CHRISTMAS NUMBER

6D MONTHLY

Television

The Official Organ of the Television Society

VOL. 2 DEC. 1929 No. 22

BAIRD TELEVISORS IN PRODUCTION

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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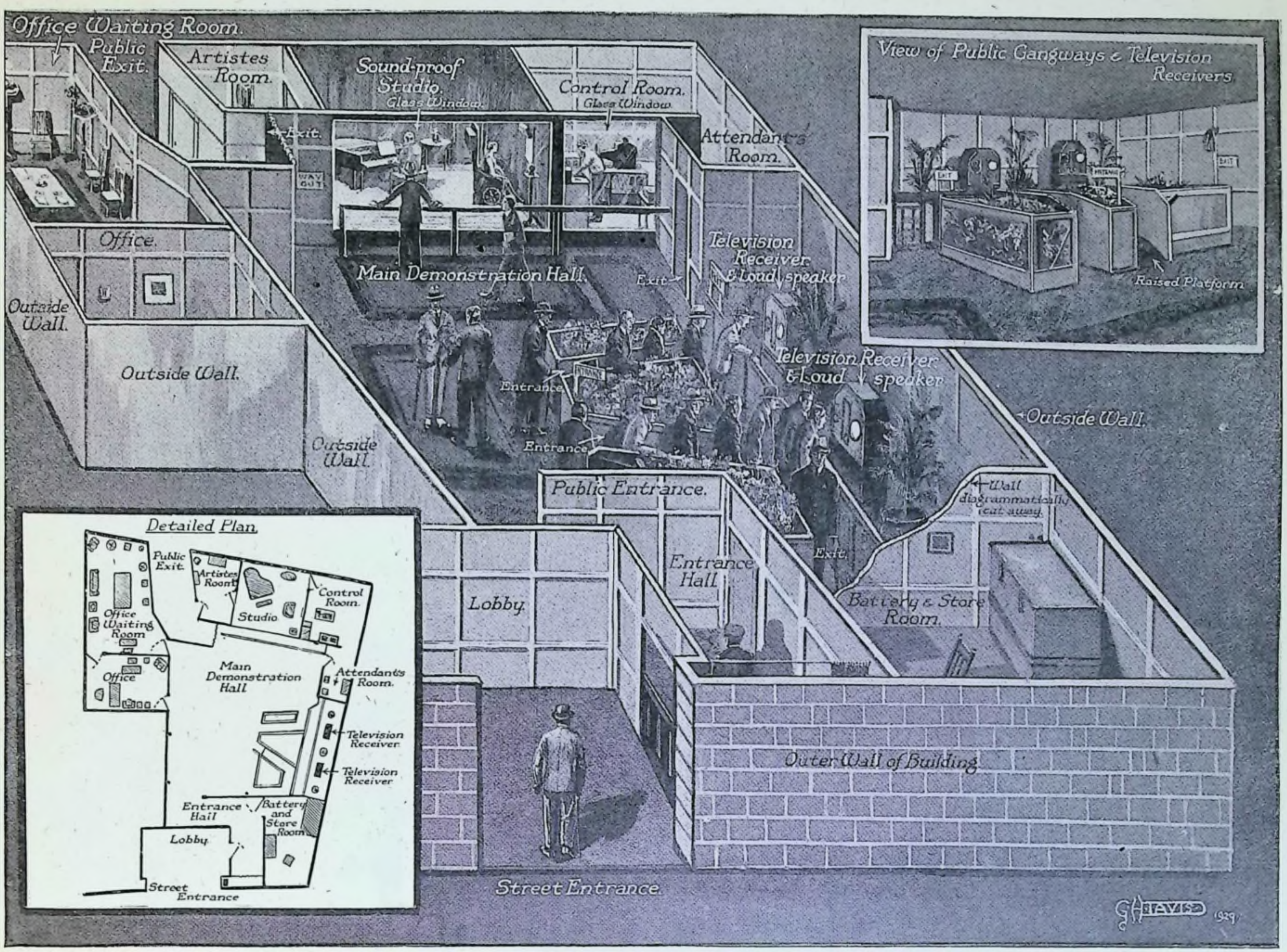

Pictorial representation of the premises in which television was publicly demonstrated during the National Radio Exhibition, Sept. 23rd to Oct. 3rd, 1929.

TELEVISION

THE
OFFICIAL ORGAN OF
THE TELEVISION SOCIETY

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VOL. II] DECEMBER 1929 [NO. 22

EDITORIAL

OUR first duty this month is to thank the large number of our readers who answered the questionnaire card included in our last issue. The number and nature of the replies reveals that we have the interested and wholehearted support of our readers, who are as anxious as we are ourselves to make TELEVISION more extensive in scope and as perfect a magazine as possible.

The comments and suggestions made, although in some cases contradictory, were of great interest and value. With one or two isolated exceptions, our new "layout" is heartily appreciated. Some of our readers want us to publish nothing but technical articles. An equal number complain that we already have too many technical articles and wish us to include more matter of a lighter character. A limited number ask us to steer a middle course and make the magazine more general in its appeal. Well, it is impossible completely to please everybody, and a middle course appears to be the only possible compromise.

A number of readers suggest that it is time that we had a new cover, more up to date. With this sentiment we agree, and new cover designs are now being considered. It is hoped that we shall be able to introduce our new cover with our January, 1930, issue.

Almost all the replies express a desire for more constructional articles. There have been several reasons for our delay in publishing such articles. In the first place it was only recently that the Baird Company revealed certain essential facts concerning their apparatus, such as the number and diameter of the holes in the scanning disc, picture ratio, and, most important of all, the automatic synchronising gear. We had no desire to repeat the mistake made in America a year or so ago, when instructions were published, and kits of parts sold, which did not include any means for attaining synchronism other than manual adjustment of the speed of the receiving motor. The resulting disappointment produced, in America, nothing but disgust for television, and stultified at birth public interest in the new science.

After the Baird Company revealed the necessary information, and television broadcasting commenced, there was still, so far as we were able to gather, some doubt as to whether the scanning disc then in use would remain standard, or whether, in the light of broadcasting experience, and for other reasons, it might not be altered. We have now succeeded in obtaining some definite information from the Baird Company as to their plans, and this is contained in an announcement which will be found on page 492 of this issue.

One Remaining Problem

There is one remaining problem, however. Unlike wireless, television does not, at present, offer unlimited scope to the experimenter to try out all manner of combinations of parts, and, again unlike wireless, those parts cannot be made simply at home with the aid of a screwdriver and a pair of pliers.

The essential parts of a televisor are (1) motor, (2) scanning disc, (3) synchronising gear, and (4) neon tube. Few amateurs would care to make an electric motor, and fewer still are competent to make one which will run with sufficient accuracy for television purposes, and which will not cause interference to the adjacent wireless receiver and amplifier. In our next issue there will be a very interesting article on this latter problem.

Only those who have tried it know how extremely difficult it is to mark out and drill a scanning disc accurately with the tiny holes required. For perfect results this must be a precision engineering job. And even then, with expensive machinery to do the work, quite a number of discs have to be discarded as unfit.

The synchronising gear can be made by anyone who has a lathe, and is accustomed to working to a thousandth of an inch, but it is not everybody who has these facilities and qualifications. As for the neon lamp, it would surprise us if there is anyone in the country who could make up one in his own home.

These remarks may sound very discouraging, but they represent the facts which have to be faced. That they have not discouraged many of our readers we know from correspondence received, and that they will not discourage others is equally certain. Our statement of the case represents the position as it affects the man who wants the most perfect results possible. There are thousands more, as wireless has already proved, who welcome a difficult job for the sheer joy of overcoming the difficulties and, although aware that the results of the finished product are not perfect, glory in them nevertheless, because they have been obtained on apparatus which is the work of their own hands.

Motors and neon tubes can be bought. Scanning discs and synchronising arrangements can be and have been made by some of our readers, and they are getting results, according to reports which we have received. In this connection we shall be delighted to hear from any readers who have not yet written to us, and who are getting results from the present television broadcasts. We are out to make 1930 a television year, and we cordially invite your help and support to that end, and to the end that we may decide how best to help *you*. As a beginning, Mr. Waters' series of constructional articles enters, with this issue, upon an interesting phase, and we shall welcome in particular comments from those who act upon the instructions given.

And now for some more replies to our questionnaire.

One reader suggests that, when apparatus becomes available on the market, we give, month by month, a review of this apparatus. That shall be done.

A New York correspondent expresses himself in the words: "Not so much Baird from cover to cover." There are several ways of answering this criticism. One is that in the early days of wireless one could write but little on the subject without mentioning the word Marconi. But we suspect that our American critic is somewhat annoyed because we do not refer to the efforts of the multitude of American television experimenters. If we did, we should only bore our readers with a repetition of technical details and principles with which they are already familiar. Baird led, and still leads, the world in television development, and in chronicling his progress we chronicle the work of successful television workers the world over. There are, of course, exceptions, and whenever anything of interest or importance occurs in any country, we publish details as soon as they become available. Finally, American journals take good care to boost American inventions. We support British inventions.

Sydney A. Moseley is unquestionably the most controversial of our contributors. It is not surprising, therefore, to find that some of our readers want his articles eliminated. But five times as many enjoy them and want them continued!

In conclusion, Christmas is almost with us again, and we allocate our last words to you on this page to wishing you all most heartily the compliments of the season.

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Educational Uses for Television

By *Sir Ambrose Fleming*, F.R.S.

NOW that television is an accomplished fact and the images of living and moving objects can be transmitted to, and seen at, distant places both by wireless and by wire transmission, an interesting question presents itself as to the nature of the objects the images of which can be so transmitted or televised.

We have to accept the fact that there is a very definite limitation at present to the size of the objects which can be televised or of the images which can be reproduced by the sizes available for the surface of the neon lamp, which up to the present has been the only available light source for reception. A further limitation (for broadcasting purposes) is imposed by the narrowness of the available wavebands.

Suitable Subjects

Such objects as the human face or the head of a large dog, or a cat, can be and have been successfully "televised." However, unless celebrated persons or those with very handsome countenances or singers or speakers can be induced to "sit" for such television, it seems probable there may be a limit to the public interest taken in it.

What is now required is a large range of objects suitable for television.

At the end of this article I have made suggestions for modifications of the transmitter which will enable objects in a horizontal position to be televised.

At present I confine myself to certain suggestions for the televising of astronomical objects. Of all these the full moon is our most attractive nocturnal object, and the question has been raised as to whether it would be possible to televise the full moon or even a lunar eclipse or a partial or total solar eclipse, so as to be seen simultaneously by many people at distant places.

The only practical method by which this could be done is by forming a good optical image of the celestial object by means of a large achromatic lens or concave mirror, and then treating this image as an object to be scanned by the revolving disk with its single turn of spiralized holes.

To fix our ideas, let us suppose a scanning disk made 12 inches in diameter. Let it have 30 holes in it, each about one-thirtieth of an inch in diameter, and let these holes be spaced 1 inch apart in a spiral of one turn with 1 inch pitch.

Suppose this disk geared to the shaft of a motor so as to be revolved at the rate of 1,000 turns per minute, which is quite feasible.

Let a sensitive photo-electric cell with a cathode surface of rather more than 1 inch in diameter each way be placed immediately behind this disk. Then form on the other side of the disk an image of the full moon, 1 inch in diameter. As the scanning disk revolves, the holes will pass across the fixed optical image in successive adjacent lines and "scan" it.

Before we go any further we must inquire into the "candle-power" of the moon. The intensity of a source of light is now measured or estimated in "International Candles," which may be taken roughly to be the intensity of a good paraffin, wax or stearine candle. If such a candle is held in a dark room 1 foot from the surface of a sheet of clean white paper, the illumination or brightness on that paper is called 1 *candle-foot.*

We find by trial that this illumination of 1 candle-foot is the least by which we can see to read comfortably an ordinary newspaper. Anything rather less than this illumination soon fatigues the eye, and for anything less than about $\frac{1}{2}$ candle-foot ordinary book type cannot be read at all.

Illumination produced by Moon.

Experiment has shown that the illumination produced by full moonlight out of doors is not much more than one-fiftieth of a candle-foot. If any one tries the experiment in this country of reading a newspaper by full moonlight out of doors with no other artificial light near by, he will find out how very feeble the illumination produced by the full moon is in fact.

The question next arises, how can we form an image of the moon 1 inch in diameter, and what will be the brightness of this image? The moon in astronomical language has an apparent angular diameter of about half a degree.

Artists and others who represent the full moon in pictures often give it a very exaggerated apparent diameter. Most persons, if asked how large the moon looks, would say as large as a shilling, or some would even say as large as a dinner-plate. As a matter of fact the full moon is just covered by the width of an ordinary pencil held at arm's length, or say, 30 inches from the eye. It would be just covered by a halfpenny held 10 feet from the eye.

When an image of an object is formed by a convex lens or concave mirror, the apparent diameter of the image as seen from the centre of the lens or mirror is the same as the apparent diameter of the object as seen from the same place by means of the unaided eye. Hence it is clear that to form an image of the moon 1 inch in diameter we should require a lens of a focal length of 10 feet.

The amount of light collected in this image is the same as that which falls on the lens from the object. Accordingly, if a lens 7 or 8 inches in diameter and of 10 feet focal length is used to form a real image of the full moon, that image will be 1 inch in diameter and will have a brightness of about 1 candle-foot.

The light which passes through the holes in the scanning disk will then perhaps be enough to generate a useful current in the most sensitive form of photo-electric cell, but the brightness of the image can be increased by using a larger lens.

Now an achromatic lens of 7 or 8 inches in diameter would be a rather costly thing, but a silver-on-glass concave spherical mirror, as made by Sir Charles Parsons process, would be far less costly than a lens and would do just as well.

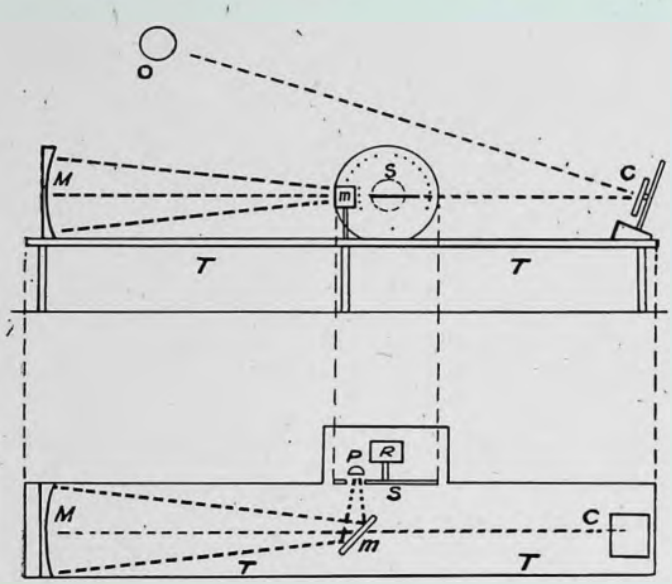


Fig. 1.—Elevation and plan views of a form of horizontal Newtonian telescope.

TT, *table;* M, *concave mirror;* m, *small plane mirror;* C, *cœlostat;* S, *scanning disk;* R, *driving motor;* P, *photo-electric cell;* O, *the moon or sun.*

Theory shows that for such a spherical mirror the radius of curvature is double the focal length, and also that for an object so far off as the moon the image would be formed at the principal focus, or half-way between the centre of curvature and the mirror surface. Hence we should require a concave mirror of 20 feet radius of curvature.

If such a mirror could be made by the silver-on-glass process of about 1 foot or more diameter, we should obtain by it an image of the moon having a diameter of 1 inch and a brightness of nearly 2 candle-feet, which would be sufficiently bright to produce an adequate response from a photo-electric cell.

For convenience of operating it might be necessary to employ a plane mirror called a cœlostat to reflect the rays from the moon constantly in one direction, and then to allow these rays to fall on the concave mirror and form a real image on the scanning disk surface.

If this could be "televised" we might exhibit not only a full moon but a half-moon, and also perhaps a lunar eclipse in its preliminary stages.

The same optical arrangements would give an image of the sun similar in size to that of the moon, since the apparent diameter of the sun is also about half a degree.

The clear sun, however, gives us nearly 400,000 times the light of the full moon. Full sunlight therefore produces on white paper exposed normally to the rays an illumination of about 7,000 to 10,000 candle-feet.

It is, however, easy to weaken the intensity of the light by dark glasses as is done in a sextant. It might, therefore, be an easier matter to "televise" the sum than the moon, and in this case a much smaller achromatic lens of 10 feet focal length would give the image required.

In order to carry out the above suggestions, possibly the most suitable method would be to construct a sort of horizontal Newtonian telescope on the lines shown in Fig. 1.

A long horizontal table must be provided, about 15 feet in length. At one end of this table must be placed the cœlostat, which is a plane mirror attached to an axis which is parallel to that of the earth. If this mirror is fixed in a proper position it will reflect the light of the sun or moon along the table. At the other end of the table must be placed a Parsons silver-on-glass concave mirror of 20 feet radius of curvature and 10 feet focal length. The diameter of this mirror might be 24 inches. This will form an image 1 inch in diameter at the principal focus. Then a small plane mirror or totally reflecting prism must be placed about 6 inches or a foot from the principal focus nearer to the mirror, so as to turn the rays out at right angles and enable the image to be thrown on to a scanning disk, the plane of which is parallel to the length of the table. Behind this scanning disk is placed the sensitive photo-electric cell of such construction that the cathode surface is not quite covered by the optical image.

Then there must be the usual arrangements for amplifying the photo-electric current and transmitting it to the distant receivers.

To secure good results the cœlostat would have to be slowly rotated by an astronomical clock so as to keep the image perfectly steady in one place on the scanning disk, in spite of the diurnal motion of the earth and moon, as is done in eclipse photography. I am pretty confident, however, that with these arrangements it would be quite possible to televise the moon.

Moreover, I am inclined to think that the same kind of apparatus could be used to televise full length images of human beings doing certain things, such as playing the violin, fencing, boxing, or dancing. It would, however, require a shorter focus mirror and some modification of the optical arrangements.

As regard the planets, it is out of the question to televise them. Even the brightest of them, viz., Venus at her best, has an apparent diameter of only 67 seconds, which is less than one twenty-fifth of the apparent diameter of the sun or moon. We cannot therefore hope to produce an image even of Venus of the required size and brightness.

The following table gives at a glance information as to the apparent diameter of the sun, moon, and planets, and of the images of them formed by a lens of 10 feet focal length. Suppose we place a half-

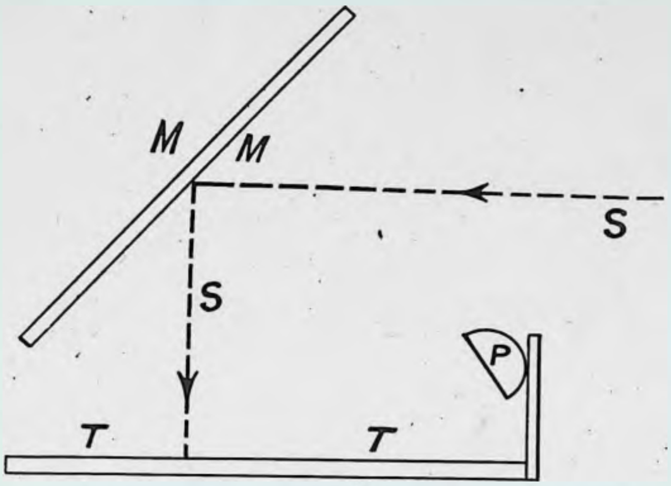


Fig. 2.—Arrangements for scanning objects on a horizontal Table, TT.

M, *large plane mirror inclined at 45°; SS scanning ray of light;* P, *photo-electric cells.*

penny at such distances as to appear as large as these celestial objects, then these distances must be—

Sun ..	10 feet	All taken to agree with the apparent diameter of the object when at its position of maximum apparent size.
Moon ..	10 ,,	
Venus ..	268 ,,	
Jupiter ..	360 ,,	
Mars ..	720 ,,	
Saturn ..	900 ,,	
Mercury ..	1,385 ,,	

Then the diameters of the optical images formed with the above-named lens would be—

Sun ..	1 inch	Mars ..	$\frac{1}{72}$ inch
Moon ..	1 ,,	Saturn ..	$\frac{1}{90}$,,
Venus ..	$\frac{1}{27}$,,	Mercury ..	$\frac{1}{140}$,,
Jupiter ..	$\frac{1}{36}$,,		

From these figures it will be seen that there is no possibility with any easily contrived means of making a planetary image large enough and bright enough for scanning.

Another suggestion I wish to make relates to the televising of things which can only be placed in a horizontal position.

At present the "subject" being televised sits up in front of the scanning disc and lantern. The scanning ray of light is horizontal in direction and moves across the face vertically or horizontally. However, there are many things which cannot be placed in such a position, but must be horizontal.

Suppose, for instance, we wish to televise the lines of force round a magnet made visible by means of iron filings sprinkled on a sheet of paper laid over the magnet. This last must then be placed in a horizontal position.

To televise this object I suggest the following arrangement. Let a large plane mirror be placed at an angle of 45° and so held as to deflect the scanning ray from the horizontal position vertically downwards (see Fig. 2). The photo-electric cells would then have to be placed so as to receive only the irregularly reflected light scattered from the paper, but all other arrangements would remain the same. With this reflecting mirror we could televise the ripples formed on mercury or water contained in a flat shallow saucer or plate. Also experiments on surface tension could be shown, such as camphor fragments running about on water.

There is, in short, no end to the scientific experiments which could thus be televised in a horizontal position.

One more suggestion I have to make with regard to viewing these images.

With the present Baird receiver it is difficult for more than two or three persons to see the image continuously without getting in each other's way, and people therefore have to take turns in seeing it if a number are present. The projection of the image on to a screen so as to enable a large number of persons to see it requires some elaborate appliances at present. The following plan will, if I am not mistaken, enable half a dozen, or even a dozen, persons to see the image simultaneously.

Over the large lens or viewing aperture of the Baird receiver must be placed a large looking-glass like an overmantel, about 3 feet long and 2 feet

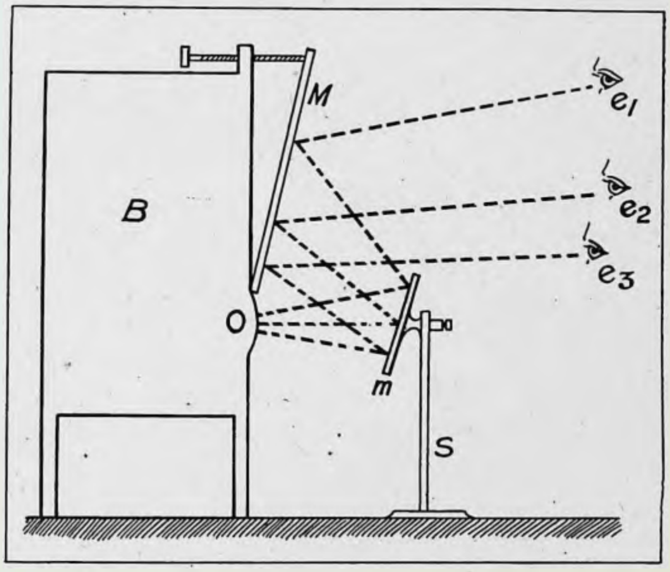


Fig. 3.—Arrangements to enable a number of persons to "look-in" simultaneously with a Baird Television Receiver.

B, *Baird Television Receiver, side view;* O, *lens;* m, *small plane mirror;* M, *large inclined mirror;* S, *adjustable stand;* e_1, e_2, e_3, *eyes of observers.*

wide. This must be capable of being tilted by a screw so as to incline it slightly at the top forwards. Then a smaller plane mirror, about 8 or 9 inches wide and 24 to 30 inches long, must be fixed to a stand like a tall retort stand, and this also must be capable of being tilted by a screw. Looking at the arrangement from the side, as in Fig 3, it will be seen that the rays of light coming out from the aperture of the television receiver fall on the small mirror and are reflected upwards on to the large mirror. Persons standing behind the small mirror and looking into the larger one will see the television image after two reflections. I am inclined to think, after a rough trial with two mirrors, that even a dozen persons may in this way see the television image comfortably.

This is important, because if we wish to give by television a science lecture to a class of boys, each boy must be able to see the image all the time quite independently of other boys. The verbal instruction would be given simultaneously by the loud-speaker embodied in the television receiver.

I look forward to the possibility, when the mental vision of the B.B.C. has been enlarged by the pressure of facts, to the broadcasting of educational lectures or talks which will appeal to the eye as well as to the ear, and it will be possible then to "look-in" as well as "listen-in" to public teaching.

Educational Aspects of Television

THE educational factors inherent in television are of obvious importance. The psychological effect of instantaneous observation of phenomena as they occur is of very great value. The attention and interest of students and the public is greatly enhanced by the ability to see and hear simultaneously. The personality and features of the speaker, singer or performer are faithfully transmitted with photographic accuracy. A lecturer can illustrate his subject by showing the objects he is discussing and make the information clear by supplementary sketches and diagrams.

To indicate the essentially practical character of this new technical facility a few examples will be of interest. By means of a blackboard and chalk, or, obversely, a white board and charcoal, text, numerals and illustrative sketches may be instantly televised. A lecturer on geometry can show diagrams and models of cubes, cylinders, prisms, conic sections or other solid figures. A demonstrator of chemistry, by the use of flasks, beakers, test tubes and accompanying apparatus and materials can show practical experiments. The results of electrical and magnetic tests can be indicated on instruments of precision such as galvanometers, ammeters, etc., and lines of force illustrated by magnets and filings. The technology of industry may be definitely illustrated by moving models of mechanical and physical apparatus of many kinds, for example, the internal and external movements of a section of an internal combustion engine. Geography, astronomy, microscopy and other sciences may be made intensely live subjects by the use of maps, orreries, magnified micro-objects, etc. The natural history student can be shown living or inanimate objects with perfect clarity, and such varied sciences as botany, biology, anatomy and anthropology become of singular interest when the images of objects are transmitted by means of television. History can be illustrated by pictures of events and personages of all periods.

Both the fine and applied arts will receive a stimulus when television is universally available. Fine pictures, sculptures and artistically designed objects of various character will form a very important item in television broadcasts. Photographs are transmitted with an astonishing wealth of detail. While drama cannot yet be shown on the large scale of the theatre or cinema, dialogues, debates and small scale plays comprising three or four characters can easily be transmitted. Music score may be shown by the standard and other notations. Of unequalled importance is the instantaneous transmission of news and captions in the caligraphy and printed characters of any of the races of the world, thus making television a world-wide means of educating all peoples of whatever racial origin or degree of educational progress.

A further development is the immediate practicability of the instantaneous broadcasting of talking films, which may be devised for greatly differentiated educational purposes. In the near future also there will emerge from the research stage the projection of the televised images upon a screen, as in the cinema, so that, in addition to home reception, large classes of students and members of the public may see the transmissions simultaneously.

It will be realised from the foregoing brief statement that the present potential educational position, apart from future possibilities of television, is already of enormous value. The universal application of this means of visual communication as an aid to education, both elementary and adult, will result in a new conception of both national and international contacts, on a plane hitherto considered to be a dream of the imagination.

Mains Brevities

PART II

By *William J. Richardson*

(Continued from our August issue)

IN the August issue of TELEVISION I dealt with many important points arising out of the use of D.C. mains, including their employment as an aerial, smoothing devices, feeding filaments in series and individual control, and we left off by querying the possibility of using the voltage normally wasted in running the filaments to supply the H.T. Before considering this, however, attention must be paid to a detail arising out of this filament and H.T. series working. Some may be inclined to dismiss the point about to be discussed as trivial, but imperfect set working frequently can be attributed to this cause.

A Series Filament Detail.

We know that a current of electricity is a flow or drift of negative electrons from the negative to the positive potential, that is, in the opposite direction to the conventional way of illustrating current flow. With a valve in operation, however, the current flow is not confined to the filament boundary but takes place in the plate circuit as well, due to an evaporation of electrons at the filament surface and their subsequent attraction to the plate when a positive potential is applied to that electrode.

Assuming H.T.—and L.T.—are common, Fig. 1 will explain what is meant if we take 5 milliamperes as being the total plate current and 100 milliamperes as the filament current. In the negative filament lead we shall have the full current flowing, but in the positive lead only 95 milliamperes return, and this difference can be registered if suitable meters are included in each lead. With parallel valve filament working, such as we normally get in battery-fed receivers, the effect is localised in each valve and does not generally produce any untoward effect, but what will happen with series filament working?

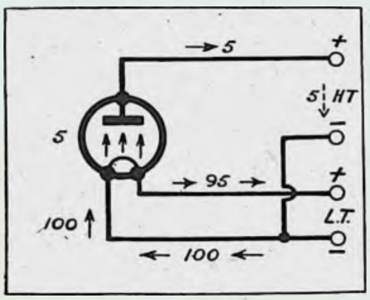


Fig. 1.—Illustrating current flow in a simple valve.

When we desire to reduce current consumption by working the filaments in series and having the resistance which normally cuts down the voltage as a source of H.T., then Fig. 2 will represent the situation for, say, a three-valve set with valves all of the 100 milliampere class. If the first valve is running normally, then the other two valves are being underrun and distortion is likely to result, especially in the last valve. If we arrange for the last valve to be correctly adjusted, then the first two valves will be overrun and this will shorten their useful life. Furthermore, it will be necessary to bear in mind that, owing to the varying currents flowing in the resistance, the H.T. voltages will not be directly proportional to the actual resistance tapped off, which would be the case if the same current flowed throughout the resistance.

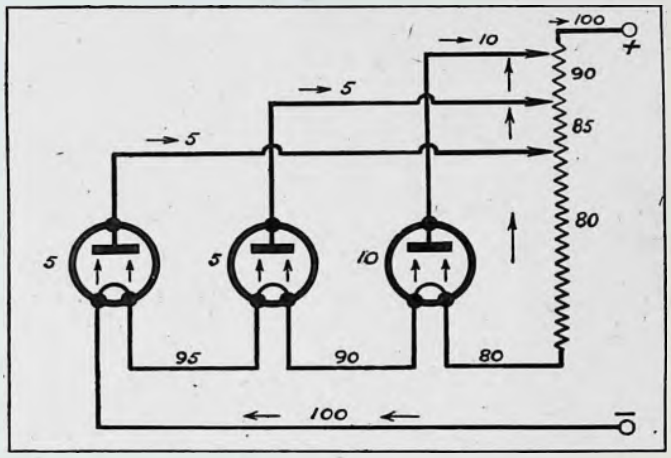


Fig. 2.—Series filament working showing current distribution.

The Complete Arrangement.

The situation, as far as the filaments are concerned, can be adjusted quite easily if we are using a power valve in the last stage, since this invariably demands a higher current than prior valves, and it will be necessary to add parallel resistances across these preceding valve filaments to by-pass excess current as shown in the previous article, and this will rectify matters. A reference to Fig. 3 will show exactly what is meant, the figures referring to currents in milliamperes, and in a case such as that illustrated no adverse effects will occur as a result of our more economical filament working. The actual value of the resistance for the H.T. tappings will, of course, depend upon the maximum filament current and the mains voltage, and is found by dividing the voltage by the amperage. Allowance must be made for any intermediary resistances, choke resistances, etc. The smoothing arrangements will now be somewhat modified, the inductance values of the low-frequency chokes depending upon the "roughness" of the mains, but 30 henries is generally the *barest* minimum.

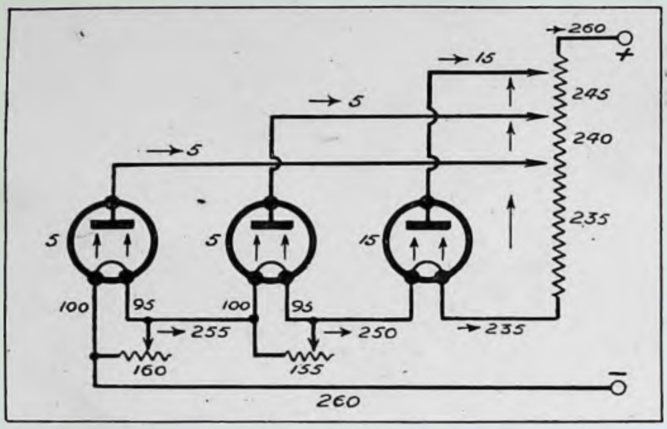


Fig. 3.—Balancing up the "current lost" by parallel resistances.

To adequately smooth D.C. mains is always a fairly difficult problem and, apart from the usual method of using chokes and condensers of appropriate size, many ingenious schemes have been propounded. One which I have used with marked success on a number of occasions makes use of a two-electrode valve (or a three-electrode valve with grid and plate joined together) in quite a novel manner. Choosing a valve which has a definite "saturation current" and will work in this condition for long periods, the characteristic curve will be as indicated in Fig. 4A, the horizontal curve AB representing saturation conditions.

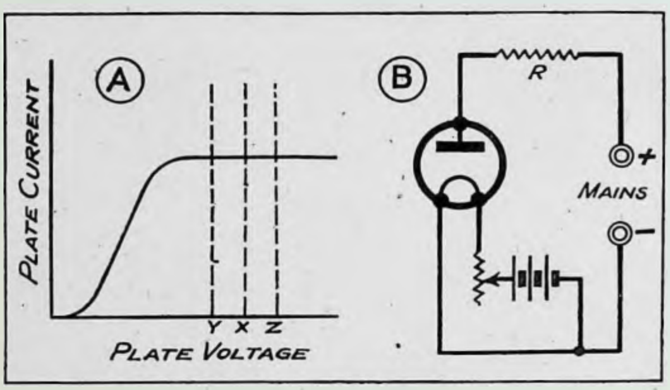


Fig. 4.—A novel smoothing scheme.

Now suppose the plate voltage is adjusted to the point X, then any increase or decrease of plate voltage within the limits YZ will not cause any current change. That being the case, arrange the valve in circuit as Fig. 4B, a resistance R being connected between the positive main and the valve plate, and adjust this resistance so that the actual plate voltage is about 20 volts in excess of saturation voltage. Thus, with 240-volt mains and a valve with a saturation current of 10 milliamps. at 100 volts, the plate voltage of 120 volts would be given by

$$\frac{240-120}{\cdot 01}=12{,}000 \text{ ohms.}$$

Consequently we have available across our resistance R a steady D.C. voltage of 120 volts, for with a mains rise or fall of 5 or even 10 volts the saturation current remains the same and hence the voltage drop across R. The valve can be looked upon as absorbing the fluctuating voltage. While any reduction of R will not cause a current decrease, the useful voltage available will be decreased, but if we increase R above the limiting value set by the valve saturation voltage then the scheme will not function. A milliammeter is therefore advisable in the valve plate circuit.

It is possible to run the absorbing valve filament from the mains providing it is a thick one, that is, one of the heavier filament current type. Under these circumstances the variation of voltage applied to the filament as a result of line fluctuations will be followed very slowly by temperature changes in the filament, a time lag effect making its appearance. The small change in filament temperature brings about a small change in saturation current and this will be passed on to the voltage across R. The effects are small, however, in comparison to the original mains fluctuation and can be minimised still further by shunting R with, say, a 5 mfd. fixed condenser.

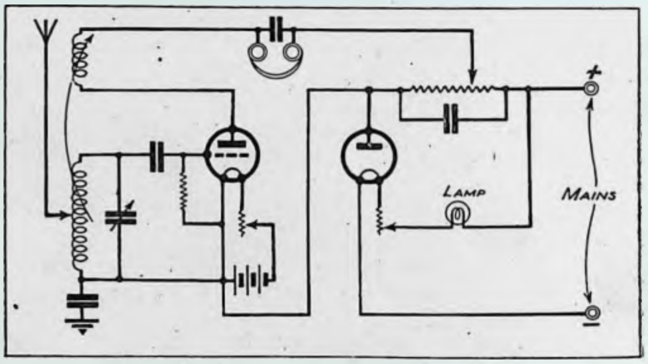


Fig. 5.—A simple single valve set complete with H.T. smoother.

Fig. 5 gives a simple single valve circuit used in conjunction with this valve smoother, and the scheme is capable of further development in so far as the feeding of both H.T. and L.T. are concerned. The difficulty here is to find a smoothing valve (or two valves in parallel) whose saturation plate current is just in excess of the normal filament current of the receiver. Valves of the L.S. 5 or D.U. 10 class are suitable, but the arrangement is not recommended for multivalve receivers. Sufficient has been said, however, to prove that really excellent results can be secured from D.C. mains receivers, the secret of success being based primarily on a knowledge of local conditions as far as the raw mains supply is concerned.

America *and* Television Progress

By *J. M. Verralls*, A.M.I.R.E.,
Fellow of the Television Society

IT was with interest that I recently read Mr. Shaw Desmond's article, "Selling America to the World," in the October issue of TELEVISION, and I would like here to support Mr. Shaw Desmond's contention that America intends to use television as her weapon for gaining supremacy in the entertainment field of the world.

The Jenkins Receiver

At the recent Radio World's Fair at Madison Square Garden, New York City, television was the most popular attraction. The Jenkins televisor, which is the best known in America, has made vast strides towards simplicity of operation, consistent with good reception results. As many stations are already transmitting television signals it is expected that this receiver will be in greater demand within a short period, because, I understand, several other television stations are under construction at this present time, and are shortly expected to be "on the air." The latest reports of the United States Radio Commission show that many applications have been made for the transmission of television signals during the coming year.

I was recently advised by the Jenkins Television Corporation that they expected an output of about 5,000 units during 1929, and that production is being expanded. Affiliation with the DeForest Radio Company assures distribution through approximately 5,000 dealers. I also understand that this corporation has other mergers in view, especially in connection with the transmission of moving pictures, which will be an everyday occurrence in the near future. It is estimated that the number of radio listeners in the United States of America has increased from 60,000 in 1920 to more than 50,000,000 at the present time. With such popularity in a vast industry like radio in America, surely it is time Great Britain made efforts to hold supremacy in the newest method of communication—television.

Since the passing of the White Act in 1927 (which, in plain words, forbids any purchase of radio by cables or *vice versa* in the United States), television is undoubtedly the weapon that will be used to gain leadership in the entertainment of the world. Using the expression "entertainment of the world" no doubt sounds somewhat ridiculous to many people, but I venture to say that such a term is not exaggerated, for only as recently as October 21st I was listening to Professor Albert Einstein's speech from Berlin being broadcast to practically every country in the world, through the medium of long and short wave stations in the United States, which experiment proved quite a success. Before long, no doubt, such world-wide broadcasts will be a regular occurrence.

The number of persons employed in the radio industry in America has risen to a figure estimated at 320,000 a few months ago. Now that television has aroused public interest this number has already greatly increased. Television is likely to make swifter strides towards perfection in America owing to the fact that the restrictions by the Government are not so rigid as those enforced by the British Government. The United States Government has given every encouragement to television and, furthermore, has helped in many ways to assist the inventors of the various systems now patented in America.

Radio—Cinema—Television Mergers

In the *Saturday Evening Post*, one of America's most popular magazines, there appeared an article written by General G. Harbord, President of the Radio Corporation of America, with the intention no doubt of impressing upon the American public the need for the reorganisation of American communications, since the recent merger of British communications had captured world leadership. Mr. Shaw Desmond states in his article that "television is to be the weapon which America will use to gain leadership in world-wide entertainment." Having just spent some 18 months in New York I am fully able to confirm this statement, as I have watched the steady growth of television, and the more recent plans under consideration with respect to the merging of motion-picture companies with radio and television companies.

If Great Britain holds the leadership of the communications of the world, as is admitted by America, is she going to let the newest system of communication (which was born in Great Britain) pass out to America, and thus let the American dollar establish a monopoly of television throughout the world? I hope not.

Television *and* What Shall

PEOPLE *will* talk, and the prolonged absence of television in purchasable form has provided an excellent subject for conversation. There are those who say that the Baird principle has such serious limitations that it will be short-lived. The contention is fundamental and must not go unchallenged. Indeed, the fact that such a view is being advanced by men of academic distinction makes an examination of the facts imperative.

At the outset it should be made clear that failure to grasp the immediate value of Baird's invention is attributable mainly to ignorance. There is a disquieting scepticism abroad which is affecting even the most credulous. As time goes on, however, it becomes clear that the cause is mental rather than mechanical—psychological rather than economic.

The Inventor's Advantage

It is a curious fact that the inventor can afford to be more sure of establishing a fundamental advance in applied science than can the pure scientist in abstract theory. The scientist has frequently to abandon his theories as new factors press for consideration. Not so the inventor. His steam-engine may have a thousand modifications and adaptations, but the invention preserves its identity. It is significant that the greatest inventions have sprung from co-ordination and rightful use of existing principles—each individually proved and evaluated by the inventor—rather than by the creation of something wholly original.

Baird is an inventor. His work has evidenced that practical thoroughness which we should expect. Never has he claimed that the achievement of television was due to his unaided endeavour.

Our contention that his method of achieving television is unlikely widely to be departed from is not difficult to uphold. There has been an extraordinary sequence of contributory inventions which have come to the aid of Baird as he has proceeded with his task. The Nipkow disc, the neon tube, the photo-electric cell—each in turn has contributed vitally to the ultimate achievement. But we may rest assured that Baird has not concentrated on one line of development to the exclusion of others. Long years have been spent by him in exploring every possible avenue of approach to the desired end. We must not forget that it was not enough simply to accomplish television in the laboratory. Baird had to face the fact that no system of television could be commercialised which did not conform to the existing conditions of waveband allocation.

Criticism has been directed at his scanning method. Probably the criticism has its origin in a growing hope in lay circles that some form or combination of photo-electric cells will be developed which will be sufficiently sensitive to pick up the detailed image of a normally lighted room and transmit it unscanned. Whether this ideal will be achieved or not it is impossible to say, but it is important to notice that other experimenters have failed to outrun Baird by recourse to any method widely divergent from his, and that from 1925 onwards he himself has continued to follow the same general principle. People who sneer at the scanning-disc in television may be likened to those who ridiculed the use of the propeller in the beginnings of aviation. How indispensable it has become!

After all the pushing and struggling, how much did you see of His Majesty? Television can bring into your own home a better view than you will get in this crowd.

But there is another reason for our contention that the Baird principle will persist. The method employed by him is commonly supposed to be extremely complicated, whereas, in reality, the principle now standardised in mechanical form is as simple and straightforward as any could well be. For this reason,

the Public We See?

By *Leslie Trenton*

if for no other, it is most likely to survive. It will be developed; it will be adapted; but the principle will persist. Its simplicity is of the order commonly associated with the greatest achievements of science. There is yet another reason. In

Germany the subject of television has for some time been receiving the closest attention. Her greatest minds have been called to bear upon the problem. But it is of overwhelming significance that whilst important work is still being carried out by German experimenters, it is the *Baird* system which, by virtue of its *immediate* practicability and value, has been adopted and launched as a commercial proposition by a combine of three well-known German companies.

Did you go to see this crowd, or the personality within the circle Television can show you this NOW —— in comfort.

Impeding Factors

In Britain the task of commercialising television has been retarded by the spreading of fantastic stories—stories which, strangely enough, have found credence in otherwise well-informed circles. Even now many people visualise television as being comparable with a large-scale cinematograph. Those who have had the opportunity of seeing television for themselves, however, have at once realised the magnitude and significance of the accomplishment at its present stage of development and the practical use to which it can immediately be put.

In the broadcast of public functions lies, perhaps, one of television's most obvious applications. It will make news *live* as it brings familiar personalities into the home. Think, for instance, of the interest it will arouse as it shows us the Prince talking in Africa or the Premier speaking at Westminster.

The King's return to London, the home-coming of Ramsay MacDonald and a host of similar events suggest material peculiarly suited to broadcast by television. Ask the average spectator of such an event what he went to see. Obviously he did not go to see the crowd. He did not go because he enjoyed being jostled and trodden upon. He will tell you that what he *did* go to see was the *individual* occasioning the demonstration, and, most probably, that he had but a fleeting glimpse.

If we will consider the circumstances of any of these events we shall realise that there is always some *central personality* commanding and riveting the attention. Look at the accompanying photographs. What more convincing testimony could there be? Remove the central figure and the point of attraction and interest disappears with it. The same applies to the cinematograph. Because the personalities are of primary importance, they are repeatedly presented to us in the form of "close-ups." Similarly, in everyday experience, it is the facial expression which, when accompanied by the human voice, enables us to appreciate the personalities of our friends.

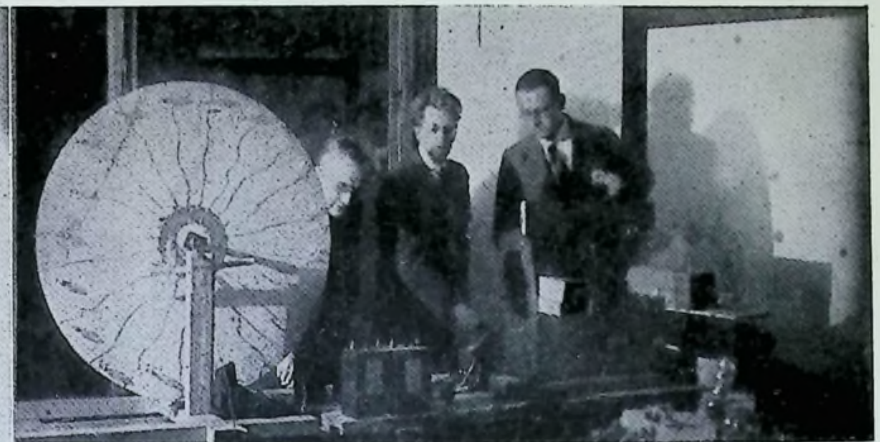
The Blindfold Listener

Now think of the frequent attempts that are made to broadcast by visionless radio public functions of any kind. How miserable is the failure to convey the personality and therefore the spirit of the event to the blindfold listener!

As 1929 draws to a close there are welcome evidences that the barriers of conservatism and misapprehension that have hindered the issue for so long are rapidly being broken down and that the commercialisation of television in this country is imminent. If by co-operation the task is handled in the right way, there need be no misgivings as to the response of the public or the benefits that will accrue.

HASTINGS MAKES HISTORY.

Councillor A. D. Thorpe, J.P., Mayor of Hastings, and Mr. Baird, photographed under the plaque after the unveiling ceremony.



The late William Le Queux (left) examining Baird's early apparatus at Hastings.

(Below) The Mayor of Hastings unveiling the plaque. *See article on opposite page.*

Hastings Honours Baird

*D*ETAILS OF A *S*IMPLE *C*EREMONY

TO Hastings belongs the unique distinction of having honoured an inventor and recognised his work during his lifetime. On November 7th the Mayor of Hastings, Councillor A. D. Thorpe, J.P., unveiled a bronze plaque attached to the partition wall of one of the shops in the Queen's Arcade, Hastings. The plaque bore the inscription: "Television. First demonstrated by Mr. J. L. Baird, from experiments started in 1924."

Although Queen's Arcade is quite close of the Hastings Town Hall, it is quite an unpretentious passageway. The shops which line it are mainly of the small lock-up variety, and deal with the usual sort of fancy goods and novelties that one expects to find on sale at a popular seaside resort. Each of them has a single storey over it, and it was in one of these rooms that Mr. Baird started his work. In 1924 the shop beneath him dealt in artificial flowers; this shop has since changed hands, and the goods on sale now consist of gramophones, wireless apparatus and snapshots of visitors taken in the streets. The building is not the sort of place one would expect as the habitation of an inventor, but then inventors are invariably folk who are not influenced by surroundings.

Unconventional Apparatus

Up aloft in this laboratory in 1924 Baird was as unconventional in the apparatus he used as any other discoverer. Strictly limited as to financial resources, he was unlimited in ingenuity. At that time, as most amateur wireless enthusiasts are well aware, there was a vast amount of cheap but very good ex-Government wireless apparatus to be picked up. Some of this formed part of his equipment. Accumulators supplied his filament current, but when it came to high tension voltages (and in his very early experiments he found it necessary to have very high voltages indeed) he did as every wireless amateur at some time or other has done—made up his high tension battery from numbers of ordinary pocket flash-lamp batteries linked together.

The most intriguing part of his apparatus, however, was the actual mechanism of the television transmitter and receiver. In these a truly wonderful collection of odd bits were put together and made to work. Scanning discs were made of cardboard; mountings for them were contrived out of the crudest and roughest types of timber; motors which should have gone to the scrap-heap, after an honoured service, were renovated and made to do duty in positions for which they were entirely unsuited; while, for the optical part of the apparatus, lenses from bicycle lamps (easily procurable at fourpence a time) were employed. Over, around and underneath the whole ran a jumble of wires of every conceivable colour and type, beside which the wiring of the most complicated telephone exchange looked simple.

With this thoroughly unpromising-looking collection, Baird not only succeeded in getting results—uncertain at times, but, when they did condescend to come through, definite enough—he also conceived, constructed in the same rough way and tested out most methods of television as at present being employed in America, Germany and elsewhere. The batteries, as can very well be understood, were his chief trouble. The current which gave satisfactory results one day had disappeared by the next, and many an anxious hour was spent chasing the elusive fault. Where other workers would have given up in despair, Baird went on, bought some more pocket flash-lamp batteries, and ran his faults to earth.

The very fact that he got results with such a nightmareish collection of impossible apparatus was a better proof than anything else that he was on the right lines to achieve television. This has been amply demonstrated by subsequent events.

At the unveiling ceremony on November 7th, which was exceedingly simple, Mr. John L. Baird, Dr. Clarence Tierney (Chairman of the Television Society), Mr. J. Denton (Honorary Secretary of the Society), Mr. W. C. Keay (Honorary Treasurer, Television Society), and a number of the Members of the Hastings Town Council, together with Mr. G. M. Norman (Headmaster of the Hastings School of Science), Captain P. S. Barlow (Headmaster of the Hastings Grammar School), Mr. E. H. Hole (Senior Science Master of the Hastings Grammar School), the Honorary Secretary of the Hastings Radio Society, and many others were present.

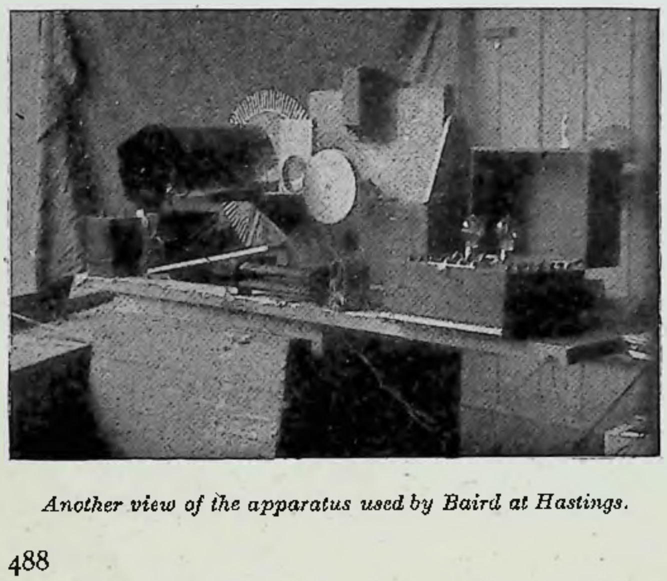
Sir Ambrose Fleming's Message

No speeches were made at the unveiling, but those present went across to the Council Chamber, where the Mayor announced that he had received a letter of regret for his absence from Sir Ambrose Fleming, which read:

"I regret very much that another important engagement at the Institution of Electrical Engineers to-night prevents me from accepting the kind invitation of the Mayor of Hastings to be present at the interesting ceremony of the unveiling of a plaque commemorating the historic and epoch-making work of Mr. Baird. This plaque will be a perpetual reminder that Mr. Baird was the first to effect practical television and to inaugurate a new departure in electric technics which will have immense developments in present and future years."

"We are very proud in Hastings," said the Mayor, "to be associated with the great name of Baird. Hastings has many distinctions, but perhaps this one in the years to come will be one of its most famous, and we are sure Mr. Baird is proud to be associated with Hastings. He will never forget his scientific achievements here, and the place where he worked." Mr. Baird, the Mayor continued, like many famous Scotsmen, was a son of the manse, and he thought he was probably correct in saying that, when he came down to Hastings, he was a struggling but intelligent young Scotsman. Mr. Baird represented for them a man who had conquered many difficulties. He had struggled for years, worked hard, and had had to negotiate many fences in his efforts to develop television. To-day he felt sure that although it was still not much more than a novelty, in a few years' time it would be a very important and practically universal feature of life. Just as Mr. Baird was the first to demonstrate true television, so, early in 1928, he was the first to send television across the Atlantic, to demonstrate television in colour and daylight television. "Mr. Baird is only 40 years of age," added the Mayor, "and we are looking forward to seeing him spared in health and strength to carry on his invention to very great lengths indeed and to be one of the most famous men in England."

Mr. Baird, replying, thanked the Mayor and the people of Hastings for the honour and pleasure they had given him. "When I arrived in Hastings in 1923," he said, "I came in search of health after a serious illness and thought I should never be fit and well again; the doctor who sent me also thought the same, but in a very short time the exhilarating atmosphere of Hastings made me a changed man. While down here doing nothing I took up the study of television again. I had been interested in it since my youth, and when I took it up here, with the aid of some apparatus I managed to get together and the cordial assistance of a number of the Hastings residents, some of whom are present now, I soon began to get shadowy images to appear on the television screen. In talking about this phase of my work I should like to mention the late Mr. William Le Queux, who was present at a number of my experiments and wrote of what he saw in the *Radio Times* and other journals.



Another view of the apparatus used by Baird at Hastings.

"In a little back room"

"In a little back room above what used to be an artificial flower shop in the Queen's Arcade, these first experiments were carried out, and although nothing very much was seen through these early machines it was sufficient to show that the right path was being followed. It is interesting, too, to note that the machines now used are, in principle, almost identical with that early apparatus. I need not go into technical details, but there are the same neon tubes, the same disc with its holes, and the same type of motor to drive the disc.

"The progress after the foundations had been laid at Hastings was very rapid. A demonstration in London was followed by a demonstration to Members of the Royal Institution in 1926, and it was the first time that television had been demonstrated. At that demonstration we showed living human faces transmitted by television, and proved that the science of television had arrived. These demonstrations were followed by others, the necessary capital for development was secured, and television began to go ahead."

Mr. Baird again thanked the Mayor and people of Hastings for honouring him in the way they had.

Mr. W. G. Nye, Honorary Secretary of the Hastings Radio Society, said he wished to thank Mr. Baird, on behalf of all the local radio enthusiasts and all those interested in radio, for the future to which they could look forward, namely, seeing as well as hearing what was happening by means of wireless and television. They hoped to form a local Group Centre of the Television Society in Hastings. The objects of the Society were to further the science of television in all its forms. In Hastings they were anxious to get their Centre going as soon as possible, as, if they did not, their rivals at Eastbourne might precede them, and then Hastings would have to form part of the Eastbourne Group Centre rather than be a Group Centre on its own. Such a state of affairs was unthinkable, when Hastings was the birthplace of television. It was up to all those interested in wireless and television to see that Hastings was one of the first Group Centres of the Television Society to be formed.

Dr. Tierney, who also spoke, said it is surprising how few people can read history in the making. They should feel privileged at having been allowed to take part in the writing of a page of it that afternoon, for undoubtedly that event, simple as it might appear, was a page in history that, as the years went on, might become a very important one.

The Story of Electrical Communications

by

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

PART XII.

*W*IRELESS AS AN *A*ID TO *N*AVIGATION

WE have seen how Marconi in his earliest experiments made use of reflectors, with the object of increasing range, by emitting the wireless waves in a concentrated beam like a searchlight in the direction required, instead of allowing them to disperse in all directions. This arrangement, however, was only possible with very short waves, and as with the knowledge then available such waves were quite unsuitable for communication over long distances, Marconi soon discarded his reflectors and turned his attention to long waves with all-round transmission. But he never lost sight of his short-wave beams, and when, twenty-five years later, altered conditions allowed of the use of short waves for great distances, he started the experiments with his beam system which has revolutionised the whole outlook of wireless signalling—but that is another story.

It was clear from the first that a beam of waves would open up the way to navigation by wireless, as a shore station transmitting a beam in a known direction would allow a ship to obtain its bearings from the station when it came within the beam, that is, when it received the signals from the station. Obviously, however, for this purpose the beam must be very concentrated, which it has only been found possible to arrange for by making use of extremely short waves, far shorter than those used by Marconi in his long range beam system of communication.

Rotating Beacons

These very short-wave beams have not yet been adapted to navigational purposes commercially, though the Marconi Company has erected two experimental stations in this country, one in the Firth of Forth, and the other at the South Foreland in Kent. The transmitting aerial at these stations is mounted on a revolving carriage fitted with wire reflectors, which allows of the transmission of a rotating beam of waves. Distinctive signals are sent out as the beam passes through the different points of the compass. The ship listens, and makes a note of the strongest signal. The bearing denoted by this signal is the bearing of the ship from the station.

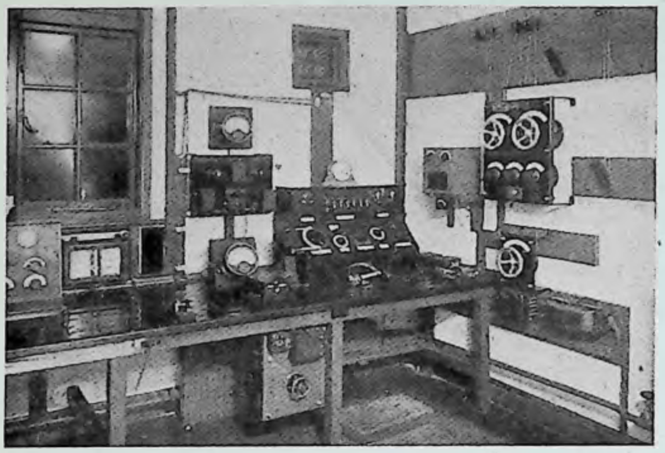
In practice, only very short waves of the order of six metres can be used with this arrangement, and ships must be fitted with special apparatus to receive such short waves. This is, of course, a serious drawback, and the system has not come into general use.

The idea of a rotating beam of waves for navigational purposes has however been developed recently by the Radio Research Board on different lines, which permit the use of waves sufficiently long for reception on the ordinary ship's apparatus. A station of this sort was erected recently by the Government at Orfordness in Suffolk, and is now in operation. The aerial consists of a vertical closed loop, rotating at a uniform speed of one revolution a minute, the waves being emitted in the direction of the plane of the loop. A signal of constant radiation is transmitted throughout the whole period of operation, except when the loop is in a north-south or east-west plane, when characteristic distinguishing signals are transmitted. The strength of the signal as received by the ship is a minimum when the plane of the station's aerial loop is at right angles to the ship's line of bearing from the station, and a maximum when the aerial loop comes into line with the bearing. The ship's operator starts a stop watch when he hears one of the characteristic signals, and stops it when the emission is heard weakest. By a simple calculation he obtains the bearing of the ship from the station.

This is the first station of the kind which has been erected anywhere for ship work, and it is too early yet to say whether the system will come into general use, though it has already proved its worth in connexion with the navigation of aircraft up to ranges of about

200 miles. The wave used at Orfordness is 1,000 metres.

Stations which emit distinguishing signals as aids to navigation are called wireless beacons, and this particular type of rotating beacon has the great advantage that the ship obtains its bearing by using its ordinary receiving apparatus.

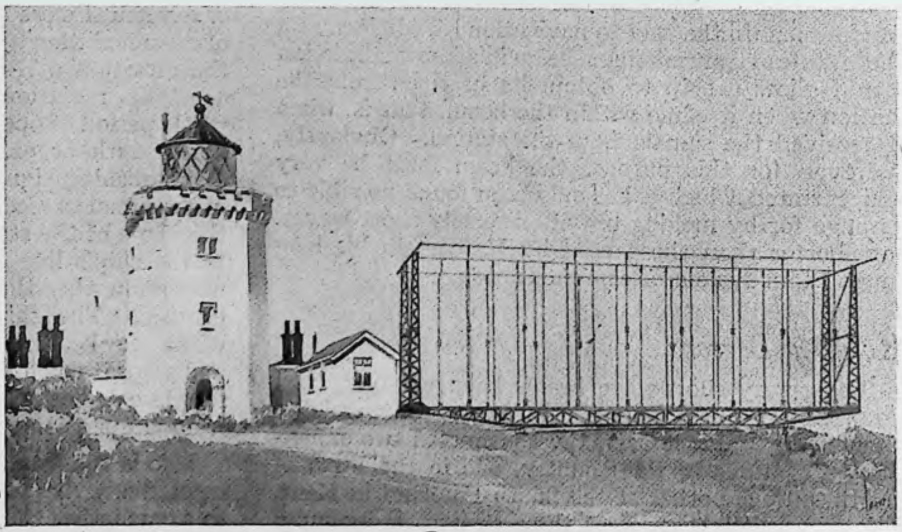


A Directional Receiver at Humber Radio.

All-Round Beacons

Another form of beacon, which is much cheaper to erect and operate, is now used extensively throughout the world. This is an all-round beacon, that is to say, it emits its distinguishing signal automatically at stated times in all directions. A ship in any position within range of such a beacon can, of course, receive the signals, which are sent on a wave of about 1,000 metres, but unless the ship is fitted with a directional receiver it cannot obtain its bearing from the beacon. This fact limits the use of such beacons, as the number of ships fitted with directional receivers is small; in this country about 20 per cent. of the ships which have wireless installations. But, as we have seen in a previous article, the new International Convention for the Safety of Life at Sea stipulates that within the next three years all passenger ships must be equipped with directional receivers, so that the number of ships throughout the world which will be able to make use of these all-round beacons will be materially increased.

Ten of these all-round beacons, operated by Trinity House or local authorities, are already in operation in this country, and more will shortly be erected. Those working are in lighthouses or lightships at Kinnaird Head, Spurn Head, Cromer, Dungeness, Start Point, Caskets, the Scillies, Liverpool, the Skerries, and Conningbeg in Ireland.



Marconi Company's Directional Transmitter (using a very short wavelength) at South Foreland.

Ships which are fitted with directional receivers can obtain bearings up to ranges of between 50 and 100 miles from these stations.

Synchronous Beacons

The stations at Spurn Head and Liverpool also transmit submarine sound signals which, in conjunction with the wireless signals, enable a ship to calculate its distance as well as its bearing by allowing for the difference in the speed of travel of the sound waves and the wireless waves. Sound waves in water travel at a speed of about one nautical mile in one and a quarter seconds, whereas the wireless waves reach the ship, for all practical purposes, instantaneously. The advantage of having such combined signals is obvious, but these stations, which are called synchronous beacons, are of course more expensive to install and to operate than the simple wireless beacons.

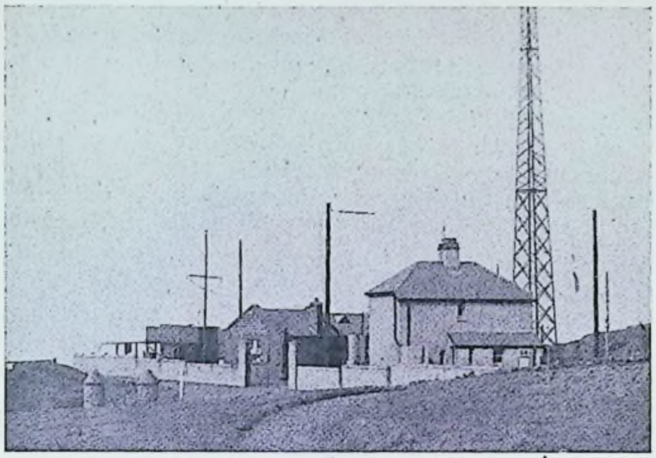
Another interesting type of synchronous beacon is now being tested by the Clyde Lighthouse Trustees. In this case wireless telephony is used, and the words, one, two, three, etc., are broadcast in conjunction with the fog sound signal in such a way that when the sound of the signal coincides with a number heard on the wireless apparatus that number is the number of miles of the ship from the fog beacon. The Trustees already make use of wireless for controlling the operation of acetylene fog guns from a distance, and this is indeed the only application of wireless for this purpose that has yet been put into commercial operation.

These all-round and synchronous beacons are only of use for obtaining bearings to ships which are fitted with directional receivers.

Directional Receivers

There are three main designs of directional receivers at present in use, viz., the fixed double loop, the rotating double loop, and the single loop.

In the fixed double loop system, the aerial consists of two vertical loops in planes at right angles to one another. The operator rotates a coil in the receiving set and by this means varies the strength of the signals heard in the telephones. The direction from which the signals are coming is determined from the position of the coil when the signals sound weakest.



Portpatrick Radio, showing the short masts for staying out the large loop aerial used for directional reception.

In the rotating double loop system, the aerial is similar, though smaller, and capable of being rotated mechanically from the wireless office. The connexions, too, of the loops to the receiver can be reversed in the wireless office by a simple switching arrangement. The operator listens to the signals and rotates the aerial until he finds a position where reversing the connexions does not affect the strength of the signals. The direction from which the signals are coming is determined by this position.*

In the single loop system, the aerial consists of a small single loop which is capable of being rotated mechanically from the wireless office, and the direction from which the signals are coming is determined from the position of the loop when the signals sound weakest.

In all cases, the bearing obtained is the bearing of the station relative to the direction in which the ship's head is pointing at the time, and depends for its correct interpretation on the correctness of the compass reading when the observation is made. There is no real difficulty in this, and in the latest sets it is arranged for automatically, so that the operator reads off the required bearing on a scale without any need for calculation.

Bearings obtained with any of these systems are, under normal conditions, accurate to within two degrees, which is all that is required for navigational purposes up to ranges of about 100 miles. When conditions are not normal the operator is aware of the fact from the character of the signals received, and in such cases reports the bearings obtained as being unreliable. If, however, the ship is in a position such that the signals received from the station pass along the coast line or over much intervening land, the observations may be unreliable, and the operator may not be aware of the fact, though it is seldom that he will be so vague as to the position of the ship as to place reliance on such bearings.

Ships fitted with directional receivers can, of course, obtain bearings from other ships and from ordinary coast stations. In such cases it is usual for the ship which requires the bearing to ask the other ship or coast station to send its call sign continuously for a minute, which is ample time for obtaining a bearing. In this country the coast station makes a charge of 5s. for each one-minute period of sending.

Direction Finding Stations

All these methods by which a ship can obtain bearings, except in the case of obtaining bearings from the Orfordness rotating beacon, necessitate the ship being fitted with a directional receiver, and, as we have seen, the great majority of ships are not so fitted. To meet the case of these ships to some extent, a number of coast stations throughout the world are fitted with directional receivers for the purpose of taking bearings. In this country the stations at Wick, Cullercoats, the Humber, Niton, the Lizard, Portpatrick and Malin Head are so fitted. These stations are carefully calibrated every year, and those sectors in which bearings may be unreliable, due to the effects of coast lines or intervening land, etc., are published for the information of shipping. In any case, the operator at the station informs the ship if he considers that there may be any doubt about the accuracy of the bearing, so that unless the ship is told to the contrary it may be confident that the bearing given by the station is accurate to within about two degrees.

The procedure is that the ship informs the station that it requires a bearing, and then sends its call sign continuously for one minute. The station observes, with its directional receiver, the direction from which the signals are coming, and signals this bearing to the ship. The stations use the 600-metre wave for this work, with the exception of the Lizard which uses the 800-metre wave, and a charge of 5s. is made for each bearing given. This service is especially useful in foggy weather, and last year these stations gave over 8,000 bearings to ships.

S.S. "Gloxinia," showing (amidships on bridge) small loop directional aerial.

*This system was originated and perfected by our well-known contributor, Dr. J. Robinson.

So far, we have considered the ship as obtaining a bearing from one station only, but it is obvious that if it is placed so that it can obtain reliable bearings from two or more stations within a very short space of time, it can fix its approximate position from the intersection of these lines of bearings on the chart.

Aircraft

With regard to aircraft, the advantage of obtaining bearings from ground stations is obvious, and all important aerodromes, such as Croydon, Lympne and Pulham, are equipped with directional apparatus. In the aircraft there are serious difficulties in fitting directional receivers as space is so limited and the personnel have so many other things to attend to. Efforts are being made to get over these difficulties, but at the moment aircraft have to rely principally on bearings obtained by ground stations.

Latest Developments

There are several other aids to navigation which utilise wireless apparatus, notably the Leader Cable and the Fathometer, but these are not yet in extensive use. There is also a very important one in process of development, viz., Mr. Baird's Noctovisor.

The Leader Cable is a method of guiding ships in or out of harbours, or through narrow waters. It consists of an alternating current submarine cable laid along the course on which the ship should steer. The ship is fitted with two special receivers, one on either side. When the ship is directly over the cable the strength of the signals received by induction from the cable in each receiver is the same; but when the ship is not directly over the cable the signals in the receiver nearer to the cable will be stronger than in the one further away. The correct course is therefore that on which the signals are received at the same strength in both receivers.

The Fathometer, which was invented by Fessenden, whom we have noted as one of the great American pioneers of wireless, is the latest method of taking soundings from a ship. The rate of travel of sound in water is known, and if a sound is transmitted from the bottom of the ship it will be reflected back from the bed of the ocean. In the Fathometer this reflected sound is amplified by valves, and is made to operate apparatus so that the depth of water can be read directly off a scale. It is a most ingenious arrangement, and will doubtless be used extensively in the future.

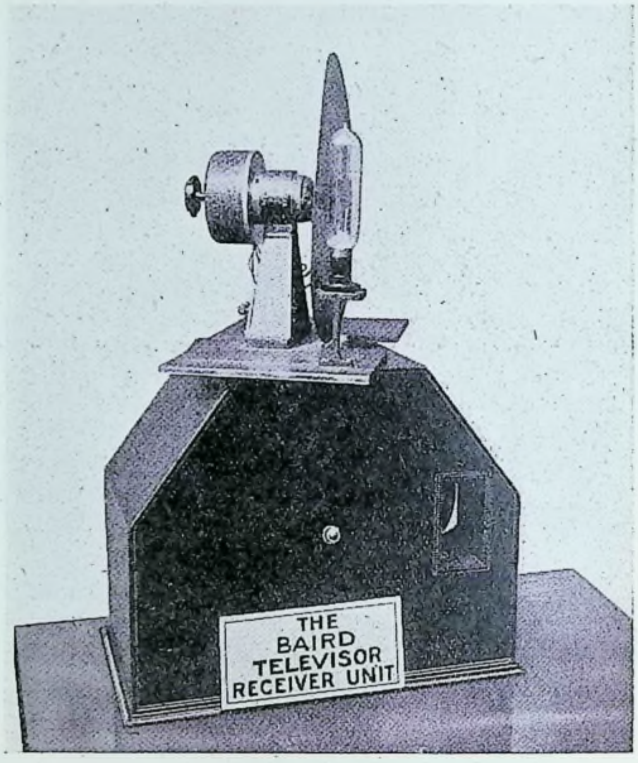
Mr. Baird's Noctovisor depends on the fact that infra-red rays, which are invisible, can penetrate fog far better than visible light rays. A ship could direct a beam of these infra-red rays, and be able to see on the screen of its noctovision receiver objects in the path of the rays, such as the navigation lights on another ship or the light from a lighthouse or lightship.

A recent demonstration given by Mr. Baird with this extraordinarily interesting invention was described in the September (1929) issue of this journal.

ANNOUNCEMENT

Following upon the television demonstrations which the Baird Company gave during the Radio Exhibition at Olympia, we understand they have received many applications from radio firms who desire to manufacture Baird "televisor" receiver units.

In view of the fact that wireless manufacturers are now in the midst of their 1930 programmes and cannot, therefore, be expected immediately to get into production with Baird "televisors" (special machinery being required), the Baird Company have made arrangements for a minimum number of 1,000 complete units to be manufactured and assembled. These units will be marketed through the trade to the public, and it is hoped to begin deliveries during the first week of January.



The Baird televisor receiver unit, removed from its case. See accompanying announcement.

The Baird unit will be housed in a separate case, and will have no wireless receiver incorporated.

We are informed that whilst actual manufacture is still not the Company's policy, their only reason for departing from it temporarily is in order to facilitate early deliveries.

In this connection we are asked to draw attention to the fact that the constructor's licences which have been issued by Television Press, Limited, were actually licences for the construction within two years of television apparatus according to a particular specification, as described in Nos. 1 to 3, Vol. 1, of TELEVISION, and they do not refer to the Baird "televisor" receivers which will now be put on the market by the Baird Television Development Company, Limited, or their licensees.

Experimental Television Apparatus

By *A. A. Waters*

PART VII

SINCE writing the last article of this series it has been possible to test all the experimental television receiving equipment already described on the morning transmissions from 2LO. Our results so far have been very encouraging, and I feel sure that experimenters who are lucky enough to have the opportunity of testing their own apparatus on these transmissions will welcome a brief description of our methods, and of the difficulties which we have encountered.

Considering first the type of receiving set required, we find that any set which is capable of giving really good loud-speaker results on an ordinary programme will give satisfactory television reception. By "really good" loud-speaker results is meant a strength of signal which is just slightly too loud to be pleasant in a room measuring roughly 12 feet square.

Suitable Wireless Receivers

Hence, a good "screen grid IV" type of set which is so popular just now will be found quite satisfactory when receiving the Brookmans Park transmissions anywhere round London. Listeners living at greater distances, and finding this type of set insufficiently powerful, will get good results by replacing the two low-frequency stages of the set by the special amplifier described in an earlier article of this series. Our first experiments were carried out using a modification of the well-known Ferranti S.G. IV receiver. The H.F. and detector stages were constructed exactly in accordance with the published instructions, and were followed by the special amplifier referred to above, making a total of five stages. This set gave greater strength than was needed, and was always used with the volume-control turned well down.

Subsequently a four-stage Resistance-Capacity coupled amplifier was constructed, using two Mazda PX 650 valves in transformer-coupled push-pull in the last stage. 200 volts H.T. was found sufficient for this amplifier, which showed some improvement in results when used in place of the transformer-coupled amplifier originally employed. Very careful screening of every stage in iron boxes was found necessary, however, in order to get the new amplifier to work really well; and of the two the transformer-coupled amplifier was the easier to operate.

With the transfer of the London programme to the new transmitter at Brookmans Park, it was found that ample strength was available without the use of an H.F. stage. Hence our experiments were continued using an Anode-bend Rectifier only in front of the R.C. amplifier; and an Osram DEL 610 valve was found suitable for the detector, when using a negative bias of about 16 volts, and an H.T. voltage of 200 applied to the valve through an 80,000 Ω coupling resistance. The signal strength is so great in central London from this transmitter, however, that we expect to get the necessary output for television reception by the use of three valves only, viz., an Anode-bend Detector, an R.C. stage, and a transformer-coupled power stage using our existing push-pull P.X. 650's.

The apparatus was first set up using an existing experimental disc, mounted in the receiver already described in these articles, together with the amplifier, neon filter, and a Ragtheon neon tube. The characteristic Baird television signal was easily tuned in, no reaction being used. For the benefit of those who have not yet heard this signal, I think it is best described as a 12-cycle succession of 360-cycle chirps. The signal is most destinctive when heard on a loud-speaker; it is almost unmistakable for anything else, and once heard, should never be forgotten.

The Image Sound

Incidentally, it is very instructive to notice the change in quality of this note when a subject comes in front of the television transmitter. A roughening is noticeable in the tone of the signal, due to the introduction of a range of higher frequencies not previously present.

On running up the receiving disc, results were immediately observed, and an image of a sort could be held in the field of view without great difficulty. No synchronising gear is fitted to our experimental receiver, but after a little practice it will be found fairly simple to hold the image in the field of view. The experimenter should try to anticipate any drifting of the image upwards or downwards, and aim at varying the speed of his receiving disc to compensate for this drift before the image begins to move too rapidly. Once the image is allowed to race away, difficulty may be experienced in finding it again, and valuable seconds will be lost. It should be born in mind that a stationary image of a very distorted nature can be obtained when the receiving disc is

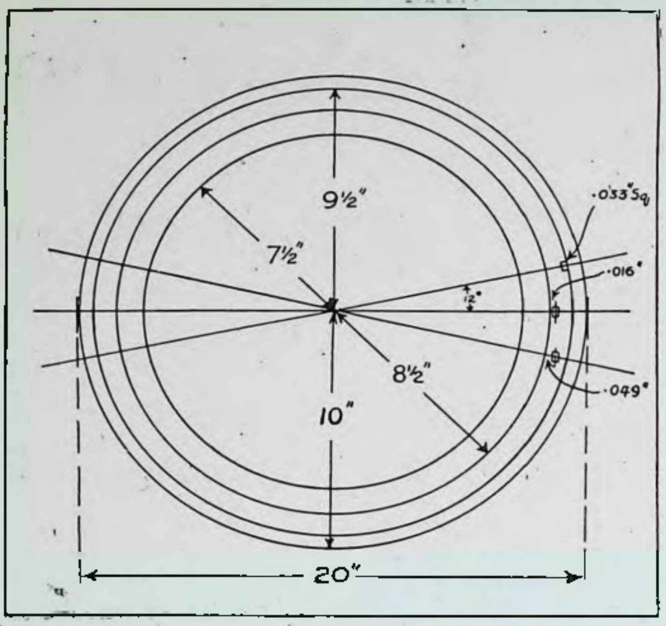


Fig. 1.—The dimensions of the disc used on the Baird transmissions. Only the first two inner holes of the spiral and the last, or outer, hole are shown, in order not to complicate the sketch.

not running at the synchronous speed, but at certain multiples of this speed; hence, whenever a very distorted result is obtained, it is wise to vary the speed of disc and to verify that a better result is not waiting "just round the corner."

First Results

Our first televised images were of a very grotesque nature, the head and shoulders of a subject appearing far too broad in relation to the height. This was expected, however, as we were using a disc chosen at hazard from among a number of experimental ones. No exact information was available as to the dimensions of the disc in use at the Baird transmitter, except that we had reason to believe that it contained a single spiral of 30 holes. This view was confirmed by the fact that the 30-hole disc first tried gave a definite, although distorted, image. Hence a number of 30-hole discs were constructed, with various ratios of length to width of image. One of these was found to give very good results, and probably represents a very near approach to that actually in use by the Baird Company. Hence we offer the constructional details of this disc to our readers as a valuable guide until the actual dimensions are published, and they may construct it with every confidence of getting satisfactory results.

Before proceeding to the description of this disc, however, I would advise experimenters to pay careful attention to the current used to actuate the neon tube. We have found that by careful adjustment of this results were obtained which are not greatly inferior to those shown at the Baird demonstrations given during the wireless exhibition at Olympia. A current between 5 and 20 *mA* will generally be found suitable, and this current should be increased in proportion to the strength of signal which the radio receiver is delivering to the neon tube.

A Word of Warning

And here a word of warning may not be out of place. If the image received is lacking in half-tones, and resembles a shadowgraph in appearance, the trouble is probably caused by too strong a signal being applied to the tube. A similar effect is obtained if overloading is occurring at any point in the set, due, for example, to the use of too small a power valve, insufficient high tension voltage, or insufficient grid bias. *It is useless to expect good television results from a wireless set which is not giving good quality during the normal programmes.* A loss of the higher frequencies will also produce this type of result, and it is interesting to note that results were relatively poor during the first weeks of the Brookmans Park transmission, probably due to the loss of these frequencies in the land line used. Only now during November are we getting such good results again as we obtained at first from the old 2LO transmitter.

The dimensions of the disc used for the Baird transmissions will be found in Fig. 1.

The first step is to obtain a piece of sheet aluminium 24 inches square by 24 s.w.g. (standard wire gauge), Particular care should be exercised in selecting a flat piece of material, otherwise it will cause trouble by vibration, due to its being untrue on the surface. A piece of material of a much thinner gauge could be used if the experimenter has the facilities for cutting out the disc, and in this case the disc may be expected to spin itself true while in use. I do not recommend the thinner material, however, except when one has the necessary tools and experience for cutting it.

The trammels which are used were described in detail in a previous article,* and have proved invaluable for making experimental discs. The diameter now required being 20 inches, the trammels should be set at 10 inches, and the cutting operation should be done on both sides of the material until the tool almost breaks through. A little paraffin oil will be found to be of assistance as a cutting lubricant.

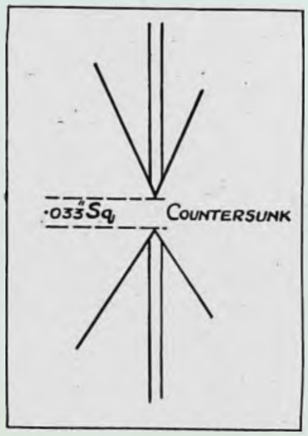


Fig. 2.—Showing how the holes are countersunk.

The marking off should be very carefully done, care being taken with the dividing of the inch into thirty parts. A slight error in this division will show up badly when the disc is in use. The points of the dividers must be kept sharp, and I would advise the use of a magnifying glass. It will be noticed that there are three circles inscribed on the disc; the smaller circle is used to facilitate the use of a small pair of dividers,

(*Continued on page* 498.)

* TELEVISION, July, 1929.

Aerial and Earth Systems for Reception

By *R. L. Smith-Rose*, D.Sc., Ph.D., A.M.I.E.E.

IN the September issue of TELEVISION I dealt with the effect of local conditions in screening wireless receiving aerials. In view of the importance of the aerial and earth system in the reception of both sound and vision signals it will be worth while devoting another article to some considerations of the manner in which the receiving aerial operates, and of its arrangement to obtain the best efficiency.

The aerial, whether it be of the open wire or closed loop type, is essentially the agent by which the energy of the passing waves is extracted for the purpose of giving intelligible signals to the loud-speaker and televisor. However much the received currents or voltages may be magnified subsequently by the use of valves, the net amount of energy absorbed from the ether is determined by the aerial circuit. To obtain the best results, therefore, in any given circumstances, it is necessary to ensure that the aerial is arranged in such a manner that the maximum possible electro-motive force is induced in it by the incoming waves, and also that the dead losses in it due to its ohmic resistance should be reduced to a minimum.

The manner in which these conditions can be met in any given case depends upon what limitations, if any, are imposed on the aerial and earth system from other considerations. For example, in one situation the space occupied by the system may be immaterial, and the aerial will then be limited in the matter of its length to 100 feet on the ordinary receiving licence. In other situations both the height and length of the aerial may be limited, and the problem is then reduced to that of utilising to the best advantage the space available.

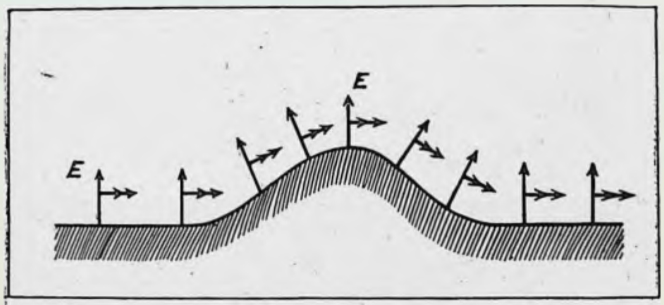
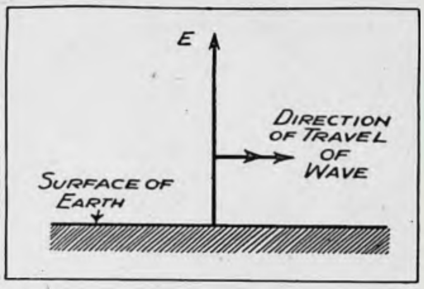


Fig. 2.—When the slope is not too abrupt the direction of travel of a wireless wave follows the contour of the ground.

Let us first take the case of getting the maximum E.M.F. into the aerial. In an elementary study of the travel of wireless waves over the earth's surface, the earth is usually assumed to be a perfect conductor,

Fig. 1. — Direction of the electric force E in a wireless wave travelling horizontally over a perfectly conducting earth.



and we are informed that the electric lines of force must always be perpendicular to such a conductor. Therefore, the wireless waves are represented as travelling horizontally along the earth with the electric force perpendicular to it; for open ground that is sensibly horizontal the state of affairs is as represented in Fig. 1.

Effect of Hills

Where the ground is not flat, but is subject to the undulations of hilly country, the above boundary condition must still obtain. Thus for a hill or mountain of moderately gentle slope, the manner in which a wireless wave surmounts it is shown in Fig. 2. If the change in slope is very abrupt, as in the case of a precipice, the state of affairs is not quite so straightforward as that represented, and other secondary effects must be taken into consideration.

In the next stage of the study of wireless waves it is appreciated, sometimes very forcibly, that the earth is, after all, not a perfect conductor; in fact, that it is a very bad conductor as compared, for example, with copper. This departure from perfection was shown theoretically by Zenneck to result in a tilting forward of the lines of electric force as the wave progresses, in the manner shown in Fig. 3.

If this forward tilt is at all large, it is evident that a vertical aerial will not have such a large E.M.F. induced in it as an aerial which is arranged approximately parallel to the electric force, as in Fig. 4 (a). Further, the direction of the slope of the aerial will depend upon the direction from which the waves are arriving. For instance, a wave arriving from the left (*L*) will induce a greater E.M.F. in an aerial sloping as in Fig. 4 (a) than in one arranged as in Fig. 4 (b); while if the wave is approaching from the right (*R*) the state of affairs will be reversed.

Although this forward tilt of the wave-front was predicted by Zenneck over twenty years ago, no experimental verification of it was made until quite recently, and our knowledge as to the possible values of the tilt in any practical cases has been very indefinite. It was known from the theoretical analysis that the angle of the tilt would increase as either the wave-length or the conductivity of the earth was reduced, but no satisfactory data were available as to the effective conductivity of the earth's crust at wireless frequencies.

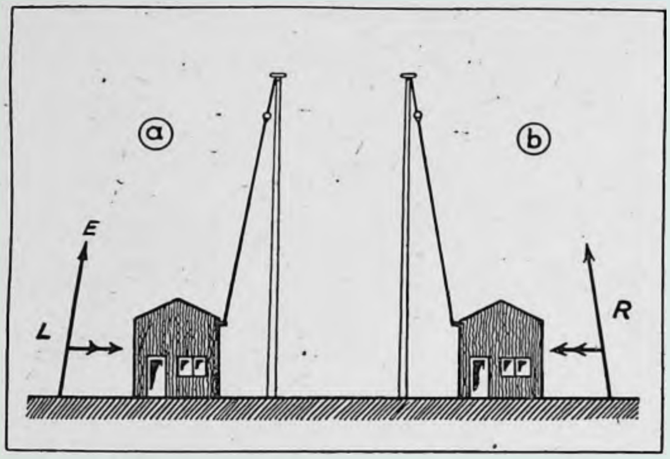


Fig. 4.—The E.M.F. induced in an aerial is greatest when the wire is parallel to the direction of the electric force.

During the past few years, however, many experiments have been carried out in different parts of England in which the inclination of the electric force to the vertical has been directly measured for various wave-lengths. The results show that for wave-lengths in excess of 2,000 metres the electric force in waves arriving under any normal conditions is never inclined at an angle of more than 1 degree to a line drawn perpendicularly to the earth's surface at the place in question. As the wave-length is diminished this angle increases to a value in the neighbourhood of 3 degrees for a wave-length of 300 metres, while for shorter wave-lengths the angle may reach about twice this value.

In the course of these experiments some measurements were made on the side of a hill sloping at 16 degrees to the horizontal, and it was verified that the waves were travelling sensibly in the manner depicted in Fig. 2. It is evident from these results that in order to get the maximum E.M.F. induced in an aerial on wave-lengths in or above the normal broadcasting band the major portion of the aerial should be arranged to be as far as possible vertical; or rather, perpendicular to the average direction of the ground in the immediate neighbourhood.

The slope of the wave-front of 3 degrees above mentioned may be interpreted in another way as indicating that the strength of the horizontal component of the electric force is only about five per cent. of the strength of the vertical component. Hence if a given length of wire be arranged first vertically and then horizontally, the E.M.F. induced therein will be twenty times as great in the first case as it will in the second. There is an important difference between the two cases, however, for with the vertical wire the E.M.F. is the same for all directions of arrival of the wave, whereas with the horizontal wire the E.M.F. varies with the direction of arrival of the waves.

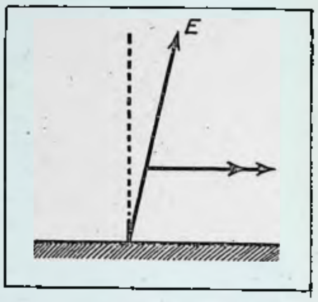


Fig. 3.—Tilting forward of the electric force due to imperfect conductivity of the earth's surface.

This effect can probably be best understood by supposing the vertical and horizontal wires joined together to form an inverted ⅂ aerial as in Fig. 5. A little consideration of the case when the waves are arriving from the left hand side (*L*) will show that the E.M.F.'s induced in the two portions of the aerial depicted in Fig. 5 (a) will be in opposition as indicated by the arrows; while with the aerial reversed as in Fig. 5 (b) the two E.M.F.'s are assisting each other. If the two aerials are rotated through a right-angle so that the horizontal portions are perpendicular to the direction of arrival of the waves, no E.M.F.'s will be induced in these portions, and the vertical parts of the aerial will alone be operative in receiving an E.M.F. from the waves.

Directional Properties of Receiving Aerials

These considerations, taken in conjunction with the numerical results quoted above, indicate that an

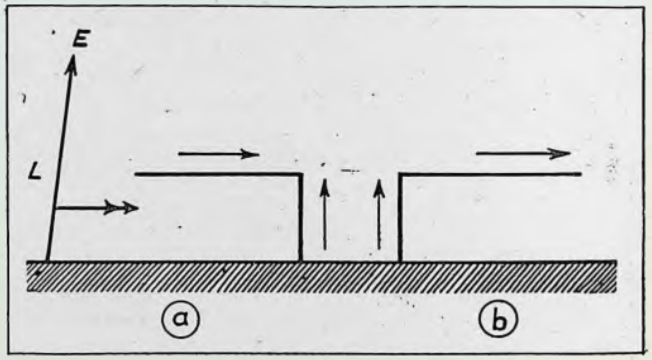


Fig. 5.—E.M.F.'s induced in two inverted ⅂ aerials by the vertical and horizontal components of the electric force of the wave approaching from L.

inverted ˥ aerial can have appreciable directional receiving properties only when the wave-length is moderately short and when the horizontal length of the aerial is several times its vertical height. In some

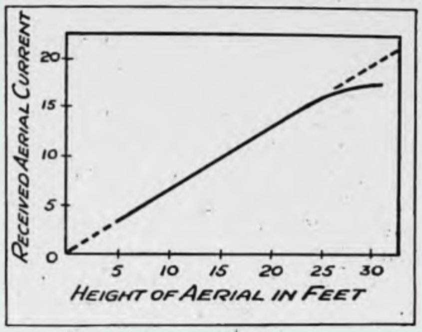


Fig. 6.—Graph showing the relation between the height of an inverted ˥ aerial 100 feet in total length and the received current measured in arbitrary units.

direct measurements which have been made of the relative currents obtained in inverted ˥ aerials orientated in different directions with respect to the transmitter, it was shown that with an aerial 20 feet high and of 80 feet horizontal length used on a wave-length of 365 metres, the difference in current received by the aerial in its worst and best positions (*i.e.*, as indicated in Fig. 5 (a) and (b) respectively) was about twenty per cent. of the mean current. The most favourable position was, of course, that in which the free end of the aerial pointed away from the transmitting station Fig. 5 (b).

In considering the importance of the directional effect in this case, which is one that might easily arise in a broadcast receiving aerial, it is to be noted that the same increase in current could have been brought about by increasing the height of the aerial by only 3 or 4 feet. If the case is carried to the extreme in which the height becomes negligible compared with the horizontal length, we see that while an appreciable E.M.F. can be received, such an aerial will have very marked directional properties. This deduction has been verified from time to time in experimental work which has been carried out on horizontal aerials laid on the ground.

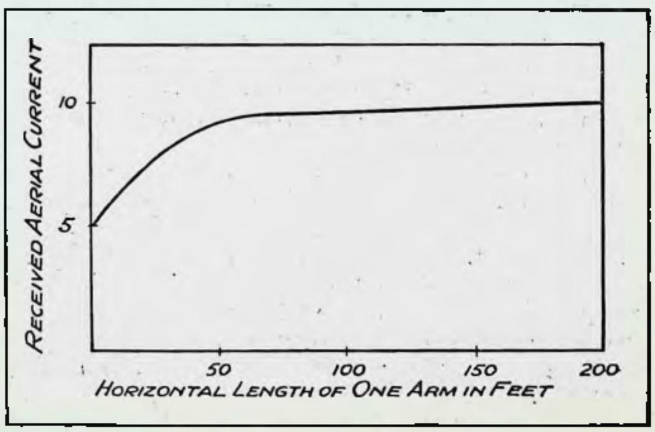


Fig. 8.—Received current obtained in a T aerial of height 60 feet, with varying length of the horizontal portion.

General Conclusions

The general conclusions which may be drawn from the discussion in this section are therefore as follows. With a view to securing that the maximum E.M.F. is induced by the arriving waves, a receiving aerial should be erected with its vertical height as great as possible. Except on the shorter wave-lengths and with long, low aerials, the directional effect in reception is not of primary importance; but if other conditions permit, the greatest efficiency will be gained by arranging that the free end of the aerial points away from the transmitter.

To confirm and extend the conclusions reached in the last section a series of measurements made with different aerial arrangements may be quoted. The use of a valve voltmeter in conjunction with a mirror galvanometer enabled a direct interpretation to be made of the current induced in the aerial by the carrier wave from the London broadcasting station at a distance of about 10 miles. In the conduct of the experiments it was decided to apply the limiting

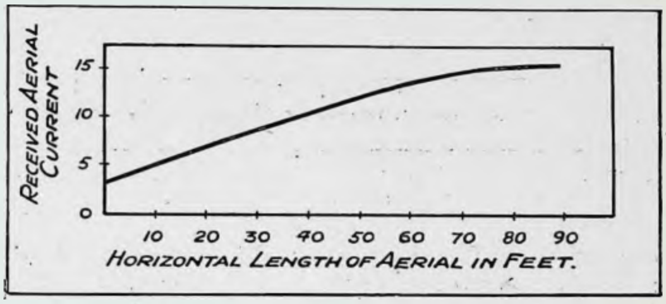


Fig. 7.—Effect on the aerial current produced by lengthening the horizontal portion of the aerial, the height being fixed at 25 feet.

condition that the total length of the aerial should not exceed 100 feet, and the experiments were made partly with a view to ascertaining in which way this length of wire could be used to the best advantage.

In the first case, using a single wire aerial of the above total length, measurements were made of the received current when the aerial was given heights varying from 7½ feet to 30 feet, the remaining length of wire being arranged horizontally in a fixed direction. The results obtained are shown in Fig. 6, from which it is seen that up to a height of about 20 feet the received current increases uniformly and is proportional to the height. Beyond this the current still increases, but not so rapidly, and the results indicate that if the height was made about 40 feet any increase in this height would produce only a small percentage increase in the received current.

In the next experiment the height of the aerial was fixed at 25 feet. With a total length of wire of 100 feet, this leaves an available length for the horizontal portion of 75 feet. It was then desired to ascertain what was to be gained by any increase in this horizontal length, and also how much would be lost should other circumstances, such as limitations of space, preclude the utilisation of the full 75 feet. The results of measurements on these lines are shown in Fig. 7. It is seen that as the length of the horizontal part is increased from zero to about 40 feet, the received current increases in a linear manner. Above this point the rate of increase falls off very considerably, and beyond the permitted length of 75 feet the increase in received current is almost negligible.

This optimum ratio of horizontal length to height of about three to one has been confirmed by other experiments in which the total length of aerial employed was not restricted to 100 feet. In Fig. 8 is given the results of similar measurements of received current on a T aerial 60 feet high and with a horizontal length up to 200 feet. It is seen that in this case the current ceases to increase after the horizontal portion has reached about 180 feet in length. All these experiments refer, of course, to the medium broadcast band of wave-length only.

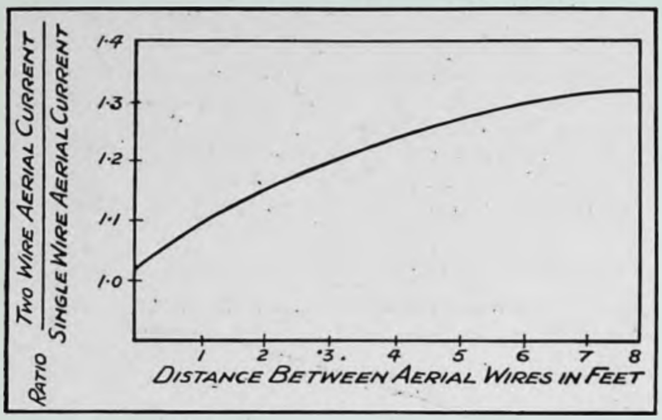


Fig. 9.—Curve showing the effectiveness of a twin wire aerial with varying distances between the wires.

Use of Aerial with Several Wires

Having thus investigated the effect of height and length of the aerial, the next point was to ascertain what advantage is to be gained by using more than one wire in the horizontal portion of the aerial, and if two or more wires are used, at what distance apart these should be. For this set of measurements an aerial was constructed in the form of two stranded wires of No. 3/19 S.W.G. enamelled copper 75 feet long, supported at a height of 25 feet above the earth screen employed therewith. Successive measurements of the received current were made while the distance between the wires was reduced in steps from 8 feet to zero; and finally a single wire of No. 20 S.W.G. was substituted for the two adjacent wires.

The results are shown in Fig. 9 in terms of the ratio of the current received on the aerial to the current received on the single-wire aerial. It will be seen that if two wires are used they should be at least 6, and preferably 8, feet apart. Even with this spacing, however, the increase in current obtainable over that on a single wire aerial is not large, being about thirty per cent. in the case quoted. Using the full 8 feet spreader space, further measurements made with three or four wires arranged symmetrically showed that nothing was to be gained by increasing the number of wires in this way.

Effect of Earthing Resistance

It should be pointed out, in conclusion, that all of the above measurements were carried out on the aerial used in conjunction with a fairly efficient earth-screen, the lowest actual resistance of the aerial circuit in the last case being about 11 ohms. If, as may easily be the case with the average aerial employed for broadcast reception, a much higher resistance were associated with the earthing arrangement, then it is evident that any improvement in the aerial alone will have less effect on the magnitude of the received current.

As an illustration of this point the case of the last measurement described above may be cited. The substitution of a single wire of No. 20 S.W.G. for two stranded wires of No. 3/19 gauge made an almost negligible difference in the received current, although the resistance of the former is nearly eight times that of the latter. The explanation is, of course, that the actual ohmic resistance of the aerial wire in this case is only one or two ohms, even at high frequencies, and that the change in the total resistance of the aerial circuit produced by the substitution is practically negligible, on account of the fact that the effective resistance of the earth connection may be anything from 10 to 50 ohms. In the absence of a somewhat elaborate earth screen or counterpoise which can be made to have a fairly low resistance, the best type of earth connection available to the average householder is undoubtedly the main water pipe.

Experimental Television Apparatus.

(Concluded from page 494.)

and the circumference of this circle is used as a fixed reference point.

The intending constructor will need a suitable rule for this particular job, since 1/30th of an inch is not a measurement used in common practice. I found that this measurement is in use by surveyors, and after trying a number of rule makers for such a steel rule, I at last obtained an ivory-edged one from Stanley & Co., 286, High Holborn, London, W.C.1.

The drilling of the holes should be done with a number sixty drill, using a very light hand brace, and paraffin as a lubricant.

These holes should next be countersunk on both sides of the disc, so as to leave a sharp edge, as indicated in Fig. 2. We next come to the operation of squaring the holes, and as it is a difficult and delicate job to make a drift of this size, I would advise the use of the tag end of a small Swiss file. If this is just pushed into the holes for the correct distance in each case, one will be surprised at the excellent square obtained.

In my next article I hope to describe the construction of a phonic wheel synchronising device suitable for use when receiving the Baird transmissions.

The Chemistry of Tungsten

By *W. F. F. Shearcroft*, B.Sc., A.I.C.
Fellow of the Television Society

In the early history of the progress of wireless transmission, we find that Edison applied for a patent for a diode valve for the purpose of controlling the voltage of electric lighting systems. The invention does not seem to have received very much attention, or practical application. That, however, is typical of our hobby. The greatest inventions have been neglected when first they appeared.

In 1904 Sir (then Professor) Ambrose Fleming applied for a patent for a somewhat similar instrument, or rather for the discovery that "if two conductors are enclosed in a vessel in which a good vacuum is made, one being heated to a high temperature, the space between the hot and cold conductors possesses a unilateral electric conductivity."

In 1909 Feming obtained a patent for a diode, in which the filament was made of *tungsten*. From this stage onward the history of the subject is too well known to need further mention, but no small part in that progress has been played by the element tungsten.

Tungsten is an element in the sixth group of the periodic table and its position with reference to other members of the group is shown in the table below :—

Group VI.

A				*B*
Cr	..	..	..	O
Mo	..	..	..	S
W	..	..	..	Se
Ur	..	..	..	Te
—	..	..	..	Po

It belongs essentially to the chromium sub-group, the members of which exhibit the usual gradation of properties. Some of the more important physical properties of the group are tabulated below :—

Element	Chromium	Molybdenum	Tungsten	Uranium
Symbol ..	Cr	Mo	W	Ur
Atomic weight	52·01	96	184	238·2
Specific heat	0·1208	0·0647	0·0358	0·0280
Melting point	1,550° C.	2,450° C.	3,267° C.	1,850° C.
Boiling point	2,200° C.	3,200° C.	4,700° C.	2,450° C.
Density ..	6·9	9–10	19	18·7

It is of interest to note that tungsten precedes that most interesting of elements uranium, which, by its radio-active properties, first started off the work on atomic structure, which has been so useful in both theory and practice.

The ores from which tungsten is now obtained were at one time thought to be tin ores. Scheele, in 1781, differentiated between the elements, and in 1783 the metal was first obtained. *Wolframite*, from which the element takes its symbol, is the best known and most widely distributed ore. It is a mixture of iron and manganese tungstates, which may be represented by the formula, not supposed to be exact, $(FeMn)WO_4$. It is a black or brownish-black mineral occurring in the Urals of Russia, Saxony, New England, Colorado, New South Wales, Cumberland, and Cornwall. There are various forms of the mineral, which are usually associated with tin ores. An average composition is :—

FeO = 18·96 per cent.
MnO = 4·67 ,,
WO_3 = 76·37 ,,

Ferritungstite (Fe_2O_3, WO_3, $6H_2O$) is a brownish mineral found mainly in Washington State. *Scheelite*, calcium tungstate ($CaWO_4$), is widely distributed, and is a yellowish or pale-brown mineral, with a waxy lustre. It is most favoured for the production of the element. *Tungstite*, essentially an oxide of the metal, is found in British Columbia.

Oxidation

The extraction of the element from its ores divides roughly into two stages, the first of which is to convert the ore into tungsten oxide (WO_3). The mineral concentrates are crushed and the impurities separated, a magnetic separation process being employed. An oxidation process follows, where the ores are rotated in the air. From this mixture of oxides the tungsten oxide is dissolved out by heating under pressure with a suitable alkaline solution. An ammonia solution results in the formation of a solution of ammonium tungstate, from which crystals of this salt can be obtained. On heating, these are transformed into a canary-coloured, amorphous powder, which is essentially the required oxide.

The oxide is then reduced to the element by heating to red heat with carbon, or by treatment with pure hydrogen.

The element itself is known in a silvery-white form

(*Continued on page* 502.)

Sydney A. Moseley

on a New

IT seems that I am no longer to play a lone hand, and time, too, don't you think? There has come from the north—and certainly the north should provide champions for Mr. Baird!—a redoubtable fighter—a new Richmond—who has been helping to make things hum. I refer to Mr. W. Barrie Abbott, a well-known chartered accountant of Peebles, whose letters I quoted in last month's issue of TELEVISION. These quotations, by the way, were amplified by the publication in full of other correspondence which he had with Sir John Reith and other eminent persons.

There has now come to my hand a further letter which Mr. Abbott has addressed to my esteemed friend, Captain P. P. Eckersley, late of the B.B.C. and now of the Gramophone Co., and I think it will add not only to the interest of the subject but to the joy of nations for me to deal with this last salvo from bonnie Scotland.

Evading the Point

"Dear Sir," writes Mr. Abbott—though by this time I should have thought that the association should have become more friendly—"I thank you, etc. . . . , *but I think you evade the main point of my correspondence,* which is that your whole attitude towards British television has been antagonistic." There, there, is not that too unkind of Mr. Abbott? He is presumptuous enough to infer that the gallant Captain would evade the main point. Now there is one thing which is going to hurt the well-known engineer more than anything else. "P. P.," as we who are his admirers refer to him, is bold even if he is bumptious; he is not afraid of his views, and although I have charged him with a good many things I should hesitate to add intellectual cowardice to them. Indeed, his views are so astonishingly original that he would be forgiven if he were a little more reticent concerning some of them. However, Mr. Abbott will have to answer this as soon as his letter catches the eye of his intended victim. I pity him.

Mr. Abbott goes on to say: "Your articles, in my opinion, were written in a jeering and supercilious way, and wherever possible, you introduced the implication that American and other foreign television investigators were ahead of British television, and you failed to give credit to the work being done in this country. You admit that Sir Ambrose Fleming is a better technician than yourself, but it is obvious that you still consider that your own opinion carries greater weight than his."

Now we are nearer the mark. You will recollect that long ago I suspected the gallant Captain of being somewhat superior, not to say supercilious, and it was this unfortunate attitude of mind that brought about a *contretemps* which, in his heart of hearts, he must now bitterly regret. To be perfectly frank and fair, as I always hope to be, I do not remember that Captain Eckersley has ever suggested that American and other television investigators were ahead of British television; honestly, the point of British leadership has never been in doubt. British television took the lead from the first and kept it, although, by the nagging and obstructionist attitude of the authorities in London, Mr. Baird was held up while his rivals forged ahead. I pointed all this out to the invincible Peter; but he remained his calm, confident self, being then, as it happened, Chief Engineer of the B.B.C. And naturally his views were not to be disregarded by those who employed him.

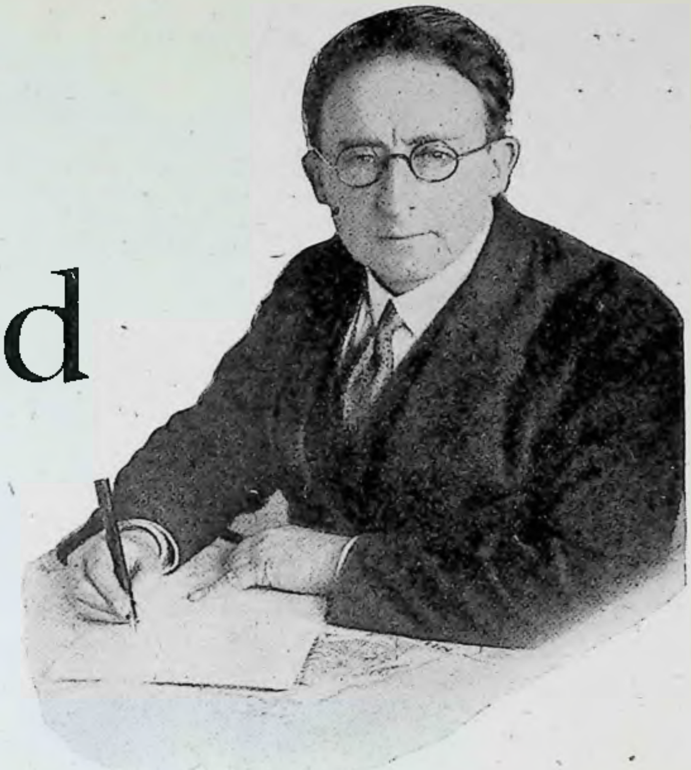
"What is Coming over Him?"

And now after all Captain Eckersley admits that Sir Ambrose Fleming is a better technician than himself! What is coming over him? Are we losing the old spirited "P. P."? Is there in his stead an engineer who is finding his normal level? Has he become merely fallible?

Incidentally, I should like to pay a tribute to Sir Ambrose for the unfailing and unwavering support that he gave to television from the very first; at any rate there was no doubt in Sir Ambrose's mind, and he was equally as bold as Peter in letting the public know it.

Now the next point in Mr. Abbott's letter to Captain Eckersley is of particular interest to me. He states that Sir Ambrose's opinion "is backed up by other technicians and prominent commercial men representing certain companies of Germany."

Richmond



It is quite true that " these companies consider television sufficiently advanced commercially to warrant their joining with the Baird Company to form a syndicate to place it upon the market. Commercial ' televisors ' are actually being placed on the market by these companies, whose names and reputations carry infinitely more weight than any purely individual opinion."

Significance not Appreciated

Perhaps I may amplify this statement, particularly in view of the fact that the full significance of this powerful German movement has not been appreciated in London. Since I had something to do with the formation of the Fernseh A.G., I may say that it was only after the closest inspection of the Baird system, and with a full knowledge of other systems, that these experts—one on motors, one on radio manufacture, and a third on optics—agreed to form a company with the British Company. The managing directors of these companies certainly *did* consider television sufficiently advanced commercially to warrant their beginning to manufacture commercial " televisors." I emphasise this because, even to-day, so-called commercial magnates, who have not had the advantage of a study of the situation, still believe television to belong to the realm of fiction. As one who had the pleasure of meeting these German experts on several occasions, I can testify that *unless they were absolutely certain of the commercial possibilities of television, not one of them would have risked his reputation,* and certainly not risked the finance of his company.

It is true that the first question asked me in Germany when I reached there was : Why does the B.B.C. not permit you to broadcast your television system ? That wanted a lot of explaining away, I admit, but the Germans are very patient people and do not jump to conclusions, and in spite of the undoubted influence of powerful opposition I was able to convince them of the realities of the situation, and this, backed up by actual demonstrations and examinations of the Baird apparatus, resulted in the formation of what has become an historic company.

Readers will recollect that I prophesied that Germany would be the first country to broadcast television officially. It was not very long after my arrival in Berlin that I realised how true this forecast was likely to be, and Mr. Abbott is correct in chastising the gallant Captain for helping a foreign country to be first in the race to broadcast television. However, let me add that the B.B.C. has now made good by extending the facilities originally offered to the Baird Company. Here I will content myself by quoting the remainder of Mr. Abbott's interesting letter.

That " Toy " Business

" It is interesting to note that you keep reiterating the phrase ' a mechanical toy.' Almost exactly the same phrase was used in the early days of the telephone. It was called an ' electrical toy,' and its inventor was chased downstairs by the self-satisfied bureaucrats of his day.

" The object of sending television through the ether is to provide facilities for the great body of amateur experimenters in the country, so that they themselves can make their own experiments on the reception of these transmissions, and in so doing there can be no doubt that they will evolve improvements and novel inventions, just as has been the case with broadcasting, where much valuable work has been contributed by the amateur experimenter, and this valuable work could never have been possible if broadcasting had not been in operation, and the amateur given an opportunity of experimenting with reception.

" The television broadcast transmissions will give this opportunity to the amateur experimenters, a vast body, and a body of workers which deserves every encouragement. You ignore this point. The first broadcast transmissions of telephony and the first broadcast receivers well merited your contemptuous observations of 'electrical toys.' I can myself, well recollect the appalling travesty of speech and music which issued from these early wireless receivers, but let us look at the results which these early experiments have led to, and how much the improvements are due to the work of individual amateurs, and the push and impetus given to the industry by the efforts of these individual amateurs.

A Terrific Fight

"It is beyond all doubt that television is having a terrific fight to establish itself in this country and that enormous powers are being employed to retard or subvert it. The following quotation from *Vox* is significant: 'It is well known that the editors of a certain group of newspapers have standing orders to print nothing but discouraging and adverse news and comments on television.' That there is some truth in this staggering accusation might be inferred from the fact that when the Prime Minister himself recently broadcast a speech in which he greatly praised television, the leading newspapers suppressed the part dealing with this subject. Do you not consider such a state of affairs appalling? I am sure that in your heart of hearts you do, and that quite well you know that I have the right end of the stick in this controversy.

"In your last letter you say: 'Of course I may be hopelessly wrong, I may be talking the most appalling nonsense.' I am afraid that I cannot reconcile this admission with your former claim to base your case on 'facts, only facts, and nothing but facts.' But no matter how we have differed in the past, I do sincerely hope that you will now join with me in my humble fight for justice not only to a marvellous British invention but also to one of nature's true gentlemen, that brilliant but modest genius who until now has received such shabby treatment from his own countrymen."

The Truth about Television

Mr. Abbott's reference to *Vox* is true enough, and no doubt he has now seen the first of my own articles in that paper, retailing the truth about television.

There you are. Mr. Abbott and I will probably find the field left to ourselves. I do not see that Captain Eckersley has retorted to the article I contributed to last month's TELEVISION. No doubt, the situation is becoming more placid—far too placid for a journalist like myself who lives and thrives on excitement. Cannot I induce my friend "P. P." to come out with another tirade, or has he lost heart altogether in face of realities, and retired from the field of controversy? I trow not!

Chemistry of Tungsten.

(*Concluded from page 499.*)

which is very similar to polished platinum in appearance, as a crystallised form and as a grey powder. It is a hard substance: 6·5 to 7·5 on the scale of hardness (diamond=10·0). It has a high melting point (3,267 ± 30° C.), and boils at nearly 5,000° C. The specific heat is 0·0358. The coefficient of expansion is $4{\cdot}2 \times 10^{-6}$ from −100° C. to 0° C. and $4{\cdot}6 \times 10^{-6}$ from 0° C. to 500° C. Tungsten is very incompressible, having in fact the lowest compressibility that has been studied so far.

Tungsten is not oxidised appreciably when heated in the air below red heat, but coloured films are formed on the surface. It combines directly with carbon, silicon and boron when heated with these elements in the electric furnace. With sulphur and phosphorus it has no direct action. It will decompose water at red heat, but exhibits great resistance to attack by acids.

As a Filament

It owes its great use as a filament in electric lamps to its high melting point and non-volatility. Its use and life as a filament is considerably improved by the addition of a small percentage of thoria—up to 1 per cent. being added in practice.

The filaments are made by a variety of processes. Mechanical drawing is used, when a wire of the element is forced slowly through a thin orifice at a temperature of 2,000° C. This process, if correctly carried out, produces a single, elongated crystal. Compression of a paste of tungsten mixed with various organic compounds, with subsequent carbonisation, sintering and shaping, is another method. Tungsten in the colloidal states has also been used, and filaments can be formed by exposing a glowing filament of carbon in an atmosphere of tungsten chloride mixed with hydrogen. This produces a coating of tungsten around the carbon core. Many other processes have been tried, and some of them are in use.

In an ordinary evacuated lamp it is safe to let the temperature rise to 2,130° C. with a tungsten filament. Above this temperature volatilisation occurs, and results in the deposition of tungsten on the glass of the lamp, and the consequent diminution of its brilliancy. This defect has been overcome to some extent by coating the inside of the bulb with various substances, which appear to dissolve the deposited tungsten.

In addition to filament construction, tungsten finds a use as a substitute for the more expensive platinum. Its hardness, good heat-conducting properties, and high melting point make it suitable for electrical contacts, and arcing points. It is used as a target for X-ray tubes, and forms an important series of alloys, of which tungsten-steel is the best known.

It forms a series of peculiar compounds which result from the reduction of certain tungstates, and are known as *tungsten bronzes*. These are very metallic in appearance, and vary from vivid golden-yellows to violet in colour, and are used as substitutes for bronze powder.

The Nature and Properties of Light

PART I.

By *H. Wolfson*

THE nature of light was a problem which gave rise to much speculation among the ancient philosophers. Plato and Aristotle, to mention but two names, were firmly convinced that light was a property of the eye, and the perception of objects and scenes was supposed to be achieved by virtue of certain invisible "tentacles," which stretched between the eye and the object, thus enabling the individual to feel or perceive the object in question.

Needless to say, theories of this sort had no physical foundation, and as soon as people realised the absolute necessity for backing up speculative reasoning by experimental data they were discarded as useless and impracticable.

The Corpuscular Theory

The most important of the theories in vogue about the middle of the seventeenth century was the corpuscular theory. Among the most ardent supporters of this theory was Sir Isaac Newton, whose name will always be world famous for his theory of gravitation, and other works which so firmly laid the foundation stones of modern mathematical and physical science.

According to this theory, light consists of a host of particles of infinitesimal size, moving with enormous velocity. It was imagined that these particles were emitted from every luminous body, in a similar manner to projectiles issuing from a gun. The force of the impact of these material particles on the retina of the eye produces a sensation which we term light.

The path of these particles is the same as the path of a projectile emitted under similar conditions, that is, the particles move in straight lines, so long as they are travelling through space. On reaching the surface of a material body the path becomes modified, and it should be noted carefully that this modification must needs depend upon the nature of the body.

If the surface be a reflecting one, then the corpuscles will experience a repulsion normal to the surface of the body, so long as the particles remain within a small distance of that surface. The path of the corpuscles, once perfectly straight, resolves itself into a curved path when the corpuscles reach the surface, and the repulsion of the particles, after neutralisation of the perpendicular component, becomes reversed. Thus we see that the initial and final paths are straight lines, which are inclined at equal angles to the normal at the surface of the reflector (Fig. 1).

The next case should be carefully noted, as it is here that an opportunity arises to test the veracity of the theory by an experimental method. Consider Fig. 2; let the path of the corpuscle be as shown. We suppose the upper medium to be less refracting than the lower one, which is transparent to light. A typical example of this case would be air and glass. We have to split the velocity of the particle up into what is known as the horizontal and vertical components. The component of the velocity which lies parallel with the surface will naturally remain unaffected since it suffers no change of medium.

The case of the component which is at right angles to the surface, and which we denote by the term the *perpendicular* component, is different, however. This will have its velocity increased as it passes through the thin layer on either side of the surface, shown in the diagram by dotted lines. After traversing this layer the velocity is supposed to undergo no further change. If i be the angle which the incident light makes with the normal and r the angle of refraction, and we assume the velocities in the upper and lower media to be v and v^1 respectively, then the volocities of the component parallel to the surface will be $v \sin i$ before refraction, and $v^1 \sin r$ after refraction.

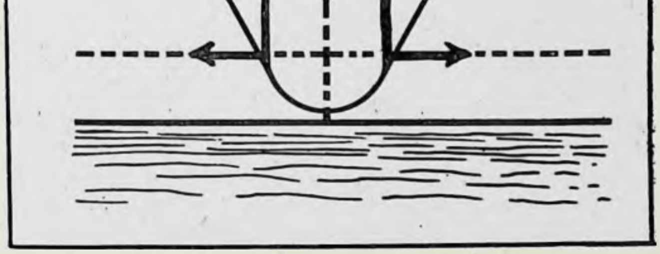


Fig. 1.—Reflection according to corpuscular theory.

Applying Snell's Law, which states that sin i/sin r is a constant, we see that this ratio in our case is v^1/v. But when light is refracted from a rarer medium (air) to a denser medium (glass) the ratio sin i/sin r is greater

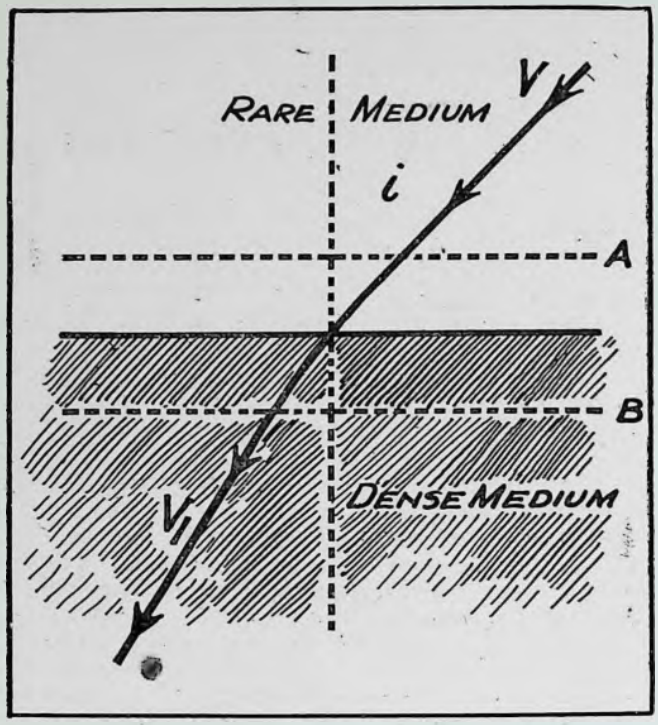


Fig. 2.—Illustrates refraction on the corpuscular theory. Note that the path of the corpuscles is curved between A and B.

than unity. It follows then that the ratio of velocities v^1/v must also be greater than unity.

We arrive, therefore, at the result that "in the denser medium the velocity of light must be greater than in the rarer one." Here, then, is an opportunity to apply an experimental method to the verification of the corpuscular theory. Foucault, the famous French physicist, about the middle of the nineteenth century, carried out a series of experiments in which he proved conclusively that light travels more slowly in water than in air. But water is a medium which is optically denser than air, which is taken as the standard of optical density, with a value of unity.

The corpuscular theory, which till this late period still exercised a considerable influence in the realm of physical thought, was now shown to be absolutely untenable. Nevertheless it still retained a few adherents, who realised the difficulties with which Huyghens' Wave Theory had to contend.

It is interesting to note that Sir Isaac Newton, in this connection, had advanced a theory which was supposed to remove any doubts which might and did arise through experiments such as those of Foucault, more than a century before. His well-known theory of "fits" is sufficiently interesting and amusing to find mention here.

Newton assumed that at the surface of separation of any two media the corpuscles of light are subject to "fits" of easy refraction and reflection. He said: "When a ray of light falls on the surface of a pellucid body, and is there reflected or refracted, may not waves of vibrations or tremors be thereby excited in the refracting or reflecting medium at the point of incidence and continue to arise there, and be propagated from thence, and are not these vibrations propagated from the point of incidence to great distances? And do they not overtake the rays of light, and by overtaking them successively do they not put them into fits of easy reflexion and easy transmission described above? For if the rays endeavour to recede from the densest part of the vibration they may be alternately accelerated and retarded by the vibrations overtaking them." This quotation from Newton's book "Opticks," published in 1750, gives us an insight into the way in which great scientists were ready to formulate minor theories (which to us appear childish and ridiculous) in order to preserve a major theory which they held in great regard.

The only alternative theory which suggests itself, when we are compelled to abandon the corpuscular theory, is that light must consist of some type of waves. We know, however, that any form of wave-motion whatsoever requires some continuous elastic medium for its transmission. We on earth receive light from the various heavenly bodies, such as the sun, moon, and stars. There must exist in space, therefore, some such medium which is capable of transmitting the waves.

Does the Ether Exist?

The term "Luminiferous Ether" is used to designate this medium. Here again we are up against the old problem that our whole arguments depend upon the existence of an invisible, all-pervading thing, of whose real identity we are unaware and whose presence we are unable to verify. Indeed, there are to-day those who discount the existence of the Ether of Space, and the late Dr. Steinmetz was one of those who was fully convinced that its existence was not essential to the proving of the wave theory of light, and the explanation of the phenomena connected with the transmission of Radio waves. Be that as it may, we are forced to admit, that although we are unable to verify the presence of this all-pervading ether of apace, we cannot abandon it in the present state of our knowledge.

A few words as to the properties which our ether must possess will not be out of place. First and foremost, the ether must possess inertia, that is, it must be able to acquire kinetic energy when set in motion. We might express this in other words by saying that the ether of space must have density, which, though small, must nevertheless be quite fixed and definite. Secondly, as indicated already, the ether must have elasticity, which is the property of obtaining potential energy when a strain is imposed upon it.

We say, quite correctly I believe, that we can only obtain light from a material body of some sort. By material body we mean such things as the heavenly bodies, a candle flame, a red-hot poker, and the like. All these and similar material bodies produce waves in the ether of space.

The transmission of any wave motion through the medium which we call ether will inevitably be accompanied by the transmission of energy. Analogy with the transmission of sound waves suggests itself while we are engaged upon the study of the transmission of light waves. I mention this fact quite early in our discussion because it is here that one of Newton's chief arguments against the wave theory arose. Sound, he said, can travel round corners, that is, the waves can bend. If light consists of waves, we should, by analogy, be forced to the conclusion that it would bend round corners. Since the rectilinear propagation of light is a firmly-established experimental fact, it seems difficult to accept the wave theory on these grounds, and it is not difficult to see why Huyghens' wave theory met with such stern opposition from men of letters. It has since been established by work carried out within the last ten or twelve years that sound waves of high frequency, the so-called ultra-sonics, travel in almost straight lines, thus tending to confirm rather than disprove the wave theory of light.

We must now enquire into the method of propagation of these supposed waves. Suppose that light is generated by some material body, as defined above, at the point P. We assume that the ether has similar properties in all directions, and it is then easy to see that the ether waves will spread out in all directions with P as centre. It is just as if one were to throw a stone into a perfectly calm pond. The point where the stone struck the surface represents P in Fig. 3, and the ripples which would be associated with the throwing of a stone into the pond correspond with the waves which we believe to be set up in the ether of space.

Terms Employed

There are a number of terms which are used in connection with the wave theory which must be made clear. We employ the term *wave front* to indicate the plane, perpendicular to the direction of wave tranmissions, to which the disturbance has just reached.

Huyghens held the view that every point along the wave front must be imagined as itself constituting a new centre of disturbance, from which light waves will emerge in all directions. This idea is illustrated in Fig. 3 where the small arcs represent the so-called *secondary wavelets*. A line can be drawn so that it touches each arc, or secondary wavelet, tangentially. This represents the *new* wave front. Thus the new wave is produced as a result of the combined action of the innumerable wavelets which originated at the old wave front. This view as to the mechanism of the transmission of a light wave through space is extremely instructive and interesting. It must be remembered that radio waves are of the same type as light waves, save only in the matter of frequency or wavelength.

Furthermore, we can apply to radio waves many similar arguments such as we apply to light waves, but it should be noted carefully that in some cases the theory may be altered or complicated by the mere fact of this different frequency range, so that it is not always permissible to apply the reasoning of one case to the other.

Zones Theory

As the distance of the wave front from the point of origin of the disturbance becomes greater we shall be able to consider a portion of the wave front as plane. The great difficulty of the wave theory, which was recognised even by Newton, is that while sound, which is a form of wave motion, can bend round corners, the propagation of light is apparently rectilinear.

The idea of zones must also be thoroughly appreciated by the reader, for, although it is not my intention to carry through the laborious details of Huyghens' work, we shall be compelled to speak of these zones. In Fig. 4 let $ABCD$ be a plane, and with O, the centre of disturbance, as centre, describe a sphere of radius $b+\lambda/2$, where b is the distance of the nearest point on the plane to O the circle C_1 will result. All points on this circle are $\lambda/2$ further from O than is the point P. Hence the wavelets must have started T/2 seconds earlier than the wavelet from P. There will accordingly be a phase difference between the wavelets from P and C_1 of π radians, or 180°. The space enclosed by the circle C_1 is called the first half-zone period. All successive circles are the result of increasing the radius of the sphere, whose centre is at O, by $\lambda/2$, which is, in effect, a half wavelength of light. Thus the annulus between C_1 and C_2 is the second half-period zone, and so forth. It can be shown mathematically that the first half-period zone is equal to the second, and further, that the area of the third is equal to the first, and so forth. Thus, when the wavelength is small, the area of all zones is equal.

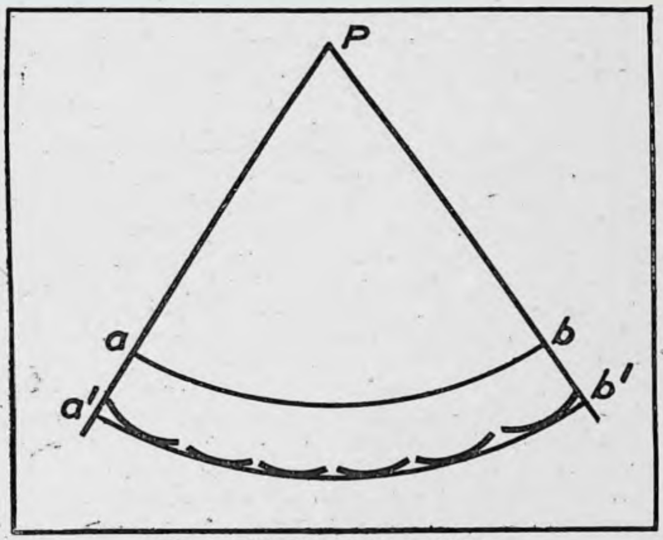


Fig. 3.—The Propagation of Waves.
a b = Old wave front. a' b' = New wave front touching secondary wavelets.

Carrying out further investigations leads us to the discovery that the displacement due to wavelets from any half-period zone is equal, numerically, to half the sum of the displacement due to wavelets from the preceding and succeeding zones.

The importance of the work summarised above will be realised if the reader considers the following. A small body, when placed a short distance from the eye, will often completely obscure a much larger object situated at some considerable distance away.

(*Continued on page* 517)

The Proceedings *of*

Meeting, Tuesday, November 5th, 1929

LECTURE ON

"Amplification and Television."

By *F. Langford-Smith*, B.Sc., B.Eng. (Associate Member).

THE November meeting of the Television Society was held at the Engineers' Club, Coventry Street, on November 5th, and in accordance with present practice it was preceded by an informal discussion at which Mr. H. S. Ryland dealt with a number of questions which had been asked as a result of his talk on "Talking Films" at the previous meeting.

The formal meeting was particularly well attended. The chair was taken by Dr. C. Tierney.

* * *

As the outcome of many modern inventions, each of which has enabled some step forward to be made, we now have available to all, such marvels as broadcasting, electric gramophones, talking films, and lastly television. It so happens that all of these are interconnected, since in each case it is necessary to employ an amplifier utilising thermionic valves in order to magnify the minute electrical impulses received to a suitable intensity of light or sound. It is my purpose in this lecture to deal particularly with this one section, but a brief outline of the principles involved in the Baird system of television will prepare the way beforehand.

In television as we understand it a spot of light scans the scene in vertical strips, commencing, say, at the top left-hand corner and moving downwards, beginning successive strips at the top and each slightly further to the right until the whole scene has been covered. This process is repeated from eight to fifteen times per second and so the speed at which the spot of light travels is very great. As the spot of light passes over light or dark parts of the scene, so more or less light is reflected, and this continual change of light is converted into an equivalent change of electrical current. This varying electric current may be broadcast by modulating a carrier wave, and received by an ordinary wireless set giving sufficient amplification and impressed on a neon tube which lights in accordance with the current. Finally, the light from the neon tube is arranged to illuminate the part of the screen corresponding to the position of the scanning light-spot.

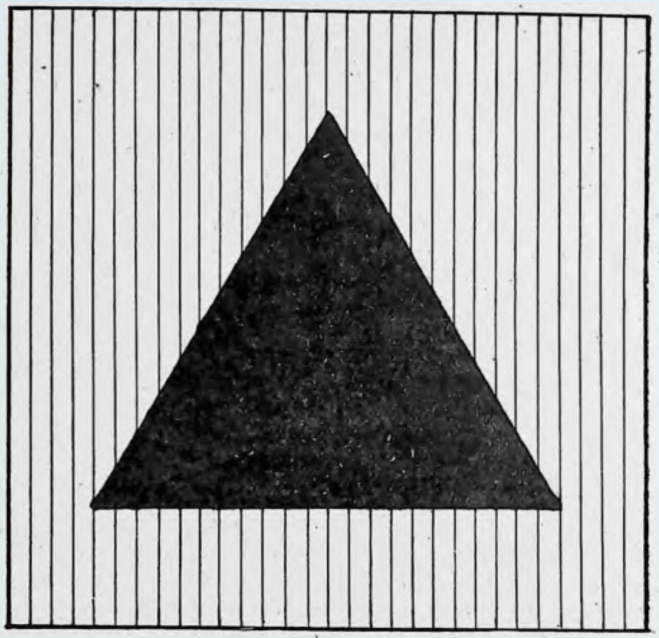


Fig. 1.

The wireless receiver itself may be quite standard, and provided that it is of good design and capable of giving very powerful loud-speaker reception, should give satisfactory results with television. But the conditions for the reception of telephony and television are not identical, and so each section must be considered in detail.

The high frequency amplifier using screen-grid valves is to be very strongly recommended as reaction should not be used owing to the consequent loss of the higher frequencies. One screen-grid stage should never give any trouble, and unless a frame aerial is essential two stages should not be attempted. The

the Television Society

ABSTRACT OF LECTURE.

Subject—" AMPLIFICATION & TELEVISION."

¶ The general principles of television as used at the present time are briefly outlined, and the requirements of the wireless set for receiving television are determined. The design of a set, and particularly the low-frequency amplifier, is taken step by step, and a suitable design for assumed average conditions is evolved. The required low-frequency amplification is between 1,000 and 10,000 times and the frequency range 300 to 9,000 cycles per second. As thermionic valves are the most important components in an amplifier, their characteristics and the method of calculating them from the curves are explained, and the choice of valves for definite requirements is considered. The alternative methods of coupling valves, namely, transformer, choke and resistance-capacity coupling, are compared with respect to both broadcasting and television, and the correct design of each is fully dealt with.

detector should be anode-bend in order to handle sufficient volume without distortion, and the valve should be of low impedance for a reason to be given later. The tuning circuits should not be too sharp (less so than on an ordinary broadcast receiver) in order to amplify the higher frequencies. Before proceeding to the low frequency amplifier it is necessary to consider the requirements for television.

The L.F. Amplification and Frequency Range

Before designing an amplifier it is necessary to know both the degree of amplification and the frequencies to be amplified. In a broadcast receiving set the low frequency amplification is not usually more than 300 or 400 times, and the frequency range is from 25 to 8,000 cycles per second in the very best sets, but over a much smaller range in the average set. In television receiving sets a very much greater amplification is required and the frequency range is different. Experience shows that an amplification of 10,000 is of the right order, that is to say that the amplification is about twenty times that of the average broadcast receiver. It is advisable to make up some of this amount in the high frequency stage, and it is for this reason that the importance of a good screen-grid valve is stressed. The Mazda 215 S.G. has an amplification factor of 450 with the correct high tension voltage, and the Mazda AC/SG an amplification factor of 1,200. If either of these valves is used the increased amplification should permit a low frequency amplifier giving an amplification of about 1,000 or even less to be used satisfactorily.

We have now to consider the frequency range required, that is to determine the lowest and highest frequencies to be amplified. In scanning the scene there will be a great variety of possible combinations of light and shade, and it is now necessary to decide upon the essential forms. As a simple case consider the black triangle of Fig. 1. If we assume 30 scanning strips, the intensity of light can be represented by the thickness of the lines in Fig. 2. It is obvious that there is a cycle of operations occurring at the frequency with which the whole scene is scanned, say ten times per second as a convenient figure for calculations. The wave-form will be flat-topped somewhat as shown in Fig. 3(*a*). Now it is possible by the application of the Fourier Series to analyse any wave-form and reduce it to a number of sine waves of various frequencies. Of these the fundamental has the same frequency as the original wave, in the present case 300 per second, the next following being the first of a series of harmonics of twice, three times, four times, etc., the fundamental frequency. For a wave of the form shown in Fig. 3(*b*) the equation is

$$e=E_1 \sin wt+\tfrac{1}{3}E_1 \sin 3wt+\tfrac{1}{5}E_1 \sin 5wt+ \ldots$$

while the equation for Fig. 3(*a*) brings in the even

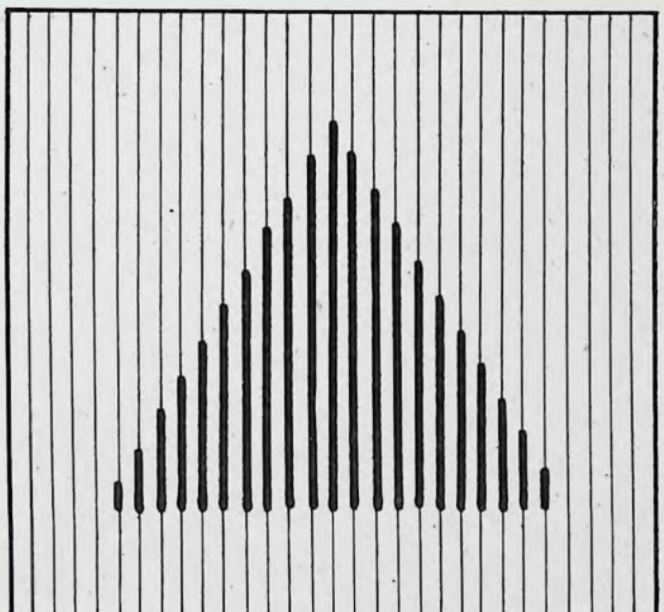


Fig. 2.

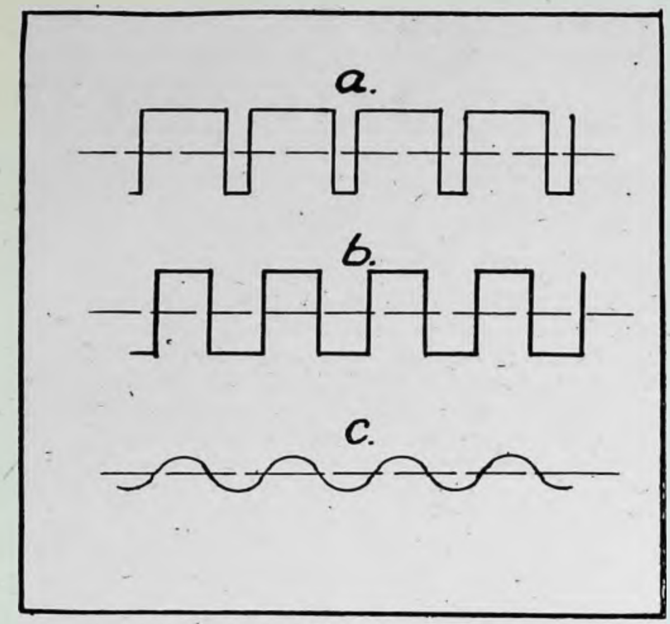


Fig. 3.

harmonics. In both cases the fundamental frequency is the same, namely, that of the sine wave 3*c*. It is obvious that the lowest frequency is this fundamental which is the number of scanning strips multiplied by the views per second, in this case being $30 \times 10 =$ 300 cycles per second. The equation brings in very high harmonics and in order to reproduce correctly a flat-topped wave-form these must be uniformly amplified. But there is great difficulty in amplifying these high frequencies and there is a definite limit, due to broadcasting regulations, at 9,000 cycles. What is the effect of losing those frequencies above 9,000 cycles per second, and what limitations does it impose on television? An actual series of calculations by the writer has shown that even for the case previously mentioned the cut-off of the higher frequencies would be quite noticeable, while, of course, for more ambitious television the effect is proportionately greater. The visual effect is to round-off and smooth over sharp contours so that small details are lost. It is preferred by some experts to treat the picture as a series of small dots like newspaper illustrations, and to assume that the highest frequency must be greater than the number of dots covered per second. This is not an accurate point of view since usually quite a number of adjacent dots are of the same shade, but if we assume it for the moment as a criterion the required highest frequency is $30 \times 30 \times 10 = 9{,}000$ or more, while for $100 \times 100 \times 10 = 100{,}000$ cycles per second. The former case is just within the fixed limit, and it looks as though the latter were impossible but fortunately the actual position is not so bad. It is difficult to say how television will develop, but a wider frequency band may be permissible or several transmission channels may be used.

However, the position is now clear for the design of an amplifier. It is necessary to amplify between 1,000 and 10,000 times over a frequency range from 300 to 9,000 cycles per second.

The Amplifier

An amplifier consists of a suitable number of valves coupled together by any suitable means. I intend dealing first with valves in general and then later with the methods of coupling and the choice of suitable valves.

1. Thermionic Valves.

For our purposes we may accept the valve as a component which has certain known characteristics, without being concerned with its internal design. As a typical example of modern valve design take the new Mazda L.210, a two-volt low frequency amplifier or small power valve. From the characteristic curves shown in Fig. 4 it is possible to determine the principal constants of the valve.

There are six variables which must be considered in a complete determination:—

1. Filament voltage.
2. Filament current.
3. Grid voltage.
4. Grid current.
5. Anode voltage.
6. Anode current.

Now provided that an adequate electron emission is attained the filament voltage and current may be settled purely from the convenience of battery supply. If then by the usual convention we regard the negative end of the filament as being earthed the number of variables is reduced to four. Moreover, as an amplifier the valve should be controlled so that the grid current is zero and a further variable is thus deleted.

It is now important to consider the connection between grid volts, anode volts, and anode current.

1. The rate of change of anode volts with grid volts

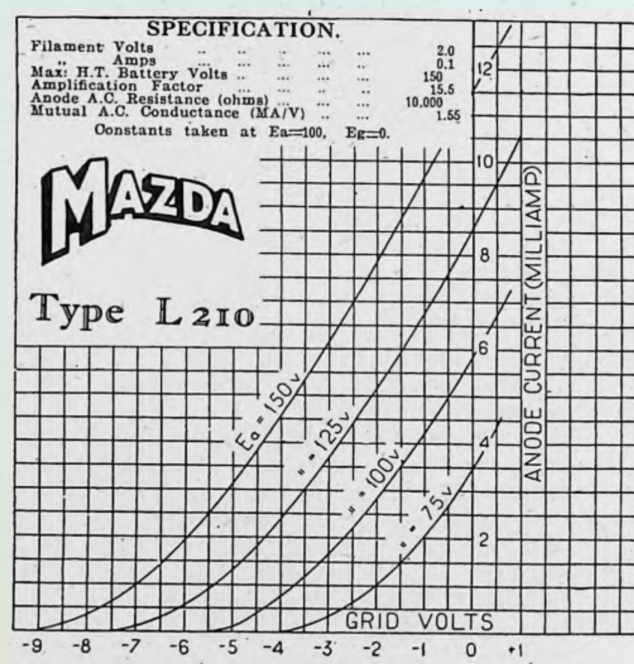


Fig. 4.

(i.e., the partial differential $\frac{\varrho Ea}{\varrho Eg}$ or the amplification factor).

2. The rate of change of anode current with grid volts (i.e., $\frac{\varrho Ia}{\varrho Eg}$ or the slope).

3. The rate of change of anode current with anode volts (i.e., $\frac{\varrho Ia}{\varrho Ea}$ or the impedance).

It is possible to derive all these values from the characteristic curve of Fig. 4. As a convention they are taken at anode volts 100 and grid volts 0.

The Rate of Change of Anode Volts with Grid Volts.—If the anode voltage is increased by 25 the negative grid voltage necessary to neutralise the change is 1·6. Thus 1·6 volts on the grid are equivalent to 25 volts on the anode, and the amplification factor is 25÷1·6 or 15·5.

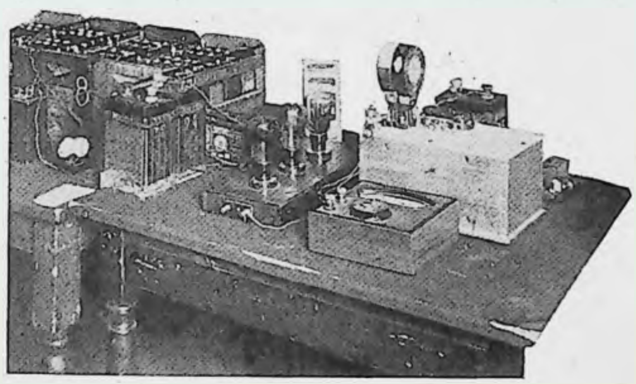
The Rate of Change of Anode Current with Grid Volts.—At anode volts 100 and grid voltages −0·5 and +0·5 the anode current is 5·0 and 6·55 milliamps respectively. Thus the change in anode current for 1 volt grid change is 6·55—5·0=1·55 milliamps, and the slope is 1·55 milliamps per volt.

The Rate of Change of Anode Current with Anode Volts.—When the anode voltage is increased from 100 to 125 the anode current changes by 2·5 milliamps. Thus the impedance is 25÷0·0025 or 10,000 ohms. It should be noted that the valve cannot be treated as a resistance obeying Ohm's law, and the so-called impedance only holds on the straight portion of the curve.

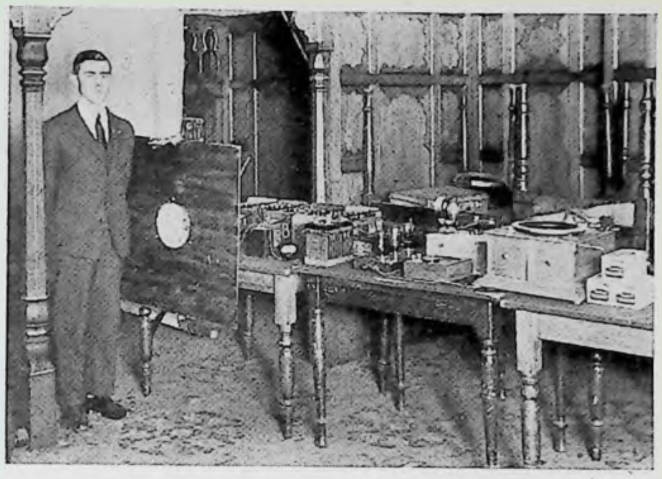
It is obvious that these three functions are interdependent and that when two have been determined the third follows immediately. The real test for the efficiency of a valve is the slope, sometimes called the mutual conductance, which is the ratio of the amplification factor to the impedance, and therefore in the same impedance class the valve with the highest slope is the most efficient. For high impedance valves the slope varies from 0·4 to 0·8, for intermediate values from 0·6 to 1·25, and for low impedances from 1·0 to over 3·5.

2. Methods of Coupling Valves.

There are two principal methods of coupling, transformer and resistance-capacity coupling.



A close-up of the amplifier and batteries.



General view of Mr. Langford-Smith's demonstration apparatus.

One satisfactory means of coupling stages in an amplifier is to use a suitable transformer which at once isolates the grid from the anode voltage of the first valve and also gives a voltage step-up. At the present time the design of transformers has been brought to such a high state of perfection that it is possible to give a sufficiently uniform amplification of about 35 per stage over a frequency range from 25 to 8,000 cycles. This is very satisfactory for the reproduction of music and speech, and the distortion due to two transformer-coupled stages used with suitable valves may be regarded as neglible. Now an inductance such as the primary of a low frequency transformer causes a phase displacement which cannot be detected by the ear, but it can be detected by the eye and transformer or choke coupling will cause visual distortion in television, and should only be employed in cases where the distortion may be neglected.

There are three parts of a transformer to be considered, the primary and secondary windings and the iron core. The requirements for good amplification over a wide frequency range are :—

1. *A Large Inductance Primary.*—This is obtained by having a large number of turns on a large core of good permeability. For broadcast reception an inductance of 50 henries or more is desirable in order to amplify the low frequencies, but for television a much smaller inductance is satisfactory.

2. *A Good Step-up Ratio.*—The greater the step-up ratio the greater the amplification, but a limit is set to the size of the secondary from distributed capacity effects. In good transformers every care is taken to reduce capacity to the minimum, but even with this careful design the size is limited. As the primary is fixed already and the secondary is limited in size, the step-up ratio is fixed, and a value of 3 or 3½ is very usual. Transformers with a larger step-up ratio are usually constructed with a small primary at the expense of the lower frequencies, but for television purposes would be quite satisfactory if the higher frequencies are properly amplied.

Valves for use with transformer coupling must be carefully chosen for their work. In order to amplify low frequencies down to 50 or 25 cycles, the impedance should be fairly low. For a primary inductance of 50 henries the impedance of the valve should be less than 20,000 ohms, and with lower primary inductances it should be correspondingly less. If as in television it is not necessary to amplify the lower frequencies a valve with a higher impedance could be used, and the consequent higher amplification factor will give a

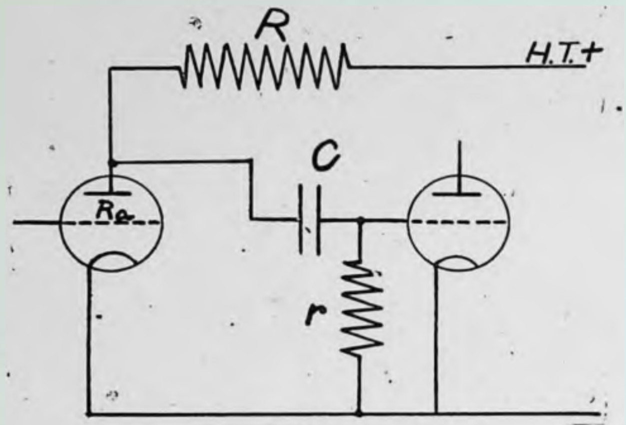


Fig. 5.

greater output. At the same time it must be remembered that there is a limit to stability, and that although a single stage of high amplification transformer coupling is satisfactory, two or three stages will probably prove unstable. If great care is taken three transformer-coupled stages may be used but the following recommendations will ensure stability.

1. Use separate anode-feed resistances and large by-pass condensers.

2. Separate the valves as far as possible and place the transformers in the position found most satisfactory, usually with successive cores at right angles.

3. Completely shield each stage with heavy sheet iron well earthed.

4. Use separate grid bias batteries.

5. Insert a resistance of between 10,000 ohms and 50,000 ohms between the transformer grid terminal and the grid of the valve.

6. Use push-pull amplification for the last stage.

Resistance-Capacity Coupling

The second important method of coupling is known as resistance-capacity coupling, the resistance being used to supply anode current to the valve while offering a fairly high impedance to the output and the condenser isolating the grid of the following valve from the anode voltage while offering a low impedance path to the output. In addition to these a grid leak is necessary to prevent an accumulated charge on the grid.

As the anode resistance R in Fig. 5 shunts the output, it is desirable from this point of view to make it as high as possible. As the coupling condenser C offers an impedance to low frequencies it should be made sufficiently large. Neither of these values are by any means critical but in a case such as the present one where amplification of high frequencies is essential, very careful design is needed.

The most important effect to be considered is the input impedance, that is, the effect of the grid capacity and grid-filament resistance. Normally the grid-filament capacity of an average valve is about 10 micro-microfarads, the internal grid-filament resistance too high to have an appreciable effect, and the grid leak is about 2 megohms. But it is found that when the valve is functioning as an amplifier there is a very important change in this input impedance, depending on the load in the anode circuit. Although the analogy is not strictly true, it can be compared to the increase in the primary current of a transformer as the secondary load is increased. Thus when the secondary load or anode load is zero the primary or grid-filament current is quite small and easily calculated. It is possible to choose constants so that the effective grid-filament capacity is 100 times as great as its measured static value, and for our purposes in designing an amplifier it is essential to reduce this to the minimum. It is possible to calculate to a close approximation the effective grid-filament capacity from the expression—

Effective capacity $= C\ (2+M)$

where C is the measured capacity.

$$M = \frac{R}{R+Ra}\ \mu$$

$=$actual amplification ;

where μ is the amplification factor,
R is the anode resistance,
Ra is the valve impedance.

From this it is seen that if the amplification per stage is 20 the effective capacity is 22 times the measured static capacity, and at high audible frequencies this larger value has considerable effect. Actually the following valve has a very considerable effect, and the capacity calculated above which is correct for a single stage does not hold for two stages, the effective capacity in this case being even greater.

There is also an effective grid-filament resistance due to the anode load, but its calculation is rather difficult and cannot be explained in detail in this lecture.

For the purpose of simplifying the calculations a specific case has been taken and in choosing the constants attention was paid to the requirements for television. Firstly, it is necessary to choose the best valve, and the criteria by which it is to be judged are: (1) The greatest possible amplification factor; (2) the least possible impedance.

Although these appear mutually contradictory, there is on the market a valve which is very close to the ideal, and fortunately for our purpose is quite satisfactory from all points of view The Mazda AC/HL has an amplification factor of 35 and an impedance of 13,500 ohms giving the astonishing slope of 2·6 milliamps per volt. An anode resistance of 50,000 ohms gives a static amplification of 29 and yet is not so high as to cause loss of the higher frequencies. Its amazing characteristics are due to its unique construction, being an indirectly-heated kathode valve without any of the faults common to this type such as grid emission, and with inter-electrode capacities no greater than those of the average battery valve. Although primarily intended for use on alternating current mains, it can be used equally successfully with direct current mains or accumulators. In the latter case a very useful feature is that the correct grid bias is easily applied by connecting the positive end of the heater to the kathode and the negative end to the grid leak. Taking the above values as the basis of calculations, the writer has determined both the input impedance and the stage amplification at 9,000 cycles on the assumption that the valve considered is one of a series extending to infinity in either direction. The error due to this assumption is not very large compared with certain other factors such as stray coupling, and the results should not be far from the true position.

Input impedance at 9,000 cycles = 30,000 ohms.
Amplification at 300 cycles = 29
Amplification at 9,000 cycles = 23

It is seen that the amplification at 9,000 cycles is 80 per cent. of that at 300 cycles, so that even with three stages the loss would not be noticeable.

Now to consider the amplification of the whole number of stages. Assuming an amplification of 25 per stage, two stages will give 625 times, and a power valve to follow will increase this to several thousand times. A very suitable power valve is the Mazda AC/P with an impedance 2,650 ohms, amplification factor 10, and slope 3·75. These three valves due to their unique characteristics will give an overall amplification greater than four valves of the ordinary type, and it is for this reason that they have been taken as the basis for calculations, but equally good results can be obtained by using a greater number of stages of the less efficient valves. There is one matter which has not received much attention in this discussion due to its lesser importance in television, but in broadcasting the coupling condenser plays an important part at the lower frequencies and with transients. A glance at the circuit of Fig. 5 will show that the impedance drop in the condenser *C* is wasted, and therefore at lower frequencies where the impedance is considerable the amplification is reduced. For television any capacity above 0·001 microfarad is suitable, but for broadcast reception 0·005 is the minimum which should be used, and 0·02 is rather to be preferred for better handling of transients.

The grid leak should be as low as possible without appreciably lowering the amplification and 100,000 ohms is generally suitable.

In conclusion it may be said that there are no insuperable difficulties in broadcast reception of television up to the limit of the present side-bands. And also within certain limits the present transmissions are excellent and capable of excellent reproduction, but what the future holds in store who can say? Is it to be wider side-bands, or single side-band transmission, or multiple channels? The wisest man will leave these things for the future and concentrate on the perfection of the present, advancing step by step.

Discussion

Mr. T. M. C. Lance said he would have liked the lecture to go very much further, as Mr. Langford-Smith had dealt very well with the side of amplification which they required at home to pick up the B.B.C. transmissions, whereas most amateurs would want to start with their own photo-cells. He disagreed with the lecturer entirely on the frequency characteristics that the amplifier would be required to deal with: 300 to 9,000 cycles had been suggested as the limit within which they would require straight line amplification, but he thought that they would have to go much lower than 300 cycles. Although he had no mathematical data at hand, his experimental results had led him to that conclusion.

Suppose, instead of the triangle, they had to televise a scene composed of white and black as shown. The spot of light scanning such a scene would subject the photo-electric cell to full light for a considerable fraction of the scanning time, then suddenly it would change to darkness.

If they constructed a curve and assumed that the current from the photo-cell was proportional to the light falling on it they would get a nice level line until they came to the point where the dark portion started. Then the current would fall to zero until such time as the scanning beam started on the bright portion again. It seemed to him that in such a case they might have to descend to as low as 30 cycles.

He had, experimentally, tried this particular type of scanning and made up a picture, half black and half white, and tried to scan it, but all he got at the

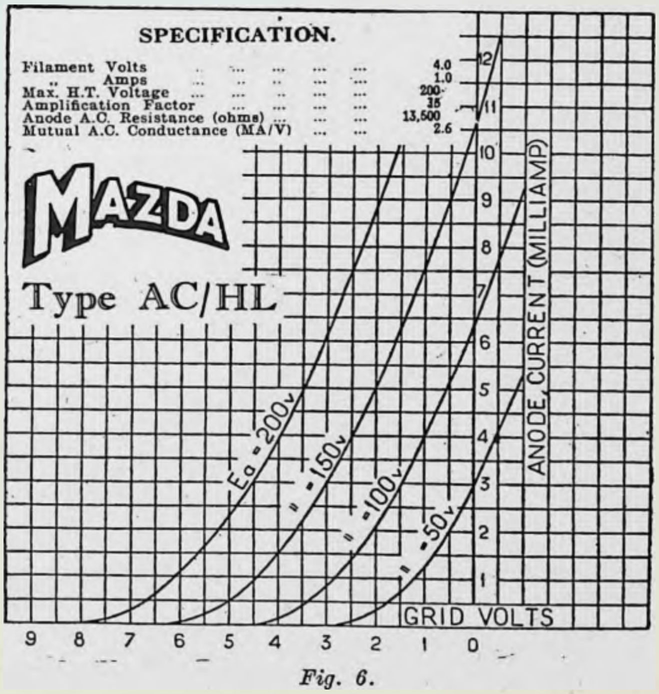


Fig. 6.

receiving end was a dotted line of light across the middle of a dark field, and he decided that this line of light was due to the fact that the present type of low-frequency amplifier did not respond to direct current input changes. The width of the line corresponded to the "cut off" frequency of his amplifier at about 6,000 cycles.

He felt convinced that in television work they had to go right down to practically zero frequency, or, in other words, they had to have direct current amplifiers, and anyone who had played about with direct current amplifiers knew that they were nightmares, for they amplified everything, from the signals they received to any nearby electrical disturbance.

The present type of multi-valve, low-frequency amplifier did not respond to direct current. If an alternating current was applied to the grid of the first valve it was transferred to the grid of the succeeding valve and so on. But if the first valve was fed from a photo-cell and they shone a steady light on the cell there would only be a kick in the second valve circuit as the light changed, and the subsequent steady current from the photo-cell would produce no effect in the amplifier. When the light was extinguished the current would stop and there would be another little kick which would be amplified, and then nothing would happen until the next beam of light fell on the cell.

That was why he had got nothing except a line of light across the screen of his receiver when trying to scan something that was half black and half white.

He suggested that in the ordinary resistance coupled unit they should replace the coupling condenser and grid leak by a battery connected between the anode of one valve and the grid of the next, this battery to be connected with the positive to the grid and the negative to the anode.

Any voltage changes on the anode of the first valve then acted directly on the grid on the second valve and so gave the required results.

A direct current amplifier seemed to be one way out of the difficulty by televising such a scene as he had suggested. There were other ways equally difficult to manage, and one was to make use of an oscillating valve, varying the strength of the oscillating current by the output of the photo-cell, and another was to chop up the light on the cell by passing it through a fast revolving wheel with many holes. Each of the methods would give a carrier current at one high frequency which would have to be rectified at the end of the amplifier to operate the neon tube, but the result would be the same as for a direct current amplifier.

If any of the members wished to do experimental work with shadowgraphs the methods suggested would be worth trying, but for serious television the direct current amplifier was the instrument they seemed to require.

MR. R. POOLE congratulated Mr. Langford-Smith on giving them a thoroughly useful paper.

One of the points emphasised was the width of the side-band required. The present system of broadcast transmission could only use 4·5 kilocycles each side of the actual wave on which the transmissions were sent out. They had just seen that that was not sufficient for good reproduction and detail.

There were several methods of increasing the width. One was to go down to shorter wavelengths with wider side-bands, but that did not help very much, because the amplifier necessary to amplify uniformly was a very difficult proposition to build and, as far as he knew, had never been produced yet.

The following message from Marquis Marconi was unfortunately received too late for inclusion in our Twenty-first issue :

"Sincere Greetings and best wishes for the success of the Television Magazine.—Marconi."

Another alternative was that of multiple channels, which again was a disadvantage, for it meant taking up the full amount of room in the ether with a multiplicity of channels, and it seemed, as far as this country was concerned, rather an impossible method. Incidentally, the Bell Telephone Company, using seven channels, had been able to run up the telephone carrier frequencies for individual transmission to about 20,000 kilocycles, which enabled them to make use of something like a quarter of a million cycles. The only immediate possibility in this country seemed to be to use a system suppressing one-half of the side-band, and then work over the full limit which present conditions entitled them to use. This would mean that instead of having a range of 9 kilocycles they had a range of 18.

The ordinary limits of speech frequency seemed to be about 4,500 cycles, which, he believed, was the limit to which gramophone makers attempted to record. Good electrically recorded gramophone records were remarkably good.

Broadcasting went to a slightly higher frequency, but the reason why it was apparently so good was not because our amplifiers produced the higher frequencies, but because we did not notice the absence of the high frequencies.

Another point he wished to raise was the question of specifying amplification performance in terms of transmission units. This, he thought, would simplify their calculations and give them a more reliable method of arriving at stage gain.

MR. C. H. WESTCOTT said he thought that they were all wrong in considering their amplifiers. They started off with a direct current output from the photo-electric cell and then had to convert it into a suitable frequency. It seemed to him that it would be much better if the direct current was converted immediately into high frequencies. They had had a whole lecture on the trouble of designing low frequency amplifiers and he wanted to get rid of them. If a photo-electric cell gave direct current, surely direct current amplifiers could be perfected if necessary.

With regard to transmitting, he suggested that the output from the photo-electric cell could modulate the transmitting valve direct. He would like to see the intensity of the carrier wave directly proportional to the amount of light falling on the cell.

At the receiving end he would cut out low frequency amplifiers completely and do all the necessary amplification on the high frequency side. If at the transmitting end they made the intensity of the carrier wave directly proportional to the light falling on the cell there would be no need in reception for low frequency amplifiers of any kind.

MR. LANGFORD-SMITH, replying to the discussion, said that with regard to speech frequencies he understood that 95 per cent. of the energy in speech was below 500 cycles. It was a matter of interest that if they blotted out that 95 per cent. and amplified the remaining 5 per cent. correspondingly, the intelligibility of the speech was very little decreased. The ear could so adapt itself to missing everything below 500 cycles that one could hardly tell the difference.

With regard to Mr. Westcott's suggestion that the carrier wave should be made directly proportional to the light falling on the cell in television transmissions, it would mean that the wave-length would range between zero and infinity, and, furthermore, it was impossible to design a high frequency amplifier with a level characteristic for the range he would want.

A vote of thanks to the speaker closed the meeting.

SOCIETY NOTES

HASTINGS.—The Society was represented at Hastings on the occasion of the unveiling of the plaque erected by the Borough Council in honour of Mr Baird, who first conducted his experiments in the building to which it is attached, by Dr. Tierney, Chairman of Council; Mr. Keay, Treasurer; and Mr. Denton, Joint Hon. Secretary.

The President, Sir Ambrose Fleming, F.R.S., notified regret for his absence, and his letter will be seen elsewhere in this issue.

A promising group centre exists in this town, and Mr. Nye (local secretary) with Mr. Sherman (treasurer) had around them local members of the Society.

Members of the Society at Birmingham met at the Chamber of Commerce, Birmingham, on November 13th, for the purpose of forming a local group centre. Mr. Latour Hordle acted as chairman of the meeting, Mr. F. L. Farmer undertaking the duties of secretary (472, Bordesley Green, Birmingham).

Affiliation to the Television Society has been granted by Council to the Scientific Society, Birmingham Midland Institute, and to Newcastle-on-Tyne Radio Society.

The particulars promised regarding lectures in connection with the formation of group centres are as follows:—

December 10th.—The Technical School, Rochdale.

December 11th.—The Technical School, Wigan.

December 12th.—The College of Technology, Manchester.

December 13th.—The University Building, Liverpool.

December 17th.—Hotel Metropole, Leeds.

December 18th.—The University, Sheffield.

December 19th.—Technical College, Derby.

The lectures will be given by Mr. Keay, at 7.30 p.m., and the members' secretary will be in attendance.

Persons desiring to attend any of the above lectures are requested to apply to headquarters for tickets before December 9th.

New members joining now will be interested to know that subscriptions will not again become due until 1931.

The next lecture will be on Tuesday, December 3rd, at 8.0 p.m., when Mr. E. George Lewin, M.Sc., A.Inst.P., will deliver his lecture entitled "Television—Some Suggested Schemes," Mr. Priechenfried, who was originally down for this lecture, having been called abroad on business. We hope that it may only be that Mr. Priechenfried's lecture is postponed for a while.

The lecture secretary wishes to thank all those members who have sent corrections for the printed "List of Members." A copy has now been posted to every member of the Society. Any member who does not receive his copy by December 1st is asked to write to headquarters, when the matter will be investigated.

J. J. DENTON, A.M.I.E.E.,

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

Joint Hon. Secretaries.

Teacher: "Stands Scotland where she did?"

Pupil: "No, Sir; daddy says it's 300 miles nearer, now we've got Television."

The Origin and Progress of Television

A Statement of Facts

By *Clarence Tierney*, D.Sc.

THE history of television is of comparatively recent date, though, if one may judge from some articles which have appeared in certain recent works of reference, there would appear to be some confusion of thought as to its origin. It is deemed desirable, therefore, to state as concisely as possible a few authenticated facts concerning its history and development, quoting where necessary from published records which are readily accessible and easily verified.

The first demonstration of television in the history of the world was given by J. L. Baird on January 27th, 1926, at Frith Street, London. Prior to this demonstration nothing but the electrical transmission of silhouettes had ever been accomplished.

Now it is astonishing to find how many writers in technical and other journals fail to understand the difference between shadowgraphs and the living image, and a simple illustration will, it is hoped, make this clear. If a person is sitting in a room illuminated by a lighted candle from a table in the centre a shadow of that person will be projected on to the wall. If, now, we place a mirror on that wall we shall observe not a shadow but the living image of that person with all its gradations of light and shade and those delicate inflections of facial expression and movement. Just so with the electrical transmission of shadowgraphs, which is one thing, and the transmission of the living image which we call television. The one is merely a silhouette of the object, while the other, a very different thing, is the real image.

The original apparatus with which Baird first demonstrated his epoch-making discovery is now housed with the national collection of historical instruments in the South Kensington Museum, and the following is the inscription placed upon it by the authorities:

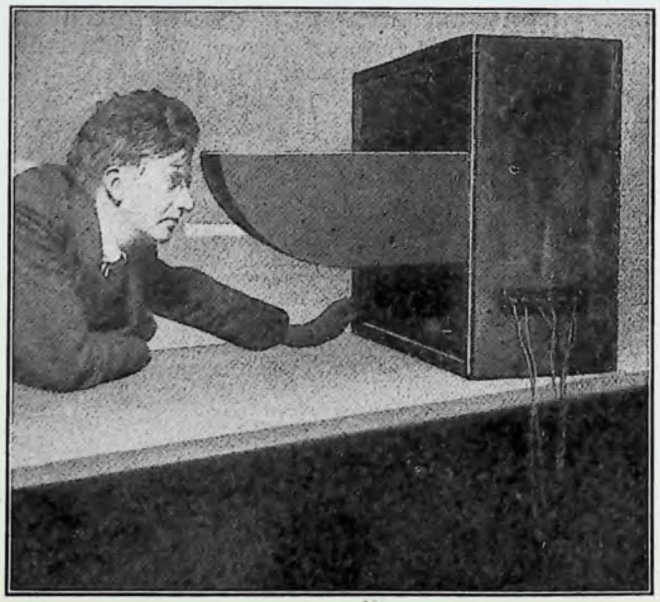
"ORIGINAL TELEVISION APPARATUS
MADE BY
J. L. BAIRD.

"This is the transmitting portion of the original apparatus used by Mr. J. L. Baird, in experiments which led him from the wireless transmission of outlines in 1925 to **the achievement of true television nine months later, when on January 27th, 1926, the transmission of living human faces with light, shade and detail was demonstrated before members of the Royal Institution, this being the first demonstration of true television ever given."**

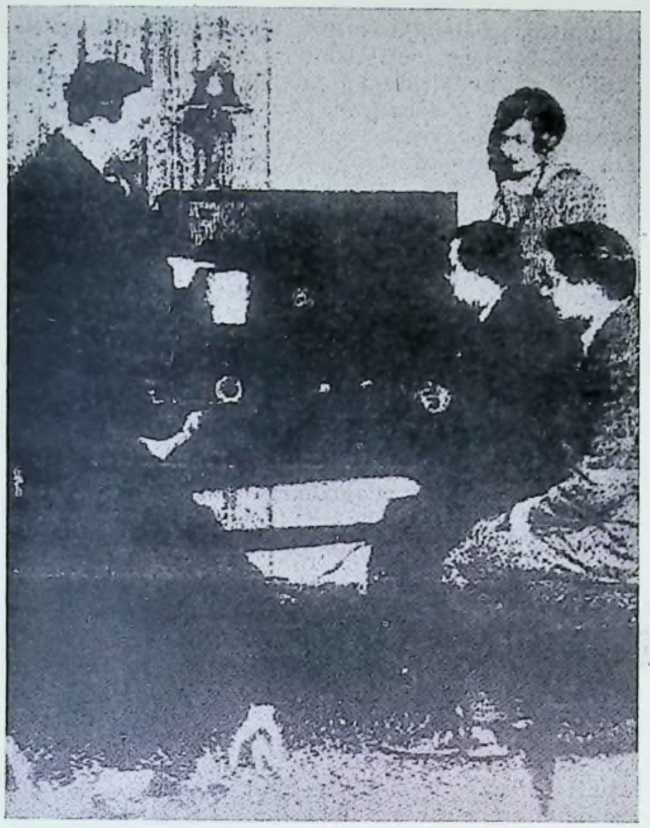
It will be observed that this original demonstration was well attested by competent witnesses, and in *The Times* of January 28th, 1926, we read:

"Members of the Royal Institution and other visitors to a laboratory in an upper room in Frith Street, Soho, on Tuesday saw a demonstration of apparatus invented by Mr. J. L. Baird. . . .

"For the purpose of the demonstration the head of a ventriloquist's doll was manipulated as the image to be transmitted, though the human face was also reproduced, first on a receiver in the same room as the transmitter, and then on a portable receiver in



Mr. J. L. Baird looking into one of his early Televisors.



A group looking in to London from Hartsdale, N.Y., on the occasion of Baird's successful Transatlantic transmission of television. This photograph was sent to London by wireless phototelegraphy (NOT *television*).

another room, the visitors were shown recognisable reception of the movements of the dummy head and of a person speaking. The image as transmitted was faint and often blurred, but substantiated a claim that through the 'televisor,' as Mr. Baird has named his apparatus, it is possible to transmit and reproduce instantly the details of movement, and such things as the play of expression on the face."

Another independent witness, Dr. Alexander Russell, F.R.S., Principal of Faraday House, writing a few months later in *Nature*, July 3rd, 1926, says:

"We saw the transmission by television of living human faces, the proper gradation of light and shade, and all movements of the head, of the lips and mouth, and of a cigarette and its smoke were faithfully portrayed on a screen in the theatre, the transmitter being in a room at the top of the building. Naturally, the results are far from perfect. The image cannot be compared with that reproduced by a good kinematograph film. The likeness, however, was unmistakable, and all the motions are reproduced with absolute fidelity. This is the first time we have seen real television, and, so far as we know, Mr. Baird is the first to have accomplished this marvellous feat."

Thus the indisputable fact that Baird was the first to achieve and demonstrate television has been freely acknowledged, and not only in England but also in America, for in the *New York Times* of March 6th, 1927, we read:

"No one but this Scotch minister's son has ever transmitted and received a recognisable image with its gradations of light and shade."

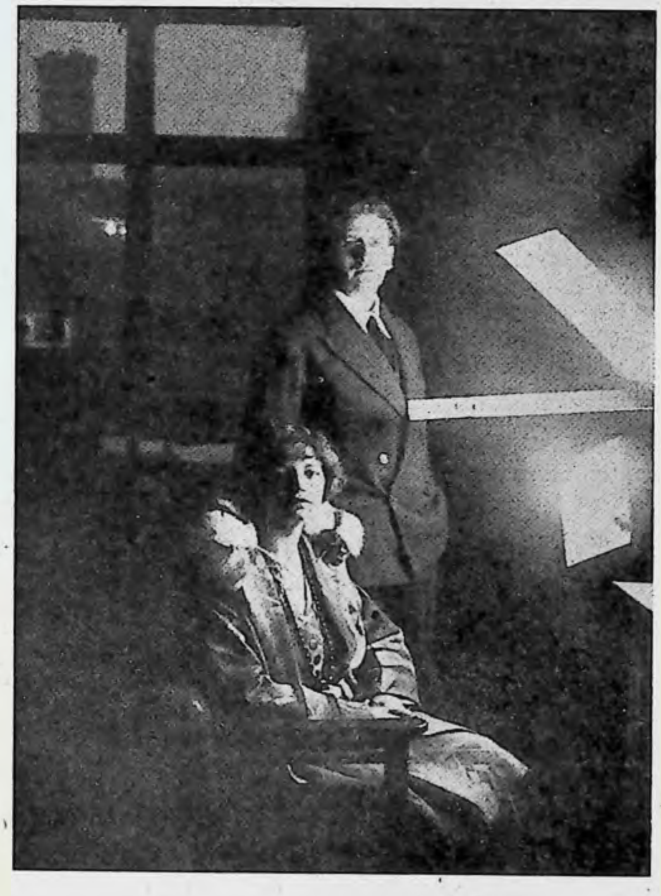
And again in an editorial of the same journal for February 11th, 1928, is the following definite acknowledgment:

"Baird was the first to achieve television."

America's leading wireless journal, the *Radio News*, also paid tribute to Baird's achievement by sending a special commissioner to England in 1926 to witness a demonstration and investigate Baird's claim to priority. This commissioner, reporting upon his visit in the *Radio News* of September, 1926, writes:

"Mr. Baird has definitely and indisputably given a demonstration of real television. It is the first time in history that this has been done in any part of the world."

Much more irreproachable evidence of the same kind could be cited, but it is surely neither desirable nor necessary to labour the matter to establish Baird's claim to priority or the fact that television is fundamentally and in practice a British invention, acknowledgment of which none but an unscrupulous person, whether by design or otherwise, would attempt to suppress.



Miss Dora Selvey photographed with Mr. Baird on the occasion when her image was televised to the "Berengaria" in mid-Atlantic, and recognised on board by her fiancé, Mr. S. W. Brown, the liner's chief wireless operator.

Let us turn now to some subsequent developments, for it must be remembered that all the demonstrations above referred to had been conducted with only a short separation between the transmitter and receiver, and it was not long before the question was raised as to the possibility of transmitting over great distances.

Baird quickly realised the essential importance of demonstrating that long distances could be covered by these delicate signals between the transmitter and receiver if the system was to be of any practical value in bridging space. Thus he was patiently and unostentatiously pursuing his experiments to ascertain the effects and remedy of extraneous interference when, on February 8th, 1928, he astonished the whole world by **transmitting across the Atlantic from a room in Long Acre, London, to Hartsdale, a suburb of New York (the longest distance ever recorded either before or since)**, the recognisable living image of a well-known New York personality which was immediately identified.


Transatlantic Transmission:- SCENE ON "BERENGARIA."

Here again there is no lack of authentic evidence to establish priority in this epoch-making achievement which will for all time remain one of the most outstanding landmarks in the progress of this miracle of modern invention. Thus we read in the *New York Times*, February 11th, 1928 :

A Milestone.

" Baird was the first to achieve television at all over any distance. Now he must be credited with having been the first to disembody the human form optically, and electrically flash it piecemeal at incredible speed across the ocean, and then reassemble it for American eyes. His success deserves to rank with Marconi's sending of the letter ' s ' across the Atlantic—the first intelligible signal ever transmitted from shore to shore in the development of transoceanic radio telegraphy. As a communication Marconi's ' s ' was negligible ; as a milestone in the onward sweep of radio, of epochal importance. And so it is with Baird's first successful effort in transatlantic television."

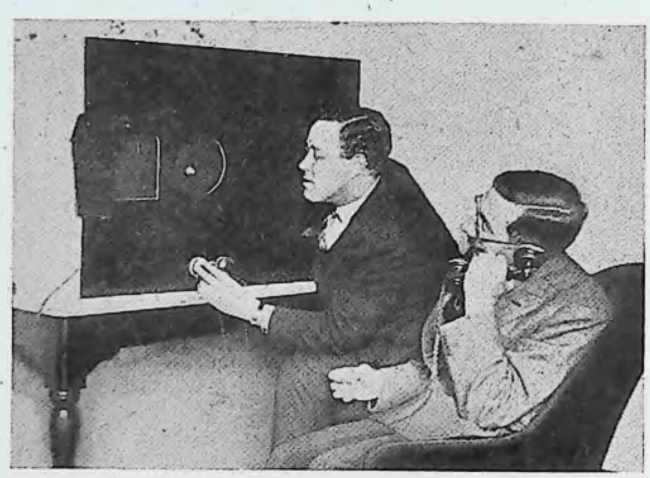
With such an accomplishment to his credit it is not surprising to find **that Baird was the first to transmit an image to an Atlantic liner in mid-ocean** with the same astounding success. A portable receiver was installed on the s.s. *Berengaria*, by means of which when the liner was in mid-Atlantic the ship's officers and others witnessed the reception of the living image of a person sitting before the transmitter in London, who was immediately recognised by Mr. Brown, the ship's wireless operator, as his fiancée. In the *Television* of April, 1928, Mr. Brown writes :

" It was a wonderful experience to be able to see Miss Selvey like that in mid-Atlantic, and the achievement clearly demonstrates the enormous progress which has been made in television."

Longest Wire Transmission.

Previous to these wireless demonstrations, however, Baird had already accomplished **the longest line transmission ever recorded,** *i.e.*, from London to Glasgow. The ordinary trunk telephone line was used, and Professor Taylor Jones, writing in *Nature*, June 18th, 1927, reports :

" The receiving apparatus was set up in a semi-darkened room, the lamp and shutter being enclosed in a case provided with an aperture. The observer looking into the aperture saw at first a vertical band of light in which the luminosity appeared to travel rapidly sideways, disappearing at one side and then reappearing at the other. When any object having ' contrast ' was placed in the light at the sending end, the band broke up into light and dark portions forming a number of ' images ' of the object. The impression of sideway movement of the light was then almost entirely lost, and the whole of the image appeared to be formed simultaneously. The image was perfectly steady in position, was remarkably free from distortion and showed no signs of the ' streakiness ' which was, I believe, in evidence in the earlier experiments.


Professor Taylor Jones (right) looking in to London over the telephone line from Glasgow.

" The size of the image was small, not more than about 2 inches across when the ' object ' was a person's face, and it could be seen by only a few people at a time. The image was sufficiently bright to be seen vividly even when the electric light in the room was switched on, and I understand that there is no difficulty in enlarging the image to full size. I was told also that arrangements will soon be made for transmitting larger 'objects,' and for increasing the number of appearances of the image per second.

"The amount of light and shade shown in the image was amply sufficient to secure recognisability of the person being 'televised,' and movements of the face or features were clearly seen. At the second demonstration some of those present had the experience of seeing the image of Mr. Baird transmitted from London while conversing with him (over a separate line) by 'phone.

"My impression after witnessing these demonstrations is that the chief difficulties connected with television have been overcome by Mr. Baird, and that the improvements still to be effected are mainly matters of detail. We shall doubtless all join in wishing Mr. Baird every success in his future experiments."

Thus far I have dealt only with Baird's historical achievements. Next month I hope to review some remarkable developments of the Baird system and its applications, and also give a summary of television experiments in Germany and America.

(To be concluded)

Iceland Broadcasting and Meteorological Station.

The Marconi Company has obtained from the Iceland Government a contract for the first broadcasting station to be erected in Iceland.

This station will be situated at Reykjavic, the capital, and is to be completed in time for the thousand years anniversary of the discovery of the island, which will be celebrated in June next year.

The transmitter will be of a new design, based on the wide experience of the Marconi Company, which has supplied wireless broadcasting stations for service in over twenty countries. It will have a power of 15 kw. in the aerial, and will work on a wavelength of about 1,200 metres.

Special circuits will be incorporated to enable it to be used for telegraphic transmission as well as broadcasting. This will enable the station to be used for meteorological services.

Meteorological information from Iceland is of great importance in forecasting weather conditions for Europe and the Atlantic. The power of the new station which the Marconi Company is building will enable meteorological reports from Iceland to be received over a wide area. It will thus form an important addition to the meteorological services.

CONTRIBUTIONS TO "TELEVISION"

THE Editor invites contributions—interesting articles, sketches and photographs—which will be carefully considered.

While every care will be taken of articles, photographs, drawings, etc., submitted, the Editor and Publishers cannot hold themselves responsible for loss of or damage to such contributions.

The Nature and Properties of Light.

(Concluded from page 505.)

This is because light does not bend round corners in the same manner as sound. We are all accustomed, of course, to hearing a band playing, even though a large building is apparently "in the way."

It is now an easy matter to show, that provided the wavelength of the light is small, which we know to be the case, that this phenomenon of rectilinear propagation is in harmony with the wave theory of light. The phases of wavelets from successive zones differ in phase by π and are therefore in opposite directions. As the order of the zones increases their effects at O become more and more nearly equal, so

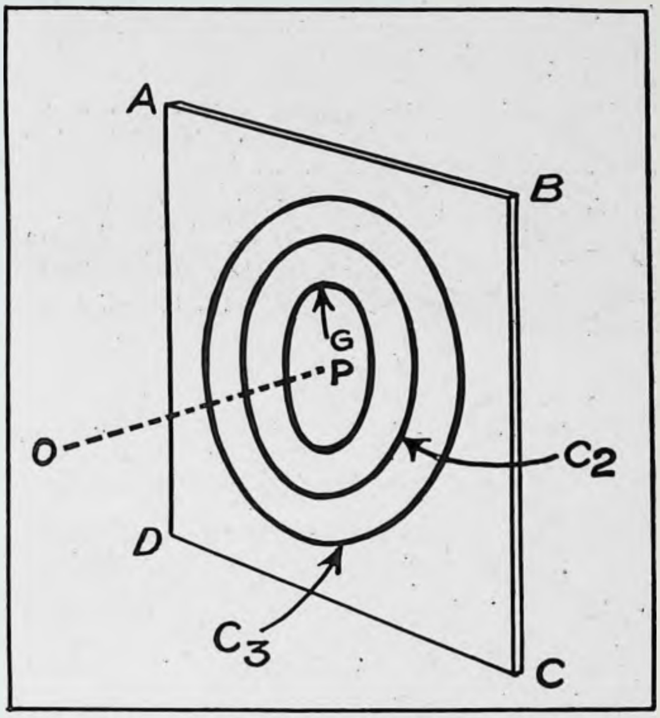


Fig. 4.—Huyghens' Zones.

that the displacement due to one zone of high order is cancelled by the succeeding one. If, therefore, we have an obstacle which will cover the first few zones the wavelets from the remaining zones will just cancel one another, and *no light will be perceived by the eye.*

We can show, moreover, that the screening action at a distance of 100 cm. of an object 2·5 mm. in diameter is complete, and equal, as regards sound, to an obstacle several metres in diameter! The higher the pitch of the note the smaller the diameter of the obstacle necessary to screen off the note, and in the case of ultra-sonics, or high-frequency sound waves, which were employed during the war for locating enemy submarines, almost rectilinear propagation is obtained and the smallest obstacle provides an efficient screen.

Next month we will consider some of the results of the adoption of the wave theory of light, going on later to consider more about vibrations and waves in general. The spectrum, and the knowledge we gain from a study of its properties, will also be discussed in due course.

The Lower Frequencies in Television

By "*D. C.*"

FROM time to time we read both in the technical and ordinary press of the high frequencies required for television. A hundred thousand has even been suggested quite often, and obviously the finer the detail we aim at transmitting, the higher the frequency we must use, and if we go on increasing indefinitely a point will be reached when to go further would be unnecessary, owing to the eye being unable

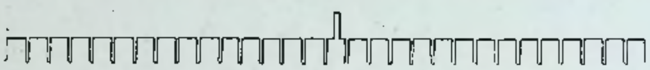


Fig. 1.—The Waveform from a blank screen.

to respond. Of the lowest frequency, however, we hear very little.

Readers who have listened into the experimental transmission by the Baird process being broadcast will be familiar with what might be described as a whistling, chirp-like note, which, if one listens carefully, varies in its tonal character. For the greater part of the time the signal note is fairly similar, but there are periods of a higher and clearer tone which are short in duration compared with the more familiar signal. These shorter periods occur when only a blank screen or background is being transmitted, which means that in the studio they are changing the scene before the transmitter.

Now the higher toned signal from a blank screen will be found to produce a note of about 375 cycles, and is caused by the light spot being cut off for a brief time after every strip, and, as there are 30 strips per picture and 12·5 pictures scanned per second,

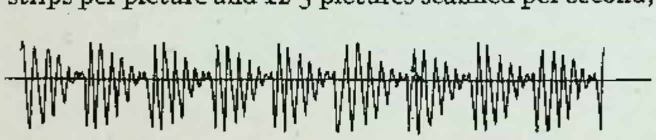


Fig. 3.—Waveform of a continuously sounded "Ah."

we get our 375 note—generally called the strip frequency. This frequency has a rectangular wave form.

In Fig. 1 an attempt is made to draw the wave form from a blank screen whose reflection power, we will assume, is 50, and the extra hump *A* will not be present. In this drawing we are considering the reflected light falling on the photo cells, and therefore the varying direct current flowing in these cells. Obviously, they will not be perfect rectangles, only being drawn as such for clearness.

As has already been pointed out, this frequency is 375, and as this frequency is always present, one is sometimes inclined to think it is the lowest. Unfortunately it is not so, and our amplifiers must pass considerably lower ones or the picture will suffer from heavy black or white shadows or flares, always starting from some given point and going up the picture, often blotting out some of the image. It may be mentioned that a picture suffering from this

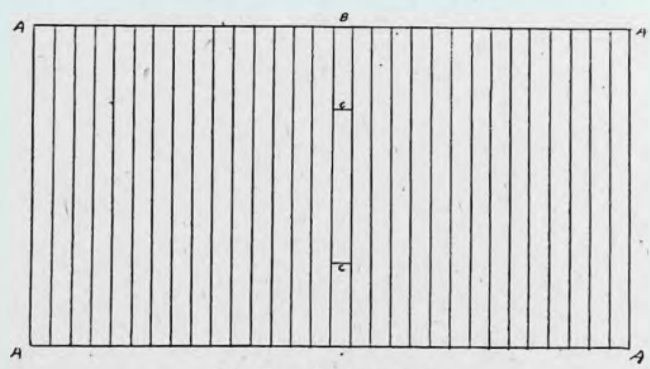


Fig. 2.—A blank screen.

state of affairs can often be improved by applying a weaker signal to the neon, which, though producing a weaker picture, will be more lifelike.

What the lowest frequency may be is dependent on the subject being televised. In Fig. 2, *AAAA* is a blank screen except for part of strip *BB*, of which the portion *CC* has a reflectory value of, say, 100, the rest of the screen having a value of 50. The result of one complete scan will be as shown in Fig. 1, but will now include the hump *A*, and if we are scanning 12·5 pictures per second, this wave form will re-occur 12·5 per second, thus bringing the lowest frequency to a similar number.

Perhaps a similar example from ordinary speech would be of help to make this clear. Fig. 3 is the

(*Continued on page* 520.)

More Light Through The Scanning Disc

By *George C. Cato*

Associate of the Television Society

ONE of the great difficulties in connection with television is that the amount of light reflected from the object is very small and consequently produces only a very small current in the photo-electric cells. The amount of light may be increased by increasing the size of the holes in the disc, but this reduces the definition of the received image as there is an averaging effect over a larger area. The writer has therefore designed a disc in which an attempt has been made to increase the size of the holes without appreciably decreasing the definition of the image. Before proceeding to an explanation of the principle, however, let us try to obtain a method of representing the definition of an image produced by an ordinary disc with a given sized hole by considering a hypothetical case. We shall then compare this with a similar representation of the definition of the image produced by the writer's disc.

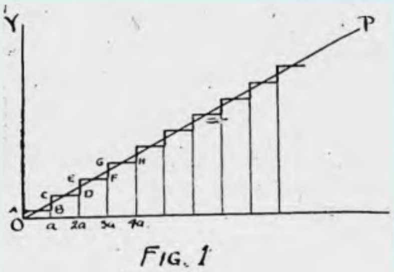


Fig. 1

Suppose we are vertically scanning an object which gradually increases in intensity from left to right; that is, the intensity of light reflected from the extreme left strip is constant over the strip but less than the intensity of light reflected from subsequent strips. The straight line "curve" OP of Fig. 1 represents such an object, the intensity being measured along OY and the distance from the left edge along OX. Now suppose the breadth of the scanning hole be a, the intensity of light recorded by the photo-electric cell and reproduced by the receiver will be the average of the intensities over the breadth of the strip from left to right, which is the intensity at $\frac{1}{2}a$, so that the first strip of the received image may be represented by the line AB which cuts OP at the point corresponding to $\frac{1}{2}a$.

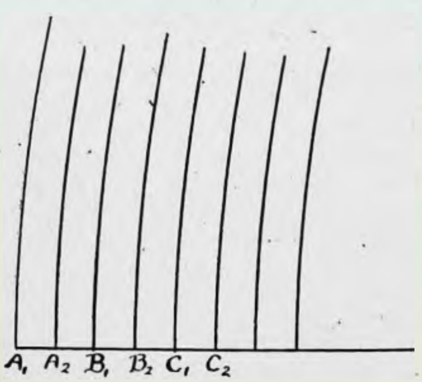


Fig. 3

Intensity Distribution

Similarly the line CD cutting OP at the point corresponding to $\frac{3}{2}a$ will represent the intensity of the second strip in the received image, and so on for successive strips. Altogether we have the straight line OP representing the televised object and the stepped line $ABCDE$ . . . representing the received image of the object.

Let us now consider the definition of the image which would result from using a disc like that shown

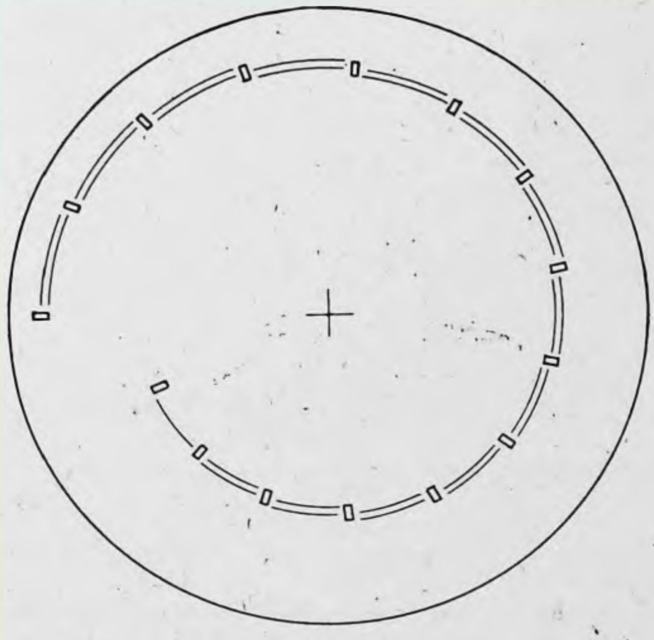


Fig. 2

in Fig. 2, with holes in which the breadth along the strips is a and the breadth across the strips is increased to $2a$, but in such a way that the paths of successive holes overlap by an amount equal to a. Referring to Fig 3, the outermost hole will scan a strip $A_1 B_1$, the next hole a strip $A_2 B_2$, the third hole a strip $B_1 C_1$, the fourth hole a strip $B_2 C_2$, and so on. In this way the object will in effect be divided up into strips of breadth a as in the case of the ordinary disc, but will be scanned twice for a complete revolution of the disc except for strips of breadth a at each edge, which will be scanned once.

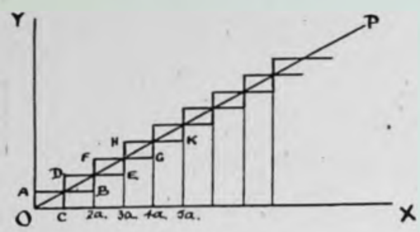


FIG. 4

By the previous argument the line AB in Fig. 4 will represent the intensity of the first strip (i.e., the strip scanned by the first hole) in the received image, DE the intensity of the second strip, FG the intensity of the third strip, and so on. The intensity of the narrow strip $A_2 B_1$ (Fig. 3) will depend on the intensity of $A_1 B_1$ and of $A_2 B_2$. Now $A_1 B_1$ and $A_2 B_2$ are not produced simultaneously but one after the other; the resultant intensity of $A_2 B_1$ will therefore be not the *sum* of the intensities of $A_1 B_1$ and $A_2 B_2$ but their *mean*. That is, the resultant curve of the image is the mean of the stepped curves $ABFG$ . . . and $OCDEHK$ . . . which is exactly the same as the curve $ABCDE$ . . . in Fig. 1.

We have, therefore, according to this argument, doubled the cross breadth of the holes, and kept the cross definition the same. The statement, however, requires qualification in certain cases, e.g., where there is a sharp boundary line between surfaces of different intensity right in the middle of one of the a strips. The change in this case occurs in three steps instead of one, as will be seen by studying the Figs. 5 (a) and 5 (b), but this is a state of affairs which would but rarely occur in practice, and other analyses which the writer has carried out indicate that the result remains substantially true for most subjects which are dealt with at present. The lengthways breadth of the holes has not been altered, so that we may reasonably assume that the definition in this direction remains the same, and since the area of the holes has been doubled we have twice as much light available for affecting the photo-electric cells. It is obvious, of course, that a 30-hole disc in either case will scan practically the same area.

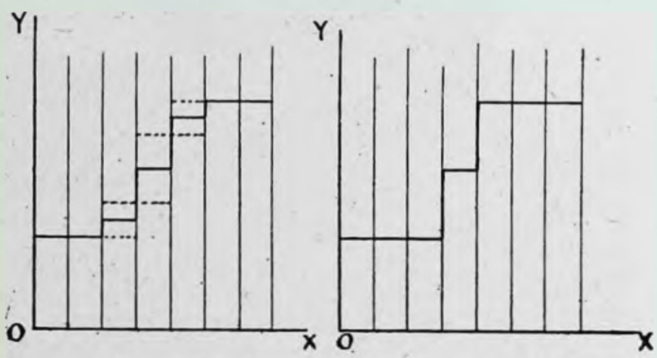


FIG. 5(a) FIG. 5(b)

The dotted lines represent the component intensities:

The writer would emphasise that the above argument is entirely theoretical, and he would be pleased to hear the results of any experiments carried out on these lines.

The Lower Frequencies in Television.

(*Concluded from page* 518.)

wave form of a continuously sounded "Ah." The fundamental frequency was approximately 800, the chief modifications occurring at 120 cycles.

Fig. 4.—" If one televises a piece of paper on which is drawn something like the eyes and mouth of a face, the usual 'face' tone is heard."

As already pointed out, the television note is lower when, say, a human face is being transmitted than a blank screen due to certain lower frequencies than those of the strip being present. By lower tone it is meant that one still hears the strip frequency as a background to the harsh-toned low frequency notes. These lower frequencies are due chiefly to the eyes and mouth. If one televises a piece of paper on which is drawn something like the eyes and mouth of a face, such as in Fig. 4, something like the usual "face" tone is heard.

The strip frequency plays a very important part in the synchronising of our television picture, but in the actual image forming it plays a very small one. The strip frequency is done away with by arranging that as one spot is just passing off the object being televised, the other is passing on: that is to say, although for a very brief period one half only of each spot is on the screen at once, we get just as good a picture.

Practical experience with television apparatus soon shows that it is rather difficult to televise any relatively large areas which are of even tone or reflecting property, owing to the low frequencies which are necessarily involved, and one quickly realises that a direct current amplifier would solve the problem of televising, say, a black background.

In conclusion, the writer would advise any readers who are experimenting in looking-in to use a resistance coupled amplifier, using rather a higher value of coupling condensers than for speech work, say ·1 MF, and anode resistance of a value not higher than that of the impedance of the valve.

Book Review

A.B.C. of Television, or Seeing by Radio. By R. F. Yates. 205 pages, 78 illustrations. Published by Chapman & Hall. **10s. 6d.**

Any amateur who buys this book, thinking he is getting a work which will tell him something about all television methods at present being experimented with, will be sadly disappointed. He will read little concerning television other than the achievements of the American Bell Telephone Laboratories. In fact, an unduly large portion of the book is nothing but an extensive quotation from the publications of the Bell Telephone Company. While the publications of this vast organisation are justly noted for the very full technical information which they give on the various problems which they have investigated, one scarcely expects them to be used as the main portion of a book entitled "An A.B.C. of Television."

The author, it would seem, is not as acquainted as he might be with the literature of his subject.

He has too thoughtlessly fallen into the error of complaining of the imaginative efforts of the Press, while doing the same thing himself. In his first chapter he states: "Due to the highly imaginative and, at times, flagrantly speculative musings of the Sunday newspaper writers, television is, at the moment, too enthusiastically appraised by the lay public. Already the public is talking of the imminence of home television, perfected to a degree where it will be possible to enjoy a football game or a Presidential inauguration from the vantage point of a luxurious living-room chair."

A few pages further on, and still in the same chapter, he quotes extensively from a skit on the television receiver of the future written by himself and printed in the *New York Herald-Tribune*, which is as "highly imaginative and at times flagrantly speculative" as that of which he complains.

One could, however, forgive him these faults if he had kept to his title a little more closely and not been so blinded by the achievements of one firm, for he is unquestionably all out for the fullest possible development of television.

His first reference to the work of Baird is in these terms:

"The imaginative and at times speculative John L. Baird, whose experiments have caused quite a stir in England, *proposes* a television system operating by the aid of infra-red rays, or 'black light.'"

"Proposes," be it noted, when the system was demonstrated before the British Association at their Leeds Meeting in 1927, and to members of the Royal Institution even before that date. Really, news seems to travel very slowly to America, despite wireless communication.

Sundry other references—and they are very few indeed—to the work of other inventors in this field are equally inaccurate and misleading.

The book bears all the signs of an ill-considered and hasty effort to get into print, and is transparently American from beginning to end. It is, for instance, of little use for an English amateur to read that "tube No. 171," or some other number, is the best "tube" to use for audio amplification purposes, while to be told that a component is mounted "back of" another component, when the obvious word is "behind," is frankly irritating to people used to English. It is also of little use to British readers to give a list of manufacturers of photo-electric cells when nearly all of them are in America and the prices are given in dollars!

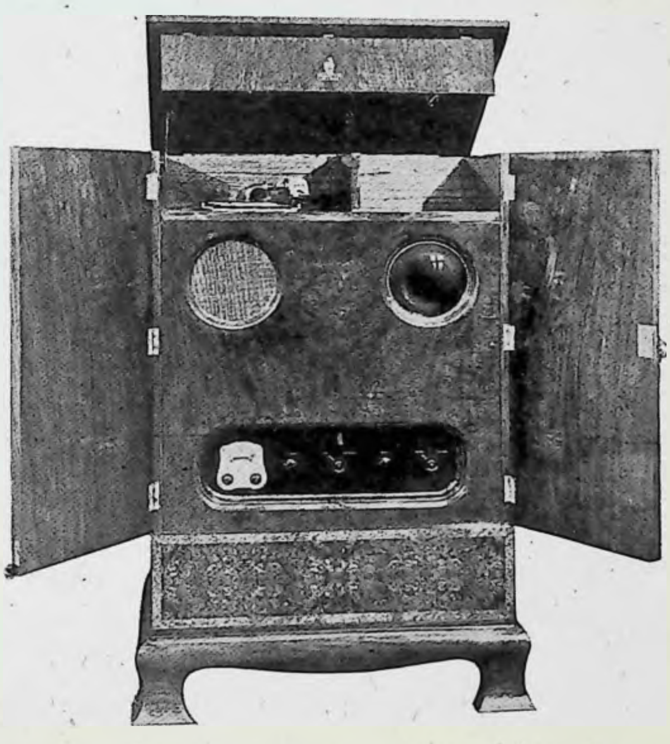
Books written in such a fashion may be quite good enough for the American market and the class of reader that is to be found there, but for other countries it will not do at all.

W. C. F.

BOOK RECEIVED

We have received for favour of review "Practical Television" (2nd edition) by E. T. Larner, published by Ernest Benn, Ltd., price 10s. 6d.

NEW NAME WANTED



The combination of a radio set and a gramophone gave us the name "gramo-radio." The above set, in addition, incorporates television. What shall we call it?

Television *in* Czecho-Slovakia

An Account of Faerber's Television Demonstrations at the Bodenbach Radio Show

By *Dr. Alfred Gradenwitz*

SUCCESSFUL demonstrations with a home-made television transmitting and receiving set were made at the Radio Show recently held at Bodenbach-on-Elbe (Czecho-Slovakia) by W. Faerber, professor at the local engineering college and one of the early pioneers of the wireless art.

Faerber's apparatus has been designed mainly on the lines adopted, in accordance with Baird's system, by the German Postal Department; it thus comprises Nipkow discs at the transmitting and receiving ends, photo-electric cells, and a glow lamp for reconstructing the pictures, everything being designed according to German standards.

The television transmitter has a 30-hole Nipkow disc, rotating at a rate of 750 r.p.m. The size of the pictures is 3 x 4 centimetres, and the number of picture elements 1,200.

Inasmuch as a simple synchronous motor (La Cour wheel) is hardly suitable for driving large discs like this, small alternating current motors are used both at the transmitting and receiving stations, and are kept in synchronism by the following method.

A small copper disc has been mounted upon the right-hand end of the motor shaft (Fig. 1) which, close to its periphery, carries eight short iron screws. An electro-magnet, fed from the alternating current system across a transformer, acts upon the heads of these screws and, as seen from Fig. 1, has been fitted to the motor socket. The eight poles with a 50-cycle current in the mains will yield a synchronous speed of 12·5 revolutions per second. A glow lamp (3), which is likewise connected up to the mains and which illuminates the disc, enables synchronism, i.e., the perfect agreement in rotation between the discs at the transmitting and receiving ends, to be checked according to what is termed the stroboscopic method. In fact, the number of revolutions under normal conditions in the mains is kept so constant by the synchronising disc that the eight poles seem absolutely immobile in the light of the glow lamp. In order, however, to make up for any occasional slight fluctuations in the number of cycles of the mains, there has been provided an additional regulations by means of eddy currents, as produced by a permanent magnet adjusted by means of a micrometer screw and an aluminium disc. However, as shown by experiments so far made, this additional regulation is only required in exceptional cases.

The easily exchangeable synchronising disc affords the advantage of enabling the same motor to be readily synchronised for widely different numbers of revolutions, by fitting other discs and pole systems, thus using it in connection with tests with various scanning speeds.

A highly efficient Pressler cell is used as the photo-electric cell and has given excellent results in permanent operation.

In order to reduce the capacitive sensitiveness of the conductor connecting the cathode of the photo-electric cell to the amplifier, this conductor has been

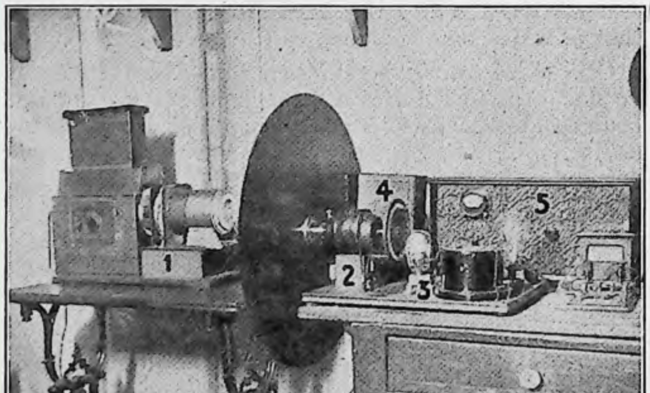


Fig. 1.—Faerber's Transmitter.

1. *Projector.*
2. *Scanning device, Nipkow disc and synchronising disc.*
3. *Glow lamp for checking synchronism.*
4. *Photo-electric cell in light-tight box.*
5. *Amplifier of photo-electric currents.*

inserted in a short metal tube, which in turn serves as the return lead, connecting with the anode of the cell. This is how a perfect electrostatic protection has been insured.

The amplifier, which is made up of six valves, has been connected up as a resistance capacity coupled amplifier, the terminal valve supplying 40–50 mA current. The first stage behind the cell comprises the milliammeter visible close to the amplifier, which is used in adjusting the grid tension while the photo-electric cell is not under load.

Faerber's receiver comprises a neon-helium glow lamp, with plate-shaped electrodes. This gives best results with a bias of about 200 volts, as derived without any disturbance from a batteryless set and good filter chain.

Modulation is most satisfactory with a choke-condenser arrangement fitted into the receiver box. A switch at the modulator enables positive or negative images to be obtained at will, which possibility is made use of, i.e., in rendering portrait negatives visible immediately as positive television pictures.

Synchronism of the transmitting and receiving apparatus has, throughout the duration of the show, been obtained without any hitch. After once synchronising and adjusting the phase difference, practically motionless pictures were obtained.

Transmissions at the Exhibition comprised the televising of small and medium-sized objects of all kinds, also movable objects held before the transmitter. Lantern slides as well as negatives were likewise transmitted, portraits being rendered particularly well, with even the most delicate shadings.

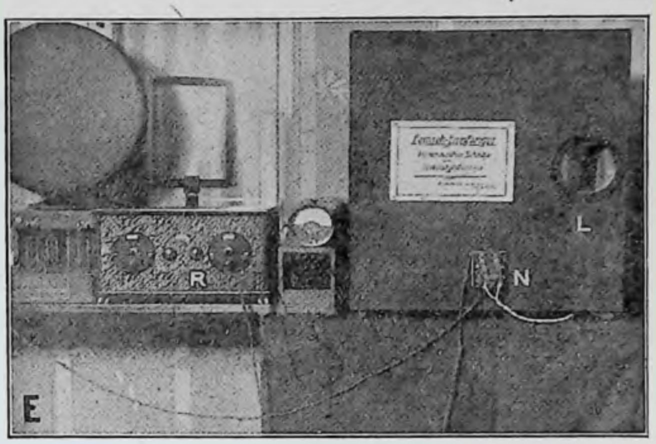


Fig. 2.—Faerber's Receiver.

L. *Observing lens; behind it is fitted the Nipkow disc and neon lamp.*
N. *Switch for changing from loud-speaker to Television Reception.*
R. *6-valve Ultradyne Receiver.*

Transmission over a wire line was adopted at the Exhibition, thus eliminating any disturbance of the wireless reception by other apparatus.

The television receiver is shown in Fig. 2 connected up to an ultradyne set which is now used by Mr. Faerber in "looking-in" at the daily experimental transmissions from Berlin-Witzleben. Another lens has been provided which is so arranged as to insure horizontally lined images.

*L*ETTERS TO THE *E*DITOR

To the Editor of TELEVISION.

DEAR SIR,—In reference to what is apparently a review of "Wireless Pictures and Television" in the November issue of TELEVISION, I feel that it is only fair to point out that this book was written nearly three years ago. The remark made by your contributor, W. C. F., that "the systems in common use are scarcely mentioned, and in this respect therefore the book is disappointing," while it would be perfectly just criticism had the book only recently made its appearance, can hardly be applied to a book written, and indeed printed, when the "systems in common use" did not exist!

I should feel greatly indebted to your courtesy if you would give publication to this letter.

Yours faithfully,
T. THORNE BAKER.

The Hut,
Hatch End, Middlesex.
November 12th, 1929.

To the Editor of TELEVISION.

DEAR SIR,—As a recent reader of TELEVISION (of which I had no knowledge until a few months ago) I should like to congratulate you on the occasion of the twenty-first birthday of this valuable paper.

I was what Captain Eckersley would doubtless describe as a member of the "real public" up to a few months ago, before starting to read TELEVISION. Then, I suppose, I became utterly degraded. In fact, I was undecided as to whether or not to give you a false name and address in case I brought down upon myself the austere wrath of Captain Eckersley.

But, as I will repeat, having been a member of the "real public"—that is, a person who did not know what television really is, and did not know the wonderful entertainment possibilities it offered, owing to reading what men like Captain Eckersley wrote about it—I think that I am fully privileged to say that Captain Eckersley's views and criticisms are all *wrong*. And this is what the "real public" would think if they only knew, for I find that whoever I explain television to is vastly interested.

Looking forward to your next issue,

I am, yours sincerely,
HENRY MILLER.

190, Rock Avenue,
Gillingham, Kent.
November 12th, 1929.

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.

Patent No. 318331, granted to C. E. C. Roberts: CATHODE-RAY TRANSMITTER.—An optical image of the object being transmitted is projected by a lens *L* (Fig. 1) on to the photo-electric surface of a cathode *K*. The density of electrons in the elementary pencils forming the cathode stream *E* varies according to the

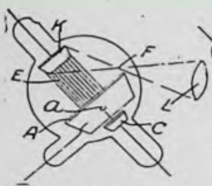


Fig. 1

Fig. 2

intensity of illumination of the surface-elements from which the pencils originate. The anode *A* of the tube is supplied with a small aperture *a*, which constitutes the scanning aperture for the picture as the stream of electrons *E* is made to oscillate in two dimensions (either by electro-magnetic or electrostatic means), thus allowing the elementary pencils to pass

Fig. 3 *Fig. 4*

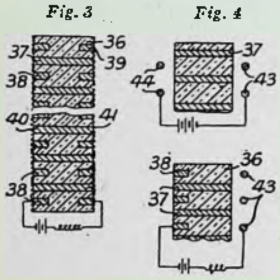


Fig. 5

successively through the small aperture *a*. The emerging pencil then falls upon an electrode *C* which is connected to the grid of a thermionic valve or other means for controlling the outgoing signals. Another arrangement (Fig. 2) allows the pencil of electrons emerging from the aperture *a* to pass through an aluminium or other window *g* into an ionisation chamber *G*.

According to the Provisional Specification the cathode stream from the picture may be encased in a more powerful stream which serves to generate synchronising signals.

Patent No. 318299, granted to J. E. Pollack: NEW FORM OF PHOTO-ELECTRIC CELL.—A slab of insulating material 36 (Fig. 3) has conductors 37 which extend right through the slab from face to face and in addition other conductors 38, 39 extending from opposite faces only a part of the way into the slab. These latter conductors form two grids connected in a battery circuit as shown. One face of the slab is coated with material 41, such as selenium or potassium hydride, responsive to cathode-rays; the other face is coated with light-sensitive material 40, such as selenium. The image of the object is formed on this latter coating, which is not thicker than the depth of effective penetration by light, while the other face is scanned by cathode-rays which thus activate the coating and complete the battery circuit allowing currents to flow dependent upon the resistance of the elemental area of selenium on the other face of the slab.

The slab may be of glass, the conductors being fine wires traversing the thickness of the slab, and the grids may consist of fine mesh screens 43, 44 (Fig. 4) adjacent to the faces, or one grid 38 (Fig. 5) may be embedded in the slab and the other grid arranged to be adjacent to the slab.

The Patent Specification describes the detailed construction of the various types of slabs.

The practical applications of the cells described above are detailed in *Patent No.* 318565, also granted to J. E. Pollack. Fig. 6 shows one arrangement of cathode-ray tube 4 (transmitter) with photo-electric plate cell 3 as already described. The resistance of the selenium coating on the front or image side varies with the intensity and colour of the light falling on it, and the circuit from the battery 15 is completed across the inner face by the exploring cathode beam, rendering small areas of the coating 41 conductive, as already explained.

The end of the receiving cathode-tube 22 is a fluorescent screen or a photographic plate 23.

Synchronisation is secured by applying two frequencies from the same generators 13, 14, to the pairs of electrostatic deflecting plates 11, 12 and 28, 29.

COLOUR TELEVISION (Fig. 7).—Three separate images in red, yellow and blue are produced respectively by three-colour screens 52, 53, 54, and projected on the photo-electric plates of three separate cathode-ray tubes *A*, *B*, and *C*, the deflecting plates of which are connected to one common pair of generators 13, 14. The images are transmitted simultaneously to three corresponding cathode-ray tubes *D*, *E*, and *F* supplied with scanning frequencies from the same generators 13, 14, and provided with fluorescent screens of such materials that each screen presents its appropriate

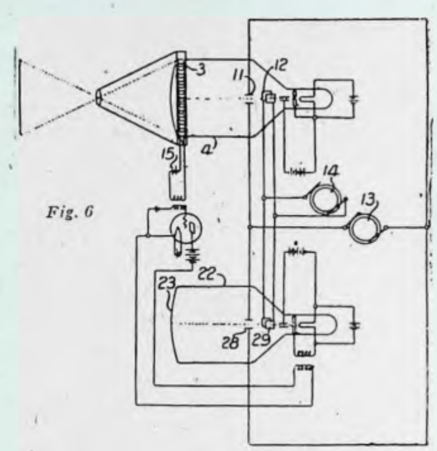


Fig. 6

colour. For example, screen 55 may be coated with bismuth sulphate, 1 part to calcium oxide 100 parts, giving red; screen 56 with antimony oxide 1 part to calcium oxide 100 parts, giving yellow; and screen 57 with bismuth oxide, 1 part to calcium oxide 100 parts, giving blue.

The three images are combined on a screen *H* by cameras *d*, *e*, *f*, and mirrors 58, 59.

For transmission and reception by wireless, energy of four different frequencies is radiated, namely, the modulating frequencies controlled by the photo-electric plate cell, the high- and low-scanning frequencies, and a high frequency carrier wave.

Details of the circuits for transmitting and receiving are shown in the Patent Specification.

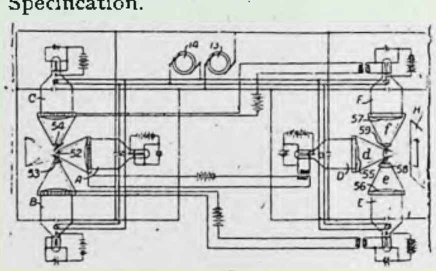


Fig. 7

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