the various systems produced the best results. In order to compare, it is necessary, somewhere or other, to introduce a common factor. So in this case I will compare the systems on the results which they produced on a transmission which they all received in common, the Post Office film transmission.

In making comparisons, also, I am taking into consideration such factors as the efficiency of the magnifying lens through which the picture is viewed. If this is not correctly designed the received image appears distorted, or the angle of vision is so limited that only one person at a time may be able to see the image, and even then perhaps not clearly.

Another factor to be taken into consideration is the brilliancy of the image, upon which depends its "depth." Poorly illuminated images look like a very "thin" or underexposed photographic negative; you can just see what is there, but the richness of detail, though perhaps present, is invisible.

Judged by these standards, then, I can safely say that the Fernseh receiver gave the best reproduction of the Post Office film. Next, on the same transmission, came the Mihaly receiver. The Post Office film receivers (which, as I have explained, were laboratory setups) did not perform at all well. The distortion caused by the viewing lens was very bad, and the synchronism was poor.

I have already given my opinion of the relative merits of the Karolus and Baird television receivers, and I need only add here that whereas Baird keeps well within the 9 kc. broadcast limitation, Karolus produces a frequency of about 14 kc.



Through a window at the end of the Fernseh stand the public, while standing in front of the receivers, could see the person sitting in front of the television transmitter.

It should be pointed out that the Baird receivers were the only instruments to show successful automatic synchronism, which is imperative for any practical apparatus.

Commercial Prospects.

The commercial prospects of television in Germany look very promising indeed. The Post Office at present is engaged on building a new television transmitter, based upon the Baird system, in which will be incorporated the best practices of the various systems. This is expected to be ready by the end of October, when the Post Office will commence regular transmissions daily, from Witzleben, between 9.30 and 10 a.m., 1 and 1.30 p.m., and also in the evening at times not yet fixed. In the meantime the private experimental transmissions at present being made daily by Fernseh, A.G., and Mihaly from Witzleben will be continued.

The official Post Office transmission periods will gradually be lengthened, depending upon the interest taken by the public, and upon the progress made by those interested in the perfection, production, and sale of receivers. Dr. Bredow informed me that the intention of the Post Office, acting through the German Broadcasting Company, is to incorporate television in the regular broadcasting service forthwith.

Zeiss Lenses and Bosch Magnetos have such a world-wide reputation that the firms concerned require no introduction to my readers. Both are newcomers not only in television, but also into the field of wireless. Loewe Radio also has a world-wide reputation in connection with multiple valves. The standing of these three firms (who are the German partners in Fernseh, A.G.) is such that throughout the world, and particularly in Germany, their adoption

Left to right: Baird portable televisor, large Baird machine, and the Fernseh receiver. On the two former television proper was received from the Baird transmitter at the end of the stand. The Fernseh receiver reproduced the Post Office film transmission.

of the Baird system of television is in itself a tremendous asset to the system. Their prestige and resources are bound to carry tremendous weight commercially, and place competitors (in Germany, at least) at a considerable disadvantage. In Germany, solid backing counts.

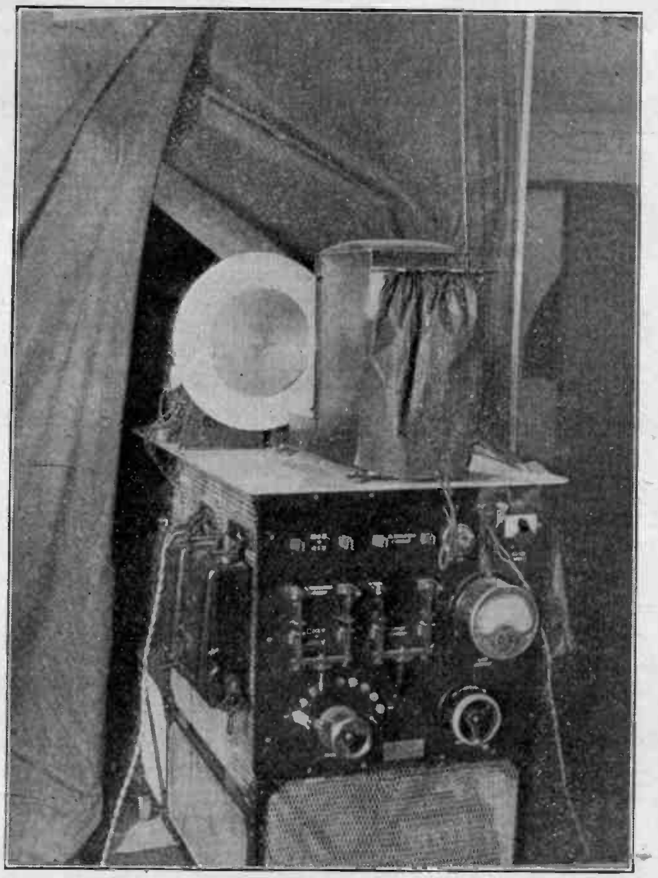
Dr. Goerz told me that during the period of the exhibition, without any advertising at all, he had booked orders at the stand for 100 televisors. The price of the Fernseh product has been fixed at 350 marks (£17 10s.). The production of the first 300 instruments is now in hand; they are expected to be ready early in October.

Mihaly's Commercial Arrangements.

Mihaly has granted a manufacturing and sales monopoly of his receivers to Kramolin & Co., of Berlin, a firm of wireless manufacturers. They propose at first to produce only one of the three models which I described above, the second one. They told me that, although they had received many inquiries, they had not booked any orders because, although they thought the price might be between 200 and 300 marks (£10 to £15), they had not definitely decided the point, nor were their plans complete for going into production, but they thought they would probably be ready to start production by the end of November.

In passing, Kramolin's estimate of price is of great interest, for it is but a few months ago since Mihaly was reported in the Continental and British Press as preparing to sell this identical model at a retail price of £5, both in Germany and in England.

In conversation with Dr. Schroeter I learned that the small Karolus receiver, using a 48-mirror wheel, a crater neon, and projecting on to a screen about four inches square, would cost somewhere about 700 or 800 marks (£35 to £40), complete with tuning fork synchronising gear. At present the mirror wheels are an expensive item, for the tiny mirrors have to be very accurately mounted by experts. It is hoped to cheapen these wheels by employing other methods of manufacture. I gained the impression that for the present, however, the Telefunken Company does not intend to market instruments.


A photograph of the Baird television transmitter showing the lantern and scanning disc.

Faith in Short Waves.

Neither Dr. Schroeter nor Dr. Karolus agrees with the standards which have been adopted by the German Post Office. They believe that greater detail (meaning more image strips and a very much wider frequency band) is necessary in order to make television a complete success. This, of course, is the academic *versus* the commercial viewpoint.

Dr. Schroeter thinks that the greatest success in broadcasting the perfected form of television which he has in mind will be obtained on short waves. The Telefunken Co. is already experimenting on wavelengths of 30 and 80 metres, using, I gathered, more than 48 image strips. These experiments, according to Dr. Schroeter, are meeting with much success.

* * *

Such is the present position of television in Germany. I came away from Berlin with the conviction that this latest adjunct to broadcasting is well launched in Germany; it is now but a matter of time and development. Public support is assured; no one could doubt it after watching for days the continual jam of people who, during a spell of the hottest of hot weather, crowded into the television section of the wireless exhibition, which, being draped to subdue external light, was, as a result, lacking in air but amply provided with degrees Fahrenheit.

The new Fernseh, A.G., may be described as being very much alert and first off the mark commercially, so that, as Britishers, we may regard the German television situation as a triumph for our own Baird system. And this triumph has been achieved within a few short months, **as a result of government enterprise and co-operation.**—*Verb. sap.*

The Story of Electrical Communications

by

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

PART X.—THE SAFETY OF LIFE AT SEA.

THE extraordinary public interest which was aroused in this country by Marconi's early experiments was not caused by any golden vision of world-wide communication for commercial gain; it was a product of the salt in our blood, a vision of the sea and of "those who go down to the sea in ships."

Wireless first came to its own as a means for furthering the safety of life at sea. It was then its most important application. It is its most important application to-day. The uttermost parts of the earth were already linked together by the telegraph, but by wireless alone has the earth been linked to the sea.

Jack Binns.

Though the importance of wireless from the shipping point of view was immediately grasped by the English people, it did not receive a really striking confirmation until July, 1909, when the liner "Republic" collided with the "Florida" in a thick fog on the high seas. The "Republic" was sinking, and plunged in darkness, the wireless cabin was splintered; but the apparatus was still workable, and the operator set an example which has been followed without a break by ships' wireless operators ever since. He stuck to his post, and by his calls for help the whole of the passengers and crew were saved. The next day that operator's name was known and honoured all over the world. His name was Jack Binns.

The next startling confirmation was when the "Titanic," with some 3,000 people on board, struck an iceberg on her maiden voyage across the Atlantic. Her signals of distress were picked up by several ships which raced to the rescue, but when they arrived, the "Titanic" had sunk, and they were only able to save some 900 persons. Without wireless all would have been lost.

The International Convention.

In the following year an International Conference on The Safety of Life at Sea was held in London. An International Convention was signed, but unfortunately, owing to the outbreak of war, it was never ratified by any of the Governments represented at the Conference. Immediately after the war, however, the British Government issued regulations which were on the general lines proposed, and other Governments followed suit with regulations which, on the whole, were less stringent than those laid down for British ships.

Another International Conference was held in London this year, and a new Convention signed which, when ratified, as we may confidently expect it will be this time, will come into force in July, 1931. It is a long document but, broadly speaking, its principal provisions are on the lines of the regulations already in force in this country, and where they differ they are better from the point of view of the safety of life at sea.

Ships' Installations.

For the last ten years it has been laid down that in general all British passenger ships, irrespective of size, and all cargo ships of 1,600 tons and upwards, must be fitted with wireless telegraphy. Exceptions are made as regards certain ships, such as short voyage ships and ships of primitive build, dhows, junks, and the like. This rule is now accepted internationally in the new Convention, as are the regulations which are in force in this country regarding the minimum technical requirements of the wireless sets installed in ships.

The main ship's transmitter must have a normal range of 100 nautical miles, that is to say, it must be capable of transmitting clearly perceptible signals from ship to ship, over a range of at least 100 nautical miles, under normal conditions and circumstances, the receiver being assumed to be one employing a rectifier of the crystal type without amplification.

There must, too, be an emergency transmitter, and both transmitters must have a note frequency of at least 100. The emergency transmitter must be placed as high above the water line as practicable, in a position of the greatest possible safety, and must be provided with a source of energy independent of the main propelling power of the ship and of the main electricity system. It must be capable of being put in operation rapidly, and of working for at least six consecutive hours. The range of the emergency installation must be at least 80 nautical miles for ships required to keep continuous watch, and at least 50 for all other ships, and whilst the ship is at sea the source of power must be maintained at its full efficiency.

The ship's receiver must be capable of maintaining reception in emergency by means of a rectifier of the crystal type, and must be able to permit of the reception of the waves laid down for the transmission of time signals and meteorological messages.

Directional Receivers.

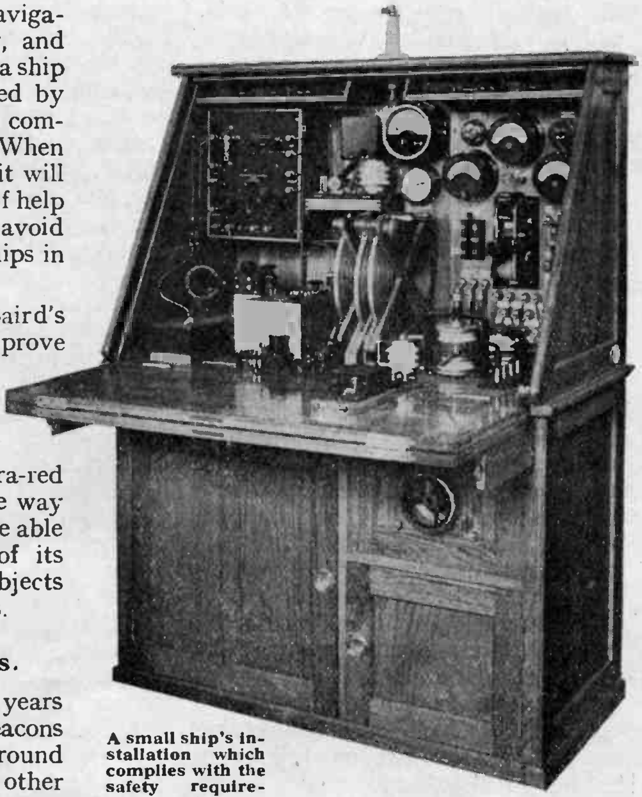
Within two years from the date on which the Convention comes into force every passenger ship must be equipped also with directional receiving apparatus. This is the first time that such apparatus has been made a compulsory fitting. All our large passenger ships are already fitted ; in fact about 20 per cent. of our ships fitted with wireless are equipped with this apparatus, so that the new regulation will not affect us much, but it is most important from the international point of view.

Directional receiving apparatus in a ship enables the operator to obtain the bearing of the ship from any other ship or any shore station which is transmitting wireless signals, so that its importance from the safety point of view is obvious. It is of great assistance to navigation in foggy weather, and has frequently enabled a ship in distress to be located by another ship which is coming to the rescue. When more ships are fitted it will also, no doubt, prove of help in assisting ships to avoid collisions with other ships in a fog.

It is hoped that Mr. Baird's noctovision system will prove of great value in this connection later on. With this system a ship will be able to direct a beam of infra-red rays in much the same way as a searchlight, and be able to see, on the screen of its noctovision receiver, objects in the path of the rays.

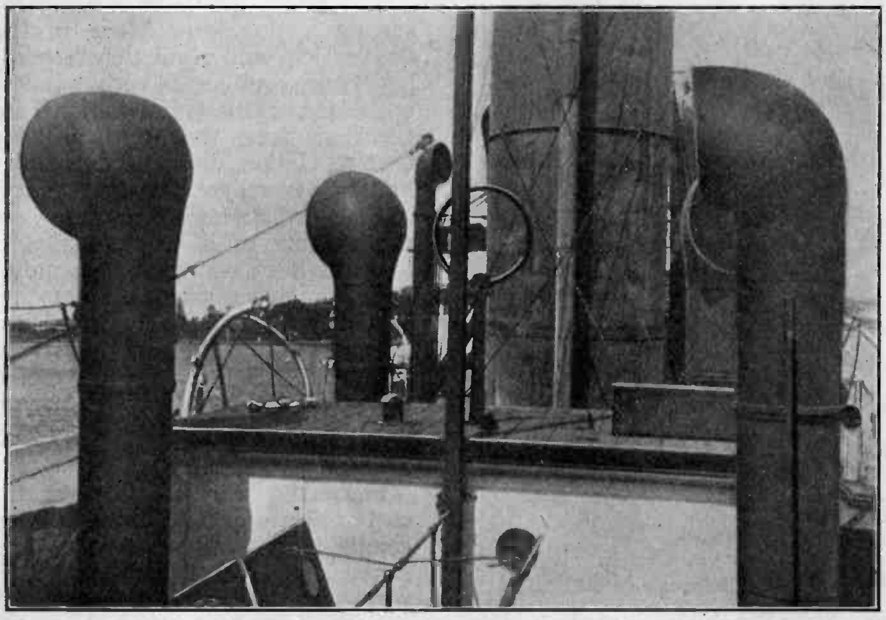
Wireless Beacons.

During the last few years a number of wireless beacons have been established around our coasts, and those of other maritime countries. More than 100 are now working, and about half of these are in the United States. These beacons emit their call signs automatically at specified times, so that a ship fitted with a directional receiver can obtain a bearing on a beacon station up to a range of about 50 miles. A few beacons emit a revolving beam, which enables a ship to obtain a bearing with its normal wireless receiver, and some others emit a submarine sound signal simultaneously with the wireless signal, so that a ship may obtain not only its bearing but also its distance from the beacon.



A small ship's installation which complies with the safety requirements.

There are, too, a large number of coast stations which are fitted with directional receivers, by which means they can obtain the bearing of a ship, and pass on the information to the ship by wireless.



The metal ring in the centre is the aerial used for the ship's wireless direction-finding apparatus.

The SOS.

The most important application of wireless in connection with the safety of life at sea is its use for the SOS signal, which is broadcast by a ship only when the ship itself is in danger. The signal consists of the three letters sent as one sign, and repeated three times. This is followed by the distress message giving the ship's position and particulars of the case of distress. Distress work is carried out on the 600-metre wave on which all ships are normally keeping watch, and all other signalling ceases as soon as the distress signal is heard. The coast stations in this country deal with nearly 100 distress cases every year.

The station which deals with the

distress call keeps the Coast Guards, the Naval Authorities and Lloyds in touch with the situation, so that all possible means may be taken in providing assistance from the shore.

The new Safety Convention recommends that the distress signal should normally be preceded by the Alarm Signal, which is used to put into operation the auto-alarm receiving apparatus in ships in the vicinity. This apparatus is arranged to ring bells in the ship for the purpose of calling the operator to the wireless cabin whenever the alarm signal is received. Auto-alarms have been in use in many British ships for the last two years, but other countries were a little sceptical of their practical utility, and the fact that this apparatus was recognised internationally at the recent Convention ensures the more general adoption of the apparatus throughout the world. The Alarm Signal consists of a series of twelve dashes sent in one minute, the duration of each dash being four seconds, and the duration of the space between dashes one second.

Safety Signals.

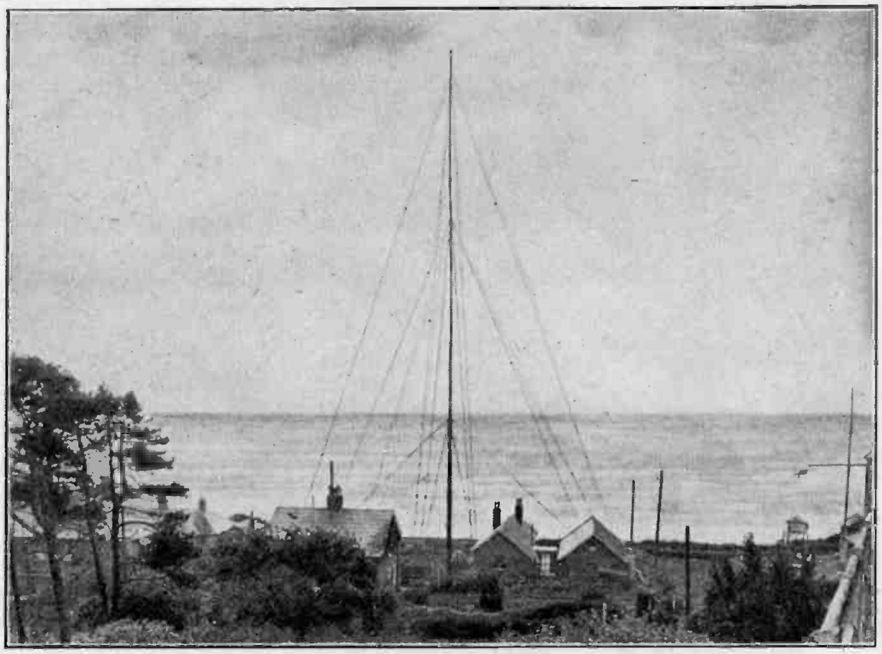
The most important signal, after the distress signal, is the Urgency Signal, which consists of several repetitions of the group XXX. This is used for urgent messages concerning the safety of ships or persons, as distinct from the SOS which is only made by a ship which is in danger.

The Safety Signal consists of the group TTT, which indicates that the message following concerns the safety of navigation, or contains information relative to meteorological warnings.

Weather bulletins, gale warnings and navigational warnings are broadcast from our coast stations. Weather reports are broadcast from the Air Ministry's station in London, and by wireless telephony from the B. B. C. station at Daventry. This broadcasting of weather reports from various stations throughout the world, is, in fact, the only use made of wireless telephony in connection with the safety of life at sea.

It is interesting to note that trials are now being made in this and other countries with the transmission by photo-telegraphy of weather charts for the use of ships at sea.

Henry Bushmeyer, the daring parachute jumper, who, while falling 3,000 feet from an aeroplane over Roosevelt Field, N.Y., described his sensations through a chin-strap microphone connected to a small portable short-wave wireless transmitter. The signals, picked up on a ground receiver, were relayed all over the United States through the National Broadcasting Company's network.



A coastal wireless station fitted with direction-finding apparatus at Niton, Isle of Wight. This station gives bearings to ships in addition to handling ordinary commercial wireless traffic.

Lifeboats.

The number and size of lifeboats, and their equipment, naturally occupy a prominent place in the Convention, and regulations regarding their equipment with wireless apparatus are made international for the first time, though there have been regulations on somewhat similar lines for several years in this country. It has now been laid down that where the number of lifeboats carried is more than 13 one shall be a motor boat, and where more than 19 are carried two shall be motor boats. These motor lifeboats must be equipped with wireless telegraphy, the range and efficiency being specified by the Administration concerned.

Inspections.

Since the war it has been the custom here, and in several other countries, to inspect ships when convenient in order to see that their wireless installations comply with their licence. All British ships which

(*Continued on page* 398.)

MORE ABOUT NEON TUBES

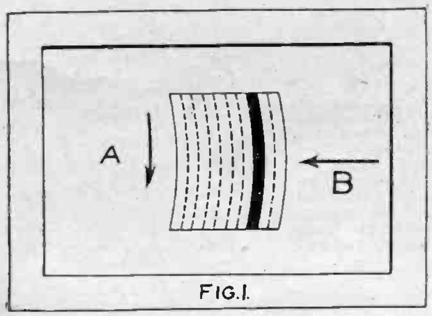
By W. C. FOX

Last month our contributor dealt with the manufacture of neon tubes, with special reference to those produced by the G.E.C. This month he describes the Philips tube and gives some notes on operation.

FOR those experimenters who have made up the neon oscillograph briefly mentioned last month the following notes on the meaning of the phenomena observed may be of interest.

Using a disc and a neon tube in the manner described, one can get an approximation to the frequency of the oscillation causing the pattern, provided it is not too rapid and the speed at which the disc is rotating is known, together with the number of holes used.

Assuming the disc is making ten revolutions a second, and has ten holes and a single black band travels across each picture, this represents an oscillation of about ten per second.



Appearance of low frequency oscillation, about 10 cycles per second, on a television viewing screen.

Figure 1 is an attempt to illustrate this. The arrow marked "A" indicates the direction of rotation of the disc, while arrow "B" indicates the direction of travel of the band which, by the way, will be the width of one hole in the disc, whatever size that may be.

Two black bands represent 20 oscillations a second, three 30, and so on. As the frequency gets higher the bands will gradually change into longish dots, giving the draughtboard appearance of Figure 2, while at higher frequencies this will change into the curious network pattern of Figure 3, becoming finer and finer as the frequency rises. These three figures are representations of extreme conditions ; between them are a great variety of forms.

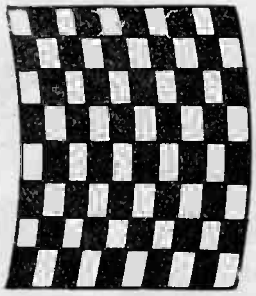


Fig. 2.

Medium frequency oscillations over 100 cycles per second, as seen on a television screen.

The reasons for the use of neon tubes as a source of illumination for composing television images have already been given, and need not be referred to again, but a few notes on the method of connecting them to the output of the last valve in an amplifier may not be out of place.

Three main methods can be employed, illustrated diagramatically in Figures 4, 5 and 6. In each case the valve indicated is of the superpower type. Of the three methods Figure 5 is to be preferred, as it is the most stable, and gives one the greatest control over the amount of illumination given by the lamp, for it must not be forgotten that although a neon is very robust, and will stand up to almost any rough handling short of breaking the bulb, it can be "burnt" out. "Burnt out" is perhaps not an accurate description, for a neon will still light in that condition, but instead of the warm, ruddy, comfortable glow of a healthy tube, one gets a sickly bluish-white type of light, and the operation characteristics are quite changed. This is mentioned because one can easily overdo the voltage. When experimenting with neons, it is better to start with a voltage which will barely glow them, and then gradually bringing up the brilliance by reducing the biassing voltage on the valve.

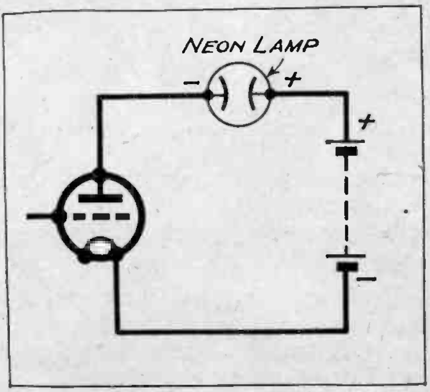


Fig. 4.

Direct method of coupling neon tube to last valve of amplifier.

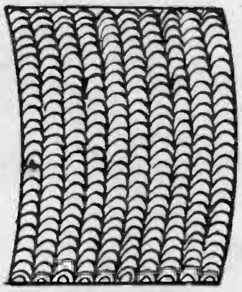


Fig. 3.

Characteristic appearance of high frequency oscillations.

The following operation data relate to a neon tube (Figure 7) specially produced by Messrs. Philips Radio for the use of television experimenters.

It has a three-pin base (Figure 8), in which one pin acts simply as a steadying device, and prevents one getting the tube in its holder the wrong way round, a small point, but one which may cause some trouble if not noticed, for the anode (which is quite insignificant in size) will glow instead of the cathode.

This tube is of the plate type, the cathode measuring 35 by 45 millimetres (approximately 1·4 inches by 1·8 inches), one side of which is covered with an insulating layer, in order to restrict the luminescence to one side only.

The anode consists of a rectangular piece of wire of about the same size.

An invaluable property of this new lamp is the almost absolute absence of inertia; the difference of time between the occurrence of a change in light intensity and the current impulse which caused it being less than one hundred thousandth of a second. The overall dimensions of the lamp are 165 by 48 millimetres (approximately 6·6 inches by 1·9 inches).

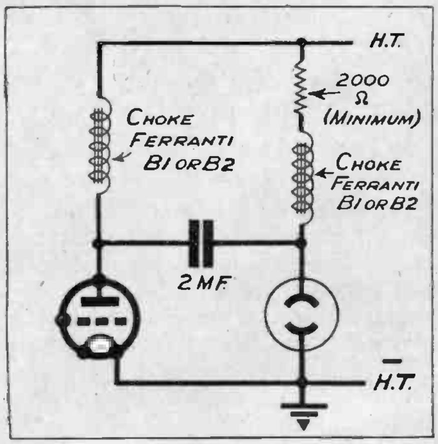


Fig. 5.

Choke method of coupling the neon tube to the last valve of the amplifier. This method is very stable and offers better opportunities of control than the direct method.

Operation of the lamp depends upon the varying light intensities on the surface of the plate caused by varying current intensities.

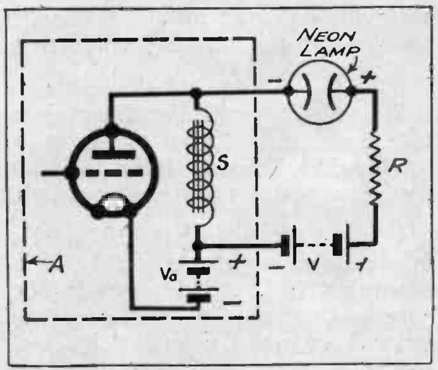


Fig. 6.

An alternative method of choke coupling a neon tube.

The entire surface of the plate should always be luminescent. This requires a minimum current of at least 4 milliamps. Similar lamps of other makes require as a rule 6 milliamps, or even more, to secure this effect. The normal current should be adjusted to 20 milliamps, so that the maximum amplitude can be $20-4=16$ milliamps. When working, the current can oscillate between 4 and 36 to 40 milliamps.

When used with the choke method of coupling (Figure 6), the choke coil must have enough self-induction to insure equal voltages between the terminals for all frequencies between 50 and 10,000. The biassing voltage for the neon lamp should be 280 to 350 volts; the limiting resistance can have a value of 1,000 ohms. The drop of potential across the terminals of the lamp is approximately 260 volts with a current of 20 milliamps.

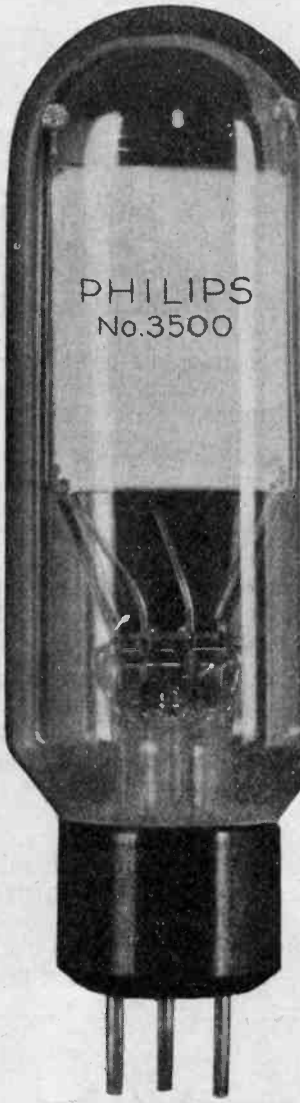


Fig. 7.

A Philips neon tube.

If the neon is wired in series with the plate circuit, as shown in Figure 4, the H.T. source must have a voltage equal to the sum of the voltage required for the power valve and the drop of potential across the neon lamp; for the valve type indicated, this will amount to 400 v.+260 v.= 660 volts. As now the internal resistance of the valve acts as a limiting resistance, no other resistance need be incorporated in the circuit.

With regard to the circuit arrangement shown in Figure 5, the necessary biassing voltage on the grid of the valve, not shown in diagram, and the resistance used in the neon circuit bear a definite relation to one another. Adjusting these to secure the best effect will produce a number of varying effects and offer endless scope for amusement, if one cares to follow it up.

When dealing with an actual television image it is as well not to adjust the voltage to get the background too dark. If this is done, black shadows will appear on the image, due to the plate of the neon tube not being evenly illuminated, *i.e.*, too low a voltage.

Although these three methods of coupling a neon to the last stage of an amplifier have been briefly mentioned it must not be thought that they are the only methods that can be employed. They are purely typical circuits which so far have been found to give satisfactory results. There are several other methods, and, no doubt, as new types of neon tube are produced further circuits will be evolved. The subject is one which will repay careful investigation.

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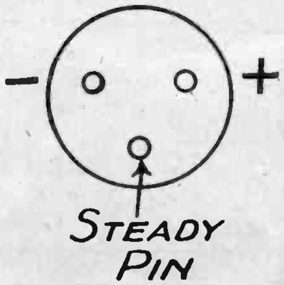
Fig. 8.

Neon tube base with three pins, one acting as a steadying pin and guide to prevent the tube being put in the holder with the connections reversed.

*



One other point. If trouble from oscillation is experienced when using a neon in conjunction with a wireless set, the trouble may be cured by screening the neon tube leads. For this purpose lead-covered wire, or the armoured cable used for motor-car lighting systems, can be used, the lead or armouring being earthed. It is not an unknown thing for a sensitive detector to pick up from unscreened neon leads and cause trouble.

Synchronisation in Television

By T. S. ROBERTS

As has been frequently pointed out in the pages of this journal, synchronism is the most vital point in any television system. It has been known for some time that the Baird Company had perfected an automatic method of synchronising which does away with any need to transmit a special synchronising signal, either through a separate channel, or superimposed on the picture signal. For commercial reasons details of this device have hitherto been withheld.

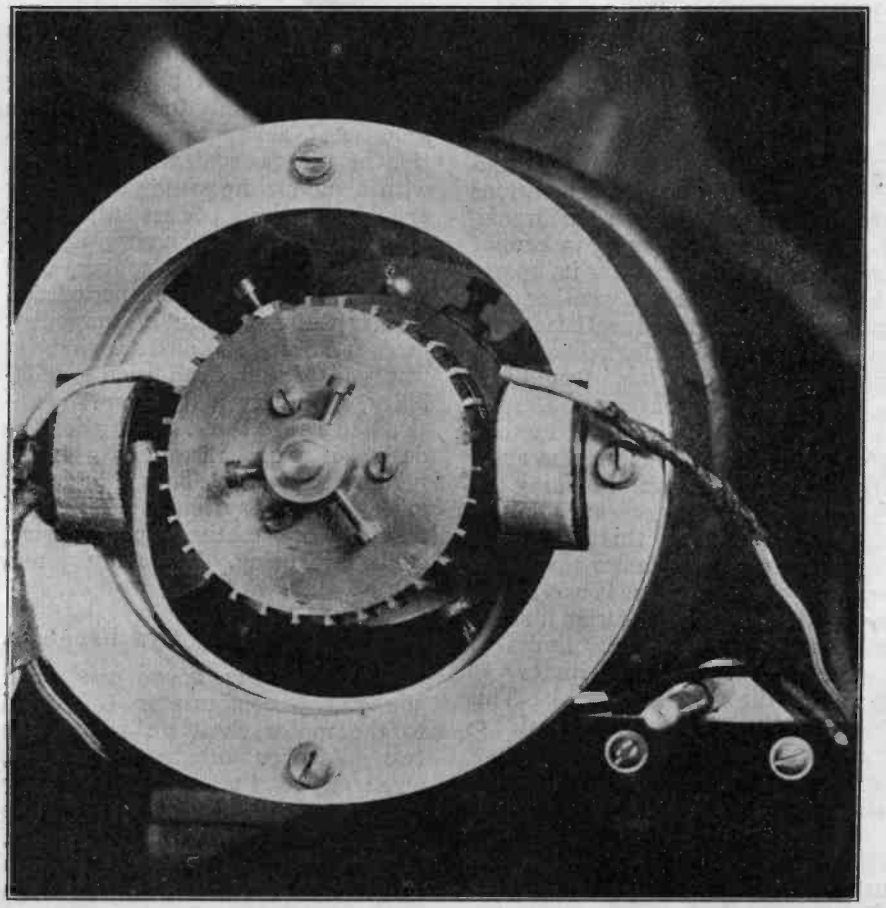
Now that the B.B.C. have commenced broadcasting television, however, arrangements are being made to place receivers on the market immediately, and we are thus enabled, for the first time, to give in the following article full details of the Baird automatic synchroniser. All who have seen a recent demonstration of the Baird system, or who see one during the Radio Exhibition, will be in a position to testify as to the remarkable efficiency of the device.

SYNCHRONISATION is a technical factor of paramount importance figuring largely in both talking pictures and television, and upon the attainment of which depended the entire success of both undertakings. Whilst synchronisation is necessary to both, the actual problem which had to be overcome in each instance differed radically. As is well known, synchronism in talking pictures implies the coincidence between sight and sound during reproduction, and should this circumstance not obtain, even though the shortcoming is perhaps an error of only a second or even less, the result is that the film is spoiled for the onlooker. Both recording methods at present in vogue, i.e., printing the photographed sound on a narrow track on the film itself, and using gramophone records, have brought with them in their train measures for meeting this requirement, which have proved generally satisfactory.

Synchronism Defined.

In television practice we cannot fail to produce synchronism as it is understood in the " talkie " industry, because any discrepancy existing between the propagation of image and sounds appertaining thereto is much too small to be of any account. With television the term refers to the speed of motors used, transmitting and receiving. Before a transmitted television picture can be viewed in a receiving televisor it is essential that its disc-rotating motor shall be accurately in step with that of the transmitting station, and the original fulfilment of this exaction constituted a vital step towards making television as a whole into a practicable commercial proposition.

Mr. Baird, early on, patiently investigated every known system of synchronising motors without discovering any which would comply with the peculiar conditions demanded by broadcast television. Eventually he abandoned the quest for an orthodox solution to the difficulty and evolved several methods of his own which he proceeded to adapt. His two outstanding devices are known as: (1) the relay system, and (2) the magnetic toothed-wheel system. These he rigorously tested one against the other until all doubt was removed from his mind as to which was the



A photograph of the magnetic toothed-wheel synchroniser, shown diagrammatically in Fig. 2. Circuit connections are given in Fig. 3.

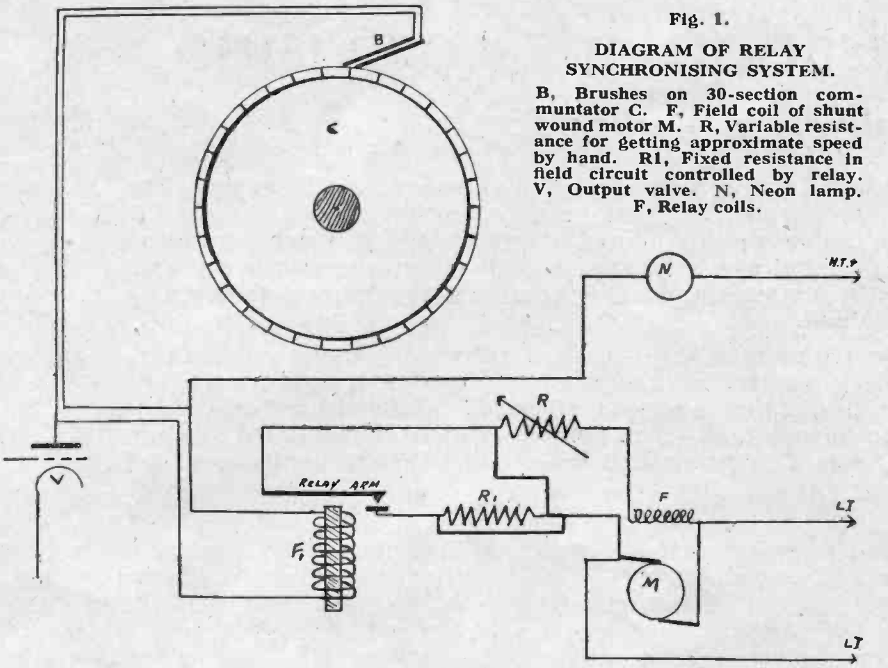


Fig. 1.

DIAGRAM OF RELAY SYNCHRONISING SYSTEM.

B, Brushes on 30-section communtator C. F, Field coil of shunt wound motor M. R, Variable resistance for getting approximate speed by hand. R1, Fixed resistance in field circuit controlled by relay. V, Output valve. N, Neon lamp. F, Relay coils.

most efficacious. The decision giving preference to the latter as standard was reached some time ago, but owing to the patent situation, publication of the details has been withheld until now.

Conditions to be Met.

We must hark back somewhat and see what are the peculiar conditions attached to our television synchronising component. Obviously we cannot afford a separate signal for its operation, as it is doubtful whether this could be transmitted satisfactorily without an additional wireless transmitter, and even so, would be uneconomic in the extreme. Despite this, however, the original method adopted to secure synchronism actually did take the form of making the transmitting motor generate an alternating current, and this had to be fed to the receiving motor through a separate channel, where it was superimposed on the field in such a manner that within fairly wide limits it practically forced the motor to maintain the requisite speed. This method, though otherwise satisfactory, was abandoned for the reason mentioned, but were an A.C. supply of a uniform character available in every home throughout the country the principle could successfully be revived.

The speed at which our motor has to run is from 12 to 15 revolutions per second, and a variation of 1/30th of one revolution would be fatal to a good picture. To attain synchronism we are forced to utilise some function or integral part of our television signal. This is mainly variable, but luckily it possesses one unvarying characteristic, and this is its strip sequence. Thirty times per revolution of the transmitting motor (or, with a picture frequency of 12½ per second, 375 times per second) a strip of signal is radiated having a well-defined beginning and ending, with an appreciable intervening period, and that is the fundamental component made use of in the Baird systems. It was realised that, in addition to reliability, simplicity and ease of operation had also to be incorporated in the design of a unit in order to give it popular appeal. Thus the very ingenious relay system and its modification, the toothed-wheel device, came into being. The relay system will be dealt with first.

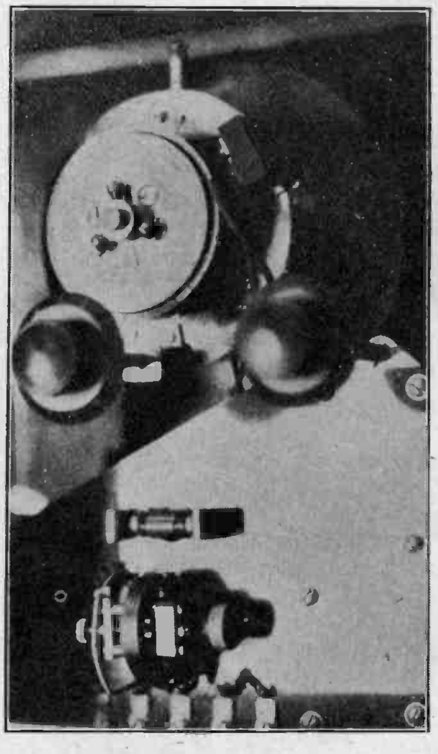
Details of Relay Synchroniser.

Consulting Fig. 1, we can see a 30-segment commutator *C* affixed to the motor shaft on which ride two phosphor bronze brushes *B*, arranged so that one is roughly 5 degrees ahead of the other. *F1* are the low-resistance windings of a relay, the armature of which controls a small fixed resistance, *R1* placed in series with the field rheostat *R* of the shunt-wound motor *M*.

H.T. is fed to the anode of the last valve of the receiving amplifier, firstly through the neon lamp and then alternately through the relay coils and the commutator. In consequence, 30 times per revolution, i.e., every time the brushes *B* are in the position indicated, the whole of signal current fluctuations pass through the relay. These fluctuations cause the armature to be attracted, which in turn short-circuits the fixed resistance *R1* and thus retards the motor speed. *R1* is only in series with *F*, the field windings, whilst the relay is open.

How it Operates.

To examine the operation in detail, the variable resistance *R* is used to bring *M* to the approximate speed of the transmitting disc. Provided both motors are running in step the relay does not operate, because whilst a strip of signal is causing current to flow in the anode circuit of *B*, the brushes *B* are short-circuiting the windings *F1*, and at the interval between no strips no signal current whatever flows in the anode circuit. Should *M* be running at a speed slightly in excess of the transmitter, then signal current is still flowing in the circuit, and as the brushes are staggered the relay ceases to be



Photograph of relay sychroniser, shown diagrammatically in Fig. 1. The commutator (above) and the relay (below) can clearly be seen.

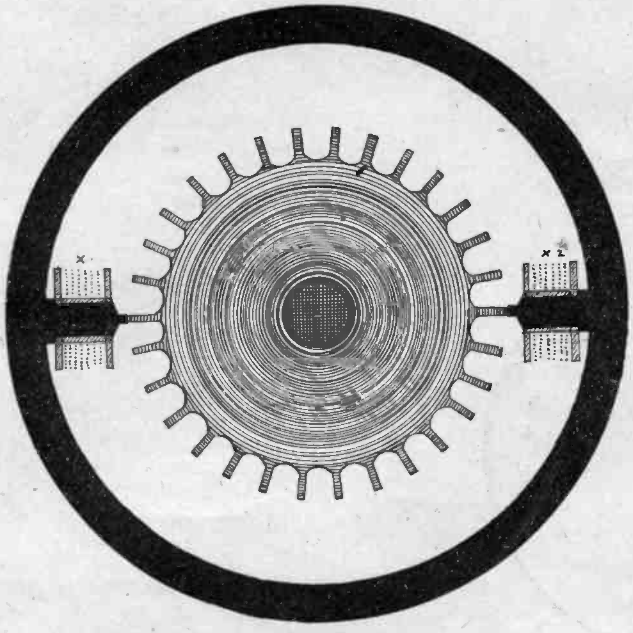


Fig. 2.
TOOTHED-WHEEL SYNCHRONISING.
The 30-toothed wheel revolves between the pole pieces (heavy black) which are magnetised by the current (which lights the neon passing through the windings X_1X_2.

shorted, the armature is pulled over, *R*1 is cut out, and the resultant increase of current in *F* slows down *M*.

Should the speed of *M* be less than that of the transmitting motor, then the action of the relay, far from being able to improve matters, has, if anything, an adverse effect. In practice one usually adjusts *R* until the motor is tending to run a fraction faster than the correct speed, using the relay action as a brake only. The Fultograph synchronising system also operates with a similar setting.

There are several drawbacks to this method of synchronising. One is that the action of slowing up the motor so frequently and drastically imparts what is known as a hunt to the picture; it rises and falls an appreciable amount in a sort of rhythm in accordance with the correcting impulses given to the motor. The relay has to be accurately set up periodically, the contacts need frequent adjusting and cleaning, as do also the brushes, the wear of which is uneven due to their staggered arrangement. Nevertheless it provided the necessary control for all Mr. Baird's demonstrations, both wired and wireless, until the toothed-wheel device was thought of and proved to be more suited to the task. The relay method is also very suitable when a large and heavy disc has to be controlled.

The Magnetic Toothed-wheel Synchroniser.

The construction of the toothed-wheel unit is comparatively simple, and is as follows: Two electro-magnets are mounted on a circular metal frame-work at points 180° apart, and between their poles is situated a mild steel wheel having thirty evenly-spaced teeth projecting around its periphery, and these, as they revolve, pass before the magnet poles with a very minute clearance. The shape and facet area of poles and teeth are identical.

Referring to diagram, Fig. 2, *X*1 and *X*2 are the magnets, and the wheel is between them. Although not shown in the drawing, a rack-and-pinion arrangement is embodied which gives a 45° movement to the pole framework, for a reason which will be explained later on.

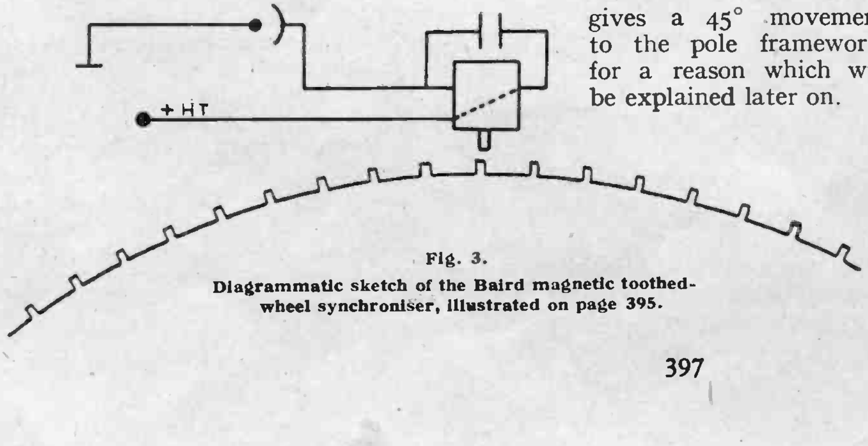


Fig. 3.
Diagrammatic sketch of the Baird magnetic toothed-wheel synchroniser, illustrated on page 395.

The action of this unit is not quite so simple, but will be described as comprehensively as possible. The received signal, after amplification, passes through the series-connected magnet coils, which themselves are in series with the neon in the anode circuit of the last valve in the amplifier. Every signal strip, by virtue of the various current values it contains, sets up a certain value of magnetic flux around the poles, and this at any and every instant is exerting itself on the two adjacent teeth of the wheel, at the periodicity of the transmitting motor.

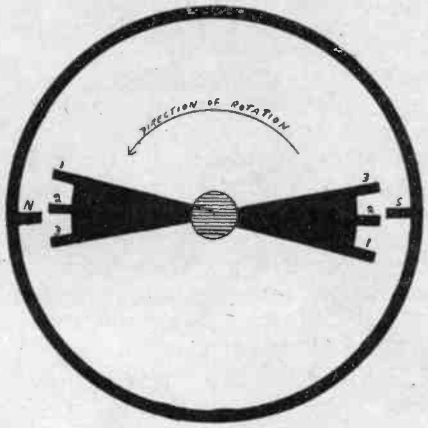


Fig. 4 (a).

In effect, this power is also more valuable as a brake to a receiving motor adjusted to run slightly faster than the transmitter, rather than as a means of urging it on should it be lagging behind. In Fig. 4 are shown four relative positions of poles and teeth covering one complete cycle of events. If a state of synchronism

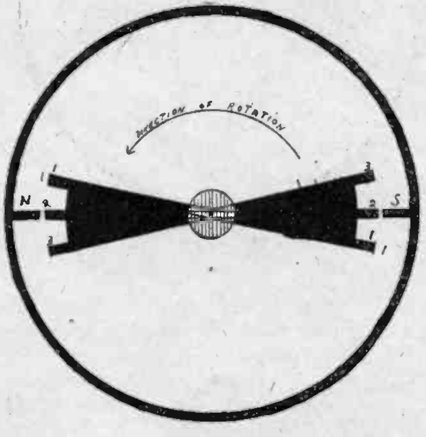


Fig. 4 (b).

exists during this cycle we can analyse the influence applied by the magnets to the wheel as follows :—

In *A* the teeth 2, 2 are being pulled in the direction of rotation, in *B* the flux has no effect. In *C* they are pulled in the reverse direction, and in *D* there is also no effect, the pull being equally divided. It will be noticed that *A* and *C* to all intents and purposes cancel each other out. Now, suppose the receiving disc motor to be lagging by 6 degrees or less. In *A* there will be no effect because the poles will be demagnetised between strips ; in *B* the teeth 2, 2 will be strongly held by the strip signal flux, further slowing the motor and causing a rise in armature current. In *C* the effect of *B* is still present, though in a lesser degree, as poles 1, 1 are beginning to help, and in *D* the retarding influence of teeth 2, 2 is entirely gone.

In passing back to the *A* position, teeth 1, 1 help the armature which will then have its current slightly reduced. On the other hand, should the receiving motor be ahead of that of the transmitter, again by not more than 6 degrees, in *A* we find teeth 2, 2 being pulled in the direction of rotation ; in *B* poles 2, 2 are strongly held, and the speed is consequently retarded ; in *C* there is no effect and in *D* also little or no effect.

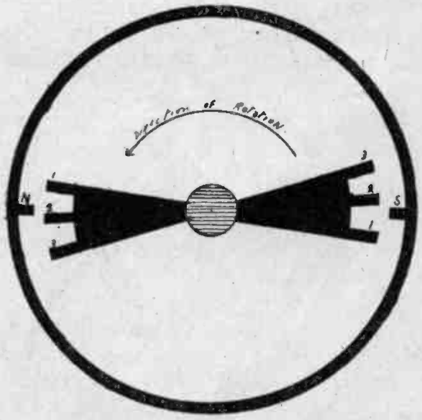


Fig. 4 (c).

In practice it is found necessary occasionally to correct the phase of the picture for images containing very marked relative light values, as these may give a disproportionately strong current impulse at one point along the strips, and that point, though having no deleterious effect, will determine the vertical position of the picture at synchronism. Moving the pole-pieces around by means of the control incorporated will counteract this tendency.

This system bids fair to become a recognised standard for television throughout the world, its advantages including simplicity, cheapness, ease of manipulation, little to cause trouble, and withal it holds the picture with great steadiness indefinitely during unchanging conditions. The hunt is so slight as to be negligible. In this connection, during a recent attempt at photographing a televised face from a televisor controlled by a toothed-wheel synchronising unit, it was found that throughout an exposure of 20–30 seconds the hunt only amounted to ·35 of an inch movement up and down from the mean at the sitter's end, which of course is barely noticeable to the human eye actually looking into the televisor.

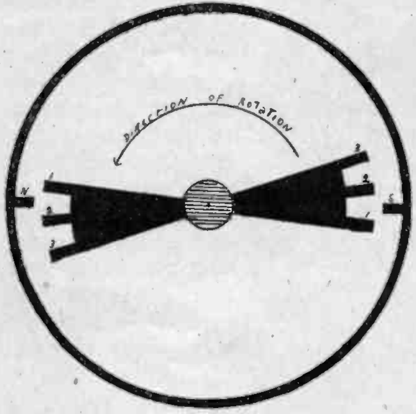


Fig. 4 (d).

ERRATA.

Please note the following corrections to article entitled "The Literature of Television," which appeared in our September issue :—

In the following items read 1929 for 1928 :—

Page 345, "Quantitative Analysis of Television."

Page 346, "Frequency Modulation."

Page 347, "Cathode Rays in Practical Television," in May TELEVISION.

On page 346, "Television, a paper read by Col. J. R. Yelf," read Vol. III for Vol. IV.

On page 346, "Alexanderson's Systems," read Vol. XX for Vol. XV.

J. H. O. H.

The Story of Electrical Communications.

(*Concluded from page* 392.)

are equipped with wireless must be licensed by the Postmaster General, and the Post Office carries out the wireless inspections on behalf of the Board of Trade. For this purpose, inspectors are stationed at the principal ports in this country, and over 3,000 ships are inspected annually. The new Convention lays down that in future a certificate must be issued every year to all ships fitted with wireless in accordance with the Convention, so that ships must be inspected at least once a year.

Watchkeeping.

Regulations regarding the wireless watches to be kept for safety purposes, that is for the SOS signal, are included in the Convention. Each passenger ship which is required to be fitted with wireless telegraphy shall, for safety purposes, carry a qualified operator, and if not fitted with an auto-alarm, shall, whilst at sea, keep watches by means of a qualified operator or a certified watcher, continuously if the ship is over 3,000 tons, or as determined by the Administration if under that tonnage. Similarly, cargo ships, if not fitted with an auto-alarm, shall keep continuous watch, if over 5,500 tons, or as determined by the Administration if under 3,000 tons. Between 3,000 and 5,500 tons, they must keep 8 hours watch a day. On ships fitted with an auto-alarm, this auto-alarm shall, whilst the ship is at sea, always be in operation when an operator or watcher is not on watch, the operator or watcher being on watch at the times laid down by the International Radiotelegraph Convention which came into force this year.

Hitherto watchers have proved to be of little practical use, and the Convention has recognised this by increasing the qualifications required. In future, a watcher must be able to adjust the receiver, read morse up to 16 code groups a minute, and be able to read the alarm, distress, safety and urgent signals when received through interference.

In conclusion, there can be no doubt that the advent of wireless has done more towards furthering the safety of life at sea than any other invention with the exception of the invention of the steam engine.

The Distribution of Waves in Wireless Transmission

By R. L. SMITH-ROSE, D.Sc., Ph.D., A.M.I.E.E.

IN the earliest days of wireless history the great attraction to the few engineers and scientists working on this subject was to obtain telegraphic communication over the greatest possible distances. Communication was first established between the Isle of Wight and the mainland, then across the English Channel, and later, in 1901, the first simple Morse signals were transmitted across the Atlantic between England and Newfoundland.

While successful communication over greater distances rapidly followed, it was soon discovered that radio communication over anything more than one or two hundred miles was a very uncertain proposition, and that the strength of the received signals varied to a very large degree in a manner dependent upon the distance and time of day. Scientific research carried out in the interval has shown that much of this variability in wireless transmission is due to the fact that wireless waves are only propagated to great distances and round the curvature of the earth by travelling through the upper portions of the earth's atmosphere. The transmission of these "atmospheric" waves is subject to the influence of the sun's radiation and the earth's magnetic field in a manner which is quite uncontrollable from the earth's surface.

Smashing Through.

The methods of overcoming these difficulties have consisted in the development of increasingly powerful transmitters and more sensitive receivers, while of recent years the selection of different wave-length bands for use at certain times of the day has proved a very useful expedient. It has to be admitted that even to-day the successful use of commercial telegraphic communication relies upon the employment of equipment which will provide the minimum received energy during the worst periods of transmission, in order to maintain continuity of service. At more favourable times, the energy provided may be very much in excess of that required, but this comparatively low efficiency cannot be avoided. Provided that the received energy does not fall below the minimum required at the worst periods, the variability of this energy is of little consequence in telegraphic communication.

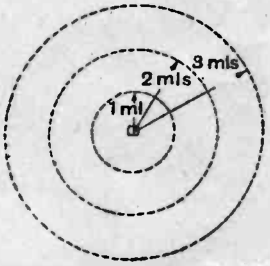


Fig. 1. Contour lines of equal signal intensity for waves radiated over a flat uniformly conducting surface.

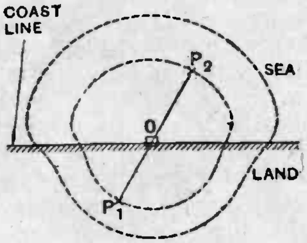
Ground Waves Required for Broadcasting Service.

The inception of broadcasting, however, brought about somewhat different conditions which had to be met. For a satisfactory broadcasting service it is necessary to provide at the receiver a radiated field of constant strength at all times during the transmission of programmes. To establish a reliable service under such conditions it is necessary to rely upon those waves sent out from the transmitter which travel straight along the earth's surface. While such waves are not influenced by the conditions in the earth's atmosphere, they are greatly influenced by absorption by the portions of the earth's surface over which they travel. Consequently, after an interval of twenty years the effect of the earth's surface in modifying wireless wave transmission has been recently studied again in some detail. Since the requirements of sound broadcasting and television transmission are approximately similar in the above field, it will be interesting to review the factors affecting such overland transmission and to illustrate some of the typical results which have been obtained in actual experiments.

Absorption Effect of Earth's Surface.

In the case of the transmission of wireless waves over land a certain amount of absorption takes place in the ground itself. If the earth were made of silver or copper or some other equally good conducting material there would be little absorption of the wireless wave energy. Sea water is a good conductor, and over the sea wireless waves are propagated with very little loss of energy. It is for this reason that many wireless telegraph stations which communicate chiefly with ships are erected near the coast. The extent of the absorption in overland transmission depends upon the nature and dampness of the soil, on the trees and ground vegetation, and upon the existence of towns or mountainous areas. In England the effect of such absorption is noticeable at distances of from 15 to 20 miles from the transmitter, even in the open country. Many transmitting stations are, however, situated at or near the centres of large towns, and in such cases an

Fig. 2. Lines of equal signal intensity for a transmitting station situated on the coast.



additional absorption effect is usually present, and this may become very serious within a few miles of the station. The resulting energy absorption which accompanies the transmission, particularly at the shorter wave-lengths, necessitates the use of a relatively large power to secure satisfactory reception at distances of only 20 to 100 miles.

Contours of Field Strength.

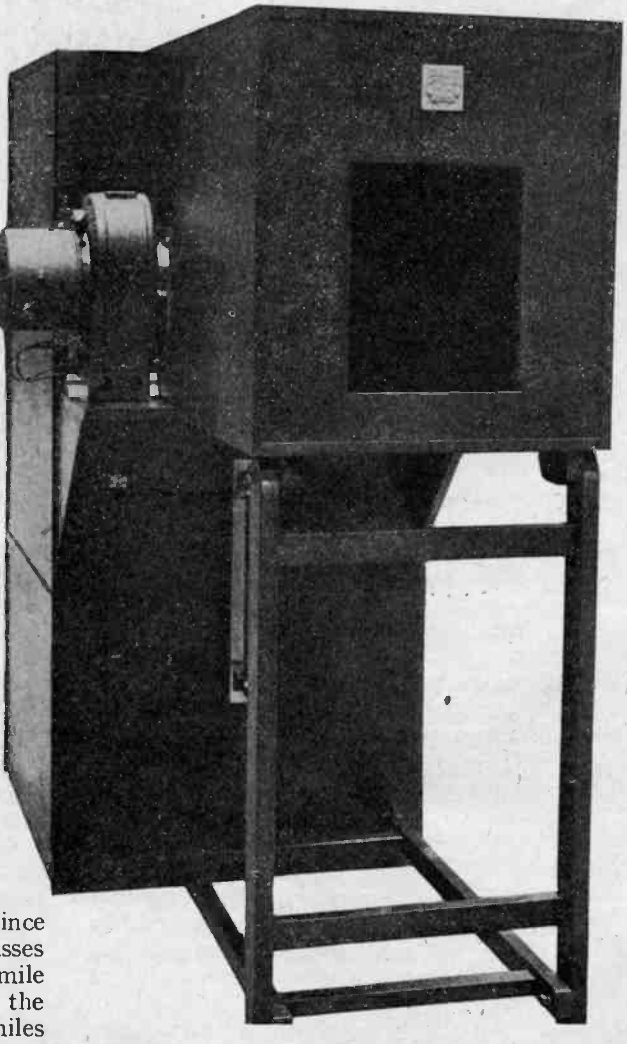
Let us suppose that, in the first instance, the earth's surface were a flat, perfect conductor. If a vertical transmitting aerial is located at any point on this surface, the waves will be radiated out horizontally to an equal extent in all directions. The expanding wave-fronts of the successive waves will, therefore, be concentric circles with their centres at the transmitting aerial as depicted in Fig. 1.

This case is analogous to the transmission of waves over the surface of a pool of water when this is disturbed by dropping a stone in it. If in Fig. 1 we imagine that these circles are the sections of small cylinders which have a fixed height in a direction perpendicular to the plane of the paper, a little consideration will show that the surface area of each of these cylinders is proportional to its radius. Therefore, since all the wave energy which passes through the cylinder of one mile radius ultimately passes through the succeeding surface of two miles radius, the energy concentration in the wave will be four times as great in the former as in the latter case. Further, since the field intensity of the wave is proportional to the square root of the energy, we see that this intensity decreases inversely as the distance from the transmitter.

If the conductivity of the earth is not perfect, but its surface is still flat and uniform, there will be a certain loss of energy due to the heating effects of the eddy currents set up in the earth by the waves travelling over it. This means that the energy of the waves will decrease with the distance from the transmitter at a rate greater than for a perfect conductor. The field intensity of the waves will thus decrease more quickly than the inverse distance from the transmitter.

Effect of Earth's Resistance.

General considerations show that the loss of energy becomes more rapid as the resistance of the earth's surface increases, although the effect is also dependent upon the dielectric constant of the earth. The energy loss also increases very rapidly with the frequency, with the result that, while on the longer waves of several thousand metres wave-length the loss may be small, it is very appreciable on the medium broadcasting band of wave-lengths, and it is still more so on the very short wave-lengths now being used for telegraphic and telephonic communication, and in some cases for sound broadcasting. In the latter case, indeed, the importance of the effect has already been felt in the difficulty of transmitting to quite moderate distances along the earth's surface, although very much greater distances may be covered by waves travelling via the upper regions of the atmosphere, and thus free from the heavy absorbing effects of the ground.



The Karolus television transmitter, as it appears to the sitter. At left, in rounded metal casing, is the arc lamp.

Whether the earth's surface be comprised of high- or low-resistance material, then, so long as its nature is uniform in all directions, the distribution of field intensity will be uniform as depicted in Fig. 1. That is to say, at any given distance from the transmitter the intensity of the signals picked up by a given receiver will be the same, whatever may be the direction in which the receiver is placed relative to the transmitter.

As a typical example of this arrangement, the case of a broadcasting station situated in fairly open country, such as Daventry, may be quoted. So long as the transmission is over moderately flat open country a given receiver should always produce the same results at the same distance from the transmitter. There is no question of "blind areas" of reception, and where the results are not uniform they are to be attributed to local absorption or screening.

Unequal Absorption.

Suppose, however, that the transmitter, instead of being situated in uniform country, is located on the coast line with the sea on one side and dry sandy soil on the other. Owing to the superior conductivity of the sea, the waves travelling in this direction will suffer less loss of energy than those travelling back overland. This means that at a given distance from the transmitter the intensity of the field will be greater over sea than over land, or, alternatively, that the same signal strength is obtained at a greater distance over sea than overland. The "contour" lines of uniform field strength will, therefore, no longer be concentric circles as in Fig. 1, but will rather take the form shown in Fig. 2. The same signal strength will be experienced at the two points, P_1 and P_2, although the distance OP_2 is considerably greater than OP_1.

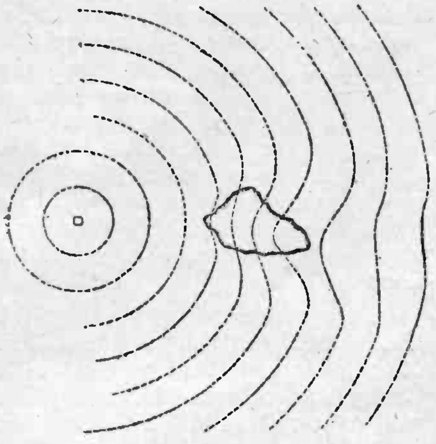


Fig. 3.
Effect of a badly conducting island on the shape of contour lines of equal signal intensity.

Next, suppose that the transmitting station is situated in fairly uniform country, but that at a short distance away a patch of very badly conducting ground exists, somewhat in the manner of an island in the middle of the sea. The wireless waves will begin to spread out uniformly, giving circular intensity contours, but when they reach the badly conducting area the rate of loss of energy will be suddenly increased, and the contour lines will be kinked in the manner shown in Fig. 3. It will be noticed that the spacing of the successive intensity curves is much closer over the badly conducting patch than over the remainder. When once this area has been passed, however, the kinks in the contour lines gradually smooth out and resume their circular form. It is thus illustrated how such an area of badly conducting ground becomes an area of bad reception; but it is also seen that the effects of such an area do not persist for a very great distance beyond it.

Experimental Investigations.

During the past few years several investigations have been carried out of the distribution of field strength around transmitting stations used for sound broadcasting. As the results of some of these investigations illustrate in a remarkably clear manner some of the points under discussion in the present article, it will be interesting to give a few examples.

The usual method of tackling the problem is to employ a portable signal-strength measuring apparatus which is transported to the various sites by motor-car. Working to a pre-arranged plan in which the points are selected with a view to showing up clearly the effects being investigated, observations are made of the field-strength due to the carrier wave of the broadcasting station at various distances up to about one hundred miles. The observations are carried out in the daylight hours in order to avoid difficulties due to the downcoming atmospheric waves, which are usually only of consequence at night-time on the wave-lengths concerned.

Field Strength Measurements.

In 1924 Messrs. Bown & Gillett published in the "Proceedings of the Institute of Radio Engineers" a description of measurements carried out in the neighbourhood of Washington and New York City. The results obtained around Washington showed that the field strength decreased with distance in a fairly uniform manner, although it was subject to some variation where the waves passed from land to water and also in passing over hills.

Wave Absorption in New York City.

In the case of New York the measurements were carried out on the transmission from a station situated near one end of Manhattan Island and employing a wave-length of 492 metres. As might be expected, the results obtained indicated that the distribution of field strength was very far from uniform; for this city, thickly covered with tall steel frame buildings, provides a large number of closed metallic loops as well as open aerials, which serve to extract energy from the waves in the course of their transmission. The results of the measurements are most easily understood from the diagram, reproduced in Fig. 4, from Bown and Gillett's paper, in which the field-strength contour lines have been superimposed upon an aerial photograph of New York City.

The large difference in attenuation of the waves in passing over open water and over the crowded city area is very well demonstrated by the relative spacing of the contour lines.

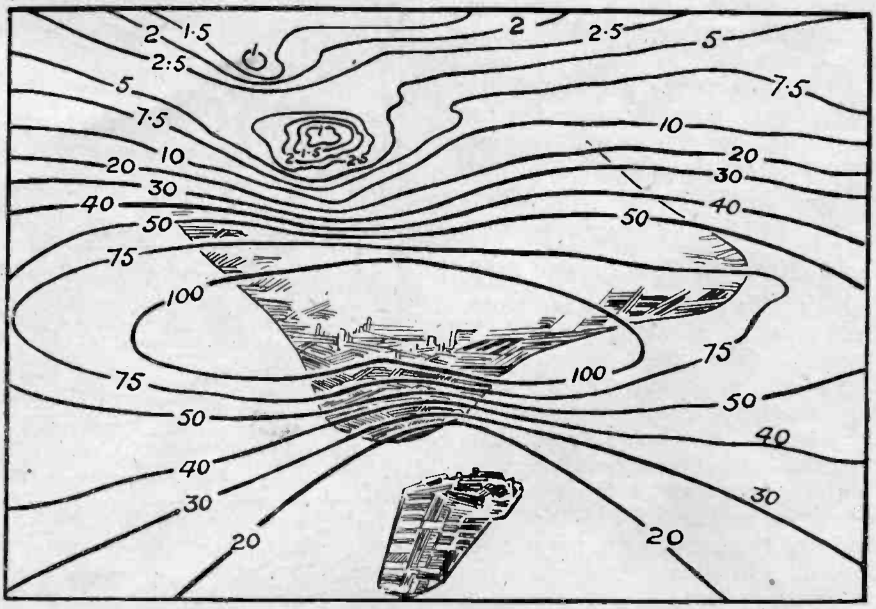


Fig. 4.
A sketch made from an aerial photograph of New York, upon which were superimposed the contour lines of field strength. The numerals indicate the field strength in millivolts per metre.

Towards the top of the photograph it is seen that the contour lines have closed in on themselves to surround

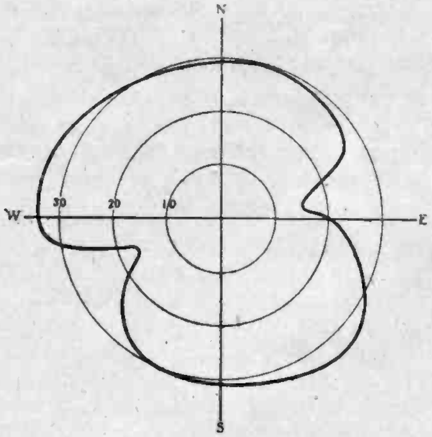


Fig. 5.

Polar curve of signal strength of 2LO at 10 km. from the transmitter (March 1927); intensities in millivolts per metre.

a small area within which the field strength was found to have a very low value. This area is located in Central Park, which is surrounded by the city on all sides, and it evidently forms a blind spot for broadcast reception. Although it is only six miles from the transmitting station, the field strength is no greater than it is at thirty miles or more out in the country in a more favourable direction. Since this blind spot is a closed area, it is observed that beyond it the field strength increases as a result of the feeding-in of energy from either side where the transmission conditions are much more favourable.

As stated by the authors of the paper from which these results are taken, New York presents a "horrible example" of the difficulties which are encountered in the transmission of wireless signals over city areas.

Field Strength Contours of 2LO.

During the past three or four years an extensive study of the field-strength distribution around the London broadcasting station, 2LO, has been carried out by Mr. R. H. Barfield. In these experiments attention was directed not so much to the absorption of the waves in passing over London itself as to a study of the subsequent progress of the waves in the outer suburbs and provinces where the majority of listeners reside. In order to obtain a polar curve of radiation for the 2LO transmitting aerial, observations were made with a portable intensity-measuring apparatus at suitable sites at a radius of about six miles from the transmitter. The polar curve obtained is shown in Fig. 5, from which it is seen that the distribution, instead of being uniform, is subject to two district minima in the approximate directions of east-north-east and west-south-west respectively. These minima or crevasses in the curves are ascribed to the directional characteristic of the transmitting aerial, and are probably due to the currents induced in the two metallic masts supporting the aerial.

Results of Survey.

The results of a complete survey of the field strength distribution of 2LO are summarised in the contour map of signal strength in Fig. 6, which is reproduced from a paper by Messrs. R. H. Barfield and G. H. Munro, published in the "Journal of the Institution of Electrical Engineers" in February, 1929. In this diagram the solid lines indicate the measured field strength, while the broken lines are circles described round the transmitter as centre. These circles are useful for comparing the signal strength in different directions at equal distances.

It is immediately evident from this map that the characteristic crevasses impressed upon the signal strength distribution near the transmitter persist at all distances up to the limits of the observations made. In addition to this, it is noteworthy that the contour lines are relatively compressed to the south of London as compared with their more open spacing to the north. This indicates that the absorbing effect of the ground on the wireless waves is much greater in southerly directions than in the directions north of London.

In a previous paper Mr. Barfield also pointed out that a comparison of the experimental results with theory showed that the absorption was greater than would be expected from the previously determined value of the earth's resistance. It was then suggested that both this fact and the directional feature of the contour lines could be explained as an effect due largely to the well-wooded nature of the English country-side.

To support this suggestion Mr. Barfield developed an experimental

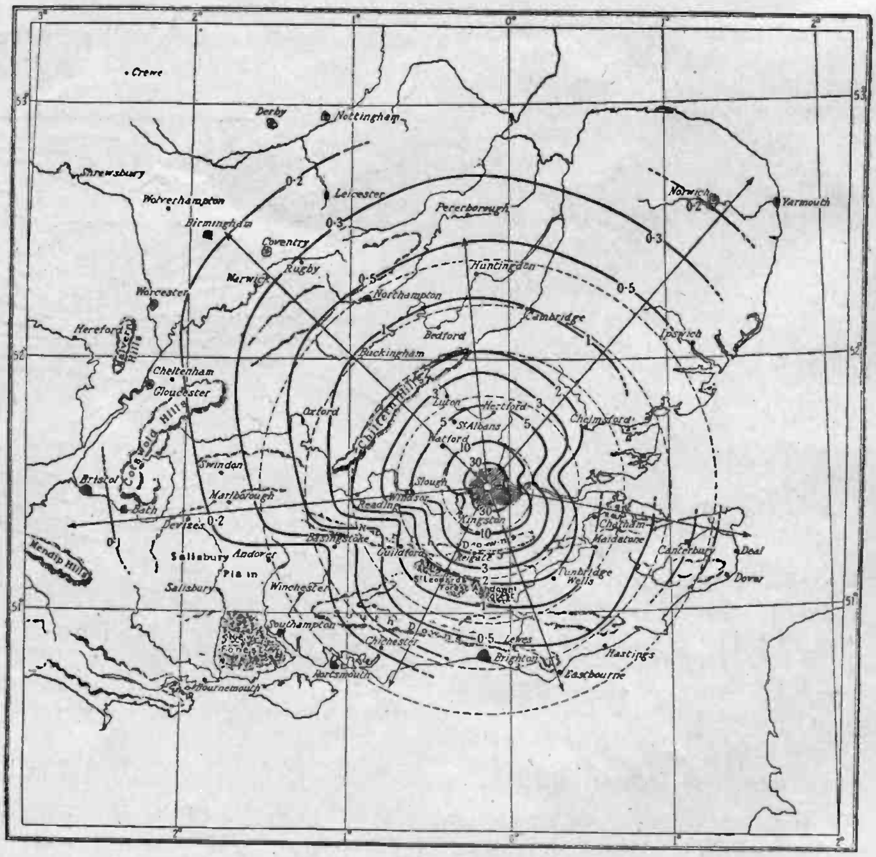


Fig. 6.

Radio contour map of 2LO; revised survey made in March 1927 (distances from 2LO shown by dotted circles at intervals of 20 km.); intensities in millivolts per metre.

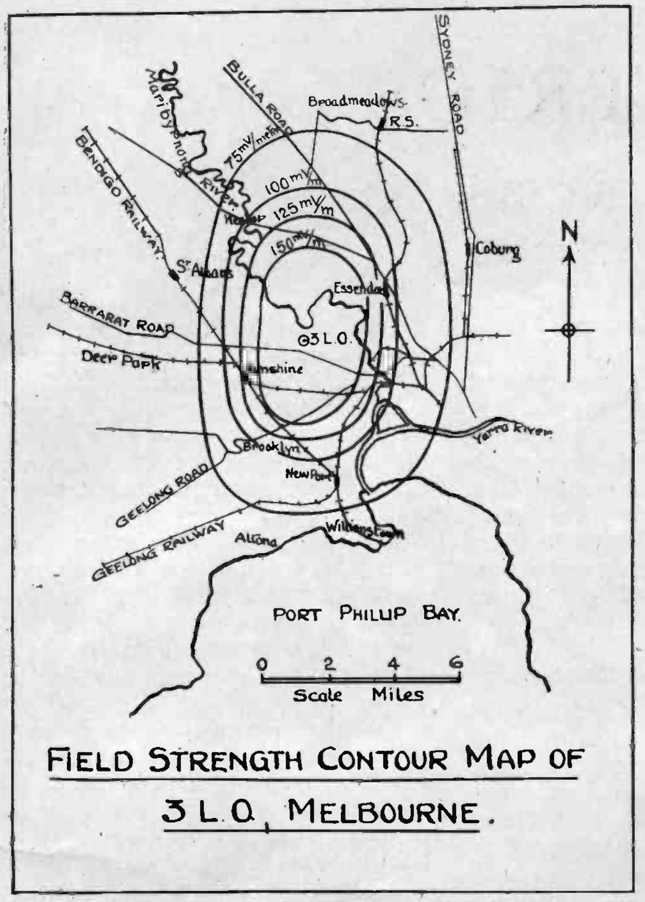


Fig. 7.

Field strength measurements made round 3LO, Melbourne, show a remarkable consistency in the all-round radiation qualities of the station.

method of measuring the effect on the field-strength produced by an individual tree, and from the results obtained the total energy-absorbing properties of a given tree-covered area could be calculated. The general conclusion arrived at was that masses of trees contribute very largely to the absorption of wireless waves on the broadcasting wave-lengths in the country, and that the difference of absorption in different directions is due to the distribution of trees. Thus the well-wooded areas to the south and south-west of London absorb the energy of the waves more rapidly than the comparatively treeless areas to the north and east, and so the signal intensity at any given distance may in one direction be little more than half that in a more favourable direction.

Experiments in Australia.

Somewhat similar measurements to those described above have been made on the transmissions from the broadcasting station 3LO, situated near Melbourne, Australia, by Mr. R. O. Cherry, of the University of Melbourne. This station operates on a wave-length of 371 metres, and measurements of the radiated field-strength were made at various places within a twenty-mile radius. The results are shown in the contour-map of Fig. 7, which is reproduced from one of Mr. Cherry's papers published by the Broadcasting Company of Australia. From this diagram it will be seen that the field-strength contour lines are of an oval shape, the signals being stronger in the north-south direction than in the east-west direction, a fact which is possibly due to a characteristic of the transmitting aerial itself. Apart from this, however, the contours are remarkably smooth, and are in great contrast to those shown for New York above. This smoothness of the contours is attributable to the good situation of the 3LO transmitter in open country and the absence of local absorption due to steel-frame buildings near it.

The examples given above lend support to the view that it is inefficient and undesirable to locate any transmitting stations providing either a sound or television broadcasting service in the centre of large towns, a practice which is rapidly becoming obsolete.

FORTHCOMING LECTURES

The following lectures on Television, with slides and experiments, have been arranged to take place during October :—

Mr. J. Denton, A.M.I.E.E., Jt. Hon. Sec. Television Society, has the following engagements :—

Oct. 10th.—The Magnet Telephone Society, Coventry, at 8 p.m.

Oct. 11th.—The Sevenoaks Society, Sevenoaks, at 8.15 p.m.

Oct. 23rd.—The Muswell Hill Radio Society, Muswell Hill, at 8 p.m.

Mr. A. Dinsdale, A.M.I.R.E., Editor of Television, has the following engagements :—

Oct. 14th.—Troon, Ayrshire.

Oct. 15th.—Y.M.C.A., Glasgow.

Oct. 28th.—Taunton and District Radio Society, Taunton, at 7.30 p.m.

DIELECTRICS

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

Fellow of the Television Society

IN designing circuits or constructing sets we are mainly concerned with getting the electric current to flow satisfactorily through some conductor. In fact, conduction of electricity is most prominent in all that deals with electrical matters. We are apt to forget the great importance of the subject of insulation.

Actually, of course, insulation is as important as conduction. Conduction, as we understand it, could not take place at all without suitable insulation. The current which flows along a copper wire is as much determined by the surrounding layer of insulating air as it is by the metal conductor. It is an interesting speculation to imagine the science of electricity in a world possessing a conducting atmosphere!

Much of the success of any electrical installation depends on the efficiency of the insulation. The problem becomes very serious when we are dealing with high-tension distribution, when currents with pressures of many thousands of volts are transmitted through wires. These wires need some support, and every support must be an efficient insulator.

Porcelain Supreme.

In this connection porcelain has no rival, and is manufactured with great care. Usually English ball-clay and china clay are mixed with a finely-ground potash feldspar and flint. After being filter-pressed, the mixture is set aside to age, which eliminates air bubbles, after which it is thoroughly mixed in a pug mill, and moulded into the desired shapes.

The shaped articles are then oven dried, trimmed and glazed, and the final firing performed in kilns, the temperature of which can be regulated. This temperature regulation controls the porosity and the brittleness of the finished product.

The insulator is then subjected to a number of tests, including a flash-over test, under pressures of anything up to 300,000 volts.

Crude rubber is another very good insulating material; but, unfortunately, in the crude state it is not of much value, as its properties alter with age. Crude rubber is a colloidal material the chemical nature of which is rather doubtful. The formula $(C_5H_8)_8$ has been given to it, but this is probably only an approximation.

Discovery of Vulcanisation.

For commercial use rubber was not of much value until the discovery of the process which we now call vulcanisation. This was first accidentally discovered by William Goodyear in 1839, after many years of experimenting. It is related that he dropped a mixture of rubber and sulphur on a hot stove, and fortunately examined the residue. It is a strange commentary, when we think of the modern use of vulcanised rubber, to recall that Goodyear spent more than one period in prison for debt as a result of his enthusiasm, which did not secure the backing of financiers.

The process of vulcanisation of rubber is a chemical one, and consists of certain reactions which take place between the caoutchouc molecule and sulphur. The simplest method is the mechanical mixture of the purified crude product with sulphur. To the crude rubber there is usually added about one-tenth of its weight of sulphur. The mixture is warmed to soften it, and then moulded into whatever shape is required, or rolled out into sheets. Vulcanisation takes place when the moulded product is further heated to between 135° to 150° C. This is done in closed iron vessels by means of steam or hot air.

A so-called *cold cure* process is in use in which the rubber article is dipped in a solution of sulphur chloride dissolved in carbon disulphide, and then heated to about 40° C. in leaden chambers, or it may be suspended in the chamber and the vapour of sulphur chloride allowed to pass over it.

A modern process which has met with success is to expose the rubber first to the action of sulphur dioxide gas for ten minutes, and then to hydrogen sulphide for thirty minutes. These two gases, when mixed, react with the production of sulphur. Produced within the body of the rubber into which the gases diffuse, the sulphur is in an active state which brings about vulcanisation in the cold.

Modern research has considerably increased the rate at which vulcanising takes place by the addition to the mixture of various accelerators. Litharge was used for this purpose, but is now being replaced by a number of more or less complex organic compounds, mostly tar derivatives.

The product is too well known to need description. Vulcanised rubber varies in its nature according to the quantity of combined sulphur it contains, and analyses vary. The rubber itself may vary from 12 to 60 per cent., while the sulphur varies from 1 to 2 per cent., mineral matter may be 25 to 70 per cent.

Constitution of Ebonite.

If the proportion of sulphur be greatly increased then the product obtained is hard, moderately brittle, and will take a very high polish. This is the well-known *ebonite*, used so widely for non-conducting panels in wireless outfits. Commonly it is made by mixing purified Borneo rubber with about 40 per cent. of its weight of sulphur. After shaping, the mixture is heated for several hours at a temperature of 135° to 150° C.

Shellac is another useful insulating material. It is a resinous material produced by the female of an insect which infests various trees growing mainly in the East Indies. The resin forms an incrustation on the twigs,

(*Continued on page* 408.)

"SELLING AMERICA TO THE WORLD!"

Can the U.S. "Corner" World-Entertainment? Where Does Britain Stand?

By SHAW DESMOND.

America means to corner the Entertainment of the World
Giant " Mergers " are planning the Conquest of Europe
Asia and Africa to follow
Television to be the Weapon

WITHIN five years from now radio-England will be face to face with America upon a battlefield which will be for her either her Waterloo or her victory.

Upon the result of this battle, you who read these lines may find yourself either flung out on to the street from your employment or may see your salary raised to a figure beyond your present dreams.

Upon it will hang the destinies of at least the three millions of people who by that time will be engaged in the radio, cinema, " talkie " and kindred industries, including the manufacturing.

Every theatre and hall in Great Britain will depend upon the result of that battle for its final control. There will scarcely be a dancer, an actor, an actress, or a singer who will not find his material destiny altered by the final verdict of that battlefield.

And I am certainly not going too far in saying that upon that verdict may ultimately hang the whole financial control of the earth.

How far this language is exaggerated or, as I contend, strictly within the bounds of moderation, you must decide by what follows.

A Gargantuan Struggle.

There is going on in America to-day a gargantaun struggle between two vast groups of interests for (1) the control of American entertainment, (2) the subsequent control of the entertainment of the British Empire, and (3) the control of Asia's yellow myriads and of the black hordes of Africa.

That struggle is being fought out between the American Telegraph and Telephone Company, for whom I recently broadcast from their palatial offices in Lower Broadway, and the Radio Corporation of America.

For three to six months you will hear the rumblings of this underground struggle come over the cables from New York, but neither you nor I will know of the result until the entertainment barons have settled the matter between themselves.

SOME months ago we were the first of our contemporaries to report the presence in this country of Mr. M. H. Aylesworth, President of the National Broadcasting Company of America. He came over to study our broadcasting methods, and as a result of his visit he announced that he hoped to organise a freer interchange of programmes between this country and America. As a result British listeners now find themselves occasionally treated to programmes paid for by American advertisers, whose object is indirect advertising.

Each of the combatants is calling up vast reserves of men and of money for what is a sort of local Armageddon, in preparation for that real ultimate Armageddon when together they will stand side by side against what I regard as one of the worst organised countries on earth—Great Britain.

Another Gigantic Merger.

I believe that the ultimate result of their mutual battle will be another gigantic " merger," and that then they will immediately set their united battle-front in order for England.

Woe to this country if by the time these two giants are ready she has not set her radio and wireless house in order!

The weapon which the Americans mean to use against British entertainment is the weapon of television. That weapon could and should first have been grasped by Great Britain, for television is the invention of a Scotsman, Mr. John L. Baird. I have only met Mr. Baird upon one occasion and so hold no special brief for him. But some day I hope to tell the world, as our American cousins have it, of the shabby, unimaginative treatment to which this gifted man has been subjected by this country.

But this weapon is now firmly in the hands of the two pseudo-combatants, who, taking time by the forelock, have been thinking exactly ten years ahead of England in the domain of " seeing at a distance."

They had reached the conclusion, to my personal knowledge, so long ago as 1927, that within a few years television would be a regular commercial proposition, that the television screen would be as common as " wireless " in the homes of England and America, and that it was the dominant factor in all future world entertainment.

Nearly two years after that, the British Broadcasting Corporation were timidly offering three quarter hours per week to the Baird Television people!

Already their teeth have been sharpened by preliminary mergers.

Paramount have arranged a merger with Warner Brothers, and five representatives of Paramount have already become directors of the Columbia Broadcasting Company. Other powerful mergers are maturing as fast as the financial controls can be got to work. "Tie ups," the modern term for amalgamations, are taking place at the rate of one a day. Soon the Americans will be ready for the first offensive with shock-tactics.

Preparations.

I must say here that the new offensive is already being planned exactly upon the lines of a Western Front offensive. The trenches have been marked out; the supply lines have been skeletonised; and the officers in command are beginning to be appointed.

There will be neither let up nor easement once the first shell is fired until the "cease fire" sounds one year or ten years later.

The first "scouting" before the shock-offensive is seen in the instalment in the homes of Britain of large and increasing numbers of their "systems," i.e. the systems of the American Telegraph and Telephone Company and the Radio Corporation of America. Within two years from now I think we shall see at least five thousand installations a year, perhaps ten thousand.

Every Listener Affected.

Now I want the intelligent reader, who should always bear in mind that these tactics concern himself, his wife and his family intimately, if he be connected with "wireless," and less directly if he be outside "wireless," to follow step by step my forecast as to the future developments of the new campaign.

When the shimozzle between the two rival groups is over and one side or the other has secured some slight advantage over its rival we shall see an entirely new series of "mergers" launched.

We shall see an attempt made, one that has been on the carpet for three years or so, to link up the *transmission* with the *publishing* and the *manufacturing* sides of radio.

Already one of the groups has bought out one of the leading publishers of light music and is now in a position to handle the television end at any moment.

The great film-producing firms will be linking up with the publishing and the part-manufacturing firms. That is the next step.

Then will follow wholesale purchases of theatres and halls, as in the case of the Radio Corporation which has just bought the important Keith Albee circuit and, as I believe, one of the largest Middle West circuits of theatres and music halls, many of which I have personally visited in Chicago and elsewhere.

Now comes that final step, which should really have been taken by this country, and not by America. That is the placing on the market of the *stereopticon* which is owned by the Radio Corporation of America.

The very latest picture of one of the world's most famous comedians. Sir Harry Lauder has made countless tours and faced thousands of people, but on September 1st he appeared for his greatest audience and at the same time made his American radio debut over the system of the National Broadcasting Company. He was featured over a coast-to-coast network of thirty-six associated N.B.C. stations and three stations in Canada. His appearance was made in Winnipeg, Canada.

The stereopticon is a new invention consisting of a stereoscopic film, with all the characters standing out as in life on the screen, the coming of which, I think I can claim without immodesty, I was the first to predict in this country—many years ago. I was laughed at for my pains!

This stereopticon has already been demonstrated upon a vast opaque glass screen 70 feet wide—the size of the proscenium of a big theatre.

At present I think I am right in saying that demonstration in colour is not yet possible. *But it is coming.*

We shall see before five years are out men and women on the screen *in their natural colours*, as in life.

All these various interests and inventions are to be securely linked up into an impenetrable front, and when this has been done they are to be launched at Great Britain.

Behind them there will be the thousands of millions (they no longer calculate their mergers in mere hundreds of millions) of American dollars to which we are growing accustomed.

Rival interests here will either be "bought out or smashed out" as an American put it to me in New York some time ago, and we are going to see some of the old Standard Oil methods now applied to radio.

I have recently seen details of the penetration by America of the following countries:—

Latin-America.
Canada.
Australia.
Central America.
The Middle States of Europe.
Russia.
France.
Italy.
Spain.
Germany.
Switzerland.
Czecho-Slovakia.

The actual facts of that penetration make illuminating, if staggering, reading. If those facts could be broadcast by the B.B.C. to the inhabitants of this country, they would cause a minor revolution.

Well, what has Great Britain to set up against all this? What are her chances in the struggle now opening? Has she any chance at all?

Humanly speaking, not a dog's chance, unless she at once sets her television house in order.

Britain's Only Chance.

Her only chance is to take the long national-international view of television and at once make arrangements through the Postmaster-General to make television an integral portion of all wireless entertainment. Not even the present offer five of half-hours a week, though they are better than nothing, will help in what is a matter of life and death to commercial Britain.

That is the first step.

(*Continued on page* 408.)

Sydney A. Moseley

ON

The Future of Television

IN the last issue of TELEVISION I told readers not to be unduly depressed by the statements made in the public press that negotiations between the B.B.C. and the Baird Company had been broken off.

Pessimists and the unkind were ready to say "I told you so," but those who have been unswerving in their faith knew that sooner or later television must be broadcast by the only available means in England.

At any rate, the optimism expressed was justified, for the B.B.C. have now arranged with the Baird Company to transmit for half an hour daily, with the exception of Saturdays and Sundays.

This is not so bad as a start.

Only those of us who have fought the battle for television all along think that *instead of doing the thing piecemeal, television should have had its proper place in the programme right away.* That is only natural.

Make a Start.

At the same time it is far better to make a start, and I hold that the offer of the B.B.C. is sufficient *to demonstrate beyond all doubt the place that television should occupy in daily transmissions.*

For, remember, this concession to the Baird Company has only been made *after repeated public tests* have been given, and when a jury of Members of Parliament pronounced in favour of it.

Also, let it not be forgotten that three Postmaster-Generals and ex-Postmaster-Generals have witnessed television at the Baird studios. They were the present Postmaster-General, Mr. Lees-Smith, the late Postmaster-General, Sir William Mitchell-Thompson, and Sir Herbert Samuel. All this is by the way, and I merely mention the matter because it is necessary to remind those unyielding critics who talk about the present facilities as being "very generous," of the true facts of the situation.

At any rate, scientific history has now begun in earnest, and television is being broadcast from the British Broadcasting Company's studios.

What of the future? While this battle in England was being fought foreign countries have been forging ahead. We have seen what has been happening in Germany, and from the Editor's report in another part of this journal, readers will realise how necessary and urgent it was to bring things to fruition in England.

Readers will remember that I talked of "tele-cinema" in recent articles. Germany in particular sees in "tele-cinema" or "tele-talkies" the stepping-stone to television proper.

My own view is that television itself is far more interesting, for here one *sees the real living image of the person or scenes transmitted,* whereas in "tele-cinema" one sees the *film* of a person or scene.

The First Film.

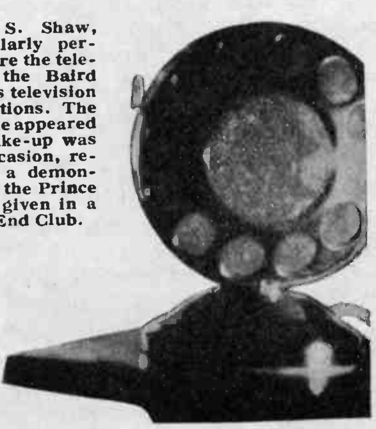
I gather that the first film to be televised by the Baird Company may be that of Mr. George Robey in his inimitable guise of a much-married woman!

I have seen and heard this transmission and found it most amusing, and a friend of mine who was present at a London club tells me that the Prince of Wales was particularly interested, and laughed loudly when this transmission was put over. He was also amused at the patter and facial expressions of Mr. R. Shaw of the Baird Company, who blacked his face and was clearly seen as a minstrel!

Granted all this.

For myself I look forward to a leading personage *being televised direct* and not second-hand from a film.

I would like, myself, to see the Prince of Wales, or I would even aim as high as obtaining the first public talk since his illness by the King!



Reginald S. Shaw, who regularly performs before the televisor at the Baird Company's television demonstrations. The first time he appeared in this make-up was on the occasion, recently, of a demonstration to the Prince of Wales, given in a West End Club.

I have received several letters of congratulation from readers who have been following my campaign in this journal and elsewhere for the recognition of television in England. What has been achieved up to now is no doubt highly satisfactory, but we must not be blind to the fact that our foreign competitors are still very active and are making incessant efforts to undermine the lead and prestige of the British inventor.

Foreign Blandishments.

I gather that the blandishments of certain foreign emissaries have not passed altogether unnoticed either at Savoy Hill or at the Post Office. It would be inconceivable, in view of Mr. Baird's great victory, that any newcomer should be allowed to steal a march on the indefatigable Scot.

While one admits that science has no boundaries and that the best developments in television should be adopted by this country, the very least that can be expected in these days of depressed trade is to encourage British inventions and British production whenever the chance offers itself.

There can be no excuse at all for not giving every encouragement and every facility to the British Company now that it has proved itself.

Readers must not imagine that with the introduction of this half-hourly transmission we have achieved all that we have set out for.

Security of Tenure.

It would be farcical if, as a result of this early experimental transmission, full facilities were not given to the Baird Company after a short time.

Listeners all over the country will want sets, and obviously British manufacturers will be nervous of going into full production until they are assured that British official support will be given to the British Company and the British inventor, and that no back-door influence will permit a foreign invasion at the eleventh hour.

Nobody can gainsay that this country has given the world the lead in television and it has maintained that lead abroad.

Now that Baird television is to be broadcast by the B.B.C. the development of the new science must be encouraged in every possible way.

Every reader of TELEVISION will, I am sure, applaud this sentiment.

Dielectrics.

(*Concluded from page* 404.)

which are picked at regular intervals. This product, known as *lac*, is then washed with warm water to remove certain dye materials and the residue is the *shellac* of commerce.

Mica is another well-known insulator. Mica is properly the name of a group of rock-forming minerals of which *muscovite* is the best known. The micas are characterised by the ease with which they cleave into thin flakes. They are complex and variable in composition. Muscovite is usually given the formula $H_2 K Al_3(SiO_4)_3$, but this is probably only approximate. The flexible sheets are largely used in the construction of dynamo armatures.

Gutta-percha, another useful insulating material, is acquired by evaporating the milky juices obtained from certain trees growing mainly in the Malay Peninsula. Gutta-percha consists of a hydrocarbon—pure gutta—which is closely allied to caoutchouc, together with certain resinous substances. The proportion of these constituents varies with the nature of the trees from which it is derived. It can also be vulcanised.

The element sulphur and the hydrocarbon paraffin, in the solid wax form, are also useful insulators for use on a small scale. There are also a number of liquids which are used as dielectrics.

The *volume resistivity* of a number of common non-conducting materials is given in the following table :—

Substance.	Millions of megohms per centimetre cube.
Mica	84
Gutta-percha ..	450
Flint glass ..	1,020
Vulcanised rubber	1,630
Shellac	9,000
India-rubber ..	10,000
Ebonite	28,000
Paraffin	34,000

Increase of temperature is usually accompanied by a decrease of resistivity. A rise of 25° C. reduces the resistivity of gutta-percha to one-twentieth of its original value. There is also a time effect, the resistance decreasing with the time to which the dielectric is submitted to electrical strain.

"Selling America to World"

(*Concluded from page* 406.)

The next step is for the trade interests, whether they be film producers, radio manufacturers, music publishers, makers of gramophone records, or what not, and, of course, including all the technical industries and processes which form an intrinsic part of modern wireless entertainment, to get together.

After they have thrashed out, and quickly, the values of their respective interests, let them merge, and merge, and go on merging. In merging lies salvation. In separation damnation.

A Solution.

Turn Great Britain into one gigantic homogeneous radio entity with television for its backbone. Let the Government, if necessary, at once subsidise television part manufacturers and give encouragement to the British pioneers of television for the placing of television screens in the homes of England. (By that they will, incidentally, by degrees solve their unemployment problem, wipe out the dole, and make the Britisher a self-respecting individual once more.)

But with this must go a wiping out of all monopolies.

Free and full competition within the country, unflinching and minutely organised opposition to the attack coming from the *outside*. That should be the policy.

But in all this, television must necessarily be the beginning and the end. It is the chief, almost the only weapon of the great American mergers in the fight that is now opening. It must also be Britain's chief weapon of defence.

I have ventured one forecast. Now I will venture another.

Another Forecast.

If Great Britain does not at once set her house in order and nationally organise against the American invasion, we shall see, without possibility of re-conquest, all the wireless entertainment *and wireless education* of the British Empire pass into American hands.

Already I know of plans for a flank attack upon certain of the British radio interests via France and Holland. That attack will be enormously difficult to meet.

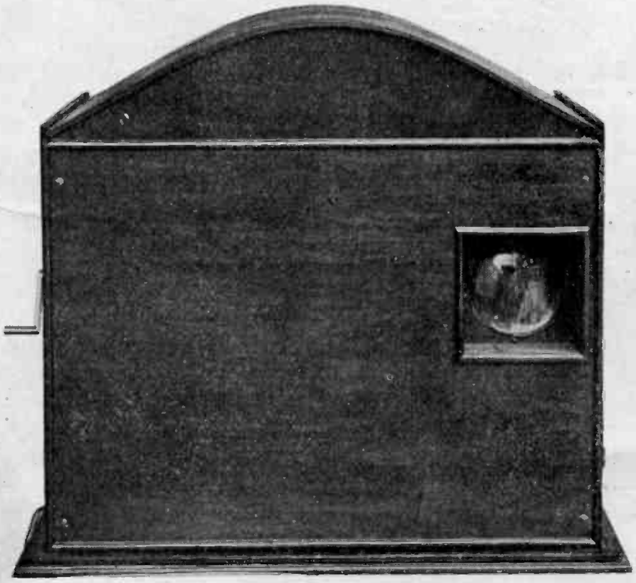
What will England do ?

THE CONSTRUCTION OF EXPERIMENTAL TELEVISION APPARATUS

Part V

By A. A. WATERS

Working in collaboration with Captain R. Wilson, a member of the Council of the Television Society, Mr. Waters has been engaged on television experiments for some time. Photographs of Captain Wilson's transmitting apparatus, as it is to-day, appeared in our last issue. To illustrate the following article we reproduce two views of the receiver, details of which are given below.



Front view of Captain Wilson's receiver.

EARLIER articles in this series have described the construction of the apparatus necessary for the transmission and reception of simple shadowgraphs.

In this article I am going to give details regarding a receiver which we built for the reception of lantern-slide pictures.

Last month's issue of TELEVISION included photographs of the transmitter and pilot receiver used by Captain Wilson and myself in our experiments along these lines—instruments which represent the outcome of many months of research.

Those of my readers who have paid me the compliment of following these articles will readily appreciate the fact that in all experimental work apparatus has to be altered constantly—often it requires to be entirely rebuilt—in the endeavour to attain the result aimed at. In making a general survey of the work which has been accomplished to date, we may regard with some satisfaction the collection of apparatus which we have accumulated as a result of our efforts to improve our knowledge by practical experience. Failures have often occurred, it is true, but much valuable information has been gained from every experiment we have carried out.

The televisor I am about to describe was linked to the transmitter by a land-line about 300 yards in length. It is necessary to lay this line carefully if loss of the higher frequencies is to be cut down to a minimum, and the two leads should be well separated. Stray capacities should be avoided as much as possible.

The construction of the televisor can be clearly seen in the accompanying photographs. The woodwork is a fairly straightforward job, and does not call for a great degree of skill. The material used for the sides and base is ⅜-inch 5-plywood, and both back and front are arranged to be detachable. Screws at the corners hold them in position. The only portion which may cause trouble to the constructor is the curved top. The requisite bending is carried out in the following way.

Bending Plywood.

First, cut the piece of plywood to the correct size and thoroughly soak it in water. After it has been immersed in the water for an hour or longer take it out and apply heat to one side. When it begins to steam commence to bend the wood away from the heat until a curve having a smaller radius than that of the curve aimed at is reached. This process will probably have to be repeated two or three times. When a curve of the desired radius is finally attained the wood must be

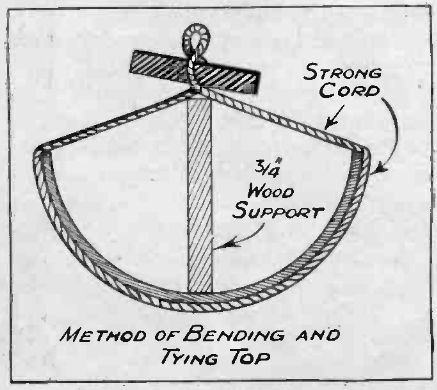


Fig. 1.

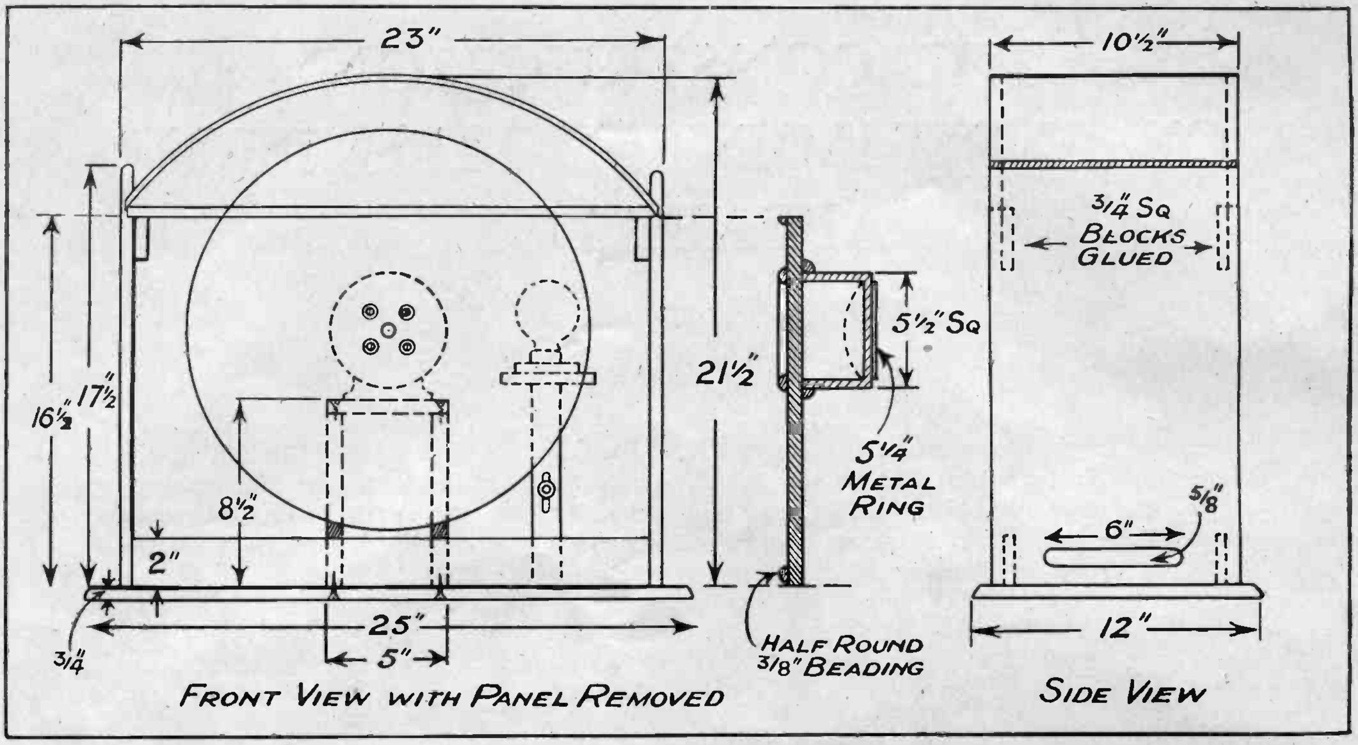


Fig. 2.—Side and end elevations of television receiver.

tied in position and left to dry. The tying is accomplished with the aid of the tourniquet method of straining, two strong pieces of rope being used.

I have included a small diagram which illustrates this method plainly (Fig. 1).

Such a curved top as I have just described is well worth the effort necessary to make it, as it takes away that "square box-like" appearance which would otherwise render the cabinet unsuitable for use in a well-appointed room. In Fig. 2 are given the dimensions of the cabinet, which is designed to house a 20-inch diameter scanning disc. Inside the cabinet should be painted black; the choice of the outside finish is left to the taste of the constructor—our particular job was treated with mahogany stain, and looked very well.

The platform on which the motor is mounted is made from deal board, $\frac{3}{4}$-inch thick, and is screwed together with No. 8 wood screws $1\frac{1}{2}$ inches long. This makes a strong job, and ensures freedom from vibration.

The details of the neon tube holder were given in my first article, and as the same holder is used I have included a diagram of the finished article only.

The type of motor required for driving the disc will depend upon the supply which the intending constructor has available. In our case a G.E.C. 1/40th h.p. Universal motor was used. The speed was varied by means of a 1,000-ohm slider-type resistance, such as is supplied by Isenthal's or the Zenith Manufacturing Company. This resistance should be able to carry without overheating the current at which the motor is rated, and should be perfectly smooth in action. It is mounted on the right-hand side of the cabinet, as indicated in the diagram.

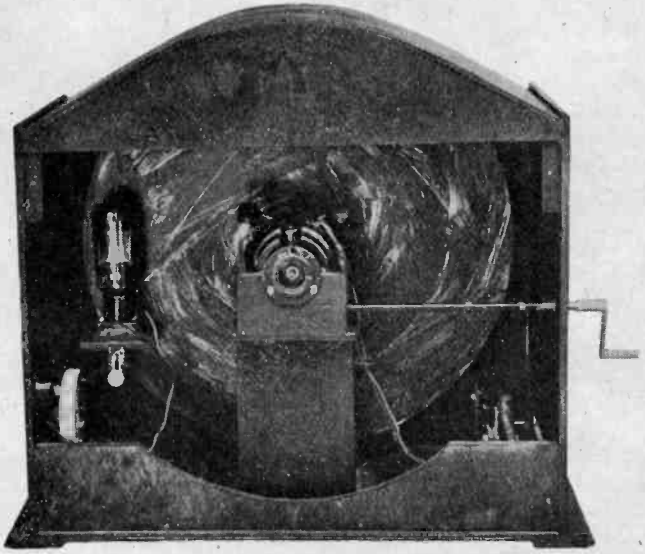
Once again I must refer the reader to previous articles in this series as to the construction of the scanning disc and the mounting used for it. This type of mounting has been universal in all our apparatus, and I do not propose to repeat here what has already been fully dealt with. The mounting will be of the greatest assistance when other transmissions are being received, as one can change the disc with ease by the simple process of removing four screws.

The viewing lens is of the plano-concave type, and has a focal length of 6 inches. It is mounted on the front panel of the cabinet and held in position by the aid of a metal ring, $4\frac{1}{4}$ inches by $5\frac{1}{4}$ inches, constructed of 20 SWG sheet tin. Details are shown in Fig. 2.

The Phasing Device.

We now come to the question of the phasing device to use. I think this is best

(*Continued on page* 419.)



Back view of Captain Wilson's receiver.

THAT WITZLEBEN TOWER

W. C. FOX

Has Another Scientific Adventure* over Berlin

SOMEONE, sometime, somewhere in some book or other, has called Fleet Street the "Street of Adventure." He was quite right, but he merely applied the term to one of the many streets which go to make up London. The whole city is the starting-off point of many adventures, the only necessary qualification being a willingness to undertake whatever offers, and a readiness to go anywhere by any means—at least, so it seems—and so it proved over this, the latest of a long series of adventures that have come my way in connection with scientific matters.

On a Monday morning about a month ago it became necessary for someone to go to Berlin in a hurry on a matter not entirely unconnected with the wireless exhibition there, and television.

This Passport Business.

As every ordinary means of passenger conveyance had left, flown, or otherwise gone to Berlin, there was nothing for it but to charter an air taxi. Securing the conveyance was only half the task, however; who was it to convey? As continental countries, together with our own, have a rather disproportionate regard for a document called a passport, the passenger had to have one of these documents, and, as I was the only fortunate possessor of one, the journey and its responsibilities fell on me.

A wild rush to gather up this all-important passport and a few clothes, and then to Croydon as fast as a taxi could go through London.

Arrived at Croydon, the one great question was, "What sort of a machine are we going in?" *i.e.*, the pilot, mechanic, and myself. As if in answer to the question the machine appeared from the hangars, taxi-ing to the filling station, an all-metal four-seater cabin monoplane, a slim, shining thing of beauty. Filling for the petrol tanks of the machine, and "fillings" at the buffet for the human beings who were to travel completed the preparations, and everyone climbed on board.

The Take-Off.

With scarcely any excitement or notice we were off. Our machine had a cruising speed of 110 to 120 miles an hour, with lots more speed, if needed; but even at this modest speed Croydon soon became a blurr on the horizon, and the pleasant fields of Kent passed quite rapidly—for an aeroplane—beneath our wings.

The flight to the French coast was without incident, except that the pilot in a moment of abstraction put his head out over the side of the machine and lost his hat, and followed this up by losing a map in the same way!

From Calais to Ostend we flew low over the waves, just clear of the beach, to the great annoyance of many swell dogs indulging in afternoon naps under innumerable deck chairs. Their barks of protest, however, were lost in the distance before they were uttered.

At Ostend, as we had no wireless, a couple of circuits were made of the aerodrome to let them know we had crossed the Channel in safety, otherwise an S.O.S. would have been sent out requiring all ships to look for a lost machine!

From Ostend a perfectly steady uneventful flight over the level land of Holland and Western Germany brought us to Hanover, just as the golden rays of the setting sun were throwing long distorted shadows of trees and houses across the fields.

From Hanover to Berlin, a journey which takes about an hour, there is a chain of "lighthouses" to guide wanderers home. The first of these we picked up shortly after leaving Hanover, a tiny winking light in the centre of a broad dark wood of pine trees. The light winked with the precision and sharpness of an electric spark, but seemed impossibly tiny. Before it had passed under our wings No. 2 had been spotted, shining through the misty haze in the distance, No. 3 almost immediately followed it, and thereafter each light was picked up, some flashing with the accurate "click" that one associates with German soldiers on parade, while others winked in a lazy, half-asleep manner. The whole formed a dead straight line that beckoned one on, and seemed to say: "You are all right, you can't go wrong if you trust us." And so we flew on while Germany gradually disappeared in the soft mists of evening and night, and the sky in the west grew from orange to deep blood-red, and then faded slowly to a cold faint glow.

The Lights of Berlin.

The last of the line was a higher, brighter light than any of the others, and went "wink," pause, "wink," pause, in a very stately and dignified manner, as befitted the most important beacon light in one of the principal cities of Europe. Simultaneously, the lights in the outskirts of Berlin came into view. We flew gaily on, knowing that we were expected, and that the aerodrome was in the heart of Berlin and a little to the south of the centre of it; but we knew nothing more.

By the time we had reached the final light all hands were looking for the aerodrome, expecting to see a blaze of light with landing signs and all the other adjuncts that form a so familiar part of Croydon—but there was nothing to be seen.

Away in all directions stretched the lights of Berlin, looking like innumerable strings of diamonds

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* Our contributor seems to be a glutton for adventure. Our readers may remember the adventures which he described in our April and November 1928 issues.

lying on black velvet, with here and there a ruby or turquoise standing up brighter and bigger than the others. Sundry blank spaces looked promising, but investigation of one revealed a suspicious shine from the surface of it; it was a lake, and another proved to be an unlit portion of the city full of house tops and other spikey objects. Neither were nice landing grounds for an aeroplane.

There was nothing for it, we were lost, and the only thing to do was to go back to our last beacon light and start hunting again. How I got to hate that light, with its stupid "flash," "flash," "flash," and not a word or sign of direction.

As we circled round it, we could see a number of buildings brilliantly lit up all round it, with crowds of people in the streets, while the ground on which it stood seemed to be laid out as an ornamental café and garden.

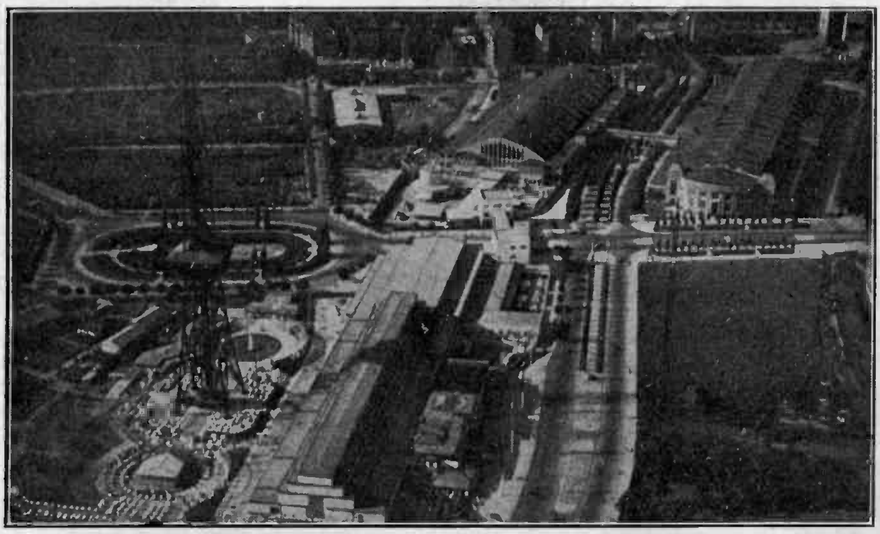
Behaving something like an angry bee that has lost the way to its hive, we came down a few hundred feet and droned round it. No response. A black patch near by, that might have been an aerodrome, contained nothing more promising than a maze of railway crossings and lines. We flew off to try other places, but all looked equally uninviting, and as we took wider and wider circles over the city, which in its turn seemed to grow ever bigger and bigger, I realised, with a queer shiver that we had been flying for something like five hours, and our petrol must be getting low! You can't stop an aeroplane, get out, have a look round and then go on. If you are flying and there is no aerodrome or suitable field in sight, you have to keep flying, or, when you come down, take your chance of hitting something.

While wondering if it was possible to land in a street without upsetting things too much, the pilot twice circled over a dark patch that we had been investigating, and I caught the word "aeroplanes." Sure enough, there, looking like ghosts, were several aeroplanes, faintly reflecting the lights from a building. We circled the spot once, twice, three times, like a hungry child passing and re-passing a pastry-cook's window, or a wasp circling a jam dish that it has been chased off, and then a surprising thing happened, a large portion of the black space was marked out with neon tubes. A second after, someone in the centre of it fired off a green Very light, which soared up and then sank back to earth.

What did it mean? We were not quite sure, but it certainly showed that someone had seen us. We circled again, wondering if those neon tubes were on the ground, six, or sixteen feet up in the air, and anyhow, why didn't they switch on the flood lights?

As a further circuit brought forth nothing but another green Very light, the pilot decided to land.

Turning his back on what was apparently the aerodrome, he flew over Berlin for some distance, turned and began to come down, both himself and his mechanic looking over the sides of the machine, watching.



The Berlin Wireless Exhibition, and the Witzleben tower, as seen from the air. The height of the tower is 420 feet. There is a restaurant one-third of the way up.

The roofs and brightly lit streets came rushing up to meet us, and still we dropped lower and lower until it seemed we must hit the house tops. The sound of the engine died away to a mere murmur, and only the rush of the air past the wings was audible. "Your right wing is low, keep up a bit, there are houses under us," suddenly said the mechanic, and we rose a foot or two as the engine briefly barked in response. Then, "We are nearly touching—nearly touching—nearly—" and with the gentlest of bumps we were down and running over the ground to the hangars. There, feeling like heroes (at least, I did), we climbed out into the midst of a group of German officials. Were they greeting us? Not a bit of it! They wanted to know what business we had to land on the Tempelhof Field when they had been told very definitely that we had landed at Cologne an hour or so ago, and were not coming on that night? No machine was expected in at all.

We also had our grievance. Why wasn't the aerodrome lit up and some sign made to welcome a person in?

Cologne, it seemed, was quite positive we had landed there, and they knew all about us, although we had not been within a hundred miles of the place, or landed anywhere on our journey. In the circumstances, both parties decided to let Cologne make the best excuses it could, and bear the whole brunt of our joint annoyance.

"All's well that ends well," goes the saying, and when we had finished dinner we appreciated the truth of the proverb, for investigation showed that when we landed there was only enough petrol left in the tanks for about five minutes further flight!

The next night I found my irritating flashing light. It is on the top of the Witzleben aerial tower (138 metres high), and under and around it was the wireless exhibition that had called me to Berlin!

The Editor is very fond of that tower and light. He tells me he has used a photo of it to head his report on the Berlin Radio show.

To me it acted rather like a friend who refuses to speak when two words will help you out of a very awkward situation. My last sight of Berlin as the train carried me back to London was Witzleben's flashing light—calling more aeroplanes home.

Television and your Wireless Receiver

By H. J. BARTON CHAPPLE, Wh. Sch., B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E.

Now that television is being broadcast we shall soon have television receivers in our homes, so it behoves us to consider whether our wireless receivers are capable of efficiently supplying a televisor. In the following article our contributor deals with several points of importance in this connection.

THE announcement that the Baird Television Development Co., Ltd., and the B.B.C. have come to terms in connection with the broadcasting of television from one of the Corporation's stations at an early date, has no doubt caused a flutter in the dovecots of the average wireless listener. The first thought that comes to his mind is sure to be "will my wireless set enable me to receive the television signals in the same way as I have received aural broadcasts. Or must I scrap my receiver for an entirely new one, or alternatively modify it ?" This will be followed by a second thought of "what sort of power shall I require and must I use two aerials or is it possible to couple more than one set to my aerial and yet prevent interference one with the other ?"

A Virgin Field.

Of course this will in no way exhaust the queries that will arise, but the purpose of this article is to try and point out where modifications are likely to be necessary, and also suggest a few lines whereby useful experiments can be undertaken and invaluable data derived which will be of great assistance in facing points that are sure to arise in connection with this almost virgin field of endeavour. The wireless man has been seeking new worlds to conquer, because with aural broadcasting nothing of an epoch-making character has occurred for a considerable period, just a steady progress in design with more attention being paid to details and a gradual awakening to possibilities with electric mains drive in lieu of accumulators and batteries. What a wonderful opportunity is offered, therefore, by "this television," a chance to display ingenuity with a reward out of all proportion to the time and energy expended. Brother fans, roll up your sleeves, you haven't a moment to lose if you want to be among the first who can claim to see as well as hear the television programmes on the air.

A Close Resemblance.

From the pages of this journal you have learnt ere this, that as far as the modulation of the high-frequency carrier wave of the transmitting station is concerned the method resembles closely that of ordinary speech broadcast. The photo-electric cell serves the same purpose in television as the microphone in aural working and the light pulses are changed to current pulses, amplified to the appropriate strength and, sent via the carrier wave, pass into space. It is reasonable to suppose, therefore, that a normal wireless receiver should be capable of rectifying and amplifying the resultant induced aerial currents and with a televisor replacing the loud-speaker, the current pulses can be re-converted into light pulses and enable images to be seen.

A Question of Power.

Let us analyse these general remarks carefully. On an average the power required to work a medium loud-speaker at comfortable strength is fairly small, unless of course one is using a moving coil instrument. Indeed, in many homes we find a two-valve receiver capable, under favourable conditions, of giving loud-speaker reception from two or three stations. Now in our televisor we must make this power operate the neon lamp, and it should be fairly clear that for this lamp to function successfully the power output from the set must be of reasonable dimensions. Of course, everything will depend upon the type of neon lamp employed, it being realised that the most common neon tube used for television purposes is the flat plate type.

Since these are now being made for low voltages we can say (without going into exact current and voltage details at this juncture) that if a receiving set is capable of giving signals of good loud-speaker strength from a particular transmitting station, then it will be capable of giving a clearly visible picture on the televisor when receiving signals from the same station. You know that it is possible to watch the neon lamp flicker with quite small imputs—substitute a neon lamp for the loud-speaker on your own set and see for yourself—but this would only mean a faint picture in the televisor and obviously this is not what is wanted. Our first criterion for successful television reception from any given station, therefore, is good or strong loud-speaker strength, it being appreciated that the television note itself has a characteristic sound of its own and if preferred the signal may be tuned in on the loud-speaker and a change-over effected to the televisor afterwards.

What of the Detector ?

Another important detail which merits consideration is the type of rectification employed, that is, whether grid leak or anode bend. Even with ordinary broadcasting, controversy has raged around this point, but the real facts of the case can only be ascertained if it is approached with an unbiased mind. The detector valve in a wireless set has only high frequency oscillations applied to it, and it converts these into a pulsating unidirectional current which usually is amplified by further stages of valves coupled in cascade. The amount of modulation of the high frequency carrier is varying throughout the time of a broadcast, but steps are always taken to prevent the wave being over-modulated as this would only introduce distortion.

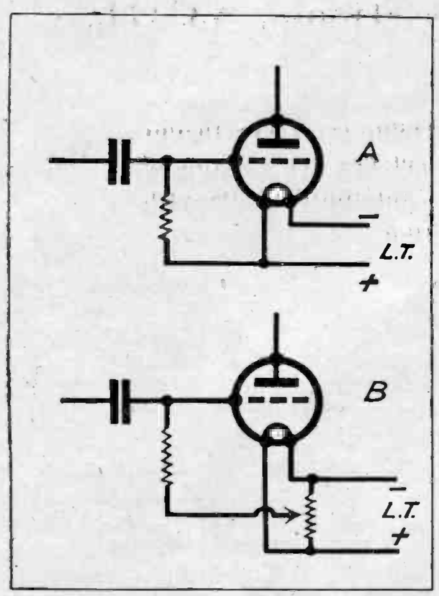


Fig. 1.
Two methods of connection for leaky grid rectification.

Now the range of frequencies to be covered extends in the case of speech and music from about 30 to 10,000 cycles, and while it is advantageous to go beyond this top limit for television purposes in order to produce greater detail, the nine kilocycle sideband limit which is in operation is capable of giving pictures which abound with a wealth of detail. No doubt in the future, television broadcasts will have special allocations as far as sidebands and wavelengths are concerned, but that does not concern us at the moment. We must see that the set in use is capable of passing the nine kilocycle band without distortion to the detector valve, and this in turn must deal faithfuly with the signal and give an output which is in no way distorted, otherwise of course the picture will not be perfect.

Which is Best Suited.

A full analysis of detection is a lengthy proposition, so we will confine ourselves to salient points in order to find which of the two methods—grid leak or anode bend—is the best suited to television reception. In the case of the former, rectification takes place in the grid circuit of the valve, and the resultant low frequency currents undergo magnification in the valve itself, whereas with the latter the reverse holds, that is, the high-frequency currents are amplified in the valve first and are then rectified in the plate or anode circuit. The usual connections of the grid leak rectifier are shown in Fig. 1 (*A*), a fixed condenser of about ·0002 to ·0003 mfd. being inserted as shown, to offer a high impedance to low-frequency currents, while the valve grid is connected via a resistance of about two megohms so that grid current flows. On receiving the high-frequency signals, oscillations pass to the grid through the small grid condenser, but owing to the high impedance of the grid leak, and to the varying grid current produced by the signal, the grid voltage varies in accordance with the low-frequency portion of the signal. Actually, the grid condenser when working collects charges of electricity which reduce the normal grid voltage and, of course, the anode current reduces in sympathy.

A Fall in Current.

That is to say, if a milliammeter is connected in the detector plate circuit the reading will decrease when receiving a signal. In addition to the fact that in grid leak rectification the valve must be adjusted so that grid current can flow, there should be ample provision made for plate circuit changes. In other words, the high tension must be so adjusted that the valve also works on the **straight part** of its plate current grid voltage characteristic and excursions must not be made into the curved portions of the characteristic or a secondary rectification will take place (actually anode bend) and distortion occurs.

Furthermore, it is frequently of great advantage to be in a position to adjust very carefully the grid voltage and to this end the arrangement shown in Fig. 1 (*B*) is used, a potentiometer being applied across the L.T. and the end of the leak taken to the variable tap. Arrange the value of the grid leak and the voltage so that the grid is working on the most sharply curved portion of the grid current curve. Examine the valve curves usually included in the carton as this will assist you in making accurate adjustments, and a reference to Fig. 2 will show what is meant from the valve curve point of view.

How Distortion Occurs.

Now when a strong signal is impressed upon the grid using this system of rectification, the grid circuit is liable to choke and distortion arises, but with relatively weak signals the system is most sensitive and gives good results. Again, with the condenser present in the grid circuit there is likely to be frequency distortion, for with increase of frequency (and we have seen that it is the higher frequencies which add to the wealth of detail in a television picture) the impedance falls off. Improvements can sometimes be effected by lowering the value of the grid condenser or grid leak or adjusting both grid and plate voltages. The inclusion of a small condenser between plate and filament (about ·0003 mfd.) must not be overlooked, but if a form of capacity reaction is in use then this will not be necessary.

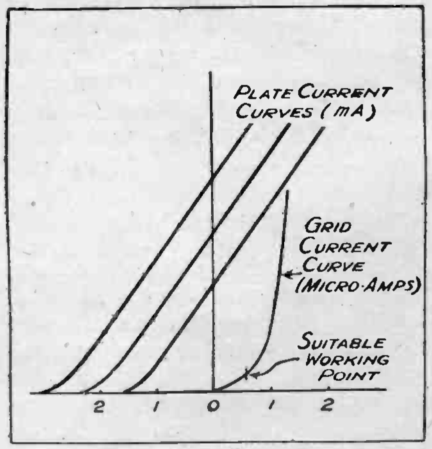


Fig. 2.
A typical family of valve curves.

Anode Bend Rectification.

Coming now to anode bend rectification, as was mentioned earlier, the high-frequency signal is amplified first and then rectified in the plate circuit, and in this case care must be taken to see that no grid current flows. We use the bottom bend of the anode current grid voltage characteristic to do the rectification, and in consequence sufficient negative grid bias must be applied to work at the proper point, the axact value being contingent upon the plate volts in use. The signal variation on the grid must not produce grid current, otherwise distortion will occur and this criterion is a good guide to making the appropriate adjustments. Fig. 3 shows one way of connecting up the valve for this type of rectification, the potentiometer in conjunction with a grid bias battery giving a fine control of the biasing voltage required, and tests can be carried out under working conditions.

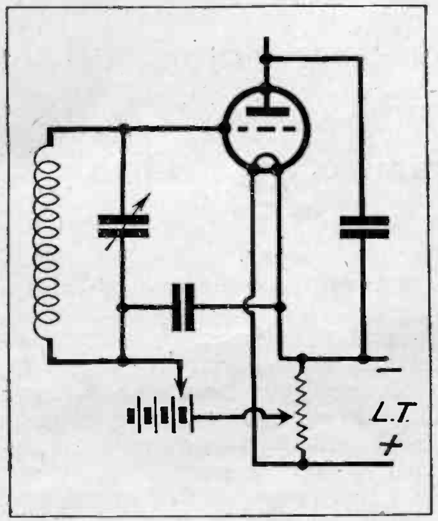


Fig. 3.
Circuit arrangements for anode bend rectification.

Fig. 4 shows in a simple manner how rectification takes place with a modulated high-frequency carrier wave applied to the grid. With the negative biasing voltage adjusted so that normal working is at *A* then the resultant plate current change is taking place on the **straight part** of the characteristic and little or no distortion occurs. If the modulation is too strong or the plate and grid voltages are too low, it is quite obvious that the grid swing will run on to the positive side of the characteristic and grid current flows, with resultant distortion. On the other hand, if signals are weak the curved part of the characteristic is used and distortion again takes place since there are not proportional plate current changes to grid voltage changes. The use of an anode circuit by-pass condenser is usually essential, although this has a tendency to weaken the higher frequencies.

Which is Best.

It should be quite obvious that with strong signal imputs to the grid, anode bend rectification lends itself to almost distortionless rectification and, consequently, better picture reproduction is obtained. On the other hand, for weak signals grid leak rectification is to be preferred. What then is best suited to the requirements of television? For all-round working anode bend rectification is preferable for two or three reasons, and having grasped the fundamentals of both types of rectification the reasons for this will be advanced next month, while the other points mentioned in the opening paragraphs of the article will also be dealt with.

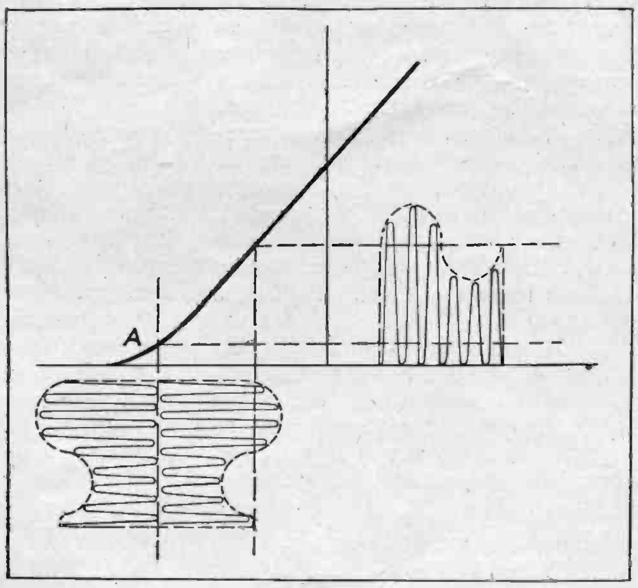


Fig. 4.
How rectification takes place.

STATEMENT FROM THE BAIRD CO.

At the time of going to press we learn that the Baird Company are making arrangements with manufacturers for the production, under licence, of television receiving sets which should, after preliminary tests through 2LO, be standardised and made available to the public.

In our next issue we hope to be in a position to give our readers some further information.

The Television Society

Latest Correspondence *re* Broadcasting.

Group Centres.

Autumn Programme. Olympia.

THE Television Society was two years old on the 7th of last month. Its first meeting was held immediately following the British Association Meeting of September, 1927, in the University Buildings, Leeds.

Since then enthusiasm has been maintained, and its membership is now over 550 members.

Lectures have all been well attended, and the summer visits proved a great success.

The change of address of headquarters to 4, Duke Street, Adelphi, W.C. 2, has evidently proved helpful to members, as its central position has enabled visitors to interview the Society's officials on all phases of television progress.

During the vacation circulars have been distributed to members, notifying them of progress towards establishing the broadcasting of television, and it will be seen from the following correspondence that the experimentalist at home will soon be afforded his opportunities.

The following completes the correspondence already circularised :—

BAIRD TELEVISION
DEVELOPMENT CO., LTD.,
133, Long Acre, W.C. 2.
10th September, 1929.

W. C. KEAY, Esq.,
The Television Society,
4, Duke Street, Adelphi, W.C. 2.

DEAR MR. KEAY,

As promised, I beg to enclose copy of a letter sent to the Postmaster-General on the 4th inst. in reply to the offer of increased broadcasting facilities of five half-hour periods per week. I do not think I can usefully add anything to the statements made in the letter, which clearly indicate that the present facilities have been accepted as a temporary measure.

Yours sincerely,
(Signed) T. W. BARTLETT.

Copy of letter from Baird Television Development Co., Ltd., to the Postmaster-General, dated 4th September, 1929.

SIR,

I beg to acknowledge the letter of Mr. Leach of the 14th August, 1929, and to thank you for it.

My Board desire me to let you know that, whilst they are of the opinion that the offer now made is inadequate and will not in any way satisfy the wireless trade that they are justified in embarking upon an extensive programme of manufacture, my Board have no other alternative but to accept the offer as a temporary measure to enable my Company to give demonstrations to manufacturers interested in becoming licensees, and representatives of foreign countries who desire to see our system working under ordinary broadcasting conditions. In the light of the results of these demonstrations the whole matter can be reopened and reviewed with a view to adequate facilities being granted, and thus making it possible for manufacturers to go into production and sets being made available to the public.

My Board desire to enlist the aid of your Department in initiating the necessary consultations with the British Broadcasting Corporation so that a service may be put into operation without the unnecessary delay of a day.

I have the honour to be, Sir,
Your obedient servant,
(Signed) O. G. HUTCHINSON,
Managing Director.

Group Centres.

Interest has been excited by the impending developments of the broadcasting situation, and members in the country and others have expressed the desire to meet locally, attend lectures and discussions, and generally aid and intensify the objects of the Society.

To meet this demand the Council has drawn up a statement of procedure, also bye-laws for the formation of group centres.

A typed copy will be forwarded to members interested, on their application to headquarters.

Arrangements are being made so that secretaries of group centres may receive advance lectures or abstracts for discussion on the same date as the London meetings. Societies, or members wishing to form a group centre of the Television Society, should apply to the undersigned for further particulars.

The work of the Society has steadily proceeded during the vacation. The index of literature has grown to over 700 references which are being very carefully scrutinised. The work of compiling has proved to be more than originally contemplated, but it is expected that publication may be put in hand during the autumn.

In connection with the "standardisation of terms," representatives of the Television Society have been elected to serve on the committee of the British Engineering Standards Association.

The last published proceedings include reports of the two last informal meetings, when discussions were held on Selenium, and on the Quantitative Aspect of Television. This has been forwarded to all the Fellows. A limited number of copies remain, priced at 6d. each, which will be forwarded to members who apply.

It is gratifying to note that the Treasurer reports that the year's subscriptions are coming in, as so

(*Continued on page* 419.)

The Actino-Dielectric Effect

By H. WOLFSON

Hitherto our contributor has dealt with the photo-electric effect in connection with metals. It is not generally known that similar effects take place when certain non-metals are exposed to light. In the following article Mr. Wolfson gives some interesting details.

THE present article is the outcome of the request of a number of readers for further information concerning the actino-dielectric effect. This was mentioned briefly in an earlier article,* and readers would be well advised to read that article in conjunction with the present one.

The actino-dielectric effect was the outcome of investigations of the photo-electric effect of non-metals, usually insulators, or substances of extremely high electrical resistance. It seems, therefore, desirable to discuss this at some length, as in our previous study of the photo-electric effect little or no mention has been made of this subject.

The detailed investigations of Goldmann and Kalandyk into the photo-electric effect of sulphur will be described first. Many of the peculiarities of sulphur are shared by other insulating substances, and this will be pointed out in the course of the article.

Conductivity of Insulators.

If one is dealing with a comparatively thick layer of sulphur or other photo-active insulator it would be expected that electrons would be liberated, not only at the surface, but also in the interior of the substance. These latter electrons, since they would not be emitted, should impart to the insulator some degree of conductivity during illumination. The experiments of Goldmann and Kalandyk support the view that these substances have temporarily a number of *free* electrons, which account for the observed conductivity.

The experimental arrangement for the investigation is extremely simple, consisting of a piece of sulphur arranged between two electrodes. The arrangement can be imitated by graphiting the surface of a smooth piece of slate, which is divided into two electrically distinct portions by means of an engraved line, of a form as shown in Fig. 1A. No graphite should be allowed to get into this dividing line, which should not exceed 1 mm. in width. After testing with an H.T. battery and phones to make sure that there is no electrical connection between the two halves, the slate can be coated with sulphur by simply heating the slate, carefully, over a Bunsen flame, and painting the sulphur over the surface embraced by the lines. Contacts are arranged at the sides, and can be either springy brass clips or clamps such as are used in primary batteries.

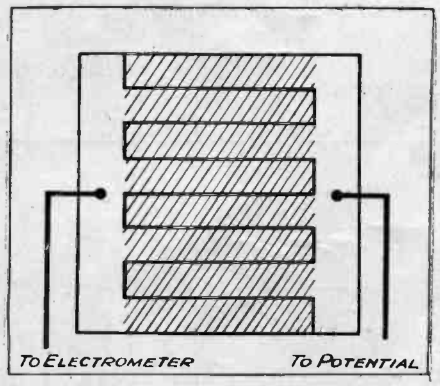


Fig. 1a.

Shows slate former, for sulphur or selenium type cell. Shading shows sulphur.

Light is incident on the sulphur at right angles to the plane of the slate, and should be from a powerful source, such as the carbon arc, already described, or a mercury-vapour lamp. It was found that the sulphur acquired a conductivity which was independent of the applied field up to 400 volts per mm. The current passing through the sulphur is then of the order of 2×10^{-9} amp.

An alternative arrangement (Fig. 1B) consists of a metal plate *P*, on which is placed the sheet of sulphur or other insulator *S*. The gauze *G* is placed parallel to the surface of the sulphur. The gauze can be maintained at any potential, either positive or negative. In the latter case the electrometer will acquire a negative charge, due in part to the photo-electrons emitted from *G* to *S*, and partly to the conductivity produced in the thin layer of illuminated sulphur.

Should the layer be of such a thickness that the illumination does not reach *P*, then there will be a separation of charges until the external field is counteracted. This is called the polarisation of the dielectric, which is indicated when the negative charge on the electrometer becomes constant after the lapse of a certain time.

With the gauze at a positive potential, however, the positive charge on the electrometer is due: (*a*) to the conductivity induced in the sulphur (if thick layer, polarisation effects come into play), and (*b*) to the escape of any photo-electrons present in the sulphur, from *S* to *G*.

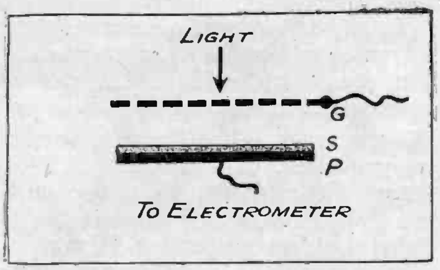


Fig. 1b.

An alternative arrangement.

Only when the layer of sulphur is so thin that it is a conductor throughout the experiment is the steady current due entirely to the surface photo-effect.

---

* TELEVISION, No. 13, March 1929, p. 40.

Without entering into a discussion of the curves, I append Fig. 2, which shows the behaviour of a 2 mm. layer of sulphur, with the distance S–G 3 mm., under two sets of conditions: (1) gauze negative and (2) gauze positive. Fig. 3 shows the effect of the thickness of the layer. We see that the effective depth of penetration of the light is about 0·3 mm.

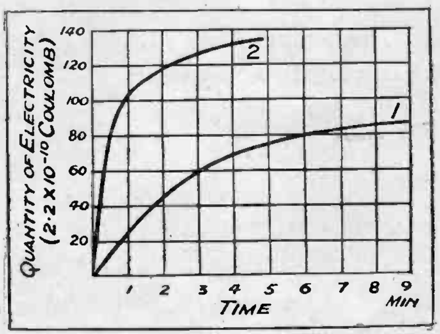


Fig. 2.

1 = Gauze at negative potential.
2 = Gauze at positive potential.

It is difficult to state the ratio of the number of electrons emitted by the surface to the number released in the illuminated layer. From the results obtained, however, it seems permissible to suppose that more electrons are liberated *in* the illuminated layer than *from* the surface. The question of the effect of wave-length has, unfortunately, been neglected. Goldmann mentions that the effect is cut off entirely by a glass plate, which suggests that light of wave-lengths shorter than 3,300 Å alone are effective in producing the surface effect, and that longer waves suffice to produce the conductivity.

Conductivity of Selenium.

It is well known, of course, that selenium becomes a conductor when illuminated by visible light, yet its photo-electric effect is not displayed till a wave-length of 2,200 Å or less is employed. The work of Ries leaves little doubt that the conductivity arises, in part at least, from the free electrons. Nevertheless, it seems to be definitely established that the escape of photo-electrons from many non-metallic surfaces requires light of higher frequency than is required to produce an increase in conductivity.

This view seems to be amply supported by the work of other experimenters on silver iodide, anthracene, and Lenard and Saeland's experiments on luminescent substances. The apparatus employed was similar to that shown in Fig. 1B. It is shown that the change in conductivity in the illuminated sheet of an insulating substance can only produce the polarisation effect when the layer which is rendered conducting is not in contact with the metal plate. The electrometer does not acquire its charge at a constant rate, but the rate of charging decreases to zero, indicating that a final polarisation state has been reached. This is the so-called actino-dielectric effect, a name given to differentiate it from the true photo-electric effect, in which the electrometer acquires charge at a constant rate. The syllable "di" in actino-dielectric is meant to stress the essential difference between the effect and the analagous changes in selenium.

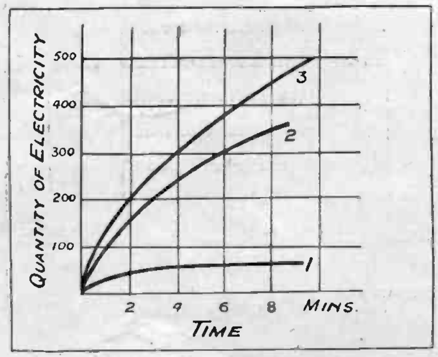


Fig. 3.

Showing the effect of thickness ;

1 = Thickness of sulphur .. 1 mm.
2 = " " .. 0·5 mm.
3 = " " .. 0·2–0·3 mm.

The latest conclusions of such workers as Oeder, Schmidt, and Lenard is that the actino-dielectric effect has no connection with phosphorescence. It should, in a dielectric displacement and formation of residual charge, be accompanied by a definite wandering of ions, which is particularly shown in long wave-length red light.

In the formula $V=kv-V_0$, which connects potential with maximum emission velocity and frequency, we regard V_0e as the energy required by an electron to be separated from the surface molecules. If less energy is required to separate an electron from an interior molecule than from a surface molecule, we should expect the increased conductivity which is produced to be brought about by light of longer wave-length (lower frequency) than is requisite for the photo-electric effect.

From time to time various workers have carried out experiments with a view to finding the connection, if any, between the photo-electric effect and the fluorescence of a number of substances. Pauli employed an interesting and novel method for the investigation of the problem. The ratio of the intensity of the exciting light to the fluorescent light was studied as a function of its relation to the wave-length of the exciting light. The photo-electric effect was examined at the same time, and it seems reasonable to expect that if there is a real and fundamental relation between the two effects, we should expect a marked photo-effect with the most active exciting light.

Electrometer Tests.

A shallow metal tray was connected to an electrometer. Around the tray was a cylindrical electrode, which could be raised to any desired potential, either negative or positive. The fluorescent substance is placed on the tray and illuminated. The substances examined all showed well-marked actino-dielectric effects. A typical case for eosine is given in Fig. 4. The two curves give the progress of the leak of the electrometer with time, the cylinder being at a negative or positive potential with regard to the illuminated substance.

If the surrounding field is positive (thus favouring the escape of negative electricity, in the shape of electrons), the actino-dielectric effect disappears after a time, leaving the ordinary photo-electric effect.

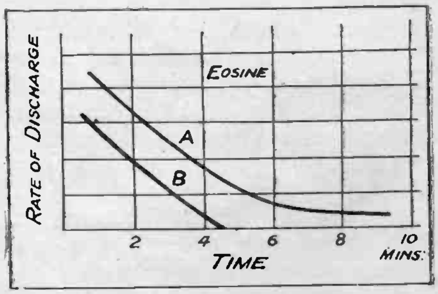


Fig. 4.

A = Surrounding cylinder at positive potential.
B = Surrounding cylinder at negative potential.

If we call the photo-activity of a standard zinc plate 2,000, the activity of anthracene was the greatest, of value 10, while eosine was least active (1·2). The next graph (Fig. 5) shows (1) the actino-dielectric effect and (2) the efficiency of the light for exciting fluorescence plotted against the wave-length. No relation at all is shown for anthracene, the maximum for the actino-dielectric effect was at 5,400 Å, and for the efficiency of the exciting light the maximum was at 4,450 Å.

Turning our attention now to phosphorescent substances, such as have been examined by Lenard and Saeland, we find further evidence of the actino-dielectric effect. It was in this connection, in fact, that the term was first employed. Quoting from the original paper by these two workers:

"When the specimen was illuminated with light containing red as one of its constituents the electrometer gave a deflection when the specimen was positive. In the case of a positive charge, however, the deflection increased to a limiting value, and then remained constant; while when the specimen was negative the deflection continued to increase as long as the illumination lasted. When the specimen had been exposed to red light long enough for the electrometer needle to have come to rest the phenomenon could not be observed again until the specimen had rested for several hours in the dark, or in some other way—e.g., by heating—had been restored to its original condition. But if the experiment was performed with the gauze alternately positive and negative, it could be repeated indefinitely. With violet light no deflection was observed unless the gauze was positive. . . ."

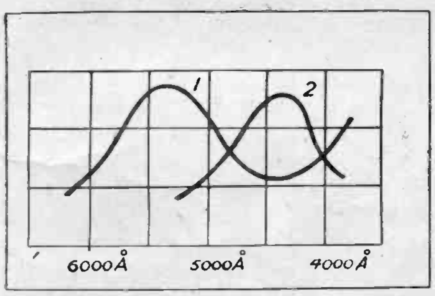


Fig. 5.
1 = Actino-dielectric effect.
2 = Efficiency of light for exciting fluorescence.

The authors point out that the phenomenon suggests either dielectric polarisation or temporary conductivity under the influence of the longer rays.

The substances studied, called "phosphors," consist of a sulphide of calcium, strontium, or barium, to which is added a trace of metal such as lead, bismuth, or nickel. The whole is fused together with the aid of a flux, which may conveniently be sodium sulphate or borax. The most active of these phosphors is calcium sulphide, with bismuth as the added "impurity"; the photo-electric activity is nearly as big as that of aluminium, but the maximum emission velocity did not exceed that corresponding to 2 volts. Since all these substances are good insulators, they show the actino-dielectric effect, which is, however, only noticeable during the first few minutes of illumination. The surfaces become charged up positively, until no further emission of photo-electrons can take place.

It was found that at the time when the surface ceases to emit any more electrons only one-tenth of the surface was actually charged. From this it seems fairly safe to conjecture that the photo-electric effect is not distributed evenly over the surface, but is localised in those centres which are active in the phosphorescent sense.

The Construction of Amateur Apparatus.

(*Concluded from page* 410.)

constructed on the following lines: The motor should be arranged to rotate about its axis, this motion being imparted to it by means of a worm drive. The case of the motor should be mounted in two independent bearings. As this sort of work requires a considerable amount of skill, and entails the use of machine tools, I do not propose to give details here. It should be noted that this method of phasing can only be used when some form of synchronisation is employed; where hand-controlled motors are used, a slight speeding-up or slowing-down of the motor will bring the picture "into phase."

In my next article, which I think will prove an interesting one, I am going to describe the construction of a filter for attachment to the output terminals of a radio receiver, having as its object the production and maintenance of the "glow" of a neon tube. Once the tube is "struck" and kept glowing its brilliancy can be varied by the signals fed into the filter by the radio set.

Television Society.

(*Concluded from page* 416.)

much of the future work of the Society must depend on the support it receives from its members.

The programme for the forthcoming half session is as follows:—

TUESDAY, October 1st, 8 p.m.—H. S. Ryland (Fellow, Optical Society): "Talking Films" (with demonstration).

TUESDAY, November 5th, 8 p.m.—F. Langford-Smith, B.Sc., B.Eng.: "Amplification and Television" (with experiments).

TUESDAY, December 3rd, 8 p.m.—G. Priechenfried, Esq.: "The Problem of Synchronisation in Picture Transmission."

TUESDAY, January 7th, 8 p.m.—E. George Lewin, M.Sc.: "Television—Some Suggested Schemes" (slides).

Next Meeting.

On October 1st the first meeting of the session will be held at the Engineers' Club, Coventry Street, W.C. 2, as usual, and the meeting will be preceded by an informal meeting for discussion at 7 p.m. During the evening it is hoped that the remaining half of the sessional programme will also be discussed.

The Radio Exhibition, Olympia.

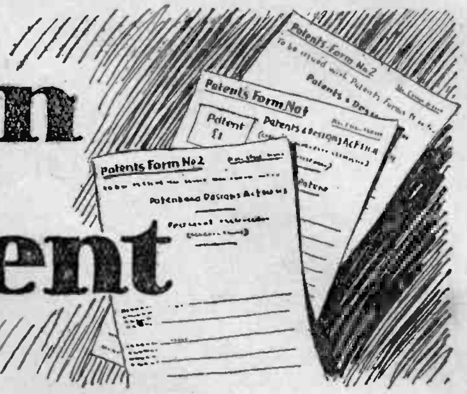
Members may be afforded an opportunity of meeting each other, or officials of the Society, by making themselves known at the stand of the Television Press, Stand No. 241. It is expected that members will introduce the work of the Society to their friends and so help to augment the membership, and make for the success of group centres in the provinces.

J. DENTON, A.M.I.E.E.,
W. G. MITCHELL, B.Sc.,
Joint Hon. Secretaries.

Newcastle Group Centre.

Mr. B. B. Brooke, of "Holnon," Runnymede Road, Ponteland, Newcastle-on-Tyne, an enthusiastic Fellow of the Television Society, is endeavouring to form a group centre at Newcastle. His efforts have met with the whole-hearted support of the local Press, and we wish him every success.

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.

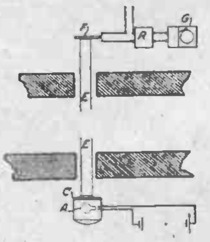


FIG 1.

Patent No. 313,178 granted to Neale, J. In a burglar alarm system, in which the shadow of the burglar causes changes in the resistance of a light-sensitive bridge, a lamp (A) with a screen (C) is used to direct infra-red rays (E) on to the light-sensitive bridge (F). This bridge controls through a relay (R) a local circuit containing an audible or visible warning device (G) and/or photographic apparatus for taking moving or still pictures.

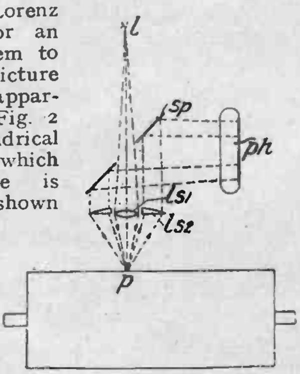


FIG 2

Protection is sought in *No.* 313,127 (Convention date, Germany, June 7th, 1928), by Lorenz Akt.-Ges. for an optical system to be used in picture telegraphy apparatus. In Fig. 2 the cylindrical drum on which the picture is wrapped is shown in the lower portion of the diagram. Light from a source (l) is concentrated by lens (ls1) to a point (p) on the surface of the picture and the reflected light is gathered by an annular lens system (shown in section as ls2) and then again reflected) by a pierced mirror (sp) on to a photocell (ph). The mirror (sp) may be curved. It should be noted that the piercings in the mirror (sp) and the lens system (ls2) accommodate the incident light beam.

FIG 3

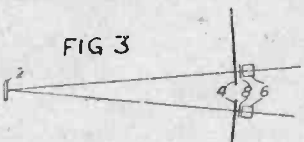
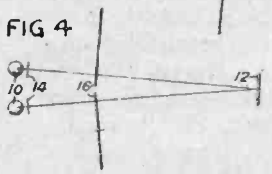
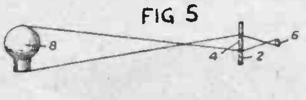


FIG 4



Patent No. 312,560 granted to Baird, J. L., and Television Ltd. (Divided on No. 312,406.) Television apparatus for colour reproduction comprises a transmitter (Fig. 3), with two or more exploring discs (4), each exploring an object (2) and each associated with a separate light-sensitive cell (6) having an appropriate light filter (8). In the receiver shown in Fig. 4, two or more light sources (10), each associated with a separate exploring device (16) and light filter (14) reproduce an appropriately coloured image (12). The exploring discs may overlap.

FIG 5



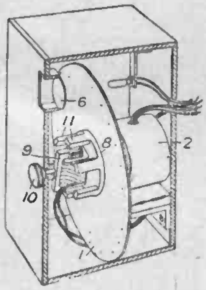


FIG 6

Patent No. 312,406 granted to Baird, J. L., and Television Ltd. (Fig. 5). In a television receiver employing a modulated light source (8) and a rotating disc (2), an optical system having a focal length of about one quarter of an inch or less and operating in combination with the exploring disc, limits the angular dispersion of the emergent rays. The short focus lens (4) placed in each aperture of the disc, is preferably cylindrical so as to expand the image (6) of the light source to a length equal to the width of the bands in which the reproduced image is explored.

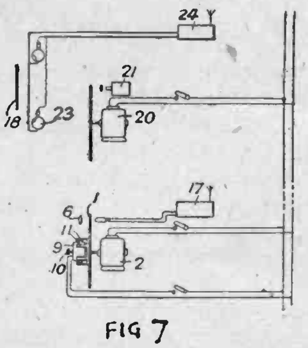


FIG 7

Nos. 312,651, 312,653, 312,654. Protection is sought in these three Patents by The British Thomson-Houston Co., Ltd. (Assignees of Kell, R.D., all bearing Convention Date (U.S.A.), May 29th, 1928) *No.* 312,651 (Fig. 6). The exploring disc of a receiver has an electro-responsive device arranged to lock the disc in synchronism with the exploring disc at the transmitter, the device being controlled manually to adjust for phase. For this purpose the disc at the receiver has a rotor (8) mounted on it, which co-operates with an electro-magnet (9). The rotor has a number of pole pieces (11). At the transmitter (shown in the upper portion of Fig. 7), light from a source (21) is reflected from the picture (18) thence to light-sensitive cells (23). The driving motors (20) (2) at transmitter and receiver respectively, are run from the same source of supply or from supplies of the same frequency. *Patent No.* 312,653 (Fig. 8). Received vision signals are impressed on the electrodes (3) (4) of a Kerr Cell (5). The exploring disc (9) is placed between the Kerr Cell and the light source, so as to restrict the light falling on the cell. The source of light (6) projects a beam through the lens (8), a hole of the disc (11), through the Kerr Cell (5), the lens (12) and is finally focussed on the receiving screen (7). *Patent No.* 312,654 (Fig. 9). The particular interest of this Patent is the means employed for collecting and concentrating the reflected light on to the light-sensitive cells.

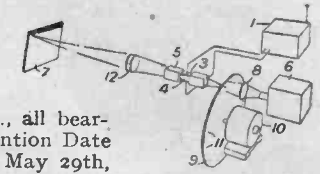


FIG 8

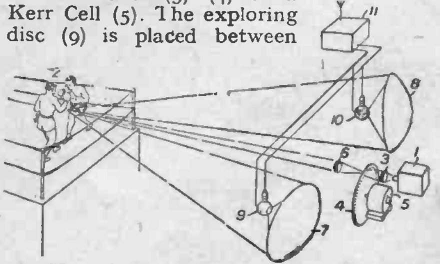


FIG 9

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OCTOBER 1929.

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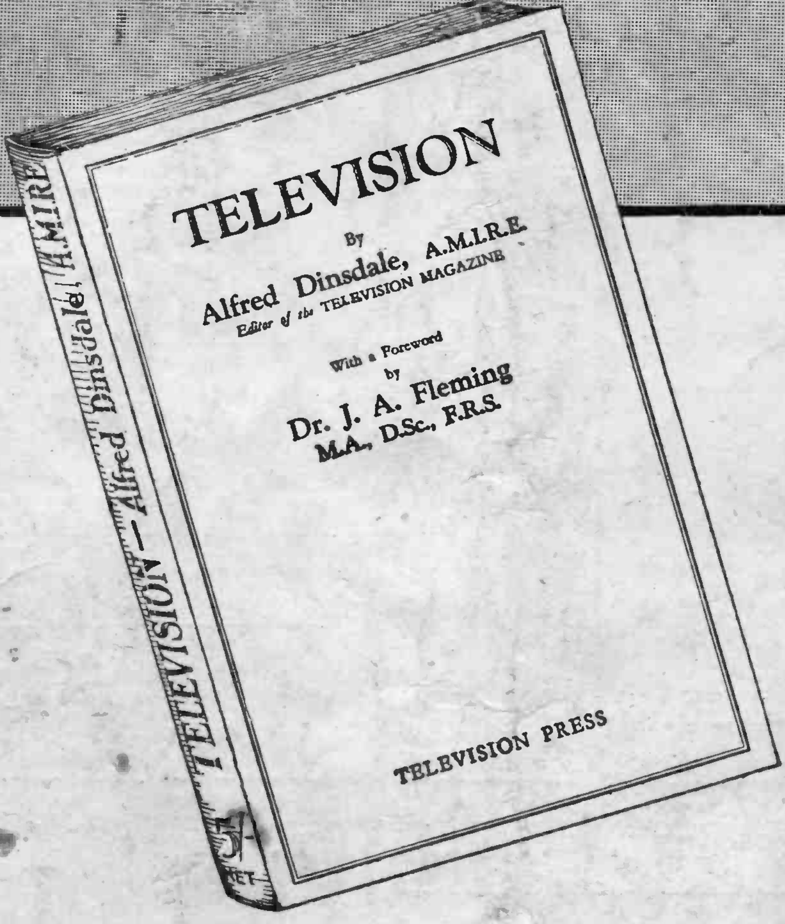
Adelphi, W.C. 2.

(Stamp enclosed.)



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