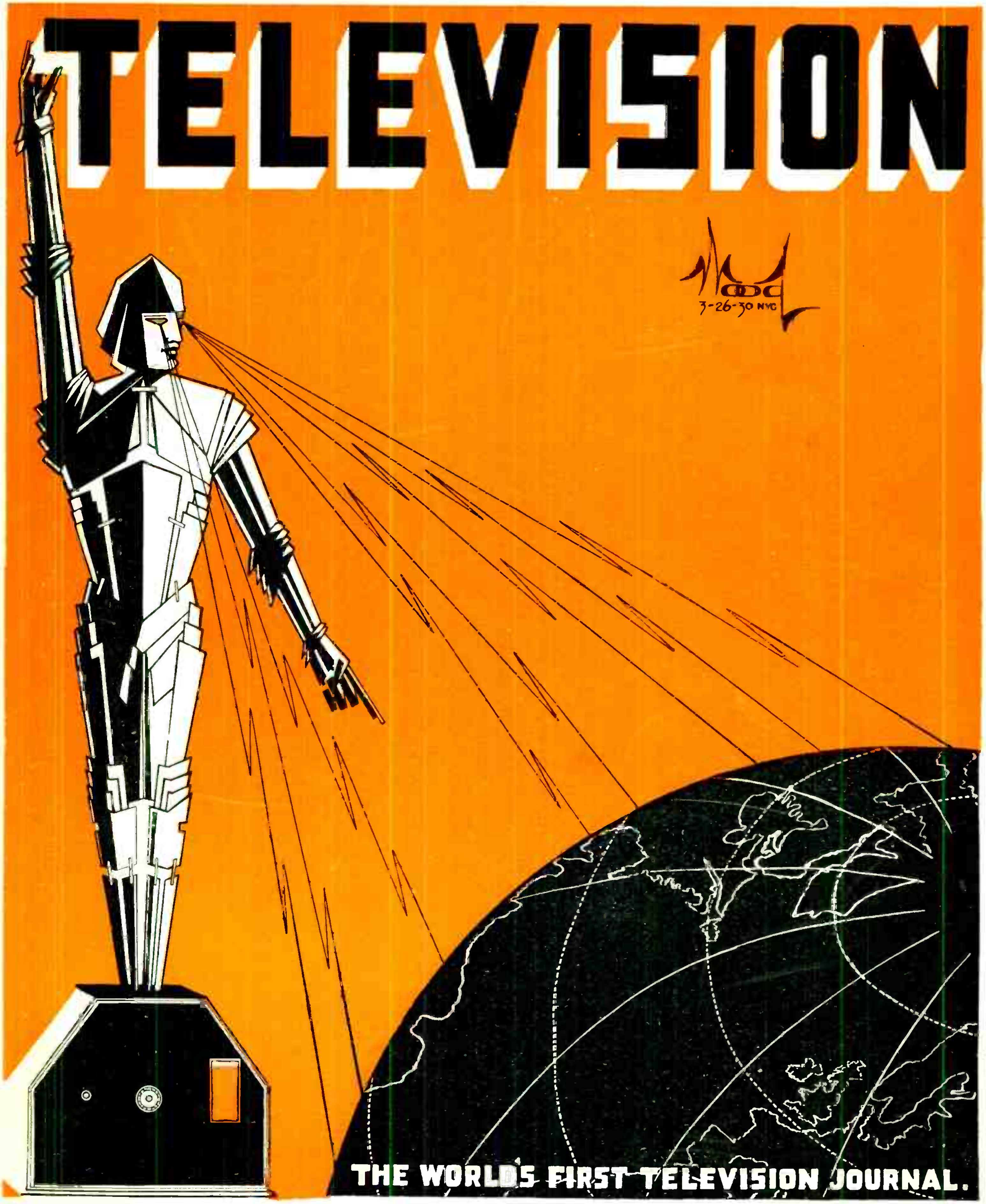
Vol. 2 FEB. 1930 No. 24 25 CENTS MONTHLY

TELEVISION



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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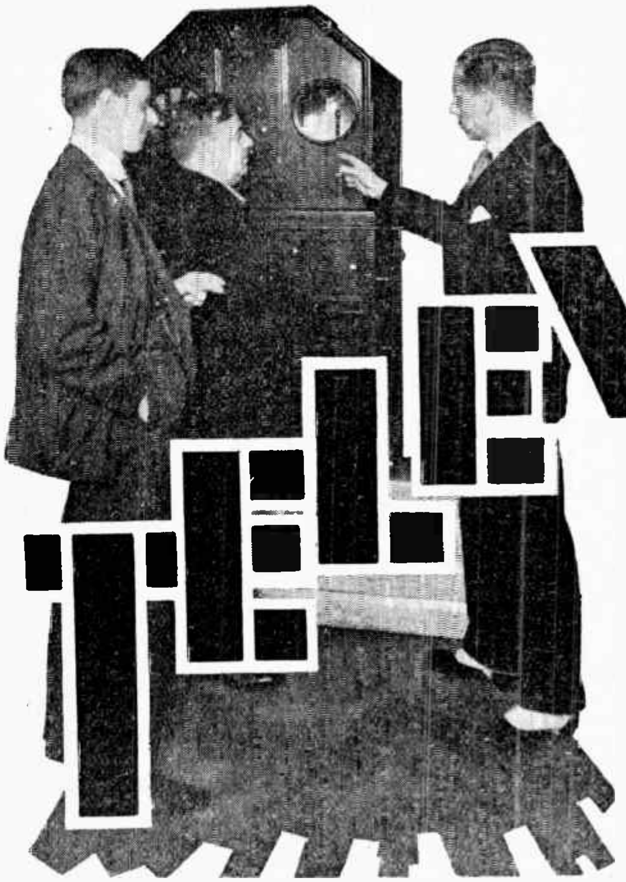

TELEVISION

THE OFFICIAL ORGAN OF THE TELEVISION SOCIETY

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EDITORIAL

CONSIDERABLE criticism has been directed at the experimental broadcasts of television which are being conducted daily by the Baird Company in collaboration with the B.B.C., the implication being that they are failing to fulfil any useful purpose.

We have already referred in these columns to a recent article appearing in a contemporary publication the author of which declared that, despite assiduous effort, he had failed to secure any results whatever in his attempts to receive the television broadcasts. Our editorial comments with regard to this may be recalled.

In this connection, therefore, readers will be interested in the various reports of successful amateur reception from unsolicited sources as far afield as Berlin. We cannot speak too highly of the important work which these amateurs are doing. Their testimony is surely the best possible answer to those critics who have been so ready to throw cold water on something which, apparently, they know but little about.

But whilst the uninformed have been quick to criticise television, it is significant that Sir Ambrose Fleming—one of the most outstanding scientists of our time—has not only recognised the value of the achievement in its existing form, but has gone out of his way to help forward the invention by suggesting lines of development along which it may progress.

His lecture, delivered at the invitation of the Physical and Optical Society, and reprinted in this issue, is as lucid an exposition of the science as it would be possible to imagine. It is the product of a fine mind and should do much to lead those who are unacquainted with the subject to a complete understanding of its methods.

By kind permission of the Editor of *Nature*, we reprint in this issue a most illuminating and epochal article by Sir Ambrose Fleming, which appeared in that journal on January 18th. Under the somewhat mundane title "The Wave-band Theory of Wireless Transmission," Sir Ambrose hits out at one of the most fundamental theories on which modern wireless transmission is based; neither does he fail to show how the future of television is being harassed and retarded by a mistaken view as to the real nature of wireless waves.

In order to add point to Sir Ambrose's article it may be *a propos* to draw attention to the remarkable association which he has had during the last half century or so with new inventions. Let us consider first the case of incandescent electric lighting.

In a small basement room in Victoria Street, London, he gave a demonstration of incandescent electric lighting by means of the first filament lamp to appear in this country. Not long afterwards he was present at another demonstration, this time at the Crystal Palace, which was attended by some of the leading gas-lighting engineers in the country. These gentlemen were unanimous in the opinion that, whilst the incandescent electric lamp was unquestionably a wonderful invention, under *no* circumstances would it ever become a means of providing light in the home!

Take another case. When Bell invented the telephone it was Sir Ambrose Fleming who used the first instrument to arrive in this country, when by its means he conversed between London and Streatham.

Coming to a more recent invention — wireless telegraphy—we find Sir Ambrose closely associated with Marconi during the course of some of his earliest experiments. Perhaps the most famous, and certainly the most spectacular, of these was the initial transmission of the letter " S " across the Atlantic, twenty-eight years ago.

As the years passed, his interest in problems relative to the development of wireless communication increased and resulted finally in his invention of the Fleming Valve, the prototype of the modern thermionic valve which has made possible, not only broadcasting and television, but all forms of long-distance electrical communication as at present practised.

It was in May, 1928, that the veteran scientist first honoured these pages as a contributor. Ever since that time, as our readers well know, he has been a staunch supporter of the Baird system of television.

From the brief outline which we have given above, it will readily be appreciated that we of the present generation owe a considerable debt to Sir Ambrose Fleming for the support which he has given, in their embrionic state, to inventions which led ultimately to the production of what are now regarded as everyday appliances and necessities. Future generations will owe an equal debt of gratitude to him for his great foresight and support of this new departure from accepted theory concerning wireless waves.

The revolution which will be brought about in electrical communication by the acceptance of this new theory is surely as phenomenal as any since the historic pronouncement of Copernicus that it was the earth which went round the sun.

It is good to know that the man who has already given so much to his day and generation is still pointing the way to a future generation by giving his support to a new understanding of wireless waves and television.

So much for the more technical aspects of the science.

During the month that has gone the public have been given two opportunities of seeing practical demonstrations of television—at the *Daily Mail* Schoolboys' Exhibition and at the Exhibition of the Physical and Optical Societies. Both demonstrations were carried out by the Baird Company and were marked by the reception of some really clear images. In the case of the Schoolboys' Exhibition the transmission was effected by land-line between the Army and Navy Stores and the Horticultural Hall, a distance of not more than a few hundred yards.

The demonstration at the Physical and Optical Societies' Exhibition, on the other hand, was carried out between the headquarters of the Baird Company in Long Acre and the Imperial College of Science at South Kensington. This involved transmission by land-line over a distance of nearly three miles, the line having to pass through no less than three post-office telephone exchanges *en route*.

With the announcement that the Baird Company is about to place receivers on the market, we may well believe that it will not be long before the public will reap the benefits that will usher in a new era in communication. If development in the immediate future is as rapid as we have reason to hope, then the years of waiting and working will not seem so very long after all.

Editorial, Advertisement & Publishing Offices:

Television Press Ltd.,

26, Charing Cross Road,

London, W.C.2.

Telephone: Temple Bar 6437.

Subscription Rate, 7/6 per annum, Post Free.
American Rate, $2.50 per annum, Post Free.

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

Television

PRESENT AND FUTURE

A Lecture given at the Imperial College of Science, London, on January 9th, 1930, at the Annual Exhibition of Apparatus by the Physical and Optical Societies of London

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

IN speaking to you this evening on the subject of television, present and future, I shall not occupy time with any historical retrospect.

The story of the various attempts made to transmit to a distance visual images of actual living or moving objects as against simple picture transmission or telephotography can be read in the pages of several excellent books already published on this subject.*

Neither shall I dwell on the various proposals for television apparatus which have been put forward, but not put in practice. Nor with those which have been put in practice with only very imperfect success in transmitting mere shadowgraphs but not true television images.

There will be quite enough to occupy our attention in a brief hour if I endeavour to give you a short account of the principles of television apparatus as now used in successful performance at present and discuss some of its possible improvements in the future.

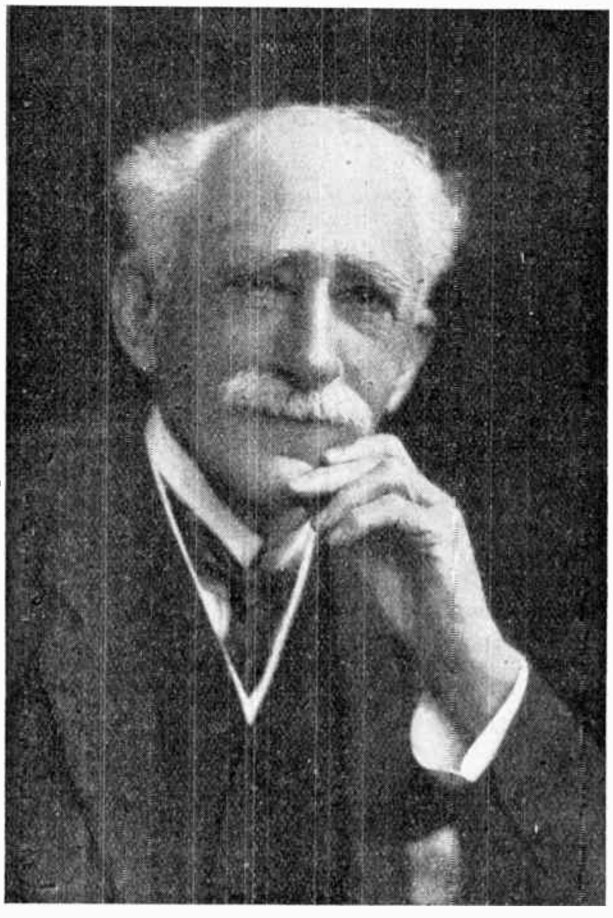


Photo. Lafayette.

A recent photograph of Sir Ambrose Fleming.

The first statement which must be made is that television, in any true sense of the term, depends essentially on a certain special property of the human eye of which we are not generally conscious.

The one essential quality of the eye on which it depends is that of persistence of vision, or the fact that a visual stimulation produced on the retina of the eye does not vanish immediately when the stimulating light ray is withdrawn.

The structure of the eye is that of a photographic camera. We ought not to say the eye is like a camera, because eyes were in existence before cameras, but the camera is modelled on the eye.

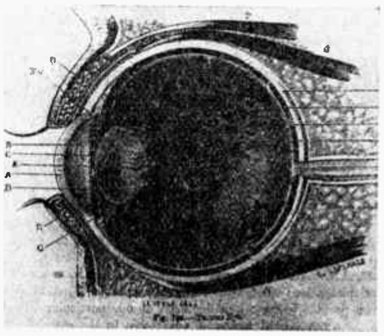
The crystalline lens of the eye forms an inverted image of external objects on the retina or interior of the back wall of the eyeball.

The retina, in addition to a close network of nerves and blood vessels, has a very complex structure in which microscopic examination detects 8 to 10 layers of tissue. The next but one to the surface contains curious bodies called rods and cones. In the outer parts of the rods a fluid called the visual purple is found. The surface layer of the retina consists of

**E.g.*, "Television," by Alfred Dinsdale. 5s. Television Press, Ltd., London; or "Practical Television," by E. T. Larner. 10s. 6d. Ernest Benn, Ltd., London.

hexagonal cells containing some colouring fluid or pigment.

There are three important regions of this retina. One, called the *fovea centralis*, is particularly sensitive to light and rich in rods and cones. Another, called the "blind spot," has no rods and cones and is insensitive to light. This marks the place of entry of the optic nerve. It is also called the optic disk. Another part, known as the "yellow spot," is characterised by a yellow pigment.



Cross section of the human eye.

When we look at any source of light or illuminated object the eyeball is automatically moved by muscles controlling it so as to bring the various parts of the image of the object we wish to see on to the *fovea centralis*.

In reading print or looking at a large object the eyeball is being continually moved so as to cause the image to rove over the retina and bring each part in turn on to the sensitive spot.

When that spot has been stimulated by light the effect does not vanish at once on the withdrawing of the light or change in the position of the eye, but lingers for a fraction of a second before the retina at that part is again ready for use.

This effect, known as persistence of vision, gives the explanation of many well-known optical and ocular effects.

If, for instance, a single bright spot of light moves in a circle or in a straight line very quickly we cease to see a single spot, but see a circular or straight line of light of a certain length. A meteor shooting across the sky appears as a line of light and a lighted squib whirled round in the dark as a circle of light.

The colour top of Maxwell for blending colour depends on the same principle. The retina of the eye behaves to a certain extent like a sheet of paper covered with Balmain's luminous paint.

Illustrating Persistence of Vision

If we were to throw on such a painted screen the image of a letter or pattern cut in a stencil plate, put as a slide in an optical lantern, this luminous letter would excite the paint and if the light beam was extinguished or stopped the letter or pattern would be seen still glowing for a certain short time, but would rapidly fade away. Then another luminous letter or pattern could then be impressed on the screen in place of it.

It has been suggested that the visual purple in the rods acts in some way like this phosphorescent paint. It appears from tests made that in various persons the degree of persistence of vision is different. In some people it is much less than in others.

Thus, suppose we were to have a cross-word puzzle painted on a large card and hung up in a dark room.

Imagine that from a lantern a slender beam of light was projected only just large enough to cover a single black or white square, and that it could be moved successively along each line of the puzzle. If it moved slowly we should only see a single square whether black or white at a time. If it moved quickly enough we might see a whole line at a time in proper order, and if it completed the whole of its journey in the sixteenth of a second and repeated them sixteen times in a second we should see the cross-word pattern complete as a whole in virtue of this persistence of vision.

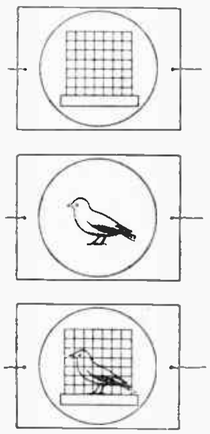
Consider in the next place a human face or any other object placed in the dark. Let a slender beam of light be projected on to it and create on it a brilliant spot of light. Let this light spot move downwards over the object and then repeat its journey a second time, slightly more displaced, say, to the right, but so that the successive spot paths just touch each other.

Imagine this shifted journey repeated again and again, say 30 times, so as to cover the whole object in time.

If this light spot journey is performed slowly we should see nothing but a spot of ever-changing colour and brightness varying from perfect whiteness to perfect blackness according to the nature of the surface over which it was at that moment moving.

Scanning Explained

If, however, the whole set of its journeys is performed in, say, one sixteenth of a second we should by persistence of vision see the whole face completely. Imagine next that we could in some way create at a distant place a spot of light which shall move over a screen exactly in step and time with the spot at the sending end just like two distant clocks each showing exact Greenwich time. If the sending-end spot moved quickly enough to cover the whole of the object in one sixteenth second and repeated its set of journeys sixteen times a second, and if the spot at the receiving end kept exact step with the sending-end spot, and, moreover, if the receiving-end spot could be made to have the same brilliancy and colour at the same instant as the sending-end spot, we should have an exact reproduction at the receiving end of the object or face and true television would be achieved. We have then these three things to consider :—



A simple experiment illustrating persistence of vision. If a bird is drawn on one side of a card and a cage on the other, and the card is rapidly rotated by strings attached to the sides, the bird will appear inside the cage.

1. How such a travelling spot of light can be produced at the sending end ?
2. How its brightness and colour can be reproduced instantly at a distant place ? and,

3. How the reproduced spot can be made to move exactly in step and identically with the sending-end spot ?

In the first place the most convenient method, and as employed by Mr. Baird, to produce the travelling spot or scanning spot, as it is called, at the sending end is by the use of a scanning disk with small holes in it arranged equidistantly along an equiangular spiral of one complete turn. It is usual to employ such a disk with 30 holes. This type of disk was first suggested by Nipkow in 1884.

How a face is scanned by a tiny spot of light.

The reduction of radius of the spiral in one turn of 360° is called its pitch, and the diameter of the holes must be such that if there are 30 holes each must have a diameter equal to the thirtieth part of the pitch.

This disk is fixed to an axis and rotated uniformly by an electric motor at not less than 16 revolutions a second, or say 1,000 per minute.

The disk is placed in the path of a beam of light so that by an objective lens a spot of light is focussed upon the object and moves downwards over it as the disk revolves. Only one single spot must be on the object at a time.

This necessitates a brilliant but perfectly steady source of light and Mr. Baird prefers to use high candle-power incandescent lamps.

This small bright spot of light causes no inconvenience when it passes rapidly over the human face, and indeed one is almost unconscious of it when being scanned.

Generally speaking, the lantern, disk and motor are placed in one room and the scanning ray passes through a small opening in the wall and falls on the face of a subject sitting before a screen in an adjacent room.

Leaving for a moment the arrangements at the receiving end, we have next to consider the method by which the scanning spot is made to produce an electric current of an intensity proportional to its brilliancy or to the illumination of the surface on which it falls. This is achieved by a photo-electric cell.

Discovery of Photo-electric Emission

As a consequence of a fact noticed by Hertz in some of his work, Hallwachs discovered in 1888 that when certain metal surfaces are illuminated by light of a certain kind they give off electrons or lose negative electricity. This is called photo-electric emission.

To catch up this current it is necessary to place a metal grid before the sensitive metal plate and to illuminate the plate through the grid. If a battery and galvanometer are connected to the plate and grid respectively, the negative pole of the battery being connected to the plate, then when the plate is illuminated by ultra-violet light a continuous current of negative electricity flows across from plate to grid.

To make a long story short, it was before long found that the electro-positive alkali metals—potassium, rubidium, cæsium—give the largest currents with visible light, especially when treated in a certain way.

A commercial form of photo-electric cell is therefore as follows.

A glass bulb rather flat on one side has this flat side coated inside with a thin deposit of silver or copper by well-known processes. This metal film has a deposit of potassium or cæsium made upon it which may be subsequently specially treated to make it more sensitive. In front of this photo-electric film is placed a ring of metal covered with a grid of fine wires, and connections are made to external electrodes with the grid and film.

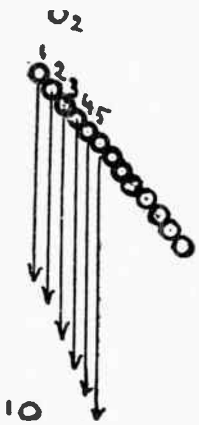
The bulb may be either very highly exhausted of its air, in which case it is called a vacuum cell, or else it may be filled with an inert gas, generally argon or helium, at a low pressure of about one-sixth of a millimetre of mercury.

The vacuum cell is much more constant in operation than the gas-filled cell, but the latter is generally more sensitive than the former. Hence vacuum cells are used in scientific measurements, and gas-filled in commercial work.

A usual type of cell consists of a thin layer of potassium deposited on copper. In other cases the cathode, as it is called, is a thicker layer of potassium sensitized by a treatment consisting of making an electric discharge to it through hydrogen gas.

A far more sensitive photo-electric cell has been developed by the General Electric Company of London at their Research Laboratory at Wembley, consisting of cæsium deposited in oxide of silver. In its best form it is ten times more sensitive than the potassium-on-copper cell.

When the cathode or sensitive surface of such a cell is exposed to light, the grid having a certain positive potential, electrons are given off from the film and create a very feeble current of about 1 to 10 microamperes or so which passes in the cell from film to grid. This current can be amplified by thermionic valves.



Showing how the travelling light spot produces adjacent vertical lines.

This photo-electric current is proportional to the total amount of light falling on the cathode and is measured in amperes per lumen.

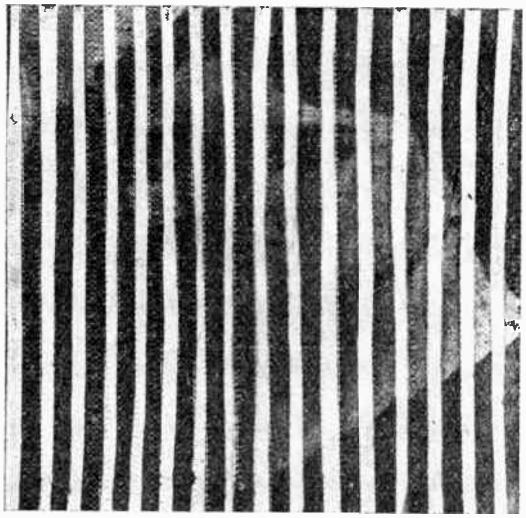
Photo-electric metals differ very much in the kind of light (that is the wavelength of the light) to which they are sensitive or to which their sensitivity is a maximum.

Thus, pure potassium is most sensitive to violet light. Potassium-on-copper is sensitive up to the red end of the spectrum.

Some curves prepared at the General Electric

Company's Research Laboratory show the variation in sensitivity of different cathode materials over the entire wavelength range of visible light from 4000 A U to 7000 A U. (I A.U. 10^{-8} cm.). Such a photo-electric cell is then an artificial eye. But it is an eye with absolutely no persistence of vision.

When the incident light is withdrawn the photo-



What a television image would look like if the image strips were separated out.

electric emission does not continue even for the millionth part of a second.

The photo-electric current starts at once on illumination of the cathode and stops at once on its withdrawal, and varies within certain limits exactly in proportion to that illumination.

Hence this artificial eye is the very thing required for television.

Return now in thought for a moment to the face or object being scanned by the travelling spot of light. At every instant light is being scattered from the place over which the spot is passing and the amount of that light varies with the nature of the surface. Where the spot is passing over dark hair, eyebrows or shadows the scattered light is small. When it passes over white forehead or teeth the light is large.

A battery of photo-electric cells can therefore be so placed and shielded from direct rays as to pick up this scattered light and translate it into its equivalent in an electric current.

This current can be amplified by thermionic valves or amplifiers and either transmitted by telegraph wire to a distant place, or used to modulate a high frequency or carrier wave transmitted by wireless to a distant place.

In either case we have a current produced at the receiving station which varies in strength exactly in proportion to the intensity of the light scattered from that point of the object over which the scanning spot is then passing.

We have next to see how this varying current is translated back again into varying light.

Up to the present only one method has been found of doing this, viz., by means of a glow light neon tube. Neon is one of the rare monatomic gases in the atmosphere forming about one eighty-thousandth part of it. When an electric discharge is sent through rarefied neon gas the tube glows with a rich red orange light.

We are very familiar with this red neon glow effect in the glass tube shop-signs so much used now at night, in which glass tubes filled with neon, one bent into the form of various letters and words, are illuminated by a high tension alternating current.

If two metal plates are placed parallel to each other in a glass vessel and about one millimetre apart, then when the tube is filled with rarefied neon at a certain pressure, and the plates connected to a voltaic battery, it has the peculiar property that at a certain gas pressure no electric discharge can pass from plate to plate across the one millimetre space. The discharge prefers to go the long way round from the back of one plate to the back of the other.

There is a certain starting voltage of about 200 or 300 volts at which this discharge just begins and coats the back of the negative electrode plate with a very faint yellow glow. If on that voltage another voltage is imposed then the glow increases in brilliancy just in proportion to the added voltage. This action is perfectly instantaneous and there is no sensible lag.

Accordingly this neon tube provides what is required in television reception.

Suppose we look at the negative cathode not directly, but through the holes in a spiral-hole scanning disk, which runs exactly in step with the disk at the sending end, and if the added voltage to the neon tube is given by the amplified photo-electric current rendered by the "artificial eyes" which are looking at the object or face being scanned the neon glow will fluctuate exactly in proportion to the light scattered from the surface over which the scanning spot is then passing.

The same picture with the strips closely fitted together, as seen on the receiving screen.

If, then, the two spiral-hole or two Nipkow disks run exactly in step we shall have reproduced at the receiving end by persistence in the observer's vision an image of the object scanned.

Although this, taken as a whole, is a complicated process, it succeeds remarkably well in reproducing images of living human faces which are smiling, laughing, or making other motions; and also the heads of animals and other things can be televised as well.

We have then to explain how these two spiral-hole disks at the sending and receiving stations are synchronized or made to run in step.

Before we can do this I must call your attention to the exact mode in which the reproduced image of the distant object is built up.

There has been in the past much misunderstanding created by the assumption that the television image consists of a set of " dots " like a process block illustration. If you look at such a printed picture in a newspaper you will see it is composed of dots of ink, very black, and close together in the dark parts of the picture, and very faint or far apart in the light portions.

To obtain a recognizable portrait we must, therefore, have not less than a certain number of dots per square inch, say 2,500. If this were the case with television images it would mean at least 40,000 electric impulses per second for television, and probably more. But as a fact there are no " dots " at all in the television image.

Strips, not Dots

It is in reality built up of a series of closely adjacent lines of light, say 30, corresponding to the number of holes in the scanning disk. Each line of light varies in brightness along its length quite continuously without breaks or interruptions, and it is repeated at regular intervals about 16 times a second.

It is easy to prove this as follows:

If you look in at the image in a Baird receiver and, whilst keeping your head still, quickly move your eyes from one side to the other you will see the image break up into lines of reddish light. Otherwise if you look at the image, not directly, but by reflection in a little mirror, and give this mirror a sudden twist about a vertical axis, you will see the reflected image break up into a set of bright lines each varying in brightness along its length. These are called the picture elements.

Now between each complete line or single scanning of the object there is a very brief pause, which shows itself as a black or bright strip at the bottom of the picture.

If these facts are held in mind it will be easy to follow a description of the process adopted by Mr. Baird for synchronizing the sending and receiving disks.

These two disks may be compared with two distant clocks the hands of which go once round in the one-sixteenth of a second. We have to make these two clocks both go at the same rate, and show the same time. This is called the problem of synchronization or time-keeping.

The Problem of Synchronism

The problem of synchronism has long been one of the outstanding problems which has prevented television from becoming a commercial reality. Various methods have been proposed.

The one which was first successful was the use of A.C. synchronous motors. This device gives quite successful results, but it necessitates the use of a separate channel of communication for the alternating current driving the two motors, as both motors must be driven from the same source.

In America use has been made of the alternating current electric supply mains, and where the transmitter and receiver are put on the same network synchronism may be achieved by this means, but it is only within very restricted areas that the same source of alternating current is available, so that this does not provide a solution to the problem.

Efforts have also been made to obtain synchronism by means of independent oscillating systems, such as oscillating crystals, tuning forks or oscillating valves, the alternating current generated by these devices being amplified and used to supply synchronous motors. Such devices are extremely complex and expensive, and are only suitable for operating under laboratory conditions, or where an expert staff is available, and are quite impractical for use by the general public.

The Imperial College of Science and Technology, departments of chemistry and physics, where the Physical and Optical Societies' Annual Exhibition was held, and where Sir Ambrose Fleming gave his lecture.

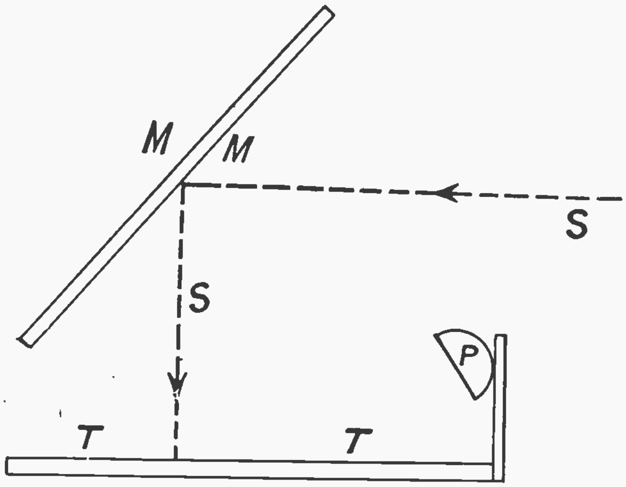
Therefore, before television could become commercially practicable for broadcasting to the home, some form of synchronism had to be devised which would not necessitate the use of separate channels of communication, and would be sufficiently simple and inexpensive to come within the powers of the domestic user. This was accomplished by Mr. Baird, and was shown in operation during the Radio Exhibition in September 1928, and was further publicly demonstrated at the demonstration given in March 1929 before the Committee of Members of Parliament and Post Office and B.B.C. engineers, when television was transmitted through 2LO and received at St. Martin's le Grand, before Lord Clarendon, the Postmaster-General and engineers and Parliamentary Committee, and was received simultaneously at Savoy Hill before Sir John Reith and officials of the B.B.C. On these occasions no separate synchronizing signal was sent out, the picture being transmitted through 2LO and the speech sent out through the Marconi Station on a separate wavelength, the picture itself providing the synchronizing impulses necessary to keep the receiver in step with the transmitter.

The synchronizing is accomplished by taking a portion of the picture-building current and using this to keep the receiving disk in step. Where a large receiving disk is used a commutator directs this current through a relay circuit for a brief interval at the end of each line of the picture. For example, if there were 30 lines in the picture the commutator sends 30 brief impulses through a relay during each reproduction of the image. Now, in operation, the action is as follows :—

Between one image and another there is a black division. This black division is not artificially produced, but is the natural demarkation between one picture and another. Now, when the machines are in synchronism the commutator connects the relay just at this black space ; therefore, no current flows through the relay. If, however, the receiver goes slightly faster than the transmitter, the commutator comes into action at a lighted portion of the image and current passes through the relay, giving a small retarding force. The receiving machine is arranged to run very slightly faster than the transmitting machine, so that by means of the relay a perfect keeping in step is effected.

The above synchronizing mechanism is simplified in the smaller commercial machines supplied to the general public. In place of a commutator and relay, the correcting signal is applied directly to the coils of an electro-magnet which acts upon an iron wheel having little teeth corresponding to the holes in the scanning disk. Thus, when the receiving disk runs too fast, the correcting impulse pulls directly upon the iron teeth and opposes the motor. The scanning disk in the receiver is set to run a little faster than the disk of the transmitter, and the action of the electro-magnets on the toothed wheel retards it a little if the disks get out of step.

By these ingenious methods Mr. Baird has solved the problem of a simple yet perfectly practical synchronization, and in the best modern Baird receivers, when properly adjusted, the received image is perfectly steady and quite sharp and clear, and every motion of the object reproduced.



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.*

We can in this way see, for instance, the image of a cat lapping her milk, or a dog barking or moving his ears, or any movements of a human head or face at a distant place. In other words, true television as compared with simple static picture transmission.

Now, an object in motion or alive is always more interesting to the general public than any mere stationary picture, and hence there is a great attraction in seeing at a distance such objects.

Nevertheless, there are only a limited number of objects which can " sit-up " in this way in front of a screen.

There are a number of objects and experiments which could be televised only when placed in a horizontal position. For instance, we might wish to show the lines of magnetic force of a magnet rendered visible by iron filings sprinkled on a sheet of paper laid over the magnet. Or we might wish to show the ripples on a mercury or water surface produced by touching it with a tuning fork or vibrating needle.

How it can be Done

I suggested lately to Mr. Baird that this could be done by placing over the horizontal object a large plane mirror or looking-glass at an angle of 45°, so as to reflect the horizontal scanning ray vertically downwards.

Thus photo-electric cells would then have to be placed in such a position as to pick up the scattered light, but at the same time be shielded from direct rays.

Another important problem which has to be solved in the future is to be able to transmit images of objects covering a large area. At present we can only televise small-sized objects such as a human head or something of the same size.

But we require to be able to transmit images of full-length human figures and of two or more people, or of a cricket match or football match or other scene.

It seems to me that the only way in which this can be done is by forming a small image of the large object by means of a large convex lens or concave mirror and scanning that image by a spiral-hole disk. But large achromatic lenses suitable for this purpose would be very expensive articles, and perhaps out of the question. The eminent engineer, Sir Charles Parsons, has however directed his attention of late years to the production of silver-on-glass concave mirrors of very large size, but not of enormous price.

A mirror of this kind, seven feet in diameter, was exhibited at the Parsons' stand in the Newcastle-on-Tyne Engineering Exhibition this last summer (August 1929).

My suggestion, then, is that if such a large mirror were placed with plane vertical it would be possible to reflect on to it by another plane mirror light sent out from a large object. The mirror would form a small image, the size of which would depend on the focal length of the mirror and the apparent angular diameter of the object.

The converging beam of light reflected from the mirror could then be turned out at right angles by a small mirror as in a Newtonian telescope, and brought to a focus on the surface of a scanning disk. Close behind the holes of this disk must be placed the most sensitive form of photo-electric cell with cathode plate large enough to contain the whole of the image formed by the mirror.

Then this image could be scanned in the usual way, and if there was light enough could be televised. I have considered whether it would be possible by this means to televise the moon or a solar eclipse.

In the case of a concave spherical mirror the angular diameter of the image as seen from the centre of curvature of the mirror is the same as the angular diameter of the object as seen from the same place. The sun and moon have an apparent angular diameter of about thirty minutes or half a degree.

If then a concave mirror of 20 feet radius of curvature or 10 feet focal length is employed as above described, it would form an image of the full moon about 1 inch in diameter. This could be formed on a suitable scanning disk with a highly sensitive photo-electric cell placed close behind it having a cathode at least 1 inch in diameter.

The image would then be scanned, and the resulting photo-electric currents amplified.

The illumination produced on white paper by the light of the full moon is only one-fiftieth of a candle foot. But by the use of a sufficiently large concave mirror it could be increased to any required amount.

The televising of full-length human beings who are seen only in normal daylight, or in bright sunshine or flooded with artificial light, may be more difficult because in this method we cannot multiply the photo-electric cells. The only way to increase the photo-electric current is by enlarging the size of the concave mirror and so collecting more light.

There is, however, still room for improvement in the photo-electric cell, and research is very active in this direction. We need not, therefore, doubt that the televising of large or multiple objects will yet be achieved.

When we remember the enormous progress made in wireless telegraphy and telephony in 20 years from their inception it is not imprudent to expect that a similar great progress will be made also in the art of television.

Although the foregoing explanations are correct as far as they go, yet this description of practical television would be incomplete without some mention of the outstanding difficulties or problems to be solved before we can make any striking advance over what has been already done. The first of these is some receiver which shall be an advance on the single neon lamp so far used. There is a limit to the size of the plate which can be kept uniformly illuminated in the neon lamp by the feeble currents which are capable of being received and handled even when amplified within the limits of non-distortion.

In America they have tried making a very large neon lamp with 2,500 electrodes in it. But such a device, though practicable for a single costly experiment, worked by experts, is quite out of the question for an apparatus usable by the general public.

Then again we desire to obtain a reproduced image sufficiently bright to project by a lens on to a screen so that a considerable number of persons may see it at once. Mr. Baird is now engaged on this problem.

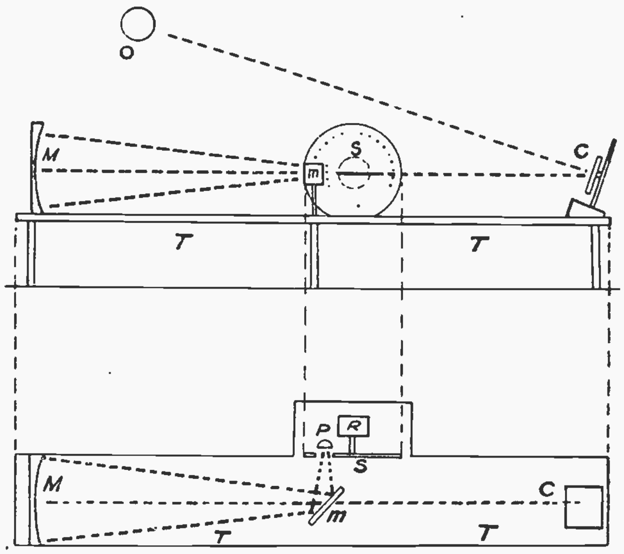


Fig. 1.—Elevation and plan views of a form of horizontal Newtonian telescope.

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.*

If we can form a small image of a large scene such as a cricket match or football match by means of a large concave mirror or lens, but to scan that image we require also a photo-electric cell of great sensitivity because the current it is yielding at any moment is due merely to the light coming through one hole of the scanning disk, and we cannot in this case multiply or use in parallel a number of photo-electric cells. Hence, one condition for further progress is a photo-electric cell which yields a larger current per lumen than is at present obtainable. The photo-electric cell formed with cæsium deposited on oxide of silver, which has been produced by the General Electric Company, is a step in the right direction.

What we must aim at, then, is a more effective device for converting the energy of visible light into energy of an electric current, and also one for converting back again an electric current into visible light in such fashion that the light brightens and electric currents vary proportionately to each other.

We may then use a large lens or mirror to form a small but brilliant image of a large scene and scan that image, and then at the receiving end transform that varying electric current back into a luminous field which varies proportionately and is bright enough to be projected on to a screen and enlarged by a mirror or lens so as to form an image visible simultaneously to a number of people.

There is nothing impossible in these advances, and when we remember the vast improvements made step by step in wireless telegraphy and telephony in the transmitting and receiving apparatus they give good reason for anticipating similar advances in the apparatus for television in the next few years.

Is Television in Danger?

asks SYDNEY A. MOSELEY

AN article in *Vox* by Mr. P. Wilson—"Selectivity in Excelsis"—calls for an immediate reply on my part. Indeed, if this writer's views as expressed in those columns are at all correct then I am wasting my time in proceeding with these articles on television. It is of the utmost importance, therefore, to deal immediately with the points he raises.

Referring to the *Stenode Radiostat*, the invention of Dr. Robinson, he states that he has been given "in confidence" a more complete explanation than has been generally afforded yet as to the potentialities of the Stenode Radiostat, which he further describes as the "event of the year for wireless folk." Mr. Wilson, apparently, was present at a special technical demonstration on the day before the press show, further indicating that he knows more of what the Stenode Radiostat is capable of achieving than anybody else.

For instance, Professor Appleton, the brilliant *Times* correspondent, whose capabilities are at least equal to those of Mr. P. Wilson, is not inclined to go anywhere near as far in estimating the possibilities of the new invention. Indeed it has yet to be demonstrated whether Dr. Robinson's Stenode Radiostat will affect the transmitting side of wireless at all, although from the receiving side there might be something in it. As sweeping as Mr. Wilson is in his admiration for Dr. Robinson's invention, he is equally sweeping in condemning Mr. Baird's invention:

> "But these" (demonstrations) "have only served to stimulate a desire for test experiments in which the various factors can be measured and controlled. Only in this way can one form a just estimate of the ultimate value of an invention of this kind. It is here, for example, that, in the writer's opinion, the whole case *for the Baird television system falls to the ground.*" [My italics.]

Such technical information as Mr. Baird has "condescended to disclose" does not "encourage any responsible wireless engineer to the belief or the hope that the methods hitherto employed are capable of extension or modification to produce anything more than a very crude form of television. No one is disposed to deny that television, of a primitive type, has been achieved; what we are disposed to ask is whether present methods are any more likely to produce real television than the Marconi coherer was to produce real radio-telephony. For this an invention of major importance—the thermionic valve—was necessary. Is not that precisely where television stands to-day?"

And so on.

Here I would like to stop and ask whether Mr. Wilson has paid as much attention to television as he has to the Stenode Radiostat. That television has been achieved even Mr. Wilson will hardly deny. If he does, let me refer him to the publicly-expressed opinions of Sir Ambrose Fleming, the inventor of the above-mentioned thermionic valve and probably the greatest living wireless technician ; and if the testimony of Sir Ambrose will not satisfy Mr. Wilson, I will refer him to the experts in Germany who have thought sufficiently well of television as an accomplished fact as to combine not with any German inventor, but with Mr. Baird, late of Helensburgh, and now of Long Acre, London.

I suppose the proof of the pudding is in the eating. Television sets are being manufactured and will be placed on the market very soon. Can Mr. Wilson make the same claim in regard to the Stenode Radiostat ?

If Dr. Robinson's claims are justified, then indeed he has achieved something of world-wide importance and he deserves our best thanks. He certainly will get mine. On the other hand one is unable to forget the similar outbursts of hyperbole prior to the broadcasting of Wireless Pictures—an experiment which unfortunately turned out so disappointingly to those who were led to believe in its immense commercial potentialities.

Dr. Robinson was adviser to Wireless Pictures, and I don't know whether he concurred in the broadcast experiments or not ; but Colonel Adrian Simpson and the Hon. Frederick Guest were associated with Wireless Pictures, and I think I am within my rights in asking those who are likely to commercialise the *Stenode Radiostat* to exercise the fullest possible care in estimating its actual capabilities before embarking on a similar experiment as was undertaken with Wireless Pictures.

So much for the Stenode Radiostat. Now I observe that Captain Eckersley has replied to my recent criticism on his attitude towards television in a weekly journal, the editor of which calls my " special attention " to what he has to say.

Captain Eckersley had evidently to go far afield to find technical backing for his opinions. He quotes Mr. Julius Winenberger, Mr. Theodore A. Smith and Mr. George Rodwin. What these gentlemen's knowledge of American television is I cannot say, but might I ask if they were aware of what British television can do ? We are all aware how far behind American television is, and it may very well be that *American* television is still nothing more than a toy.

May I remind Captain Eckersley that Professor Appleton, writing in *The Times* some months ago, stated that Baird television was so clear that it was possible even to read the time on a watch. An apparatus which can perform such a feat is surely no toy.

May I point out that Mr. Baird has demonstrated the transmission of large and small objects (I suppose a watch may be called a small object, and a boxing match a large object). No special skill is required to operate the synchronising of the British system—being a point, by the way, worthy of note, for in America they have no such thing as automatic synchronism, and depend upon manual manipulation. It is perfectly feasible, then, that American television might be classed as a toy. Anyone who has tried to synchronise manually will realise how hopeless the task is, and how impossible it is to get clear television without synchronism.

Mr. Julius Winenberger, Mr. Theodore A. Smith and Mr. George Rodwin have given their opinions of American television, but their opinion is not shared by the scientists and engineering experts who have witnessed television in London.

" In my opinion," Captain Eckersley says, " we shall need more like 1,000 k.c. before we can get service value out of television." This statement is highly misleading. What does Captain Eckersley mean by " service value " ? To use his own quotation : " The majority of dramatically interesting situations are reduced to two, or at most three persons . . . ." and it has been amply proved that these can be transmitted quite satisfactorily without the use of anything like 1,000 k.c. They have been sent through the B.B.C. stations. The statement which he quotes and which he seems to regard as authoritative is that the *minimum* requirement is 100 k.c.

In the United States, amongst other things they have not solved is the problem of automatic synchronism, and therefore a separate channel is required for the synchronising signal, which may account in some manner for this rather remarkable statement. It is quite obvious that the U.S.A. are far behind in this art.

What does Captain Eckersley want ? Does he want television to be forthwith removed from the ether because he and a few American technicians—whose names are quite unfamiliar and the value of whose testimony therefore can only be surmised—are of opinion that the B.B.C. cannot give a sufficient waveband ? Does the fact that his opinions are directly opposed to those held by technicians of considerably greater eminence than himself, and by commercial undertakings whose technical reputations are world-wide, not bid him, at least, hold his tongue and wait events, rather than attack a science which is just emerging into commercial life ?

The Cathode-Ray Tube in Practical Television

PART III*

By *W. G. W. Mitchell*, B.Sc.

IN the February, 1929, issue of TELEVISION I gave a few details of Dr. Zworykin's cathode-ray system for television, using these words in the last paragraph of that article :—

" It is not possible at the moment to give any details as to the actual results achieved by these (*i.e.*, Dr. Zworykin's) methods. The matter is being actively pursued in the laboratory, and we shall certainly await results with the greatest interest. It remains to be seen whether the luminous intensity of the cathode ray, when projected at a potential of some 300 volts, and distributed over a large viewing surface, would be sufficiently bright to compare with the present known methods of integrating a television picture. If it does, then we shall have reached another landmark in the progress of television."

The actual achievement of practical results (either wholly or partially by cathode-ray methods) which has been eagerly awaited by many keen observers, was announced on November 18th, 1929, from New York in the following terms :—

" . . . Television which can be viewed by a room full of spectators rather than by one or two was announced to-day by Dr. Vladimir Zworykin, research engineer of the Westinghouse Electric and Manufacturing Company, to members of the Institute of Radio Engineers. The use of a cathode-ray tube as a receiver gives this new type of television many advantages over the well-known scanning disc method of visual broadcasting.

" The inventor is already in a position to discuss the practical possibility of flashing the images on a motion picture screen so that large audiences can receive television broadcasts of important events IMMEDIATELY AFTER A FILM of these is printed. These visual broadcasts would be synchronised with sound.

" The cathode-ray television receiver has no moving parts, making it more easily usable by the rank and file of the radio audience. It is QUIET IN OPERATION, and synchronisation of transmitter and receiver is accomplished easily, even when using a single radio channel.

" By using a fluorescent screen the persistence of the eye's vision is aided and it is possible to reduce the number of pictures shown each second without noticeable flickering. This in turn allows a greater number of scanning lines and results in the picture being produced in greater detail without increasing the width of the radio channel.

" The apparatus described by Dr. Zworykin is now being used in experimental form in the Westinghouse research laboratories in East Pittsburgh. A number of similar receivers are being constructed in order to give the set a thorough field test through station KDKA, Pittsburgh, which already is operating a daily television broadcast schedule with the scanning disc type of transmission.

" The pictures formed by the cathode-ray receiver are 4 by 5 inches in size. They can be made larger or brighter by increasing the voltage used in the receiver.

" The TRANSMITTER of this new television apparatus (Fig. 2) consists of a motion picture projector rebuilt so that the film to be broadcast passes downward at a constant speed. This film is scanned horizontally by a tiny beam of light which, after passing through the film, is focussed as a stationary spot on a photo-electric cell. The scanning motion of the beam is produced by a vibrating mirror which deflects the light from one side of the film to the other.

" Dr. Zworykin was forced to develop an entirely new type of cathode-ray tube for his *receiving apparatus* which he calls a ' kinescope.' In this tube a pencil of electrons is bombarding a screen of fluorescent material. The pencil follows the movement of the scanning light beam in the transmitter while its

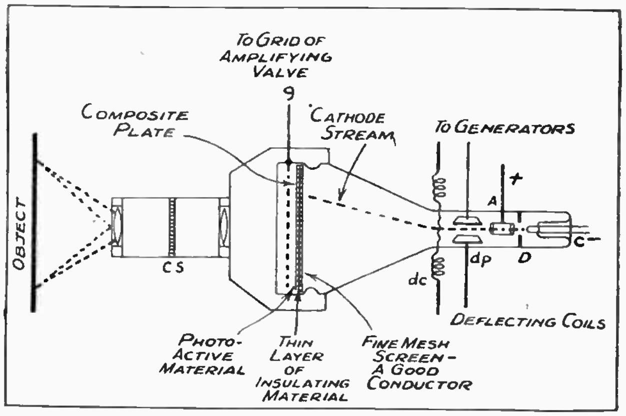
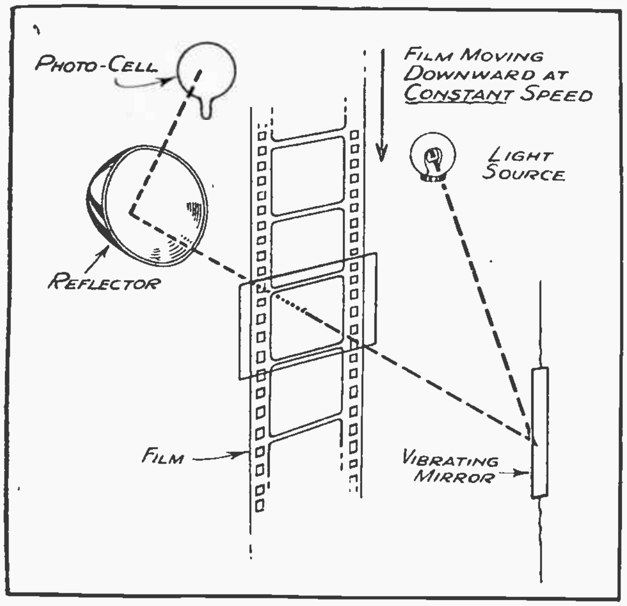


Fig. 1.—Dr. Zworykin's original transmitter.

* See TELEVISION, February, 1929; May, 1929.

intensity is regulated by the strength of the impulses received from the transmitter. The movement of the scanning beam, consequently of the cathode-ray pencil, are so rapid that the eye receives a perfect impression of a continuous miniature motion picture.



Light modulation based on Dr. Zworykin's new scheme.

"A reflecting mirror mounted on the receiver permits the picture to be observed by a number of spectators.

"This condensed description of the methods used by Dr. Zworykin to effect television transmission can give only an idea of the possibilities of the new system. To the radio public it means, when perfected, a means of television which will be simple to operate because it has no scanning disc or other moving mechanical part. *The receiver* will operate in silence, offering no interference to sound broadcasts.

"To the radio engineer the invention is important for the same reasons and because it will not be wasteful of radio wave bands. This because the transmitter and receiver can be synchronised, using but one channel."

I have thought it desirable to give the official announcement in full if only for the reason that, in the absence of any technical details, it appears to make rather wide, if not extravagant, claims for the ease of operating a cathode-ray receiver built for television.

Scanning

Quietness of operation is, of course, a strong point in its favour, although I have not noticed that the "purr" of the motor driving a revolving disc causes unpleasantly loud noises, or is in fact audible when the loud-speaker is working. Certainly the revolving disc, motor-driven, seems an easier means of scanning than the method of deflecting the cathode-beam by applying electric or magnetic stress to the deflecting plates or coils (Fig. 3), for we have, as yet, no very definite information as to how this is to be accomplished in practice.

If we turn to the original patent specification (British Patent No. 255,057) we find provision made for two separate generators at the transmitter, assuming the use of cathode-rays. One generator (see Fig. 1) is so constructed as to generate alternating current of a frequency of about 1,000 cycles/sec., while the other is adapted to give an alternating current of a frequency at about 16 cycles. Dr. Zworykin seems to have dismissed this method for the time being in favour of a mechanical drive for the vertical component of motion of the film, and a moving light spot, operated by an oscillating mirror for the horizontal component of scanning.

But in any case the two scanning frequencies have to be separated out at the receiver. In the Patent Specification already referred to this was to be accomplished by making the oscillating circuit (*ab*) (Fig. 3) resonant to current of two distinct frequencies. By means of the H.F. transformer coupling (*b*) associated with this oscillating circuit, modulated radio-frequency currents for scanning purposes are passed to the grids of detector valves (*vp*) (*vc*) through H.F. transformer coupling (*x* and *y*), and thence to the deflecting plates (*dp*) and coils (*dc*). The pair of plates (*dp*) and the coils (*dc*) are so positioned that the magnetic field produced by the coils is parallel to the electrostatic field generated by the plates.

Modulating

The action of the cathode-ray receiver is then as follows: The received picture signals are transferred

Dr. Zworykin and his new cathode-ray tube, which he calls a "kinescope." The television images appear on the round flat end at right.

from the oscillating circuit (*ab*) through the transformer (*a*) to the grid of the detector valve associated with this circuit, and thence to the plate and grid (*g*) of the tube. Cathode-rays are shot out from the hot cathode (*C*) under the influence of an accelerating voltage (from 300 to 4,000 volts) applied at the anode (*A*). A thin beam of these rays passes through the pinhole tubular anode, having previously been slightly deflected (and in consequence their intensity has thus been modulated) by applying the rectified picture signals to the grid (*g*) of the cathode-ray tube.

The cathode stream impinges on the fluorescent screen (*fs*), the intensity of the spot at any time being in accordance with the received picture signal and the position of the spot on the screen at any instant being in accordance with the relative actions of the deflecting plates and coils.

Sensitivity

We have no very definite information whether Dr. Zworykin's cathode-ray tube is completely evacuated or filled with an inert gas, such as argon, at very low pressure. If the latter is the case, then under average conditions, using an accelerating voltage of about 300-400 volts on the anode, a deflection of, say, 1 mm. per volt change on the deflecting plates may be expected.

The actual traverse on the screen would be about 120 mm. For a vacuum tube, if a potential difference *E* is applied to the deflecting plates, the stream of cathode-rays will be deflected through a distance *n* (in cm.) given by the relation

$$n=\frac{eE\lambda}{mv^2d}\left(L+\frac{\lambda}{2}\right)$$

Where e is the charge on an electron $= 1{\cdot}59\times 10^{20}$ (E.M.U.)

m is the mass of an electron $= 0{\cdot}9\times 10^{-27}$ gm.

v is the velocity of the cathode stream

d is the distance apart of the plates

λ is the length of the plates

L is the distance travelled from the deflecting plates to the observing plane

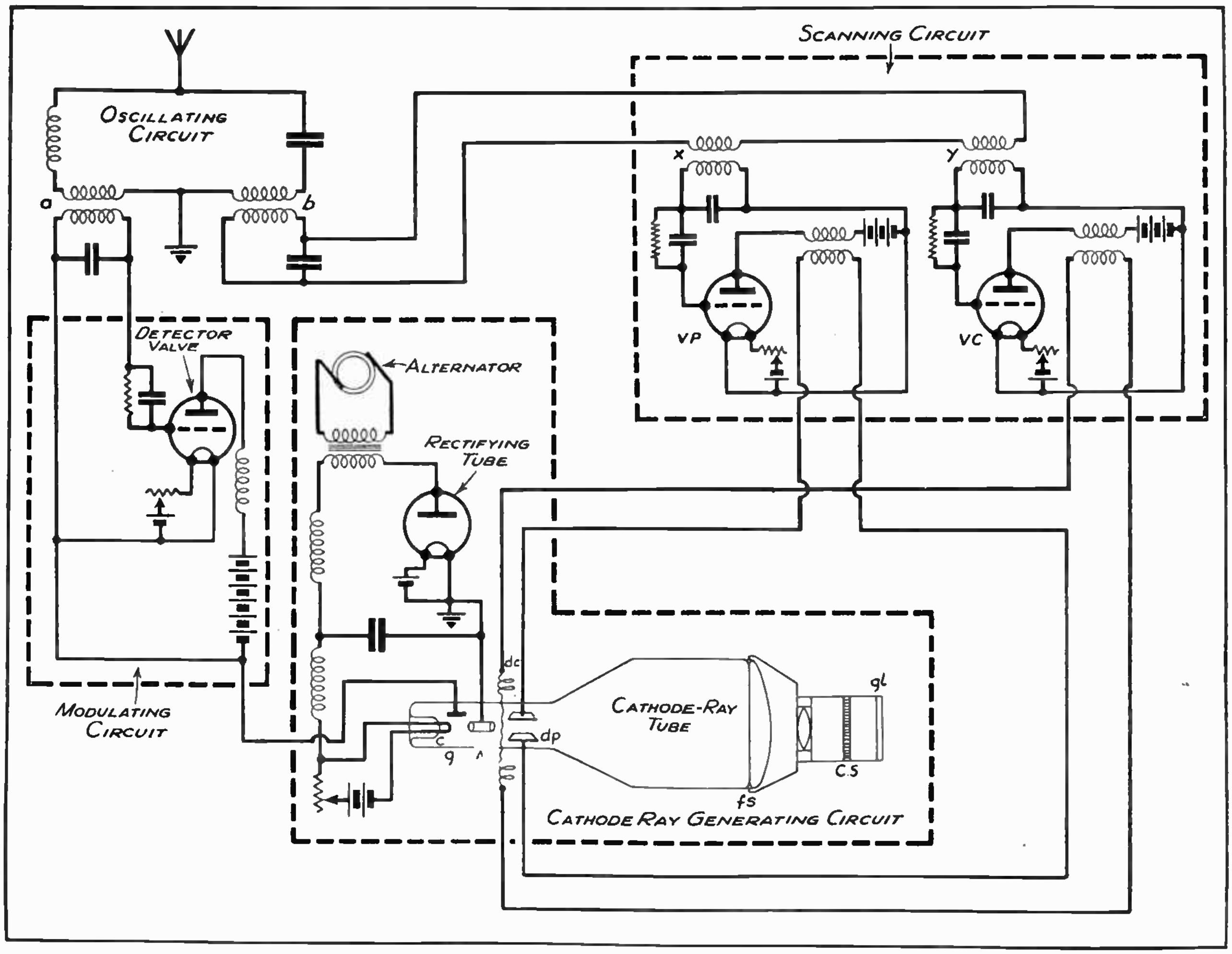


Fig. 3.—Schematic diagram of Dr. Zworykin's cathode-ray receiver.

The *electrostatic* sensitivity of the oscillograph, *i.e.*, $\frac{n}{E}$ is therefore increased by—

(1) increasing the length of the deflecting plates;

(2) increasing the length of the path from the deflecting plates to the observing plane;

(3) decreasing the distance apart of the plates;

(4) decreasing the velocity v of the cathode-rays.

Since $v = 5{\cdot}95\sqrt{V} \times 10^7$ cm./sec., the sensitivity is inversely proportional to the voltage V accelerating the cathode stream.

The *voltage* sensitivity is

$$\frac{\frac{\lambda}{d}\left(L+\frac{\lambda}{2}\right)}{2V} \text{ cm. per volt.}$$

If $V=500$ volts, and $\lambda=8$ cm., $L=20$ cm., $d=0{\cdot}5$ cm., then the sensitivity is 0·38 cm. per volt or 2·6 volts per cm. deflection. Increasing the voltage V to 2,000 will reduce the sensitivity to one-quarter of that when $V=500$ volts. So that to obtain increased sensitivity low accelerating potentials must be used. But by reducing V, we reduce also v, the velocity of the cathode stream and consequently the penetrating power of the rays is correspondingly decreased.

Cost

One very serious difficulty (perhaps the main difficulty) is to produce in practice with anything like regularity an intensely bright concentrated point on the fluorescent screen. The pinhole tube of the anode may be of extremely small bore, nevertheless the beam will tend to "spread." Striction coils wound round the axis of the tube simply tend to set up a spiral motion in the cathode stream itself, and only add to the complications of the apparatus.

In former articles I have stressed the comparatively short useful life of the ordinary low-pressure gas-filled, hot filament type of tube, which is probably due to the back-bombardment of the cathode by heavy argon atoms. In a recent form of cathode-ray oscillograph, described by Dr. A. B. Wood (*Inst. Elec. Eng. Journal*, 63, page 1046, 1925; and *Proc. Phys. Soc.*, Vol. 35, page 109, 1923), and of the vacuum type, the different parts of the tube are made demountable. This form of tube certainly possesses many advantages over the ordinary commercial type, *e.g.*, the deflecting plates can be adjusted and altered at will, and the filament can be renewed quite simply. A very accurate fit of the ground glass joints is indispensable, and a continuous vacuum must be maintained by pump action. Provision must also be made for a D.C. generator to give the 3,000 or 4,000 volts required for the anode potential.

"A Laboratory Instrument"

The oscillograph we find listed at £120, or with accessories (mercury vapour pump or high vacuum pump with motor and high-tension D.C. motor generator equipment) about £100 extra, which places such an equipment outside the range of practical television. The results given are indeed excellent, but the instrument in its present form is essentially a laboratory instrument, requiring skill and patience in its operation.

It should perhaps have been mentioned that the original scheme given in Patent Specification 255,057 was ambitious, as provision was made for colour television by means of a three-colour screen of the "Paget" type (*cs*) (Fig. 3), the natural colour effect being viewed through a ground-glass screen (*gl*). But my intention in this article has been to examine critically, as far as it is possible in the light of published information, the merits of the cathode-ray system for television purposes.

Photograph of Zworykin's new cathode-ray television receiver. The images are projected on to a mirror on the top of the cabinet, thus making it possible for a number of people to watch at once.

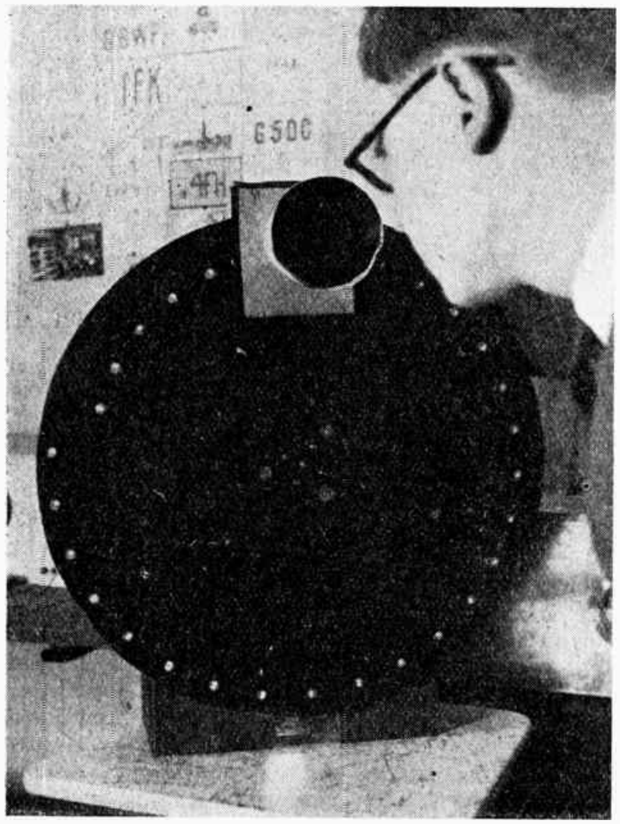
The outstanding difficulty still seems to me to be able to secure an intensely bright and concentrated spot on the fluorescent screen with ordinary voltages of, say, 300 volts anode potential, added to which is the present high cost of tubes and auxiliary apparatus. But it is to be hoped that before long we may have a chance of examining Dr. Zworykin's apparatus under working conditions in this country, and perhaps then I shall be able to revise my remarks in the opening paragraph of this article in the light of practical achievement.

How Amateurs are Receiving the Television Broadcasts

THE television critics and pessimists have been asking "What use are the amateurs making of television transmissions?" and answering for themselves "Nothing." But to judge from letters received the amateurs, as fast as they can get apparatus made, *are* making use of the transmissions. This, no doubt, is somewhat disconcerting for the critics and pessimists, but very gratifying to those who have fought for broadcast transmissions.

As far as the morning transmissions are concerned very few amateurs seem to have been able to "look-in," but even so, several reports have been received from places as far away as Weymouth. One amateur from Broadstairs took the trouble to come up to London to enquire, and, walking into the Baird Laboratories, singled out one of the staff as the man he had seen by television.

It was not, however, until the evening transmissions started that the majority of amateurs had a chance to do very much, but that they were all waiting for a more favourable transmission time is now evident. The record for long distance reception is at present held by Mr. H. Hewel, of Berlin.



Mr. H. Hewel, of Berlin, looking into his Televisor.

Writing on Jan. 4th he says: "I heartily congratulate you to the fine development of television. The images I received were not much worse than those I saw with my apparatus in June, 1929, when you made experimental television over our local Witzleben transmitter and *better than our German Radio-Movies*." As Mr. Hewel's letter was in English his words have been given unaltered.

Following the paragraph already quoted, he goes on to say that in the tele-reading, which formed part of the transmission, he read the words "Carmen, who will appear at the next television concert," and adds that as he had got his motor and disc set up backwards everything was reversed, and he found it a little difficult to read the letters backwards! All the same, he read them aright, and as his only means of synchronising at present is by running his motor a little fast and then pressing his finger on the spindle to slow it, he could scarcely be expected to retain synchronism by such crude means long enough to read the whole bulletin.

He did, however, see and recognise one of the staff as a person who was televised in Berlin, and correctly describes his movements.

He uses a superhet. receiver driven from the D.C. mains, with four pentodes in the last stage. The neon tube is his own construction fed by a circuit arrangement, also his own, and taking about 25 m.a. His motor is a D.C. instrument fed from 220 v. mains, but as his scanning disc is the standard German one with a picture ratio of 3 to 4, his images were somewhat compressed and distorted in a vertical direction. He is making a new disc with the right picture ratio, and concludes his letter by asking the times of the evening transmissions.

In a later letter Mr. Hewel reported that he had reversed his disc and motor to receive things the right way round, and gives a correct programme of the January 6th evening transmission of television. This was received without the aid of a correct synchronising device, his finger used as a brake on the motor spindle still being used.

By the following Friday, January 10th, a correctly proportioned disc was constructed, and writing of this reception he says: "I was sitting before the televisor surrounded by seven people eagerly looking in. After a few moments speed was correct and he (meaning one of the subjects) was to be seen. The picture was O.K.! (*and the seven heads banging together!*). The suspicious were astonished at the quality of the pictures; they could even see the convolutions of the ear of the subject. The face of the televised doll and the hand moving it were at once recognised. Statics very often destroyed the image. In spite of this fact the demonstration was a great success."

The telereading was read by three of Mr. Hewel's friends—the others did not understand English.

Dr. F. Banneitz, technical director of the R.P.Z. and editor of *Fernsehen* (the German television paper), rang Mr. Hewel up on the Saturday following this reception, and while discussing it with him admitted that he had seen nothing like letters. Mr. Hewel adds, "with the big apparatus behind him!" and goes on to explain that the secret of his own success is due to the variably coupled intermediate frequency band pass filters in the set he uses. His set has only two dials and a rheostat for tuning.

It would seem that Germany possesses the same type of experts as England, for Mr. Hewel remarks that his experience contradicts an article in *Fernsehen* which states "a good television reception over distances of hundreds of miles is possible only with such complicated apparatus that no layman can tune it, if reception is possible at all."

His experience but further proves what amateurs all over the world have known for a long time; experts are all right when they are treading beaten paths, but when they express opinions on new work they become mere children beside the experienced amateur.

TELEVISION sends Mr. Hewel hearty congratulations on his success. His work is more valuable than the pious opinions of all the experts.

The next longest distance report of reception comes from Rotterdam, where Mr. M. W. H. de Gorter utilised Boxing Day morning to tune in to London. It was his first chance to listen to a television transmission. He, as yet, has no "televisor," but he reports that on a three-valve set he got signals more than loud enough to work a loud-speaker and, using the neon tube from his wave-meter, he was able to employ the signal to cause the lamp to flicker. He is getting very busy about an experimental "televisor," and as he is a capable experimenter and short-wave enthusiast he should be getting results before very long.

Coming to England, Mr. A. E. Kay, of Waterloo Street, Lower Crumpsall, Manchester, holds the long distance record for this country. His set is a screen grid, detector, and two L.F. with one valve resistance capacity and the output push-pull with 350 volts H.T. Being unable to get a suitable neon, he is using an Osglim with the resistance in the cap. The whole of his apparatus is home-made and he says he has been very successful.

In a second letter he gives more details of what he has been able to see and describes one of the young ladies who was transmitted, with considerable and accurate detail. So far, he has had no synchronising device in use but is busy building one and hopes to have it in operation soon. His receptions have been seen by many folk in the district and he says all have been surprised and delighted at the results he is getting.

Mr. Colin P. Garside, of "Two Gates," Maidenhead Court, Maidenhead, a member of the "Television Society," seems from his letters to have had the most consistent reception, for apparently he has missed very few of the transmissions, morning or evening. The whole of his apparatus is home-made and mains driven, in this case, D.C., 230 volts. He is using anode bend detection and three stages of R.C. with two valves in parallel in the last stage. His neon is choke fed and he uses an Osglim flat plate type. His synchronising gear is of the Baird type fed through a special valve, transformer coupled to the picture output. He started reception with leaky grid detection but changed over to anode bend, and now says "During the last few weeks images have been really good. . . ."

"The lettering (he refers to the news bulletin which forms a part of most transmissions) "of course, comes through perfectly."

In a later letter, the detail in the image is referred to as being "surprising."

Another amateur using home-made apparatus, synchronising device, etc., is Mr. A. R. Knipe, of Southsea Avenue, Leigh-on-Sea.* He employs two stages of R.C. with two valves in parallel in the output stage and 230 volts H.T. and says he receives an image which is "quite easily recognisable."

For sheer hard work and enthusiasm, the report of Mr. F. Austen, of Church Street, St. Peters, Broadstairs, would be hard to beat. He has a set developed largely from his experience of public address systems, in which he is interested, and uses a screen grid, anode detection, two stages of R.C. with push-pull for the output. Before television transmissions began he was experimenting, but on the day of the first broadcast he rose early, took a sheet of 1/8 galvanised iron, marked it out, drilled and countersunk the holes, and by 11 o'clock had it mounted and had some sort of reception.

During the day work suffered, for he was thinking scanning discs. That evening, or night rather, he put the result of his meditations into practice and on the next day was successful in his reception. He has no synchronising gear but has a particularly well-made ball-bearing motor run off accumulators. It runs so steadily that a variable resistance in the field has so far met his synchronising requirements. Discs have been his great trouble and he has made a number but is now on the right track with one made of thin aluminium sheet. He it was who visited the Baird Laboratories and made the somewhat startling declaration to one of the staff: "I saw you by television yesterday."

As a result of his experiments he has thoroughly stirred up local enthusiasm for television reception and has usually a queue of folk waiting to "look-in" when anything is on.

W. C. F.

*See our January issue for details of Mr. Knipe's apparatus.

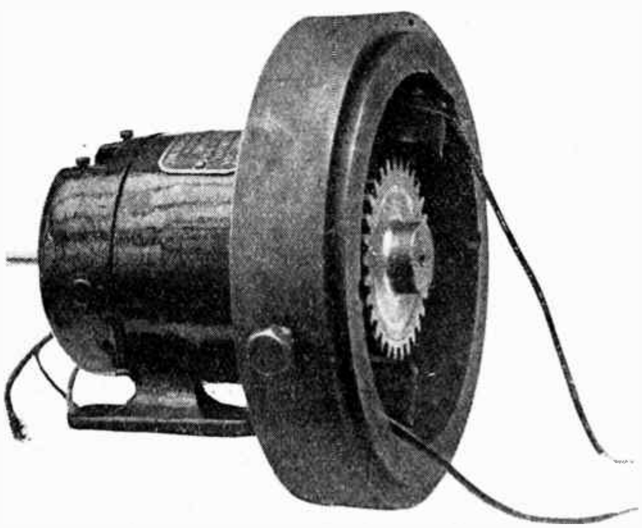
Experimental Television Apparatus

By *A. A. Waters*

PART IX

IN the preceding article of this series a detailed description was given of a phonic wheel type of synchronising device, together with complete constructional data. The apparatus described is somewhat similar to that used in the television receivers now being manufactured by the Baird Company, and is intended for use when receiving the television transmissions from 2LO. In view of the considerable interest at present being shown in the technical Press in the practicability of this system of synchronisation, and as an assistance to those experimenters who have constructed synchronising devices on these lines, I propose to devote this article to a description of the experimental results obtained from the apparatus, together with a brief technical review of the problems involved, and a few suggestions for the improvement of the construction already described.

Before commencing experiments with a phonic wheel synchroniser the experimenter should realise that he is actually using a simple form of alternating current synchronous motor. When the field coils of the phonic wheel are supplied with alternating current,



General view of the driving motor, showing how synchronising gear is attached.

of frequency n cycles per second, the wheel will tend to rotate at a speed given by the expression :—

$$\text{Synchronous speed (r.p.m.)} = \frac{60 \times n}{N} \times 2,$$

where N is the number of teeth in the wheel.

It must be realised, however, that this effect will not be produced unless the phonic wheel is first rotated by some external means at the correct synchronous speed, after which it will tend to continue rotating at this speed ; and if the apparatus is well designed, and supplied with sufficient current, the wheel should run as a motor and develop appreciable power.

The reason for this is easily seen. The field magnets will exert a magnetic pull during each half-cycle of the alternating current. Actually the polarity of these magnetic impulses will be alternately reversed, since the positive and negative half-cycles will respectively magnetise the field magnet cores in opposite polarity.

If we assume, however, that the wheel itself is of soft iron, and is not permanently magnetised, it will become magnetised during each magnetic impulse by the process of magnetic induction. Thus the particular tooth of the wheel which happens to be nearest to one of the field poles during a particular half-cycle of the A.C. supply will be automatically magnetised in the reverse polarity to that pole, and hence will be attracted towards it. This will always occur, whatever polarity the field poles may be. When the phonic wheel is rotating at synchronous speed, a tooth will be approaching each field pole at the moment of maximum pull, and will be attracted by it. As this tooth passes the pole, the magnetic pull will have fallen to the low value which occurs between each half-cycle of the A.C. supply. The tooth can thus pass away from the pole without any appreciable magnetic pull to retard its progress, and the next tooth will be approaching the pole in time to be attracted towards it by the magnetic pull caused by the next half-cycle. Thus at the synchronous speed only, these pulls of the field poles on successive teeth are cumulative, and produce a rotation of the wheel. At other speeds the magnetic impulses are not so co-ordinated and no resulting pull on the wheel as a whole will be experienced.

An attempt to make this action clear is shown in

Fig. 1, in which a few teeth of the phonic wheel are indicated in the position which they would occupy during rotation at a moment of maximum magnetic attraction.

It is interesting to note that a tendency to rotation

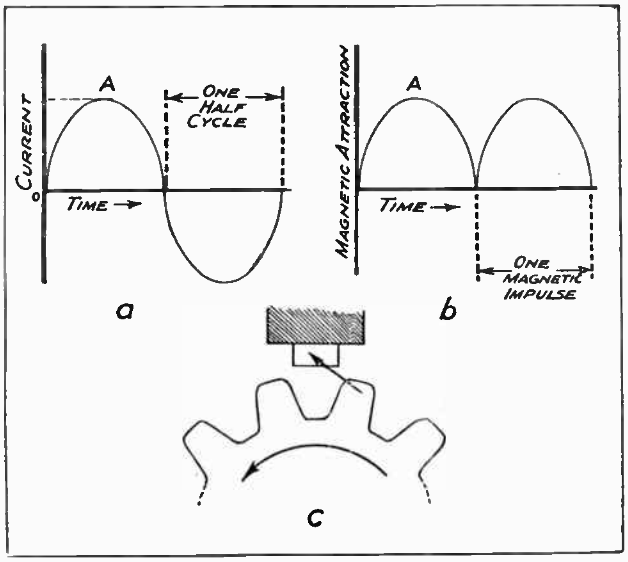


Fig. 1.—Illustrating the action of a phonic wheel. (a) *Curve showing A.C. through field coils.* (b) *Curve showing corresponding magnetic attraction of poles (neglecting effect of hysteresis.* (c) *Showing position of a tooth at time corresponding to* (a).

can exist at speeds other than the synchronous speed, but which are harmonically related to it. The power developed under these conditions, however, is usually very small.

The conditions of operation described in the foregoing remarks have certain disadvantages. The direction of magnetisation of the iron which composes the wheel and poles is being continually and rapidly reversed. Owing to the effect of magnetic hysteresis and magnetic lag, the intensity of magnetisation of the iron will never reach the value which it could attain if the direction of magnetisation were always the same. This effect becomes very serious when attempts are made to run the phonic wheel from alternating current of high frequency, and increases considerably as the frequency is increased. It has the effect of reducing the efficiency of the device very appreciably.

The performance of the wheel is greatly improved if the field coils are excited by direct current in addition to the alternating current which drives it. In this case the magnetic impulses are superimposed upon a steady magnetic pull. If the steady magnetisation is greater than that due to the A.C. impulses, which can be assured if the direct magnetising current is more than twice the peak value of the alternating current, then all magnetic impulses will be of the same polarity. There will then be one magnetic impulse for each cycle of the alternating current, and this will be due to a change of current which is double that in the previous instance. Moreover, it can easily be shown mathematically that the magnetic pull per impulse is greatly increased when the current fluctuations are superimposed upon a strong pre-existing field.

It is for this reason that a strong permanent magnetic field is always used in the case of telephones, loudspeakers, and other apparatus which operates by virtue of magnetic attractions and repulsions. The state of affairs existing in this case is indicated in Fig. 2. It is important to note that the synchronous speed in this case is only half what it would be if the phonic wheel be operated from alternating current only; or, alternatively, only half the number of teeth are required to give a particular synchronous speed. This is because there is now only one magnetic impulse per cycle, as compared with two impulses in the first-mentioned case. The expression for the synchronous speed now becomes :—

$$\text{Speed (r.p.m.)} = \frac{60 \times n}{N}$$

Consider now the case of the Baird television transmissions. We wish to operate the phonic wheel from the "line frequency" which is a prominent component of the television signal, and is given by the product of the number of pictures transmitted per second and the number of holes used in the scanning discs. This will be $12{\cdot}5 \times 30 = 375$ ~/sec. Hence we can work out the number of teeth required if the wheel is to drive our disc at the picture speed of 12·5 revolutions per second. If the field is fed from pure alternating current, at 375 ~/sec., we have :—

$$\text{Speed} = 12{\cdot}5 \text{ r.p.s.} = 2\frac{375}{N} \therefore N = 2\frac{375}{12{\cdot}5} = 60 \text{ teeth.}$$

Or if the field coils also carry direct current :—

$$\text{Speed} = 12{\cdot}5 \text{ r.p.s.} = \frac{375}{N} \therefore N = \frac{375}{12{\cdot}5} = 30 \text{ teeth.}$$

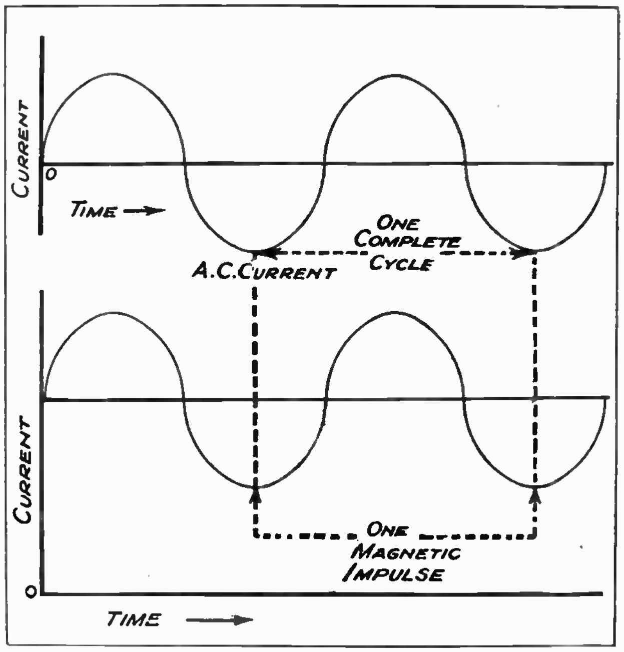


Fig. 2.—Showing the relation between current and magnetic impulse.

Thus it becomes clear that when a 30-tooth phonic wheel is used to synchronise the receiving disc on the Baird transmissions the field coils must be excited

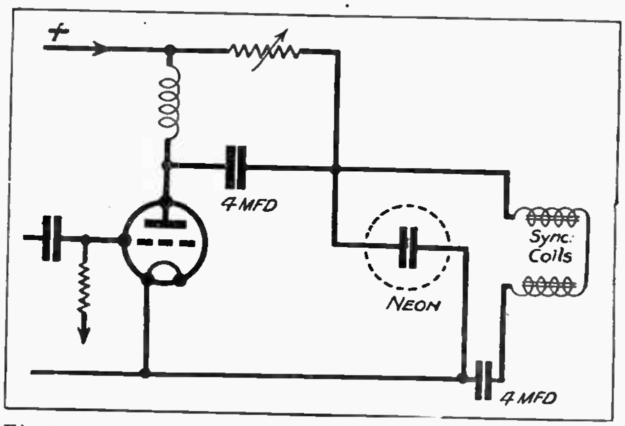


Fig 3.—" No results of consequence could be expected from a circuit such as that shown above."

with direct current. No results of consequence could be expected from a circuit such as that shown in Fig. 3, in which these coils are fed with the " line frequency " only through the medium of a choke and condenser filter; and it is easy to understand why results cannot be obtained by experimenters who have made the elementary mistake of using this arrangement in conjunction with a 30-tooth wheel, or its equivalent. A 60-tooth wheel is necessary to give success with this circuit, although in any case the synchronising effect may be expected to be poor. In our own case, and using the phonic wheel described in our last article, no synchronising effect at all could be observed.

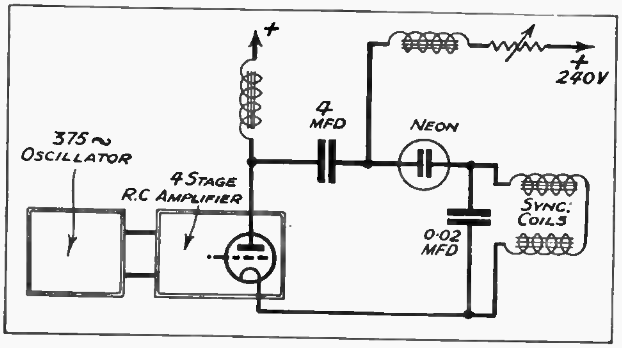


Fig. 4.—By connecting the synchronising coils in series with the neon tube definite results will be obtained.

As far as the writer is aware, the circuit used by the Baird Company in their standard receivers is substantially that given in these articles last month, the field coils of the synchroniser being connected in series with the neon tube. Thus the steady current used to illuminate the neon tube, which may be about 20 milliamps for an average commercial tube, will flow through these coils, and will produce the necessary magnetic field.

Since the variation of current through the neon tube is unlikely to be more than 5 or 10 milliamps, the condition in which the steady current exceeds the alternating current peak value is also achieved.

In order to check the performance of the phonic wheel unit, an artificial source of signals was arranged, consisting of a suitable oscillator of approximately 375 ~/sec. frequency, supplying a four-stage television amplifier. Two B.T.H. power valves, type PX650, were used in parallel in the output stage of this amplifier, the high tension voltage used being approximately 240 volts. The signal strength given to the neon tube and synchroniser connected in series, as in Fig. 4, was increased until the anode current milliameter in the power stage indicated the beginnings of overload, and the direct current motor driving the receiving disc was run up until stationary horizontal dark bands indicated that synchronous speed had been attained. A quite definite effect due to the phonic wheel could be detected, there being a tendency for these dark bands to rock gently up and down instead of rotating slowly as is usually the case when no synchronising system is in use. It was necessary, however, to keep the D.C. motor carefully adjusted, the controlling effect of the phonic wheel not being very powerful.

Consideration will show that the impedance of the field coils of the synchronising device is an important factor in its efficient operation. The impedance of a glowing neon tube may be taken as sensibly equal to its D.C. resistance, which is of the order of 9,000 ohms, and hence if one-half of the available energy is to be used for synchronisation, the impedance of the field coils would have to be of the same order.

Approximate calculation indicated that the impedance of the coils in use when mounted in position, and wound with 36 S.W.G. D.C.C. wire, which was originally chosen from considerations of mechanical strength, would be unlikely to exceed 300 ohms, and hence these windings were unsuitable for direct connection into the neon tube circuit. Hence the circuit shown in Fig. 5 was evolved. The coils were supplied from a 20/1 ratio transformer, of a type intended for use with low resistance moving coil loudspeakers. The step-up of current thus obtained was expected to operate the coils more efficiently, their effective impedance being now raised to the correct order. The magnetising current was now obtained

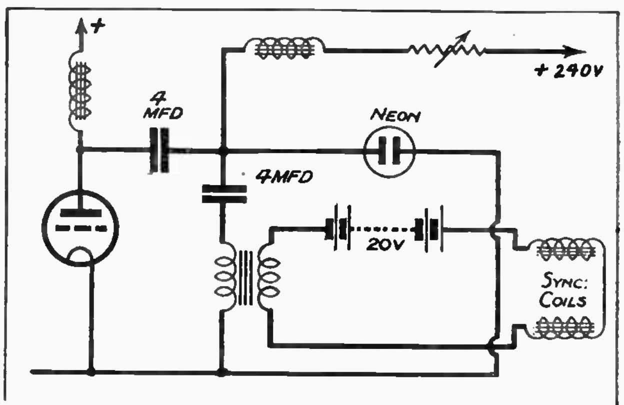
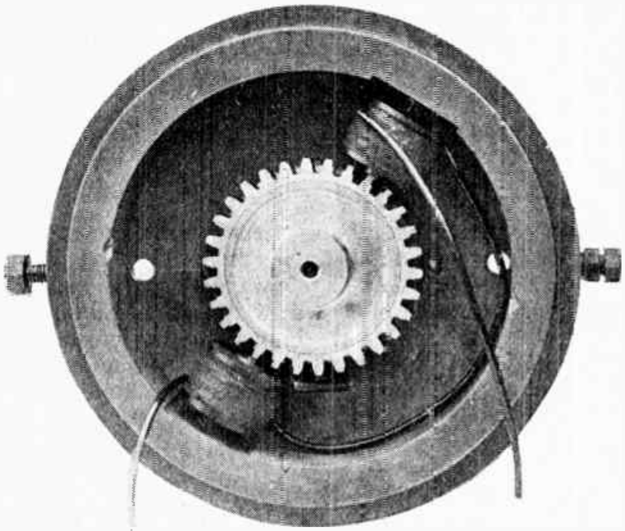


Fig. 5.—A transformer coupled circuit.

from a 20-volt battery of accumulators placed in series with the transformer secondary and the field windings. A current of 1 ampere then flowed in this circuit, and the strength of field thus obtained was sufficiently great that the pull of individual teeth



An end view of the synchronising gear. These photographs should be studied in conjunction with the instructions and drawings given by our contributor in our January issue.

could be very easily felt on rotating the scanning disc slowly by hand.

On repeating the synchronising test, very promising results were obtained, the scanning disc remaining in synchronism for considerable periods. Provided that the D.C. motor is running very steadily, the image remains framed for periods which may reach several minutes ; and the result may reasonably be described as satisfactory. It should be unnecessary to emphasise at this stage that success depends very largely on the quality of the D.C. motor used, and the steadiness of the supply from which it is being run. The power developed by the phonic wheel is not sufficient to control any very pronounced variation of motor speed.

As a further experiment, the field coils were removed, and re-wound with 8,000 turns each of 40 S.W.G. S.S.C. copper wire, which was estimated to raise their impedance to about 5,000 ohms at 375 cycles/sec. The resistance of each coil was then 3,500 ohms. The circuit of Fig. 4 was then tried again, and gave very similar results to those obtained when using the transformer and lower impedance coils. Hence this winding can be recommended to those who prefer not to use a transformer.

It was now thought that the time had come to test the arrangement on the morning television transmissions. Therefore, the input to the four-stage R.C. coupled amplifier was transferred from the oscillator to the output of a radio receiver comprising and H.F. and detector stage. Television reception was obtained in the usual way, but owing to the high impedance of the field coils preventing the higher frequencies from reaching the neon tube, it was found essential to shunt these coils by a condenser before good definition of the image could be obtained. A capacity 0·02μF proved suitable.

We were pleased to observe a definite synchronising effect, which was of considerable assistance in holding the image in view. In the ordinary course of events it was not found possible to dispense entirely with the hand control, although on a few occasions when the receiving motor was kindly disposed, the image rocked gently in view without adjustment for some time, in one case for as long as three minutes.

In view of these results it can definitely be stated that a simple phonic wheel, as described in the preceding article of this series, will give a useful degree of synchronisation when properly handled. It must be remembered that its construction is by no means perfect, and that with a more advanced design the results might approach much nearer to perfection.

For example, the use of an ordinary cast-iron gear wheel for the phonic wheel, and of a cast-iron outer casing, is not a good practice, and can only be justified from the point of view of cheapness and availability. Those who are prepared to have these parts constructed from soft iron, mild steel, or one of the new high magnetic permeability steels which are now in use for transformer cores, etc., may expect an increase of at least threefold in the power developed by the phonic wheel. An increase in the number of field poles to four and the use of a more ambitious power amplifier are other improvements which the keen experimenter might like to incorporate in his designs.

Owing to the fact that the present television transmissions consist so largely of head and shoulders reproductions, and seldom show rapid motion or sudden change of scene, it is not possible to give an opinion as to whether this would throw out the synchronising effect.

The "Wave Band" Theory of Wireless Transmission*

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

IN scientific history we meet with many examples of scientific theories or explanations which have been widely adopted and employed, not because they can be proved to be true but because they provide a simple, easily grasped, plausible explanation of certain scientific phenomena. The majority of persons are not able to see their way through complicated phenomena and so thankfully adopt any short-cut to a supposed comprehension of them without objection.

Ease of comprehension is not, however, a primary quality of Nature, and it does not follow that because we can imagine a mechanism capable of explaining some natural phenomenon it is therefore accomplished in that way. There is a widely diffused belief in a certain theory of wireless telephonic transmission, and also of television, that for securing good effects it is necessary to restrict or include operations within a certain width of "wave band." But although this view has been very much adopted there is good reason to think that it is merely a kind of mathematical fiction and does not correspond to any reality in Nature.

Let us consider how it has arisen. We send out from all wireless telephone transmitters an electromagnetic radiation of a certain definite and constant frequency expressed in kilocycles. Thus 2LO London broadcasts on 842 kilocycles. This means that it sends out 842,000 electric vibrations or waves per second. Every broadcasting station has allotted to it a certain frequency of oscillation and it is not allowed to depart from it.

It is like a lighthouse which sends out rays of light of one pure colour or an organ which emits a single pure musical note. For most broadcasting stations this peculiar and individual frequency lies somewhere between a million and half a million per second, though for the long wave stations like Daventry it is so low as 193,000 or 193 kilocycles.

When we speak or sing or cause music to affect the microphone at a broadcasting studio the result is to cause the emitted vibrations, which are called the *carrier waves*, to fluctuate in height or wave amplitude, but does not alter the number of waves sent out per second. It is like altering the height or size of the waves on the surface of the sea without altering the distance from crest to crest which is called the wavelength.

Suppose the broadcasting station emits a carrier wave of frequency n and let $p=2\pi n$. Then we may express the amplitude a of this wave at any time t by the function $a=A \sin pt$ where A is the maximum amplitude. If on this we impose a low frequency oscillation due to a musical note of frequency m and let $2\pi m=q$, then we can express the modulated vibration by the function

$$a=A \cos qt \sin pt.$$

But by a well-known trigonometrical theorem this is equal to

$$\frac{A}{2}\left\{\sin (p+q)t+\sin (p-q)t\right\}$$

and thence may be supposed to be equivalent to the simultaneous emission of two carrier waves of frequency $n+m$ and $n-m$.

If the imposed note or acoustic vibration is very complex in form, then in virtue of Fourier's theorem it may be resolved into the sum of a number of simple harmonic terms of form $\cos qt$, and each of these may be considered to be equivalent to a pair of co-existent carrier waves. Hence the complex modulation of a single frequency carrier wave might be imitated by the emission of a whole spectrum or multitude of simultaneous carrier waves of frequencies ranging between the limits $n+N$ and $n-N$, where n is the fundamental carrier frequency and N is the maximum acoustic frequency occurring and $2N$ is the width of the wave band. This, however, is a purely mathematical analysis, and this band of multiple frequencies does not exist, but only a carrier wave of one single frequency which is modulated in amplitude regularly or irregularly.

If the sounds made to the microphone at the broadcasting station are very complex, such as those due to instrumental music or speech, then in virtue of this mathematical theorem the very irregular fluctuations in amplitude of the single carrier wave can be imitated if we suppose the station to send out simultaneously a vast number of carrier waves of various frequencies lying between certain limits called the "width of the wave band."

This, however, is merely a mathematical artifice similar to that employed when we resolve a single force or velocity in imagination into two or more component forces. Thus, if we consider a ball rolling down an inclined plane and desire to know how far it will roll in one second, we can resolve the single vertical gravitational force on the ball into two

* This article appeared in *Nature* on January 18th last, and is reprinted here by kind permission of the Editor of that journal.

components, one along the plane and one perpendicular to it. But this is merely an ideal division for convenience of solution of the problem; the actual force is one single force acting vertically downwards. Similar reasoning is true with regard to wireless telephony. What happens, as a matter of fact, is that the carrier wave of one single constant frequency suffers a variation in amplitude according to a certain regular or irregular law. There are no multiple wavelengths or wave bands at all.

The receiver absorbs this radiation of fluctuating amplitude and causes the direct current through the loud speaker to vary in accordance with the fluctuations of amplitude of the carrier wave; the carrier wave vibrations being rectified by the detector valve.

The same thing takes place in the case of wireless transmission in television. The scanning spot passes over the object and the reflected light falls on the photoelectric cells and creates in them a direct current which varies exactly in proportion to the intensity of the reflected light. This photoelectric current is employed to modulate the amplitude of a carrier wave, and the neon lamp at the receiving end translates back these variations of carrier wave amplitude into variations in the cathode light of the neon tube.

There is neither in wireless telephony nor in television any question of various bands of wavelength. There is nothing but a carrier wave of one single frequency which experiences change of amplitude. The whole question at issue then is: What range in amplitude is admissible?

In the case of television it is usual for critics of present achievements to say that good or satisfactory television cannot be achieved within the limits of the nine kilocycle band allowed. But there is in reality no wave band involved at all. It is merely a question of what change in amplitude in a given carrier wave can be permitted without creating a nuisance.

It is something like the question: How loud can you whisper to your next neighbour at a concert or theatre without being considered to be a nuisance? People do whisper in this way and, provided not too loudly, it is passed over. But if anyone is so ill-mannered as to speak too loudly he is quickly called to order, or turned out.

It is, however, not an easy thing to define a limit to wave amplitudes. They are measured in microvolts per metre and are difficult to measure. But a wavelength is easy to define in kilocycles or in metres, and hence the method has been adopted of limiting emission to an imaginary band of wavelengths which, however, do not exist.

The definition is imperfect or elusive. It is something like the old-fashioned definition of metaphysics as " a blind man in a dark room groping for a black cat which isn't there." Similarly, the supposed wave band is not there. All that is there is a change, gradual or sudden, in the amplitude of the carrier wave. It is clear, then, that sooner or later we shall have to modify our code of wireless laws.

We have no reason for limiting the output of our broadcasting stations to some imaginary wave band of a certain width, say nine kilocycles or whatever may be the limiting width, but we have reason for limiting the range of amplitude of the carrier waves sent out.

Some easily applied method will have to be found of defining and measuring the maximum permissible amplitude of the carrier waves as affected by the microphone or other variational appliance. It may perhaps be thought that an unnecessary fuss is here being made on what may be regarded as simply a way of explaining things, but experience in other arts shows how invention may be greatly retarded by unessential official restrictions. Consider, for example, the manner in which mechanical traction was retarded in Great Britain for years by ridiculous regulations limiting the speed of such vehicles on highway roads. The only restrictions that should be imposed are those absolutely necessary in the interests of public safety or convenience, and all else tend to throttle and retard invention and progress.

[Since the above article was published in *Nature*, of January 18th, the author has extended his argument as follows, with special reference to the case of television.—Editor of TELEVISION.]

The futility and obstructiveness of this wave-band theory, especially as regards the transmission of television images, may best be seen by the following manner of regarding the facts. It has been shown above that when a single carrier wave of fixed high frequency electro-magnetic radiation is sent out as from a broadcasting station, and when this wave is modulated by super-imposing on it a low-frequency oscillation, the result is to produce a wave which varies periodically in amplitude or has *beats* on it, but which retains the carrier-wave frequency.

In virtue of the mathematical theorem explained above this actual modulated wave may be regarded as due to the sum of two fictitious or imaginary carrier waves of frequencies respectively equal to the sum and the difference of the frequencies of the actual carrier wave and the super-imposed low-frequency oscillation.

Thus, suppose the 2LO station to send out a carried wave of 842 kilocycles, the regulation is that the wave-band due to modulation must not be more than 9 kilocycles wide: that means the imaginary components must have frequencies lying within the limits $842{,}000+4{,}500$ and $842{,}000-4{,}500$.

This implies that the carrier wave of 842 kilocycles must not have more than 9,000 *beats*, to use the musical term, or increases of amplitude on it per second of time. But the possibility of disturbance to other receivers depends not upon the number of the beats per second but upon their amplitude, and it is futile to put restrictions upon the number of fluctuations of amplitude per second whilst ignoring the effect of any excessive amplitude.

In television this operates injuriously because it compels a certain degree of coarseness in the image. To obtain good television reproduction, no hindrance

(*Continued on page* 604.)

Television for the Beginner

PART II

By *John W. Woodford*

IN introducing our subject last month we saw that in any television process no *actual light* is transmitted but merely an electrical replica. This is important, for there are some people who seem to regard television as being something in the nature of a magic field glass which is going to destroy all privacy. This is just as far from the truth as imagining a delicate earpiece with which it is possible to listen to any sound no matter from where that sound emanates. Since a process of conversion has to take place it must only be possible to show scenes or objects which come within the range of the mechanism used to transmit them. Of course developments will continue to be made whereby the scope of the subject will be increased, but at the moment we are concerned with things as they are and not what they will be.

Broadcasting Television

I gave my reasons for intending to deal with the Baird process in detail, although the different television systems which are engaging the attention of scientists all over the world have certain points in common, but before going into any detailed explanation of the apparatus I will confine my remarks to generalities.

The process of broadcasting television may be best explained by stating that, first of all, the scene, object, person or persons in front of the transmitting apparatus are, in effect, turned into minute electric currents. These can be heard as sound in a pair of headphones, and each scene has its corresponding sound. An experienced television engineer can even go so far as to recognise outstanding objects by their image sounds. For example, a hand held in front of the transmitter causes a somewhat harsh rattling note, whereas a face gives a softer note without any suggestion of rattling.

Some of the Apparatus

A special optical apparatus is placed in front of the televised object. Essentially this consists of a rapidly revolving metal disc with a powerful source of light housed in a chamber with a truncated funnel placed behind it, somewhat as indicated in Fig. 1. Equally spaced around the disc and located near the edge is a spiral of tiny holes as shown. Now as each hole passes before the intense light area at the end of the funnel it will permit a ray of light to pass through the hole and move upwards.

As soon as one hole has finished its travel in front of the light and caused the ray of light to trace a vertical strip on a screen situated a few feet away from the disc, so another hole performs the same operation. But since each hole is situated a little nearer to the centre of the disc than its predecessor, each ray of light passes over a different strip area until all the holes have passed round. The process then begins all over again.

Narrow Light Strips

Now what effect is produced by this simple piece of apparatus? That is, the fixed source of light and the rotating disc perforated with holes. Why, if a person sits between the disc and the screen, his or her features will really be sub-divided up into a number of narrow light strips. Every part of the face is therefore successively illuminated by a small point of light, the ultimate result being to break up the features into a series of strips next to one another. An idea of what is meant will be gathered by examining Fig. 2, which shows the head and shoulders of a person located within the area of light traversed on the back screen.

Each revolution of the disc causes a repetition of this process, and the rapidity of the repetitions is plainly dependent upon the speed with which the perforated disc rotates.

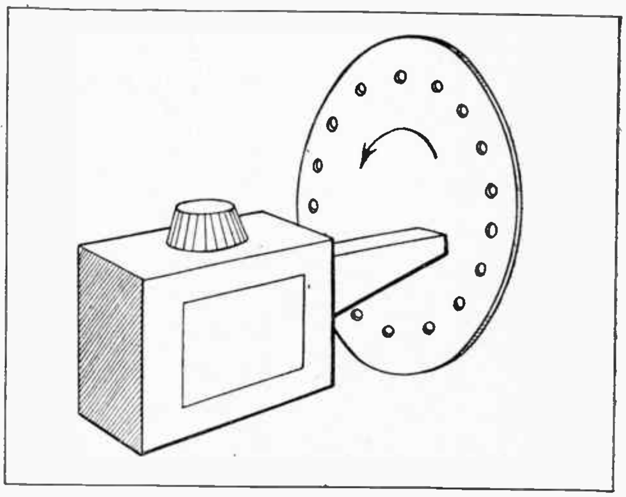


Fig. 1.—The essential mechanism of a Television Transmitter.

Reflecting Light

It is fairly well known that every surface is capable of reflecting a certain percentage of the light which is focussed upon it, the nature and quality of the surface governing the quantity "thrown back." Therefore, depending upon what part of the face the light spot is moving over, so a variation of light or shade, or a combination of both, will be reflected back. Thus, on the forehead, for example, a reasonable amount of light would be thrown back, whereas when the spot traversed black or dark hair very little light would be reflected.

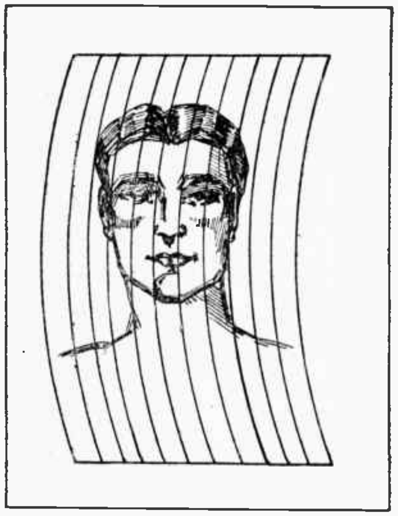


Fig. 2.—How a television image is built up of closely fitting strips.

Now this reflected light is "picked up" or influences the photo-electric cells which are arranged above the individual and between the screen and disc. These cells possess a very important property, namely, that they respond in an electrical sense to varying amounts of light and shade, and convert them faithfully into electrical variations of corresponding strength. That is to say, a strong light reaching the sensitive or active area of the cell will cause a relatively large current to flow in a circuit of which it forms a part, whereas weak light only produces a very weak and minute current.

Relative Terms

The terms used to describe the resulting current must only be looked upon in a relative sense, for in actual practice the currents are only fractions of a millionth of an ampere! Now, since these currents of varying intensity are proportional to the amounts of light and shade reflected from the face, they represent an electrical replica of the person's features. Owing to their minute nature they have to be amplified considerably, and then really correspond to the current effects produced by converting, say, a human voice through the medium of a microphone. The cells can therefore be looked upon as acting in the nature of a very efficient "light microphone."

It is these tiny currents that we can hear on headphones, as was mentioned earlier in the article, and although this turning of light into electricity is not new, it is little known, and later on, when we particularise, we shall have to deal with the discoveries which made this transformation possible.

An Interesting Photograph

Actually, no personal discomfort is experienced by the person being televised, for the process of scanning the face with the spot of light is extremely rapid, and it only passes over the eyes for a very small fraction of a second. It certainly is a great deal more unpleasant to be in the beam of a theatrical floodlight than to sit in front of a television transmitter.

An examination of the accompanying photograph gives an impression of the scheme adopted. A lady is shown seated in front of a back screen, while the position of the photo-electric cells is plainly visible. The actual lamp and rotating disc is located behind the aperture in the draped wall, but illustrations will be published later showing how this is arranged. Note the microphone used for picking up the speech, song or music for the dual aural and picture broadcasting.

Tuning-in the Signal

Now the wireless process of broadcasting these currents produced by the photo-electric cells need not be dealt with here, for it is identical to that employed

View of a person being televised. Photo-electric Cells are above the opening at right. The Microphone can also be seen.

for speech broadcasting, so let us transport ourselves to the receiving end, and imagine we have tuned in our set to the station that is broadcasting the television signals. We are rewarded with the distinctive but droning note which we mentioned earlier, and our next problem is to see how we can convert this sound or its electrical equivalent into something visible to the eye instead of being heard by the ear.

Have you ever tried the experiment of disconnecting the loud speaker from your set when you have tuned in a strong wireless signal and substituted one of those little neon lamps in its place? You will know the type I mean if you call to mind the familiar beehive pattern which are so popular as nursery night-lights. What happens? Why, signals become visible instead of audible, for you can see the flickerings of the lamp instead of hearing the vibrations of a diaphragm. But if you had tuned in a television transmission, then the flickering or light variations of the lamp must correspond to the amount of light reflected from the televised object, since this originally governed the signal intensity.

At the Receiving End

How can we spread these light flashes over a surface or area corresponding to that occupied by the original subject sitting in front of the transmitter? We know that an artist is capable of forming a picture from brush touches on a canvas, so we should be able to build up a picture from these light and dark illuminations of the lamp. Surely the easiest way is to more or less duplicate some of the transmitting apparatus.

Our first requirement, therefore, is a disc with the same number of holes positioned in spiral formation near the edge, and a motor to spin it round at the same speed and exactly in step with the transmitting disc. By being in step I mean to convey the impression that the relative angular position of, say, No. 1 hole on the shaft of the transmitter motor must be identical to that of No. 1 hole at the receiving end. This is what we understand by the term synchronism which is talked about so largely in connection with television, and about which I shall have something to say later on in this series, for it is of extreme importance.

Remember, also, that it is only in the Baird process of television that a commercially practicable scheme of synchronising is in operation. For this reason alone Baird is far ahead of any of his competitors, and this must be a source of pride to every Briton.

I know some of the readers of this new series of articles are beginning to ask questions of themselves as to why this process of transmission has to be gone through, and why certain pieces of apparatus, say, for example, the disc, have been chosen. I must ask them to bear with me, however, while the process is described in more or less general terms, for we shall then be in a better position to examine the scheme in detail and put forward reasons for choosing such apparatus. The broad outlines of what happens at the receiving end will be dealt with next month.

The "Wave Band" Theory of Wireless Transmission

(*Concluded from page* 601.)

must be put upon the fine-grained-ness of the image. That means the photo-electric current which controls the modulation at the transmitting end must be allowed to fluctuate as much as necessary and produce any required modulation of the carrier wave, provided the amplitude does not become so large as to disturb adjacent receivers tuned to a different wavelength.

There can be no disturbance produced by mere modulation provided the wavelength remains constant and the amplitude is not too great. This is proved by the fact that when a receiver is set to pick up 2LO broadcast it is in adjustment no matter what the pitch of the musical notes transmitted may be, whilst a receiver not accurately adjusted to 2LO is not disturbed. Accordingly, the 9-kilocycle rule is absurd as regards television because it merely limits the fineness of texture of the image without really securing freedom to other receivers from disturbance by the transmission.

It is just as absurd as it would be to limit the number of persons who may ride in a motor car, without limiting in any way its speed, with the object of securing safety to pedestrians in the same road.

Since the television image (at present) is built up of 30 scanning lines and is scanned in 1/12·5 second, the 9-kilocycle rule restricts each line of the image to about 24 changes of amplitude of carrier wave, and this is too little.

The Story of Electrical Communications

by

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

PART XIV.

POINT-TO-POINT WIRELESS (II)

IN the last article we traced in broad outline the development of point-to-point wireless telegraphy from the first transatlantic circuit in 1902 up to the end of the war. As soon as the war was over, the Government again turned its attention to the development of the wireless communications of the Empire, and at the close of 1919 the whole subject was referred to a Government committee under the chairmanship of the late Lord Milner.

This committee produced a new scheme for imperial high power stations of the latest design, some with valve and some with arc transmitters, but the idea of a chain remained, an idea which was not welcomed by the Dominions or India, who wished for direct communication with this country and with each other, as opposed to communication through intermediate stations.

Marconi and the Post Office

With the knowledge then available, fortunately as it turned out, this direct communication was impracticable, and the scheme was being delayed, when in the spring of 1924 Marconi announced the extraordinary results which he had obtained by the transmission of short waves over long distances in the form of a beam. Within a few months the Post Office had signed a contract with the Marconi Company for the erection of short wave beam stations in this country for communication with similar stations in Canada, Australia, South Africa and India. At the same time it was decided that the Post Office should complete the erection of the English station at Rugby, under the old scheme. This station was to be by far the most powerful valve station in the world, and presented a host of problems which had never before been tackled.

It was an inspiring time for the wireless engineers of this country. They were erecting two new systems for world-wide telegraphic communication, one on short waves for communication with definite points, the other on long waves for broadcasting all over the world; and they were engaged on a third new system, in co-operation with the United States, for opening up transatlantic telephony for the first time in history. Ever since the war it had been said on all sides that England was being left behind in the development of wireless signalling. This great effort was to be the answer, and the rest of the wireless world, just a little nervous, sat back in its chair and waited.

England Takes the Lead

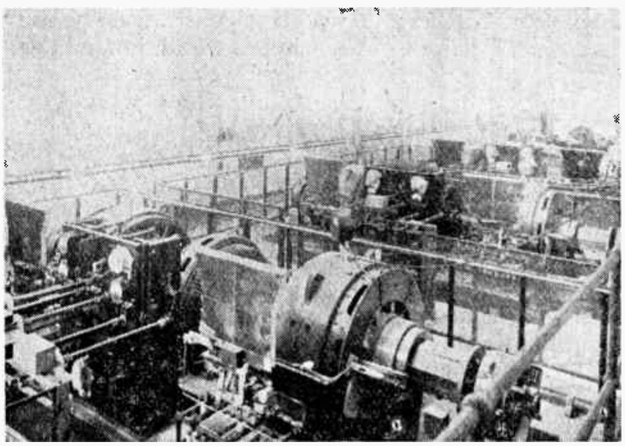
It had not long to wait. In January, 1926, Rugby started broadcasting messages by wireless telegraphy to stations and ships all over the world. In January, 1927, the Rugby wireless telephone transmitter got busy, and for the first time a commercial long distance wireless telephone service was established, viz., the transatlantic service with the U.S.A. In November, 1926, a commercial high speed wireless telegraph service on the Beam system was established with Canada, to be followed, in 1927, by similar services with Australia, South Africa and India.

Those two years, 1926 and 1927, changed the whole course of wireless development. England, far from being behind, had thrown into the melting pot all the long established ideas about world-wide electrical communication. The rest of the world had looked on and waited to see what would happen, and what did happen was well worth waiting for; a new era had opened, and, honour to whom honour is due, this new era was the direct result of years of strenuous work on the part of our Post Office engineers, the engineers of the British Marconi Company, the engineers of the American Telephone and Telegraph Company and of the Western Electric Company, and last, but not least, the genius and driving force of the greatest of all wireless pioneers, the Marchese Marconi.

The Imperial Beam Services

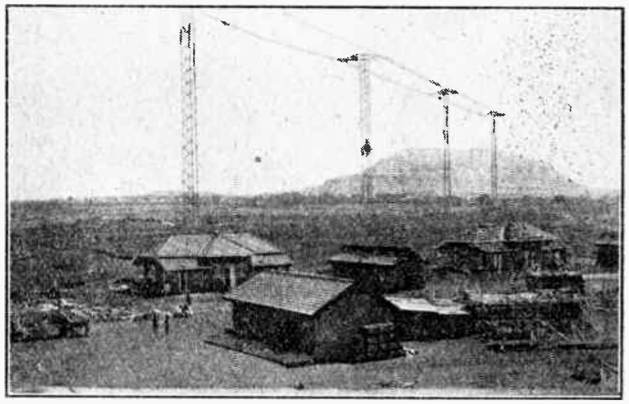
Short waves had of course been used experimentally for several years before Marconi carried out his Beam experiments, but they had not been developed for commercial working. We have already seen how prominent a place was taken in the pioneering work on short waves by amateurs in this country and in the United States. The climax of these experiments was reached in October, 1924, when Mr. Goyder, then a boy at Mill Hill School, established communication with Mr. Bell in New Zealand, but much of this early amateur work has been rather overshadowed by Marconi's famous experiments which led up to the brilliant success of his Beam system as a commercial proposition.

This success may be judged by the fact that the amount of traffic being handled by the Post Office on this system with Canada, Australia, South Africa and India was about 900,000 words a week when the circuits were transferred to the Merger Company in September last. The speeds obtained on these circuits vary from about 100 to 200 words a minute, duplex, according to conditions, but in regularity of working they are not yet up to the level of cables. The circuits, which were operated from the General Post Office, are now, under the merger arrangement, operated from Radio House in Wilson Street, London, and will be transferred later on to the headquarters of the new company on the Embankment. The transmitting stations for Canada and South Africa are at Bodmin, and for Australia and India at Tetney, the receiving stations being at Bridgwater and Skegness respectively.



The Power Room at Rugby.

The wavelengths now used for each service are below 40 metres and are the result of practical trial. There is still much to be learned about the conditions of propagation of short waves, as these alter according to whether the great circle path which passes through the two stations is in daylight or darkness, or a combination of the two. Generally speaking, short waves fall off in strength up to a range of about 100 miles, but waves below about 60 metres become stronger as the distance increases, and in daylight the shorter the wave the greater the recovery in strength. This is generally explained by the fact that, up to about 100 miles, propagation depends mostly on direct rays which are emitted from the aerial at low angles and whose energy is rapidly absorbed. At greater distances it is assumed that the increased energy is obtained from radiation which leaves the aerial at higher angles, travels along a conducting layer some 50 miles above the earth with little absorption, and is later on bent down to the earth again.



The Indian Beam Transmitting Station at Poona.

The power used at each transmitter is about 25 kw., and the methods of transmission and reception of signals are those described in a previous article which dealt with the latest developments of machine telegraphy; in fact, the operation of all modern point-to-point wireless circuits is now on the same lines as modern line telegraph working where the Morse code is used.

Advantages of Short Waves

The great advantage of being able to use short waves for long range communication is that far less power is required, which means not only a great saving in running costs but a great saving in capital expenditure. For instance, a world-wide long wave station like Rugby costs somewhere about £500,000 to erect, about ten times as much as a short wave station, and as the power used is in even greater proportion, the running expenses are much greater. Then, again, the speed of signalling of a short wave station is greater than it is possible to obtain from a long wave station, another advantage of the first importance, though, as a slight set-off to this, the regularity of communication is greater with the long wave station unless strong atmospheric disturbances are present.

(To be continued)

The Economic Side of Television*

By *Dr. Ing. P. Goerz*

IN the present stage of the development of television to seek to judge its economic side would be tantamount to prophesying, and prophesying regarding the development of a sphere which is even now in its very early days, and has hardly left behind the laboratory era, is an unthankful task. Therefore to discuss the economic side of television within this compass one must confine oneself to making suggestions for an economic building up of the domain of television. If these suggestions are to be fruitful care must first of all be taken to see that they contain the germ of economy.

In the interest of a sound development it is to be hoped that the domain of television will not experience the same shattering which the development of wireless apparatus has undergone. We all know what an enormously rapid rise wireless had in Germany after its introduction, in which connection allowance must of course be made for the fact that it received assistance from the currency inflation existing at the time, which, as is known, inflamed the lust of enterprise of many manufacturers. Very shortly after the appearance of the stable currency many manufacturers disappeared from the picture, and in the course of years the construction and sale of wireless apparatus became more and more restricted to economically strong firms, and thus did wireless become an important economic factor in the German market.

It is not to be assumed that television will follow the same path, as the sphere itself is a much more difficult one than that of wireless, and even for this reason only those firms will concern themselves with the sphere which have suitable scientific collaborators at their disposal and also the requisite economic reserve for the thorough development of such apparatus. Furthermore, television is already so circumscribed by protective rights, or this territory will very shortly be so far surrounded with protective rights, that many firms will again be thereby prevented from constructing such apparatus.

As regards the individual systems of television, we are always confronted in this connection (in Germany) with the three well-known names of Karolus, Baird and Mihaly, and in the best economic interests of the new sphere one might even now wish that, just at the commencement of the various developments, the systems should unite and the groups themselves economically combine. Such a combination—loose or close—can hardly be long in coming, as the Reichspostzentralamt (German G.P.O.) must ultimately decide on

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a particular system of transmission, and so soon as this happens it may easily come about that one or other system will be thereby hindered in its further development.

This should not, however, be the object of the Reichspostzentralamt; on the contrary it may be assumed that this is precisely the office whose duty it is to inspire the closest possible combination of the three groups. It is also desirable that the Reichspostzentralamt should keep well informed regarding innovations in the transmitting sphere those firms which concern themselves with the manufacture of television receivers, so that they may take such information into consideration when building their apparatus.

Moreover, the recently formed Television Society should set itself the task of constantly working for the uniting of the systems and the economic collaboration of the inventors.

Precipitate Development—Warning

Whoever has had the opportunity of reading the articles which have appeared recently in many newspapers regarding television would have obtained the impression from these that the appearance of television receivers on the German market was to be expected before the end of 1929. As enough warning against a precipitate development cannot be given, it should first be stated that the reports were not in accordance with the truth. The Fernseh A.G. will, of course, deliver at the beginning of this year a batch of television receivers which, however precise, in view of a rational development will be small. It is to be readily appreciated that the initial batch will have to undergo further laboratory improvement. As, moreover, the judgment of the public has to be awaited, it would be uneconomic at this juncture to place large quantities of television receivers under manufacture. Further, every expert knows that the details of mass production work require much time to work out. Only after mature reflection from all economic points of view will it be decided to start mass production on a large scale.

There is also a further factor which remains to be settled, namely, the final fixing of the number of picture points. All television firms will probably agree that on the basis of the picture point number first laid down by the Reichspostzentralamt a television picture satisfying all requirements is not to be obtained. We do not disregard the fact that the difficulties which arise in the fixing of a higher picture point number are great, because for the transmission of these picture points higher frequencies are necessary than are to-day at the disposal of the wireless transmitters, if a disturbance of neighbouring transmitters is to be avoided.

It therefore remains to be seen whether a change to short waves comes any nearer to the solution of the problem, and how far the desirable coupling between picture and sound can be effected. The ideal is undoubtedly the installation of two transmitters with as similar a wavelength as possible, one transmitter being intended for the transmission of the picture and the other for the acoustic accompaniment. In any case the installation of two transmitters of very different wavelengths would hardly come nearer to the wishes of the public in that the ranges of the individual wavelengths are different, and the disadvantage can result that, for instance, in the distant foreign country televised pictures can be received on short waves, whilst the acoustic accompaniment by a transmission on long waves is no longer to be heard, and *vice versa*. For this reason also it would be advisable to wait upon development and not tie up unnecessary capital in the extensive manufacture of products which might later be unsaleable.

Because of the small quantities at first produced, the price of the apparatus will then be scarcely less than RM. 350 (£17 10s.). However, it may be safely assumed even at this juncture that these prices are susceptible of quite considerable reduction when manufacture on a large scale is begun. The sale of the apparatus should hardly be influenced by this price level, for, on the introduction of wireless, although the apparatus had long been introduced abroad, prices on this level were readily accepted and paid. Therefore the evolution of the prices will probably proceed along the same lines as in the case of wireless apparatus. It is probably to be assumed with certainty that even in a few years' time a cheap popular receiver will dominate the market as the cheap wireless sets do to-day.

Television will, however, apart from the transmission through the wireless transmitters, be able perhaps to conquer other economic spheres. For instance, the possibility is contemplated of supervising a warehouse from a central point from which the manager is in a position to observe what is going on in the separate departments. Just as to-day close touch can be maintained with various departments by microphones and loud-speakers, so will the simultaneous supervision of various departments be made possible by means of the televisor. A saving in supervisory staff would be thereby quite conceivable.

Police Uses

Further, one could imagine that the police might use television installations for various purposes, as, for example, the supervision of railway barriers, for the confrontation of criminals, or comparison of photographs with the original sent through the television transmitter. In this way time and costly journeys could be saved.

Again, the use of noctovision is contemplated—that is to say, the recognition of invisible light signals in darkness or fog; for instance, light signals at sea.

Finally, let us mention the use of television transmitters and receivers in business life, as, for instance, a combined television and telephone installation between two towns, or between two individual firms, which perhaps have their central establishment in the capital and their branches in the country, whereby

(*Continued on page* 617.)

The Television Society

Fourth Meeting of the Session held on Tuesday, January 7th, 1930, at 8 p.m.

LECTURE ON

"Photographic Problems of Picture Telegraphy"

By *W. S. Newton*, B.Sc. (Hons.)

ABSTRACT OF LECTURE.

The paper discusses the problems encountered in the attempt to reproduce a transmitted photograph identical with the original.

A brief discussion of the Picture Transmission systems in use at the present time, comparing Bell, Siemens and Belin systems.

The effect of transmission on resolution.

The determination and the use of standard photographic methods in Picture Telegraphy.

THE novelty of receiving photographs by transmission over wires and radio has now disappeared and there is a demand that these pictures should have good definition and a pleasing gradation of tones.

This paper is an attempt to show how the photographic problems have been analysed and overcome in the Bell system of picture transmission now in use by the *Daily Express* between London, Manchester, and Glasgow. It is necessary to briefly describe the methods now used in picture telegraphy and the Bell system is taken as an example, but at the same time the paper comments on the methods of the Siemens-Karolus and the Belin system.

The photograph to be transmitted is prepared in the form of a photographic transparency 7 in. by 5 in. in size; the method of preparation being discussed later.

This is mounted on a cylindrical holder with the 7 in. as length and the holder is then placed on a carriage which is attached to a screw mechanism, the mechanism rotating so that the holder advances along its axis with each rotation.

The image of a small, brightly illuminated, rectangular aperture is focused on the film, the light transmitted being proportional to the density of the film.

This light illuminates the window of an anode ring potassium hydride photo-electric cell and the changes in intensity of illumination cause a corresponding change in electron flow.

The electron flow passes through a large impedance and the voltage drop is impressed on the grid of a three-valve battery coupled amplifier, the grid of the last valve being impressed by 1,300 c.p.s. frequency from a valve oscillator so that the output of the oscillator is modulated by the current pulses from the photo-electric cell.

The light spot has the same width as the thread on the lead screw, i.e., 0·01 in., thus the whole picture is scanned in the form of fine strips and the various densities in the film are expressed as modulations of the 1,300 cycle carrier.

The carrier current is amplified and transmitted over a telephone line which is suitable for the range of frequencies, produced by the modulation.

In the Siemens apparatus the original print is placed in the cylindrical holder 27 cm. in circumference by 18 cm. in length and the light spot is reflected back into the photo cell. Here the light, before incidence on the print, is interrupted by a rotating disc with holes in the periphery so that a carrier current of about 1,300 c.p.s. is produced and the output is amplified by a four-valve resistance coupled amplifier and transformed to the telephone line.

In the Belin apparatus reflected light is again used but a large portion of the print is illuminated and a small point focused into the photo cell, the carrier frequency again being derived by an interruption disc. Here prints 6 in. by 4 in. are used.

Receiving

Returning to the Bell system, at the receiving end the picture currents are amplified after passing through a high pass filter and then passed into a device called a light valve. This consists of a metallic ribbon strung in a strong magnetic field from a large field coil. The light valve is mounted on an optical bench so that the light from a lamp is focused on to the ribbon through an aperture in the field coil. By means of two movable jaws placed parallel to the ribbon, the ribbon when stationary can completely cut off the light.

When the picture currents pass through, however, the ribbon vibrates under the alternate polarities and when correctly adjusted the amplitude of its vibration is proportional to the modulation produced in the photo cell current. The light thus allowed to pass then falls upon a lens and is condensed on to a small rectangular aperture similar to that of the traversing light spot at the transmitting end. This aperture is focused on to the unexposed receiving film 7 in. by 5 in. mounted in a similar manner to, and rotating and advancing synchronously with, the transmitting film.

Thus as the lights and shades in the transmitting film cause greater or less modulation of the carrier, the ribbon allows more or less light to pass, and greater or less exposure is recorded on the film.

In the Siemens system the picture current coming from the line through a high pass filter is amplified and transformed to give about 600 volts which is placed across a Kerr cell.

Light from a lamp is sent through an aperture, lens and Nicols prism, Kerr cell Nicols prism, and is then focused on to the film.

The Nicols prisms are crossed so that, with a definite voltage on the cell, no light is passing, but the varying voltage across the Kerr cell changes the angle of polarisation of the nitrobenzene in the cell thus allowing more or less exposure on the receiving film which is mounted and moving in synchronism with the transmitting print.

In the Belin apparatus the varying amplitudes of the current change the angle of swing of an oscillograph which reflects a beam of light into an aperture, the light then being focused on to the film or paper.

Synchronisation

It is necessary for the transmitting and receiving films to be in synchronism so that the varying exposures at the receiver occupy the same relative position as the corresponding lights and shades in the transmitting film.

In the Bell system the transmitting machine is driven by a phonic impulse motor, which in turn is driven from a 110 volts D.C. supply at 60 cycles, the supply being interrupted by a 60-cycle tuning fork. The motor has a 10-point rotor and hence is driving at 360 revolutions per minute. The screw mechanism is geared 1 : 4 to the motor and the cylinder at 1 : 1 to the lead screw. Thus the cylinder rotates at 90 revolutions per minute.

The tuning fork also interrupts the output of a 490 c.p.s. oscillator, which is put to line through a low pass filter at 30 TU below the picture current level.

The 490-cycle current is rectified and operates a relay which supplies 110-volt D.C. to a similar fork at the receiving end. This fork drives the receiving motor and hence the two motors are always in synchronism.

It is also necessary to ensure that the two machines start in phase.

Both lead screws are operated to the motors by means of a mechanical clutch magnetically operated and when at rest the clips holding the ends of the films are stationed in front of the light spots.

The transmitting clip is pierced by a small hole which allows light to pass into the photo cell and send current to the line. This current is then rectified at the receiving end by operating a self-locking relay which changes the amplifier to a rectifier and causes another relay to break the clutch circuit when the driving key may be thrown over. Upon receipt of the start signal from the receiving station the transmitting operator starts his clutch current, the

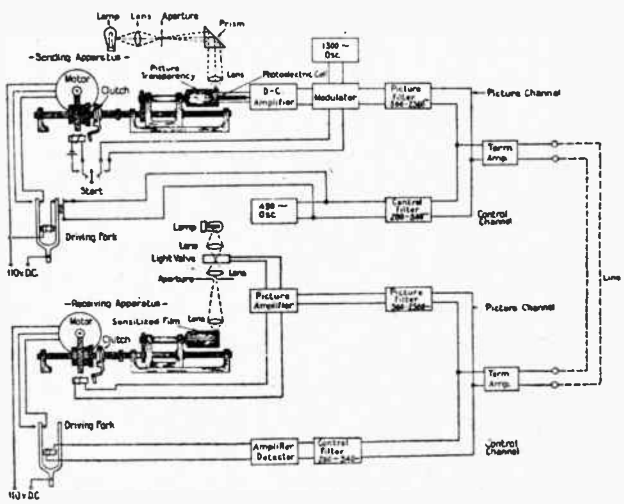


Fig. 1.—Schematic layout of the Bell System.

switch at the same time interrupting the picture carrier. This interruption releases the clutch relay and the receiving machine starts in phase with the transmitter, and the amplifier is then back into the picture condition, i.e., passing alternating current into the light valve ribbon.

In the Siemens system the machine is driven by a D.C. motor governed by an A.C. motor working from

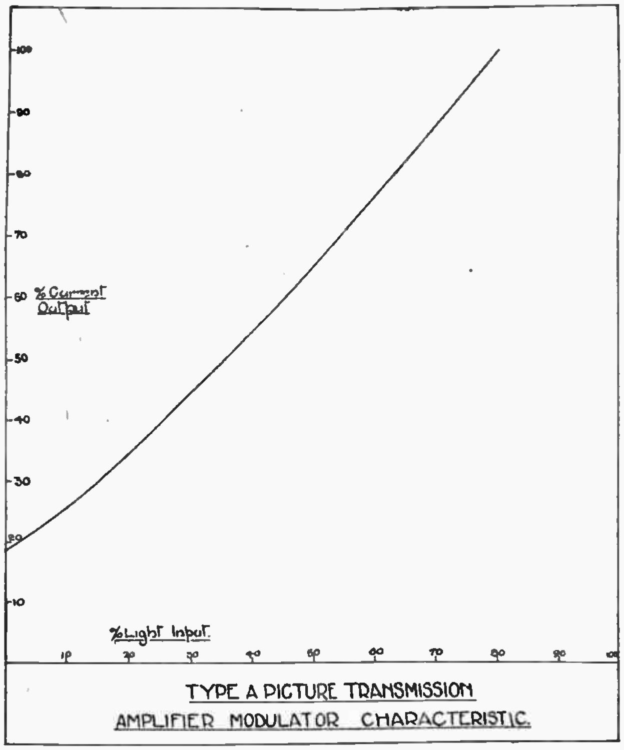


Fig. 2.

the amplified tone from a 1,600 c.p.s. valve-driven tuning fork. This fork is thermostatically controlled and has constant speed.

At the receiving end a similar fork governs the receiving machine and as the forks are entirely independent, fork frequency is amplified to line and compared stroboscopically with the receiving fork, the frequency being slightly adjusted by reaction on the receiving valve condenser.

For phasing, the two film drums can only fit the rotating shaft in one position and at the transmitter a small white spot on the drum sends tone to line at each revolution. By observing the rotation of the receiving drum against a neon lamp illuminated by this current the two machines can be brought into phase by rotating the stator of the driving motor.

No starting relay is thus necessary since both clips pass the light spots at the same time.

In the Belin apparatus phonic wheel motors driven by a 30-cycle fork are used and relay starting causes both machines to start in phase.

The general schematic layout of the Bell system is given in Fig. 1. This brief description serves to establish the relationship of the transmission characteristics subsequently mentioned.

Resolution

The first essential of a photograph is that it should be sharply defined and hence transmitted pictures must have as good resolution as possible.

With a given transmitting medium such as a telephone circuit and a given size of picture, the speed of transmission is inversely proportional to the resolution.

In the Bell system the actual photograph is 6½ in. by 4¼ in. on a 7 in. by 5 in. transparency, the loss being required for mounting, the circumference of the holder being 5·5 in.

The pitch of the lead screw is 0·01 in. and hence the structure of the picture received is of that dimension. Since the exposure on an aperture image represents the average tone value of that portion of the picture, distortion is inevitable. It is found that with a structure less than 75 lines to the inch this distortion is resolved by the eye. Since time of transmission is an economic factor, and that to obtain structures over 100 lines to the inch gearing must be used, 0·01 in. is taken as the structure width. The scanning spot is 0·01 in. by 0·0075 in., and at 90 revolutions per minute the linear speed of the film is 8·25 in. per second.

Thus the highest modulating frequency is from clear film to opaque film and back to clear film, and this must take place in two aperture heights.*

Thus the maximum modulating frequency is

$$\frac{8{\cdot}25}{0{\cdot}015} = 550 \text{ c.p.s.}$$

Since a frequency p modulated by frequency n gives frequencies p, $p+n$, $p-n$, the band of frequencies

* The relationship of aperture length to cyclical variations is discussed in Horton's "Transmission of Pictures and Images," Proceedings of the Institute of Radio Engineers, Vol. 17, No. 9.

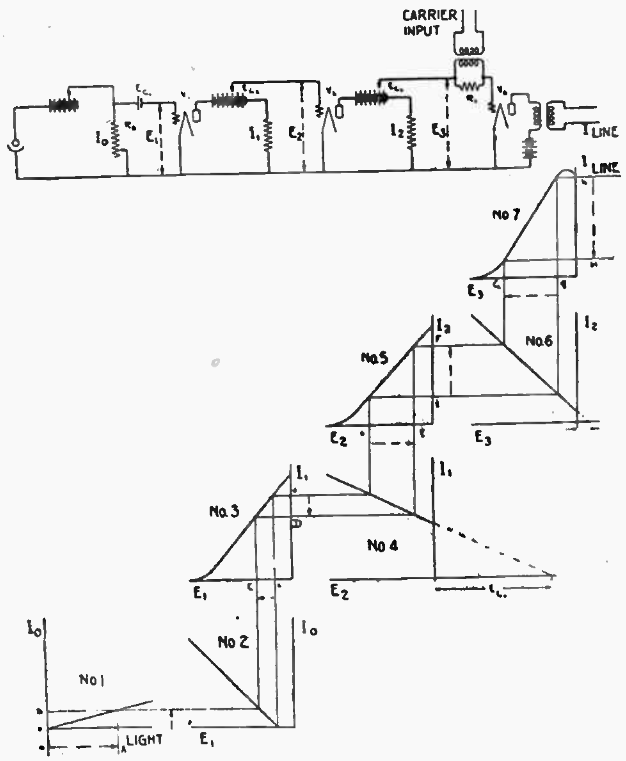


Fig. 3.

required at 1,300 cycles carrier current is 750 c.p.s. to 1,850 c.p.s., for which range a telephone line will give a flat attenuation frequency characteristic.

If aerial wires are used with a cut-off of 6,000 c.p.s. a carrier frequency of 4,000–5,000 cycles would be used and hence the speed increased three times.

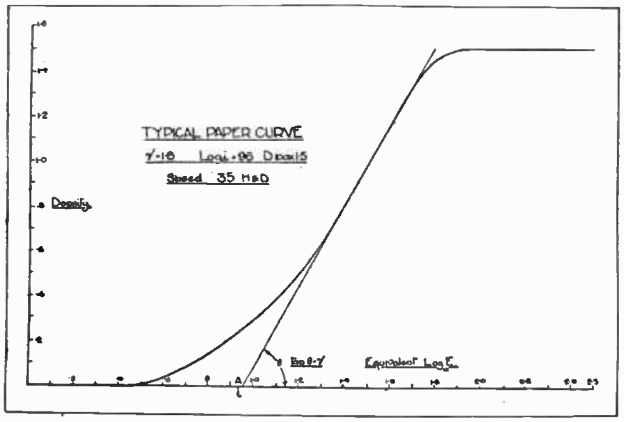


Fig. 4.

Thus all picture systems now in use over telephone lines have a scanning beam of about 100 lines to the inch and take approximately one minute to transmit 1 inch.

Another factor is that of transients. If portions of the apparatus or the circuit are overloaded or over-equalised, or if the wrong aperture height is used, a transient effect is produced which owing to the sensitive nature of the photographic recording, completely mars the sharp delineation between black and white. Again irregular impedances on the line will cause echo, which results in ghosts, or white shadows, on the picture.

The optical arrangement at both transmitting and receiving ends is a big factor. The scanning beam is often diffused by the fact that long optical systems containing prisms are used, and scattering is inevitable in the reflected light method.

At the receiving end the image on the film should be the sharply focused image of the aperture, which should be adjustable so that the structure does not overlap or underlap but forms a flat surface.

Photographic Problems

The aim in picture transmission is to produce a transmitted photograph, which has the exact tone gradation of the original picture.

Everything is governed by the transmitting characteristics of the apparatus and it is essential that the relationship between the photo-cell circuit and the transmitting and receiving apparatus be carefully studied and analysed.

The amplifier-modulator characteristic is obtained by plotting % light input to the photo cell against % current from the amplifier-modulator.

This is shown in Fig. 2.

It is desirable to have this curve as straight as possible with a slope of unity, and the curve shown meets these requirements except for a slight bend at the bottom end.

The controlling factors are the voltage on the cell, this voltage being well below that for ionising point, and the adjustment of the bias voltages in the amplifier.

The arrangement of these is shown in Fig. 3.

The density limits of the transmitting film are determined by the ratio of exposure through this film to current output, and it is necessary here to give an explanation of the definitions and photographic principles used.

The following definitions are required :—

(1) Transmission $= \dfrac{\text{Transmitted or Reflected Light}}{\text{Incident Light}}$

(2) Opacity $= \dfrac{1}{\text{Transmission}}$

(3) Density $= \text{Log}_{10}$ Opacity

(4) Log E $= \text{Log}_{10}$ of the per cent. light reflected or transmitted in making the exposure.

The exposures are given in relative values, and to avoid negative logarithms the % opacities are taken as whole numbers.

Light from unexposed and fixed out paper is taken as 100 per cent. reflection and for film 100 per cent. transmission is full illumination on to the measuring device with nothing interposed.

If the densities resulting, after development from a given series of exposures on a photographic emulsion, be plotted against the log E of these exposures a curve similar to Fig. 4 is obtained.

The slope γ of the curve represents the contrast, or the tone gradation in the photograph and this

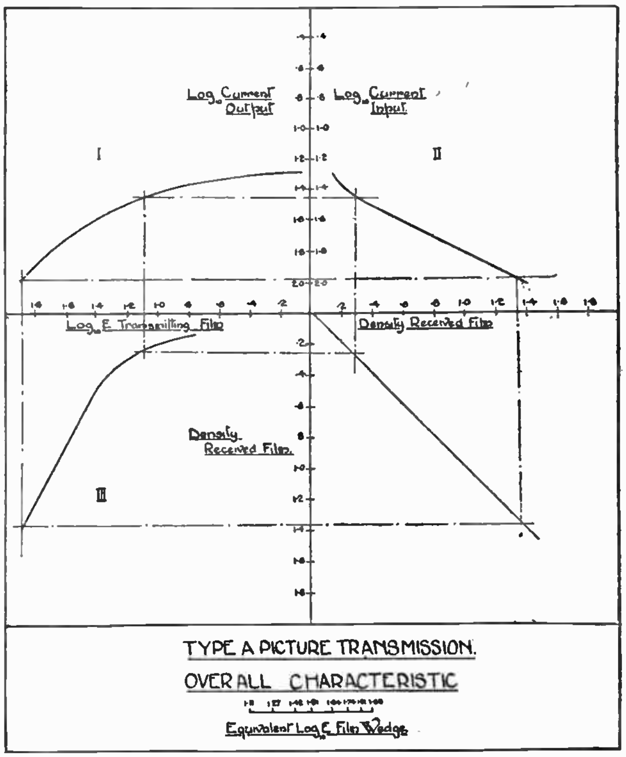


Fig. 5.

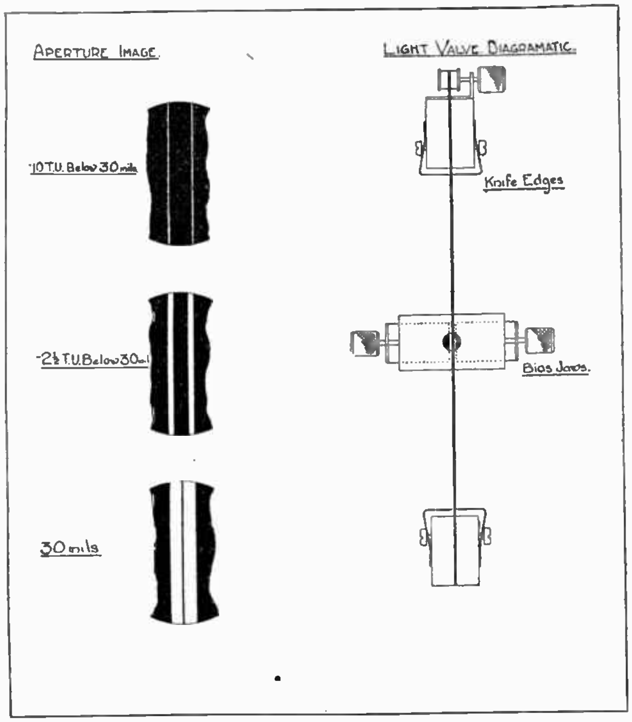


Fig. 6.

contrast swings round the point A according to the time and temperature of development.

It will be noticed that the curve flattens out in the blacks and whites and to avoid loss of detail in these portions it is necessary to fix the exposures so that the curve is used between the toe and shoulder.

The point A where the straight line cuts the axis is given by the speed of the emulsion, the speed being $=k/\log i$, where k is some constant for convenience so that speeds can be given in whole numbers, i.e., we speak of a plate as having an H. and D. speed of 80.

This photographic characteristic has to be combined with the transmission characteristics so that each photographic reversal will give as a graph a straight line with slope of unity to give correct tone reproduction. If one step deviates, another one must be adjusted to compensate for it.

In transmitting a picture a photographic reversal is made, i.e., if a negative transparency is used on the transmitter a positive is received and vice versa. This is necessary since the curvatures of the photographic emulsions would be accumulative, as will be seen if a reversal was not made (Fig. 10).

Consider the ordinary photographic process of making a print from a negative. According to the exposure given while taking the negative and the subsequent development a characteristic will be obtained, similar to the curve in Section I., Fig. 4 (A).

The density range in this negative will give the exposure range on to the paper, the characteristic of which is given in Section III., Fig. 4 (A).

Now if the object brightness of the print—i.e., log % reflection—be plotted against the object brightness of the original—i.e., $\log_{10}E$ on the negative—it is obvious that for the print to match the original in tone gradation this curve must be linear and have a slope of unity.

This curve is given in Section IV., and it will be seen that to obtain a good curve the products of the γs of the negative and print must equal unity and the exposure range on the negative must not extend over the straight portion of the curve.

The straight line in Section II. is used to transfer the densities of the negative on the ordinate to exposures on the abscessæ, and we can regard picture transmission as the making of a print from a negative at a distance where the straight line in Section II. represents the transmission characteristic. The difficulty is that whereas in making an ordinary print the paper may be chosen to suit each negative, in transmission the receiving operator has no knowledge of the transmitting negative and hence standard methods must be used.

In actual practice the transmission characteristic is not quite linear, and its slope is not unity, but the γs of the photographic curves are adjusted accordingly.

Thus the problem consists of obtaining Fig. 4 (A), Section IV., but this time including the transmission apparatus.

The next step is to obtain a curve plotting $\log_{10}E$ of transmitting transparency against log % current output from the amplifier-modulator (Fig. 5, Section I.).

Since the base of the film absorbs 20 per cent. of the light, maximum current is given by a $\log_{10} E = 1{\cdot}9$.

It will be seen that the change in log E from 0 to 0·8

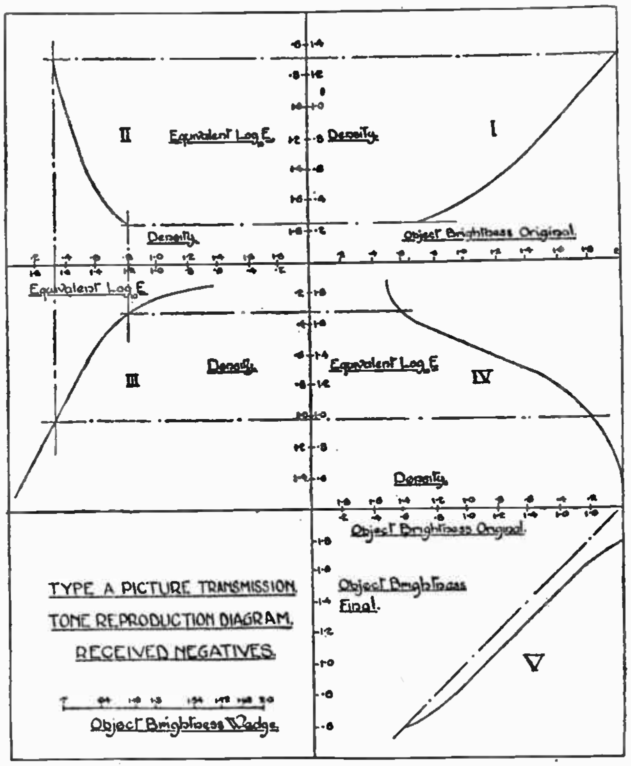


Fig. 7.

makes very little difference to the current output and hence the transmitting transparency must have an exposure range from 0·8 to 1·8, i.e., density range from 1·20 to 0·2, since it is not advisable to have absolutely clear film in the high lights of the transparency.

It will be noticed that there is a current difference of 0·7 in log values, i.e., 14 TU, and before transmission the output from the amplifier-modulator is in the light condition passed into a resistance pad with 14 TU loss in order to adjust photo-cell voltage so that there is this current loss between clear and opaque film.

To plot the receiving characteristic a few details of the receiving apparatus are needed.

The illumination of the receiving lamp is fixed at a definite value and the current input from the line is amplified so that 30 mils is passing through the light ribbon valve, the tension of which is adjusted so that it has a natural frequency of 2,600 c.p.s. Thirty mils is the current for clear film at the sendint end and -14 TU below 30 mils gives the current (6 mils) for opaque film.

The exposures on the receiving film must now be arranged between these current values.

This is done by adjusting the bias jaws on the light valve so that definite predetermined densities are obtained for currents $-2\frac{1}{2}$ TU and -10 TU below 30 mils. This is the standard method of adjustment, Eastman process film, 5 minutes development in D 14 at 65° F. being used. Fig. 6 shows a diagrammatic sketch of the ribbon strung between the bias jaws and the illumination which passes through the aperture for different currents through the ribbon.

By measuring the densities for a series of current values between 30 mils and 14 TU below 30 mils and plotting these densities against log % current input the receiving characteristic is given (Fig. 5, Section II.).

The slope of this curve can be altered by taking various densities for $-2\frac{1}{2}$ TU and -10 TU, and this curve is the one used to correct deviations in other curves from the unity slope. If the contrast is decreased beyond a certain limit the curvature at the toe of the curve also increases and a choice must be made between these two factors, always bearing in mind that the lower point is fixed by the current output not falling below $\log_{10}$ % current=1·3.

Combining the transmitting and receiving characteristics gives the overall characteristic (Fig. 5, Section III.), and from this curve it is possible to

Fig. 8.—(Left) *Original.* (Right) *The same picture as received by the system described.*

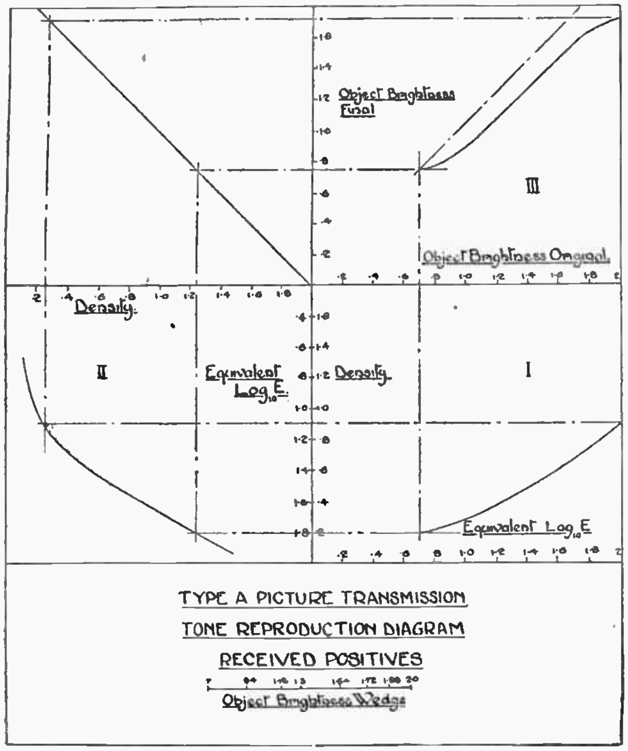


Fig. 9.

find the density on the received film for any exposure through the transmitting film.

Whether a negative or a positive is received depends upon the time and circumstances, the former process requiring two more photographic steps than the latter.

Receiving a Negative

The original photograph is copied to give a plate negative, from which the film positive is prepared.

In order to have standard methods, a special copy-camera bench is used and time-temperature development in Eastman D 14 developer.

The illumination on the bench consists of four large lamps spaced equidistant from the axis of the camera lens and placed such a distance from the screen that uniform illumination is given over a considerable area.

Since it is necessary to copy all sizes of prints to a 7 in. by 5 in. negative and hence have varying illumination on the image, an exposure facture is used to correct for this variation.

$F=v^2/4f^2$ Where F=exposure factor.
v=distance of image from lens.
f=focal length of lens.

From this equation a scale is made which gives the variation in time necessary to give the same exposure as in a 1 : 1 copy, for any position of the camera lens, i.e., if time of exposure is 10 seconds in 1 : 1 position and in 1 : 2 position the lens is at 0·8 on the scale, 8 seconds exposure is given.

To investigate the photographic curves a wedge of paper densities was made, the densities ranging from white to black. The reflection densities were measured and the relative exposures or object brightness from the wedge thus obtained.

The wedge was copied at 1 : 1 on Illingworth ordinary plate, H. and D. 80 exposure being 10 seconds at f—11, 3 minutes development in D 14 at 65° F.

Plotting the curve (Fig. 7, Section I.).

This gives a maximum density of 1·13 and has a γ of 0·58, while a fairly straight curve is given.

A film positive is prepared from the negative in a projection camera, the ratio being 1 : 1. An exposure of 15 seconds at f—22 is given on Eastman commercial film 7 in. by 5 in., and this is developed for 1½ minutes in D 14 at 65° F., giving a characteristic as in Fig. 7, Section II.

To obtain this curve the equivalent $\log_{10} E$ of the densities of the copy negative shown in Section I. are plotted against the measured densities of the film.

This gives a maximum density of 0·90 and a minimum density of 0·30 and has a good slope, and it will be noticed that the curve is so arranged that it extends over the straight portion of the overall characteristic.

From the above data tone reproduction diagrams* were plotted, i.e., the exposures from the film positive were transposed to densities on the received negative by means of the overall characteristic.

It is necessary to make a print from the negative and the paper used is normal press bromide. The

* This method of photographic analysis was devised by Dr. L. A. Jones, of the Eastman Kodak Laboratories, Rochester, N.Y., and published in his paper "On the Theory of Tone Reproduction with a Graphic Method for the Solution of Problems," in the *Journal of the Franklin Institute*, July, 1920.

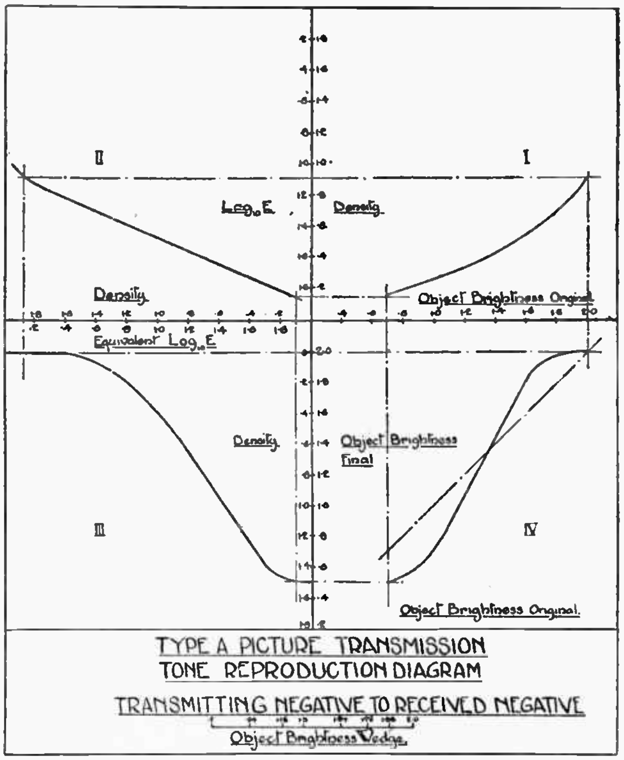


Fig. 10.

An example of a photograph received from Berlin on January 7th, the opening day of the new London-Berlin picture telegraphy service. The system employed is the Siemens-Karolus.

relative exposures on this paper will, of course, be given by the range of densities of the received negative and the tone reproduction diagram (Fig. 7) consists of the interpolation of the transmitting positive II. to the overall characteristic III., and then to the paper characteristic IV., when a wedge of densities similar to the original is produced.

By comparing the reflection densities of this wedge with those of the original we should have a straight line with slope of unity and this is shown in Section V. of the tone reproduction diagram. The important thing is not to produce the exact densities as in the original but to produce the same tone gradation.

It is to be noticed that the half-tones are correctly reproduced but that there is a slight loss of detail in the ends of the blacks and whites. This loss will be noticed in the comparison of transmitted against original picture in Fig. 8.

Received Positive

In newspaper work time is valuable and a method was evolved whereby two steps in the above process were deleted: (1) the making of positive transparency; (2) the printing from the received negative.

Here the copied original gives a film negative and a film positive is received and sent direct to the art department.

The negative is made on Eastman commercial film, 10 seconds exposure at f—22, 4 minutes development in D 14 at 65° F.

This has a characteristic given in Fig. 9, Section I. Maximum density 0·88, minimum density 0·17, and again extending over the straight portion of the overall characteristic. Using this in a tone reproduction diagram (Fig. 9) we have a very good curve for object brightness original, against object brightness, transmitted picture.

This method gives very good results since definition is improved by removal of two processes and the fact that standard methods can more easily be adhered to, whereas in making the print from the received negative the photographer has a tendency to use his own judgment.

It is also found that better process blocks can be made by transmitted light through the film than by reflected light from the print.

Fig. 10 shows the result of receiving a picture without a photographic reversal. The transmitting characteristic is now reversed by reversing the battery connections on the photo cell and the resulting tone curve is very contrasty and flattens off very much at both ends, in other words, the received picture is "soot and whitewash."

Experiments have been made to receive a print on paper instead of on film to allow for retouching

Another picture received from Berlin on January 7th. The charge provisionally fixed for the transmission of a photograph is £1 for a picture of 15 square inches.

and almost perfect tone reproduction was obtained, but the latitude of the paper is so small that the adjustments of density for $-2\frac{1}{2}$ TU. -10 TU have to be so exact that the practicability of the method under working conditions is doubtful.

This method of analysis and construction could no doubt be applied to the Siemens apparatus, but up to date no opportunity has been available to make any experiments.

In conclusion, acknowledgments are due to Mr. F. G. Gardner, of the Western Electric Company, for permission to use the diagrams and data of the Bell system in this paper.

* * *

At the conclusion of the lecture Mr. E. S. Ritter, M.I.R.E., a member of the Post Office Engineering Staff, who was in the audience, announced that he had brought with him some examples of photographs received from Berlin that day by the newly-opened London–Berlin phototelegraphy service. These were handed round and much admired by the members. Some of them are reproduced here.

* * *

Society Notes

The next meeting of the session will be held on Tuesday, February 4th, at the Engineers' Club, Coventry Street, London, W.1, at 8 p.m., when Mr. G. P. Barnard, Grad.I.E.E., will give a lecture on "The Photo-Conductivity of Selenium and various other Substances."

Informal discussion (members only) at 7 p.m. on Mr. Newton's paper on "Photographic Problems of Picture Telegraphy."

* * *

The lecture tour, December 10th to 19th, 1929, undertaken for the purpose of helping members interested in the formation of local groups, was much appreciated.

Large audiences attended, mostly of technicians strengthened by members of the local radio and scientific societies.

For the organising arrangements the Society owes its best thanks to the Association of Engineering and Shipbuilding Draughtsmen.

Following the lecture and demonstration, discussion was allowed, and finally arrangements for the formation of a group centre of the Television Society was made.

The following gentlemen promised to act as local secretaries (*pro tem.*), and all interested in these districts should send in their names:

LIVERPOOL.—E. G. Lewin, Esq., M.Sc., A.Inst.P., Castle House, Harwarden, Chester.

MANCHESTER.—T. C. Dickie, Esq., Regent House, Cannon Street, Manchester

ROCHDALE.—S. Thorn, Esq., 31, Queen Victoria Street, Rochdale.

LEEDS.—H. Wolfson, Esq., The Dingle, Grove Lane, Headingley.

SHEFFIELD.—H. Taylor, Esq., 29, Edale Road, Ecclesall.

DERBY.—A. Evans, Esq., 383, Brighton Road, Derby.

WIGAN.—M. M. Das, Esq., B.Sc., Physics Laboratory, Wigan and District Technical School.

The lecture given before the Birmingham Midland Institute by Dr. Tierney was followed by the formation of a group centre at Birmingham, and readers interested should communicate with the local secretary, F. L. Farmer, Esq., 472, Bordesley Green, Birmingham.

It is with regret that we announce the death of one of our active members, Mr. E. J. Baker, of South Side, St. Sampson's, Guernsey.

Mr. Baker constructed one of the early pattern television receivers, and his reception of television images was very successful.

The hon. treasurer directs attention of members to the recent notice reminding them that subscriptions for the current year are now due.

Members will facilitate the work of the Society by forwarding their remittances to the hon. treasurer, Television Society, 4, Duke Street, Adelphi, W.C.2.

Now is the time for new members to join, and the form of application issued in this journal will receive immediate attention when forwarded to headquarters.

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

The Economic Side of Television.

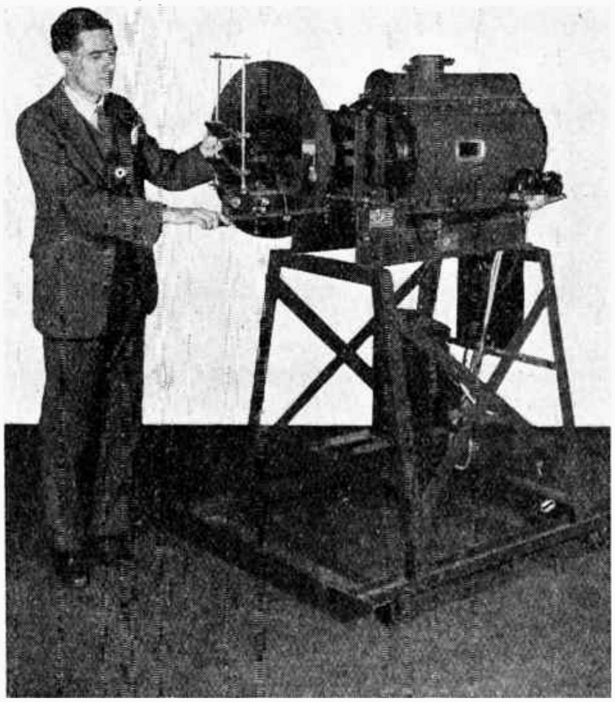
(*Concluded from page* 608.)

business people will be afforded the possibility of hearing and seeing in the picture the person with whom they are in communication. It often happens to-day that in important business conversations the one call is not enough; it is frequently necessary to check the accuracy of the report or the identity of the communicant by a counter-call.

Moreover the distant transmission of Sanscrit and other pictorial languages, the wireless telegraphic transmission of which is impossible, should not be forgotten in this connection.

It would lead too far to mention within this compass all the spheres which sooner or later would permit of the application of television. It is, however, to be hoped that the new sphere of activities will create for itself an *entrée* into as many economic circles as possible, and develop into a sound branch of industry in the interests of a strengthening of our German economic life.

Baird Television *in* America



A television transmitter developed by the Baird Television Corporation of America, showing the "periscopic scanner," an arrangement of mirrors.

DURING recent weeks there has appeared in some English newspapers a short paragraph giving the opinion of Mayor James Walker, of New York, that the next Presidential election would see television in use everywhere and would be used to broadcast complete political platforms of speakers during the campaign. This paragraph and the opinion quoted is the very small echo that the daily papers here have gathered of a demonstration of television given by the Baird Television Corporation of America in New York, in December last.

Mayor Walker, Miss June Collyer, Miss Betty Compson, Miss Irene Delroy, Mr. Mayer Gordon (the B.B.C. solo violinist) and many other stage and screen stars, together with prominent Americans, were televised at a very successful demonstration. Mayor Walker, in addition to the remark already quoted, also said at the close of the demonstration that compared with the early cinema shows the demonstration of television he had just witnessed was miles ahead.

These statements were made good use of by the American newspaper men in their reports, but the thing that seemed to surprise them most was that a newspaper, held before the transmitter, could be seen in the "televisor," and the headlines read. Tele-reading also seemed to strike them as being rather remarkable. All of which, of course, is a tacit admission that the standard 30-hole disc as used by all the Baird Companies is capable of giving much better definition than the experts believe, and that Baird television is better on the whole than that so far shown in America.

The real interest in the demonstration, however, lay in the use of a new "periscopic" scanner, which enables any selected portion of the studio to be transmitted. This is the invention of the Baird Television Corporation of America, and enables the spotlight beam to be turned about in any direction like a searchlight. If artistes are seated or standing, tall or short, does not matter, the beam can be directed on them. In the past, artistes being transmitted had to keep in a sharply defined area. This meant the use of a special chair which could be raised or lowered according to the height of the person being transmitted. Further, nothing outside the direct line of the beam could be sent. Now artistes can place themselves comfortably, and the engineer in charge of the studio sees that they are scanned properly, by simply adjusting the beam to cover them. This is done by an arrangement of mirrors placed immediately in front of the focussing lens of the spotlight projector. The first mirror reflects the light upwards on to a second mirror which throws it forward. By adjusting the angles of these mirrors in relation to one another and in relation to the optical axis of the lantern, the scanning beam can be directed in any required direction. The accompanying photograph shows the device clearly.

Broadcasting Facilities Applied For

According to the American press reports received, Captain O. G. Hutchinson, the Joint Managing Director of the English Company, who is at present in America in charge of the demonstration, stated that the Baird Corporation are applying to the Federal Radio Commission for permission to conduct television experiments during the evening hours.

So far no attempt has been made in America to transmit speech and television together. This, the Baird Corporation seek to do, to prove that television has a definite entertainment value in conjunction with broadcasting.

Low Frequency Amplifiers for Television

PART II

By *William J. Richardson*

LAST month we referred briefly to the six-circuit diagrams which were submitted as being suitable for television amplifier work, and pointed out a few of the essential features which have to be considered if good results are desired. Two articles have appeared in the October and January issues of this journal, under the title of "Television and Your Wireless Receiver," in which the main details of the receiver in general have been ably expounded, so we can confine our remarks concerning the amplifier to outstanding points.

Output Strength

Let us presume that the detector and high frequency section of the set (if this latter should be required) have been efficiently designed on the lines mentioned in the articles just quoted. Then the low frequency amplifier must be capable of dealing faithfully with the signals from the detector valve, and pass on an output to the neon lamp which is in no way distorted, otherwise, of course, the picture will be spoilt. As a judge of the signal strength required for securing a good picture, we can say that the television note as heard on the loud-speaker must be of good strength. That is, somewhat above the usual comfortable listening standard but nothing approaching the volume required for a public address system.

Many people are under the impression that the output signal must be of such a magnitude that it would fill a hall if handled by a loud-speaker or loud-speakers. This is quite erroneous, so the reader should dismiss it from his mind at once. Just bear in mind that in the televisor receiver the output power has to operate a neon lamp, and hence the necessity for a stronger output than one usually associates with a wireless set or low frequency amplifier.

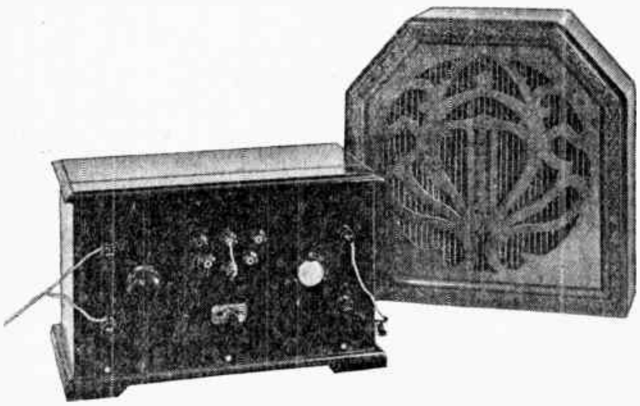
"Over-cooking"

Any attempt to secure too strong a signal will only result in an "over-cooked" picture. That is, too great a contrast will exist between light and shade, and the picture will be spoilt. This is comparable in wireless parlance to an over-loaded loud-speaker. Generally, it is advisable to arrange for the output from the amplifier to be switched over to a loud-speaker or the neon at will by means of a change-over switch, as in addition to judging signal strength it is often advantageous to tune in the television signal by ear. The characteristic rythmical hum is no doubt familiar to readers ere this.

In this connection do not forget to alter grid bias on the last valve when effecting a change-over. The neon will require a lower negative bias when working than is required for the loud-speaker, and the output valve plate can get red hot if the bias is not increased when using the speaker, and, naturally, this is detrimental to valve life.

Frequency Range

Now for another important side of the amplifier design which must be considered. This is the frequency range to be handled. Many and varied have been the discussions on this point alone, but, unfortunately, in many cases the theories propounded have been based on incorrect foundations. At present the side-band allocation for television broadcasts is the same as that for speech and music, namely, 9 kilocycles. It is to be hoped that in the near future this will be extended without any recourse to the use of the ultra short waves, but since good results are now being obtained within this frequency band, what of the theorists who with paper and pencil prove *conclusively* that television would invade the ether on a kilocycle front of hundreds of thousands? They must have got muddled with their ciphers!



It is generally advantageous to be able to switch the amplifier over to neon or loud-speaker at will by means of a change-over switch, such as that shown at bottom, centre of this photograph.

A special amplifier undergoing an actual "visual" test at one of the Baird Company's laboratories.

In considering a television picture we must remember that the higher frequencies are responsible mainly for the detail, and any undue loss of these frequencies gives the picture a rather woolly or somewhat hazy appearance. On the other hand, cutting off the lower frequencies will evidence itself in the picture as undesirable dark shadows, while the presence of pure white or any strong surfaces tends to throw these up somewhat.

Any mathematical calculation which proposes to specify the *exact* frequency limits required for television is extremely complicated, and must take account of disc dimensions, speed, number of holes, etc. Actually, the amplifier should be able to handle frequencies down to zero, but provided the limit of thirty or forty is reached efficiently then there will be little trouble. At the other end of the scale, the lower the cut-off of the higher frequencies the greater will be the rounding-off and smoothing over of any sharp contours, so that very small details are apt to be lost.

Again, the narrower the side-band allocation for television the more restricted becomes the scene which can be transmitted with intelligent recognition. However, with the present 9-kilocycle limit it behoves the constructor to make sure his amplifier will work up to this without any marked falling off in its characteristic.

For the Best Results

Practice has proved that the best results generally are achieved by resorting to relatively low amplification per valve stage and employing several stages. This is preferable to, say, attempting to secure all the amplification in one or perhaps two stages. Resistance capacity coupling is most favoured as a rule, but really first-class push-pull amplifiers are capable of giving excellent results.

Now let us refer to the first of the circuit diagrams given last month and reproduced here as Fig. 1. The inter-valve coupling condensers C_1, C_2, and C_4 should be of the high grade mica type with a capacity of 0·1 mfd. Naturally, the exact values of the plate resistances, R_2, R_4, and R_5, and the grid resistances R_1, R_3, and R_6 are dependent upon the valves employed, and it is suggested that V_1 be as an LS5B, V_2 an LS5, and V_3 and V_4 two LS5A's in parallel. Frequently one of these LS5A's can be dispensed with and good pictures obtained. Everything will depend upon signal strength, etc. R_4 and R_5 are shown as two resistances in parallel in the plate circuit of V_2, owing to the fairly high plate current that generally passes in this circuit, but if power resistances such as the Varley or Ferranti type are used, then one will be sufficient to handle the power. Remember that if one resistance replaces the two shown it should be one-half the resistance value of R_4 or R_5.

Picture Brightness

With the neon lamp itself in series with the output valves it becomes necessary to use at least a 350-volt high tension supply capable of delivering an output of 30 to 40 milliamperes. The actual consumption will depend largely upon the ambitions of the operator. In other words, if he requires a very bright picture, or "neon field" as it it is generally termed, then G.B.—3 must be reduced accordingly, and plate milliamps will rise. On the other hand, a judicious handling of the grid bias values will bring about quite an appreciable reduction in plate current without detracting from the picture in any way.

Full details concerning the use of the separate synchronising valve illustrated in Fig. 1, and test results with an amplifier made up in this fashion, will be given next month. I also hope to include a suggested layout with wiring diagram, so as to form a basis for experimenters to build up their own apparatus and make tests.

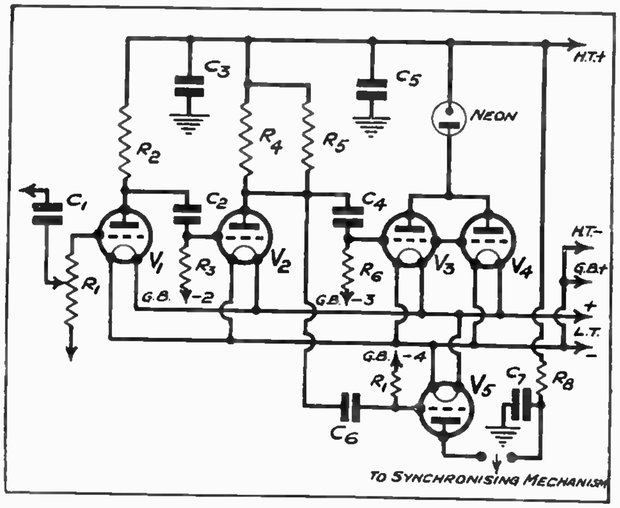


Fig. 1.—A suggested three-stage R.C. amplifier incorporating a separate valve for feeding the synchronising mechanism of the Baird "televisor" receiver.

To What End?

By *A. F. Birch*

SURELY the most obvious truism with which to preface an article for publication in this journal is to remark that every day sees more and more scientific discoveries harnessed to the intimate life of the nation. The present enlightened generation are naturally more mechanically minded than in any previous period, and familiarity with Robotism has inevitably bred a contempt for the marvels thereof.

We do not wait nowadays for intricate instruments to be thrust upon us in our homes, we literally go out and look for them. The most complicated mechanism that is offered to us is quite placidly accepted provided its function is one calculated to add another pleasure or pastime to our everyday existence. The "instruments of the Devil" viewpoint has long since found an unhonoured grave. The fact that labour-saving contraptions have become a fetish in industrial concerns is quite comprehensible because they represent a money making investment to the manufacturer, but in the home-life of the worker it seems strange to find so many appliances giving and expected to give reliable regular service, the possession of which not so many years ago would have been dubbed wizardry, and their owners fit subjects for the pillory, ducking pond, or even worse. Moreover, whereas previously a new departure of science was more often than not heralded with a dubious scepticism on the part of the public, this is now replaced by an intelligent interest in, and desire to possess, anything having a utilitarian value.

Merely compare the excited agitation and pros and cons throughout the country at the advent of the steam engine (a really quite comprehensible machine) to the calm reception of wireless telephony, the whys and wherefores of which have to be grasped by the average person in his imagination only or by the results obtainable from his receiving set. Other innovations which seem to call for similar comment are the automatic telephone, invisible burglar alarms (of the infra-red ray type), gramophone reproducers, even electric lighting and heating, not to mention talking pictures, flying, and the many and varied uses to which we put the internal combustion engine in our quest for pleasure.

These inventions would have confounded and confused the early Victorian mentality, but this generation has managed successfully to dovetail the miraculous into the everyday, and withal a bountiful science continues daily to add to our already rich possessions.

It is a subject which has before and may still provide us with abundant subject-matter for thought, to gaze retrospectively ahead and astern along the highway marked out for us by this progressive civilisation of ours. Looking back we see the mechanical era struggling to evolve from its chrysalis state in the middle and end of the nineteenth century and slowly emerging, but oh so slowly, from that stage during the first few years of the twentieth century, its progress hindered considerably by the "ca' canny" outlook of the wiseacres of the period, who could see little good and much harm resulting from the general speeding up of existence indicated.

Then the cataclysm of 1914-1918 descended upon us. Undoubtedly the war did much towards finally disposing of the anti-progressive point of view. The youthful "mechanica" emerged from the strife triumphantly, received encouragement from all directions, and has since blossomed forth as a beneficent genii endowed with wondrous powers. In fact the post-war period has been marked by so many scientific strides and adaptations that it is daily becoming harder even for the initiated to keep abreast of the tide. We live in a veritable maze of marvels.

Now to peer ahead along the unbeaten road stretching before us. Whither is this forward urge guiding us? This is a more difficult task and few people are

One of the pictures sent from Berlin to London by the new phototelegraphy service which was opened on January 7th last.

sufficiently gifted to foretell the vista which the first turn of the road will unfold, let alone the whole journey. We can only gauge an approximation thereof from our present surroundings after examining the beaten track which led to them, and rely on our intuitive judgment for the rest.

The writer's ego is not of the calibre which encourages the indulgence of farseeing predictions beyond those for which training and environment qualify him, so that we will not venture ambitiously to decide whether Utopia or Armageddon awaits us at the cross-roads. We can, however, endeavour calmly and impartially to look ahead and discuss the prospect in so far as one scientific gift to civilisation is concerned I refer to television.

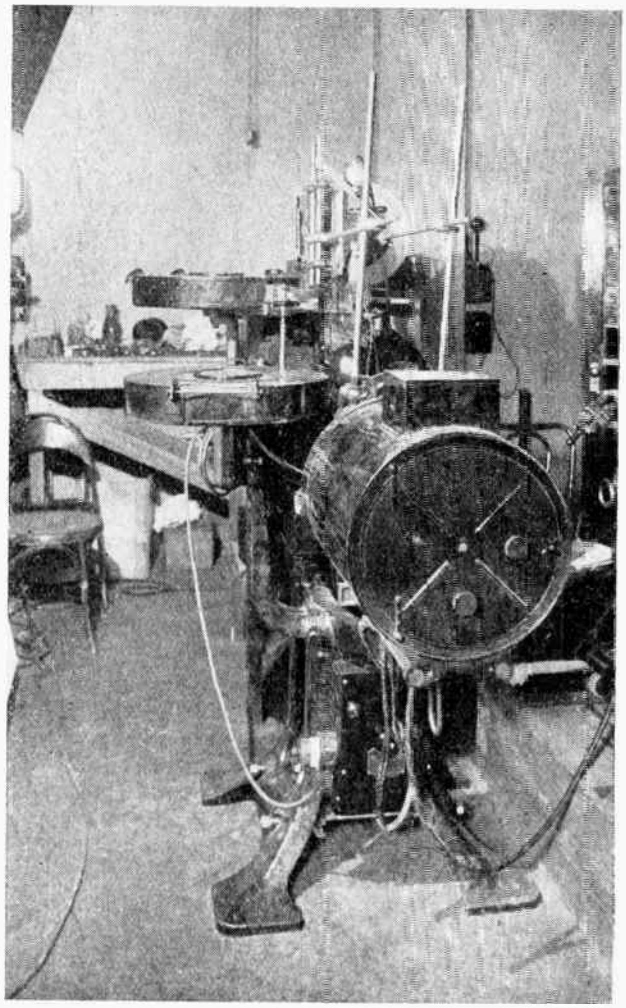
This invention of a Scotsman is one possessing such epoch-making potentialities that perhaps the talented inventor can find it in his heart to forgive those of us who inadvertently reverted to the mid-Victorian viewpoint in our reception of his offering. It meant our conceptions were still insufficiently expansive to cope with the idea in a concrete form.

It is interesting to quote again the chrysalis simile in connection with television. The science has definitely been in such a state for several years. Its emergence was postponed chiefly by sceptically antagonistic influences (many bigotted) but, of course, eventually it could not be withheld. How much quicker it would have emerged in a warm sympathetic and welcoming atmosphere to which, in view of the world's present mentality towards the creations of science, it was surely entitled.

The time is bound to come when people will look back on Mr. Baird's critical belittlers as amusing pagans handicapped by stunted imaginations. The sadder aspect of this, however, has been the fact that a scientific genius, instead of being encouraged to devote all his resourceful energy towards developing and perfecting his invention, has perforce had to give a large proportion of his personal attention towards the conversion of unbelievers in television. To such a man this must have been a wearisome and heart-aching business, calculated to deter many with a smaller measure of courage and determination.

As responsible technician during most of the television demonstrations in this country within the last year or so, the writer can bear witness to the patient courtesy displayed by the inventor in effecting these conversions, irksome and monotonous though they must have been at times. Admittedly there have been those few people who, after having seen the tangible results on the screen, still maintained their scepticism under the guise that its scope at present was limited, a flicker was seen, and other petty objections, but really these were more to be pitied than not. Their mentality would expect George Stephenson's "Rocket" to put up the performance of the "Flying Scotsman," and Wilbur Wright's first aeroplane to bring home the Schnieder Trophy.

As we know, the fight to secure the long-delayed official recognition for the Baird system of television is ended. The first broadcast of a regular service nature through a B.B.C. station determined that. And for the rest—surely it is the most apparent



A tele-talkie transmitter installed in the New York studios of the Baird Television Corporation of America.

thing in the world—that for such an invention there is no turning back. From now on there are only progressive milestones to be registered.

What we wish to foresee is if, how, and to what extent television will revolutionise our home-life. We can, generally speaking, category our pleasures and pastimes into two distinct groups, indoors and out-of-doors. Of recent years we find that to the list of normal indoor home attractions have been added wireless and the gramophone, whilst outdoor attractions have been swelled by the movies, motoring, dog-racing, outboard boating, the dirt track, and sundry others, the balance heavily on the out-of-doors side of the scales. A small matter, perhaps, but undoubtedly television will tend to even up matters in this respect for those able to afford it.

A complete television receiving outfit will unfortunately be an item of expenditure not within the means of all of us, but even so, neither is a car, and the installation will not cost anything approaching so much as that. Those of us unable to afford a car are restricted to other means of transport. Similarly, until we are able to purchase a televisor, we must content ourselves with cinemas for our screen entertainment. It is no condemnation either to ourselves or to the invention that we cannot pick up television on our crystal sets. A televisor must be regarded in the same light as a car, in so far that it will be an extra reward for thrift, and a visible sign of prosperity in its possessor.

At present the television screen is viewed through a lens, and at most four persons are able to see at a time. An early modification will undoubtedly be to have a fair-sized screen placed at one side of the room and to focus the received image on to this from the other, and so provide enjoyment for a room full of people. A more brilliant type of neon lamp is the main requirement needed to accomplish this.

A finer grained and detailed picture will be possible as soon as the sideband problem is surmounted or circumvented, and there is evidence that this will come about sooner than is generally anticipated.

The broadcast entertainment provided will consist of current events seen and heard instantaneously at first hand, likewise plays, etc., from the B.B.C. studios and theatres. Public personages will similarly be seen by audiences of millions. Sound films, or extracts therefrom, will be periodically presented over the ether, the B.B.C. transmitting these under an amicable arrangement with film-producing interests.

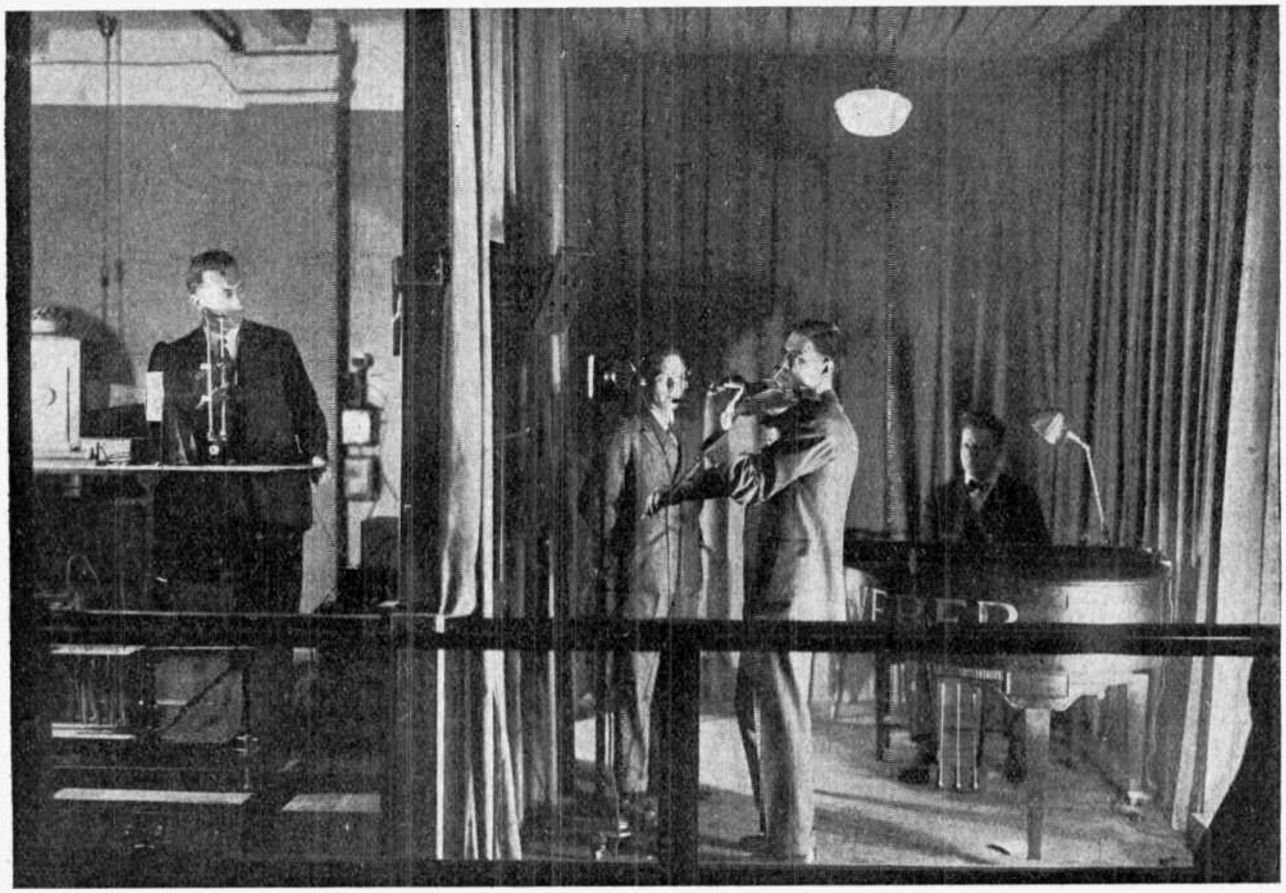
It is unlikely that in so doing that damaging effects will be felt in the film industry any more than the gramophone industry was harmed by the broadcasting of records. It is possible that cinemas will be equipped to enable them to relay broadcast news events to their audiences, although one hesitates to prophesy that there will be a wider application on public screens than this.

All in all, television will provide the necessary adjunct to ordinary broadcasting to supplement the powerful fireside inducement which this exerts over so many of us. An extra luxury will be within reach whose influence will prove to be entirely beneficial in both these and its other applications.

More news: " When talking films are broadcast with the aid of television, one London hotel will be ready to let their guests see and hear whenever they feel so inclined." The guests had better take care in case they are transmitted.

* * *

We are told that the B.B.C. is looking for a wireless programme in the talking-picture world. To train the imaginations of listeners.



A general view of the television studios and transmitting room in New York of the Baird Television Corporation, showing an actual transmission in progress. It will be noted that these studios are arranged in a manner similar to the studio used by the Baird Television Development Company to demonstrate television near Olympia, London, during the period of last year's Radio Exhibition.

High and Low Tension Accumulator Hire and Maintenance

The Romance of a Novel Enterprise

WHEN broadcasting commenced seven years ago one of the biggest difficulties the wireless user had to contend with was the proper and careful charging and maintenance of the accumulators. Expensive accumulators were in many cases ruined in a few months by unskilled charging. Nothing was more annoying to the enthusiast than to find that the accumulator failed him when he had succeeded in securing good reception after hours of patient work.

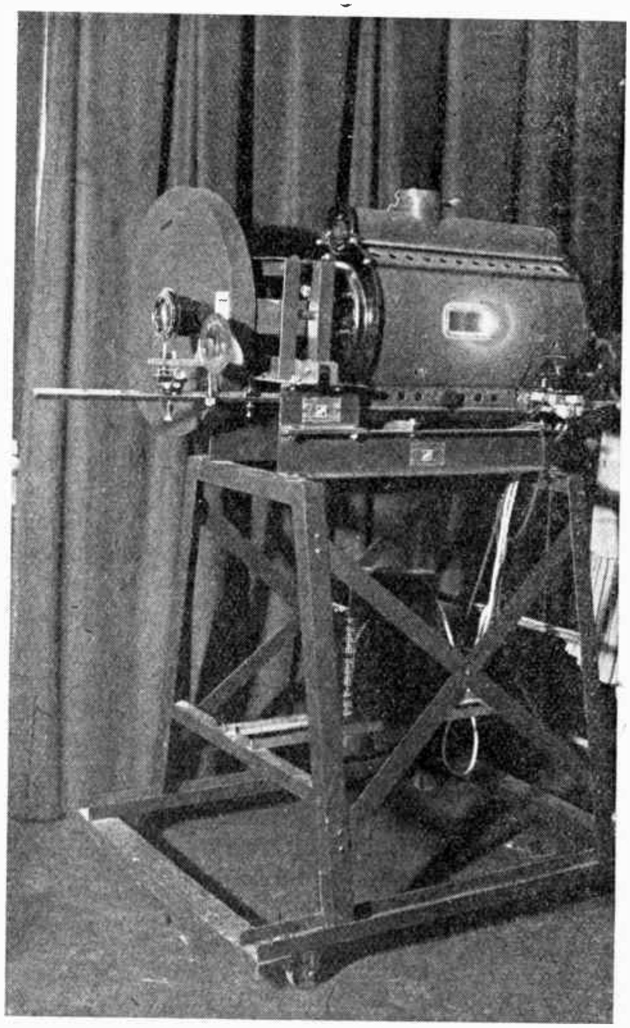
One of these enthusiasts, having experienced the above troubles, conceived the idea of establishing a business devoted entirely to the hire and maintenance of wireless accumulators, at such prices as would show a saving of approximately half the cost of buying one's own accumulators, and having them ruined by unskilled recharging; combined with regular collection and delivery by motor transport in the London area.

Accordingly, small premises were taken in Camden Town, and converted for this purpose. The large number of orders received, immediately proved the urgent need for such a unique service, and at the same time provided the founder with many difficulties to overcome, in order to meet the demands. The primary difficulty was to secure an adequate stock of batteries. This necessitated a tour of many battery manufacturers and agents in London, to purchase their entire stocks irrespective of make or size. The next difficulty was the charging of such a large number of accumulators. Every bank was filled to capacity, charging going on night and day; even the radiator used for heating the office was brought into commission, the batteries being wired up in series with this radiator.

In a very short space of time, larger premises had to be taken, and the firm of Radio Service (London), Ltd., of 105, Torriano Avenue, Camden Road, N.W. 5, came into existence. Every requirement of the wireless user was now provided for, and the delivery radius extended to 12 miles from Charing Cross.

A special type of low tension accumulator was designed purely for use in connection with wireless, and it now became possible to hire any size of these specially designed batteries. In addition, customers having only one accumulator were assured of a continuous supply by joining the part-hire service, having one of the Company's batteries alternately with one of their own. Those who possessed two accumulators secured the benefits of skilled charging and maintenance, coupled with a much longer life of their batteries, in addition to which regular collection and delivery was guaranteed.

About this time a new service was introduced, which improved reception beyond belief, namely, the hire of high tension accumulators in place of unreliable dry batteries. With these accumulators stronger and clearer reception was secured, and all irritating and crackling loud-speaker noises disappeared entirely.



A photograph just received from America showing a new transmitter developed by the Baird Television Corporation of America. Note enclosed disc.

The cost of hiring these accumulators worked out at no more, and in most cases less, than the cost of dry batteries. The inauguration of this service resulted in 1,100 applications being received in two days.

To-day this Company has over 10,000 satisfied subscribers, catered for by the largest battery-charging station in the country; eight large vans deliver daily with practically clockwork precision, making 10,000 calls fortnightly.

In addition to this service, all classes of wireless repair work are carried out with the same care and promptitude. It can be genuinely claimed that this service saves the wireless user both money, time and trouble, and it is the safe and certain way to secure both L.T. and H.T. current. It will also prove invaluable to users of television, where a continuous supply of high and low tension current at a constant voltage is required.

Says a critic: "It is as yet too early to speak in detail of the probable effect of television on entertainment." More opera glasses.

* * *

She: "When a man who bores me asks where I work, I always say 'In a television laboratory.'"

He: "Aha! That shuts him up, I expect. But where do you work?"

She: "In a television laboratory!"

FORTHCOMING LECTURES.

Lectures on television will be given as follows during the month of February:—

Mr. J. J. Denton, A.M.I.E.E., Joint Hon. Secretary of the Television Society.

February 26th.—Conway Hall, Red Lion Square, W.C.2.

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

Feb. 6th.—Beacon Hill Village Club, Hindhead, Surrey, at 8 p.m.
Feb. 10th.—St. Mary's Hall, Coventry, at 8 p.m.
Feb. 11th.—The Institute, West Bromwich, Staffs., at 7.30 p.m.
Feb. 13th.—Moseley and Balsall Heath Institute, Moseley, near Birmingham, at 7.30 p.m.
Feb. 14th.—The Co-operative Hall, Fleetwood, Lancs., at 7.30 p.m.
Feb. 19th.—New Church Sunday School, Accrington, Lancs., at 7.30 p.m.
Feb. 25th.—Y.M.C.A., Aberdeen, at 8 p.m.
Feb. 26th.—Parish Hall, Elgin, Morayshire, at 8 p.m.
Feb. 28th.—Town Hall, Dingwall, Ross-shire, at 8 p.m.

Letters to the Editor

APPRECIATION FROM AMERICA.

To TELEVISION PRESS, LTD.,
26, CHARING CROSS ROAD,
LONDON, W.C. 2, ENGLAND.

GENTLEMEN,–I ran across your magazine, TELEVISION for November, in a local news stand, and really enjoyed it very much. It is the first British magazine on the subject of television I have seen. Being a radio service man for eight years, I am naturally an ardent student of television. I raid the news stand for any book on it, which are very few here.

Television is progressing fairly well here. So far it is worked on short waves only, between 40 and 150 meters. Sometimes it comes through on the regular wave band, but it is always during working hours, so I haven't had a chance to try my own outfit yet. The nearest station to me is in the city of Chicago, sixty miles away. They put on a test once in a while. There is not enough television transmission available here in the mid-western states for us to experiment on, as yet, but I hope they do soon.

I intend to construct an experimental station of my own for my own use. I am looking forward to new issues of your magazine. I remain,

Yours truly,
D. L. GILBERT.

681, N. Harrison Avenue,
Kankakee, Illinois, U.S.A.

OUR NEW COVER.

To the Editor of TELEVISION.

DEAR SIR,—As a recent reader of this paper I should like to congratulate you on your new cover design.

My interest in television was first roused when I visited the Berlin Radio Exhibition last September and saw various methods of television there. Since then I have been an ardent reader of your valuable paper. I always look forward to the next number of this magazine with great eagerness, and I only wish that TELEVISION would appear weekly instead of monthly.

I am, yours truly,
ERNEST H. TRAUB.

Fernhill, 34, Dartmouth Road,
London, N.W. 2.
January 13th, 1930.

To the Editor of TELEVISION.

DEAR SIR,—As I could not find TELEVISION for January upon the stall of my newsagent, I asked the youth in charge for a copy of it. "Why, sir," he said, "there's a copy right before your eyes," and indeed he was right. For what I saw now was not a new, lurid-covered, boys' scientific journal, such as, for instance, "Amazing Stories," "Scientific Adventures," etc., but TELEVISION with a new cover.

But, seriously, do you intend to keep this cover (well meant, no doubt), hoping to attract all and sundry with such a picture? Frankly, I consider the former cover times over again much better. Indeed, the original cover was designed by a genius, so softly shaded, with the stage in the background and the televisor in the foreground, conveying a sense of space, bridged. Anyway, what matter the cover if what is underneath is worth reading, but really . . . .

Yours well meaningly,
H. MILLER.

P.S.—The first thing I did was to tear off the new cover. No, not to frame it!

190, Rock Avenue,
Gillingham, Kent.
January 7th, 1930.

NAME OF A NAME!

To the Editor of TELEVISION.

DEAR SIR,—With reference to applying a name to the radio-television-gramophone set referred to in your December number, may I raise a protest against the objectionable word Gravideorad.

I venture to propose Radiographoscope, as being more suitable, pleasant-sounding, and etymologically permissible. Its derivation is simple and requires no explanation, and contains but one more syllable and five more letters than the other word.

Gravideorad, on the other hand, is a harsh and ugly word, and contains two hideous abbreviations, with a spun-out word in the middle; it has no proportion, and a syncopated balance which is untrue.

Television is a very badly-named science in every way, but that can be put right in time, if only we spend a moment's thought and a little trouble in choosing a pleasant name instead of illiterately grabbing at some harsh, vulgar and impermissible noise.

I am, yours very sincerely,
A. J. C. SHERED, S.M., Iv.S.

Dundaff Muir, Camberley,
Surrey.
January 7th, 1930.

To the Editor of TELEVISION.

DEAR SIR,—In answer to your request for a name for the gramophone-television-wireless set, I offer my suggestion Gramoradioviser, as being a name which would be understood by the man in the street.

Yours truly,

L. ROSEWORTHY.

20, Queen's Road,
Walthamstow, London, E. 17.

January 8th, 1930.

To the Editor of TELEVISION.

DEAR SIR,—Might I suggest "Gradivid"—Gra (gramo.), radi (radio), vid (video, I see)—for the instrument in question.

Yours truly,

C. SKELLY.

Y.M.C.A., Dale End,
Birmingham.

To the Editor of TELEVISION.

DEAR SIR,—You may be interested to know that I am successfully receiving the Baird transmissions of television broadcast twice weekly from Brookman's Park on a home-made television receiver.

My success is due in a large measure to the very excellent articles published from time to time in your journal and to experimental work on my own account.

I may also add (for perhaps the assistance of other experimenters) that I find it unnecessary for experimental purposes to purchase a special neon lamp, but I am using with great success an ordinary commercial Osram figure "8" type neon lamp, and by reflecting back the glow from the reverse side of the plate with a cheap concave mirror I am able to "fill up" the slots forming the "8," thus giving to all intents and purposes the appearance of a flat glowing plate.

By this simple device I am enabled to get very good detail and a bright image, the smoke from a cigarette, held by the person being televised, being clearly visible.

I am endeavouring to photograph my received image, and, if successful, I will forward a print to you.

Yours faithfully,

A. R. KNIPE.

5, Southsea Avenue,
Leigh-on-Sea.

January 19th, 1930.

To the Editor of TELEVISION.

DEAR SIR,—I have read with great interest the article on "The Polarisation of Electro-Magnetic Waves" by your contributor, Mr. Smith-Rose, in your issue of January, 1930.

I think however, that your readers should be informed that his conclusions on page 533, viz., "that horizontally polarised waves can be transmitted over the earth's surface only with difficulty, if at all, and that the effect of such waves is entirely negligible compared with the effect of any vertically polarised waves emanating from the same transmitter," are at variance with the experiments carried out by Dr. Alexanderson, and also those by the United States Department of Scientific Research.

Dr. Alexanderson found that the horizontal radiation gave better service in the zone from 60 to 250 miles from Schenectady, whilst at greater distances the vertical antenna radiation was more satisfactory.

The U.S. Department of Scientific Research extended the experiments to the longer waves up to 15,000 metres, and found that in certain circumstances a plane polarised wave may be transformed to an elliptically polarised wave, this being, of course, due to the presence of two components out of phase.

You would, I feel certain, wish that your readers should be in possession of all available data on the subject, hence this letter.

Yours faithfully,

C. G. PHILP.

Television Demonstrations in Glasgow

The First Scottish Electrical, Wireless, Engineering, Musical, Photographic and General Trades Exhibition will be held in the Kelvin Hall, Glasgow, between January 29th and February 8th, 1930. The exhibition will be opened by Lady Inverclyde.

This exhibition, being the first of its kind, will be of great interest to our Scottish readers, and more especially so in view of the fact that the Organiser, Mr. John R. Mungo, has arranged with the Baird Television Development Company to give demonstrations of television in the Kelvin Hall during the period of the exhibition.

At the meeting of the British Association held in Glasgow in September, 1928, Mr. Baird personally demonstrated to members of the Association his two latest scientific achievements, stereoscopic television and colour television. The forthcoming exhibition however, will be more especially noteworthy in that it will provide the first opportunity for the citizens of Glasgow to witness commercial television.

We understand that the television demonstrations will be open to members of the public at certain specified times daily, and as only a limited number of people can be accommodated, the exhibition authorities have decided to make a charge of sixpence per head for admission.

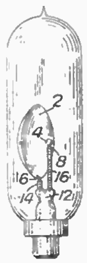
Lord Angus Kennedy, Vice-President of the Television Society, will be present at the exhibition.

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.

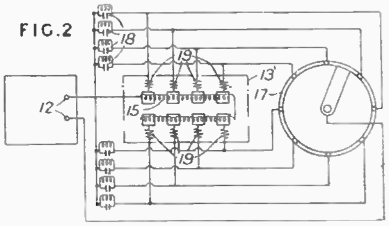
SEVERAL enquiries having come to the writer of these Notes regarding Patent No. 316,340 (November TELEVISION), all of which request further information, it should be stated that the abstract was prepared from the available information published, and was inserted in these Notes in the hope that some reader would be able to elucidate the various points which seemed obscure. For any further information the reader is referred to the full published patent specification.

FIG. 1.



Patent No. 321,196, granted to J. L. BAIRD and TELEVISION, LTD. Fig. 1 shows a neon discharge tube having a concave reflecting anode (2) and a ball-shaped cathode (4), the latter being situated approximately at the focus of the reflector. Conducting supports (6) (8) for the electrodes are insulated above the pinch (12) by glass tubes (14) (16). In a modification, a rod-shaped cathode is situated in the axial focus of a part-cylindrical anode, which is secured by three supports. To concentrate the glow upon the front of the reflecting anode, the back of the latter may be coated with an insulating material such as mica or micanite, which may be secured by metallic clips. When used with television apparatus, the reflecting anode may be larger than the viewing aperture.

FIG. 2



Patent No. 321,194, granted to J. JOHNSTON. To prolong the illumination of neon or other lamps forming a receiving screen (13) in Fig. 2, after the received impulses have been distributed by the commutator ring (17), each lamp is provided with a shunt reactance element such as a condenser (18), with or without an inductance in parallel with this condenser, and with or without a resistance (19). One terminal (12) of the receiving apparatus, such as a valve amplifier, is connected to a common lamp electrode (15). Certain areas of the screen may be scanned at different frequencies.

Patent No. 321,138, granted to J. L. BAIRD and TELEVISION, LTD. The scanning devices at the transmitter and receiver of a television apparatus are run so that the speed of one is a sub-multiple of the speed of the other. If the scanning mechanisms are identical, and the speed of the receiver is a sub-multiple of that of the transmitter,

FIG. 3.

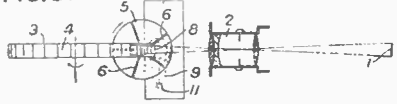
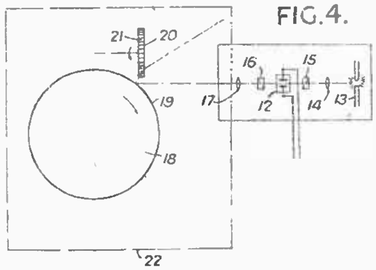


FIG. 4.



multiple images are formed at the receiver, all but one of which may be masked out. On the other hand, the receiving mechanism may have the appropriate number of complete sets of light-apertures so that a single reduced image of equivalent detail to that transmitted is reproduced at the receiver.

Patent No. 320,999, granted to J. S. SHINTON. In a television transmitter (Fig. 3) images are intermittently reflected on to a selector device, comprising a stationary slot and a rotating slotted disc. The image of an object (1) is projected by a lens (2) on to the edge of a rotating wheel (3) having a number of mirrors (4) arranged tangential to the rim and parallel to the axis of rotation. As the wheel rotates, each mirror reflects and focusses the image on a disc (5), rotating about an axis perpendicular to that of the wheel, and provided with radial or other slits (6) overlapping a slot (8) in a fixed member (7). Behind this member is a light-sensitive cell (9). It is stated that wheel (3) may rotate at 2,000 revolutions per minute, and disc (5) may have five slits and rotate

FIG. 5.

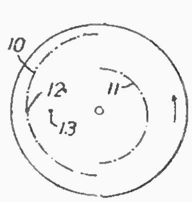
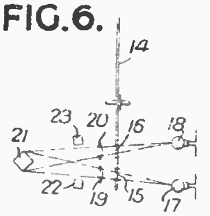


FIG. 6.

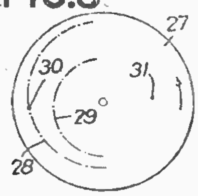


at 60 revolutions per minute. The receiver is shown in Fig. 4. Light from a source (13) passes through a lens (14), polarising Nicol (15), Kerr cell (12), analysing Nicol (16) and lens (17) on to a wheel (18) similar to that at the transmitter. The output of the photo-cell (9) is applied to the plates of the Kerr cell. Modulated light-signals are reflected by the tangentially arranged mirrors (19) on wheel (18) to further mirrors (21) on the edge of wheel (20) (which is rotating about an axis perpendicular to the former wheel) and thence to a receiving screen (22). The wheel (20) may have 30 mirrors and rotate at 10 revolutions per second.

Patent No. 321,389, granted to J. L. BAIRD and TELEVISION, LTD. Details are given in this patent specification of the system used for producing images in natural colour by using a number of light-sensitive cells of different colour sensitivity, and a number of correspondingly coloured lamps at the receiver,

FIG. 7.

FIG. 8.



the correct re-combination of colours being secured by an arrangement of slip rings and commutator.

Patent No. 321,441, granted to J. L. BAIRD and TELEVISION, LTD. In stereoscopic television, two aspects of an object or scene are transmitted successively through a single communication channel and reproduced side by side at the receiver, some 12 images of each aspect being sent per second. The scanning disc (14), Figs. 6 and 7, is provided with two sets of holes (10) and (11) shown in Fig. 5, lying on spirals whose "operative points" are (12) and (13) respectively, and which are spaced any desired distance apart, as for example, the spacing of the human eyes. In the transmitter (Fig. 6) the light-sources (17) (18) scan the object (21) alternately through the spirals (10) (11) from a different angle. Light reflected from the object is received by the light-sensitive cells (22) (23). At the receiver (shown in Fig. 7) glow discharge lamps (24) (25), used in conjunction with an identical scanning disc (14), produce two images in alternation which are side by side, and are viewed by a stereoscope (26). Exaggerated stereoscopic effects may be obtained by using scanning discs of the type shown in Fig. 8, where (30) (31) are the widely spaced "operative points" of the spirals. Colour effects can be obtained by using a red and blue filter, one on each set of holes. Details are given in the specification for using a three-colour process.

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