SERIES II.
Vol. I. Part IV.

March, 1932

JOURNAL OF THE TELEVISION SOCIETY

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Published by

THE TELEVISION SOCIETY

PRICE FIVE SHILLINGS NET

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*Recent Advances in Television**

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

SUMMARY.

1.—General introduction, giving a brief outline of the principles involved in television.

2.—Tracing the growth of the present television broadcast service, which was inaugurated in September, 1929, for vision only, and March, 1930, for dual sound and vision. Extended scenes.

3.—Zone television, its advantages and disadvantages.

4.—Daylight television, and recent outstanding demonstrations in connection with same, including the Derby.

5.—Television on a large screen. Comparisons between the Baird developments of the lamp screen, Kerr Cell, and the Baird television arc.

GROWTH OF TELEVISION BROADCAST SERVICE.

EARLY in 1929 the Baird Company gave a demonstration of television through the old 2LO station before a representative Committee of the engineers of the Post Office and B.B.C. and Members of Parliament. Television was received on portable " Televisors," both at the Post Office and at Savoy Hill, no separate synchronising signal being transmitted, and only the ordinary broadcast service channel as used for speech being employed.

This established once and for all that television could be broadcast under commercial conditions, and the demonstration was hailed by the Postmaster-General and his Committee as a " noteworthy scientific achievement." This led up to the successful conclusion of the lengthy negotiations between the B.B.C. and the Baird Company for an experimental television service through 2LO, and this was inaugurated on September 30th, 1929. This was for vision only, as on that date the present Brookman's Park transmitter was unfinished, and during the inaugural ceremony it was necessary to transmit first of all speech and afterwards the vision of each individual speaker and artiste.

This single service of vision alone ran for seven months, and on March 30th, 1930, dual sound and vision made its bow to the public from the completed Brookman's Park twin transmitting stations.

Originally the control room and studio situated at the Baird Company's premises at Long Acre were of rather small dimensions, and it soon became apparent that, if the service of television was to be maintained at a high standard, it would be necessary to increase both the size of the studio and the control room. This was done and has been in use for several months now.

There are two transmitters employed, one a light-spot disc model somewhat similar to the early pattern of transmitting tables used by the Baird Company, except that it is now possible to " swing the light beam " vertically and horizontally as required in order to follow the movement of the artistes.

This particular transmitter is utilised for the familiar close-ups, that is the head and shoulder images. In the early days of television broadcasting it was felt that from the entertainment point of view a great deal was missing, owing to the inability to transmit full-length images.

* Extracts from a paper read at the opening meeting of the Session on Wed., Oct. 14th, 1931, at University College, London.

Intensive research work has, however, enabled the Baird Company to develop this side of their service, and in the control room there is now a mirror-drum transmitter which is employed for semi-extended and extended scenes, it being also possible, as in the case of the light-spot disc model, to follow the movement of the artistes when such a course is necessary.

During the transition stage from one type of scene to another, a synchronising signal is radiated on the vision wave-length, so as to enable lookers-in to maintain their vision apparatus in synchronism, both phase and frame, and thus be ready immediately for the next scene without having to adjust motor speed, etc. This is a big advantage, and avoids any break in the continuity of the programme from the receiving end. In addition, in order to assure lookers-in that the television transmission has not failed while this change-over is made, some gramophone records are transmitted on the sound wavelength, this being faded out as soon as the television transmission is ready to re-continue.

EXTENDED SCENES.

In the early days many of the critics passed uncomplimentary remarks, and frequently these were based on the fact that a head and shoulder image, after the first interest had worn off, presented very little entertainment value. To a certain extent this criticism was justified, inasmuch as it restricted the nature of the broadcast. It was possible, however, to exploit this close-up in such a manner that it produced some really interesting transmissions, as witness the televising of "The Man with the Flower in his Mouth," in July, 1930, with the co-operation of the B.B.C. In addition, small sketches in which only one artiste had to appear at a time were successfully produced, and another transmission which proved successful was the Marionette Players.

The whole technique has altered, however, now that extended scenes are possible. No longer need the activities of the Studio Director be confined to close-up views, for he can show full-length images of the artistes. This extended scene has proved most popular, and to give an idea of the type of entertainment which can now be put over quite successfully, I can mention that, in addition to sketches with two or three artistes complete with stage properties, lookers-in have an opportunity of watching ballet, cabaret and Scotch dancing, tap, buck and wing dancing, classical dances, illustrations on how to play tennis, cricket and badminton, hints on physical culture, ju-jitsu, etc. Furthermore, there are illustrated talks in which the demonstrator can show models; while another popular turn is to watch the pianist at the piano, both piano and pianist being in full view of the looker-in. A few days ago three short rounds of a boxing match provided excellent entertainment; and, according to reports received, this came over remarkably well.

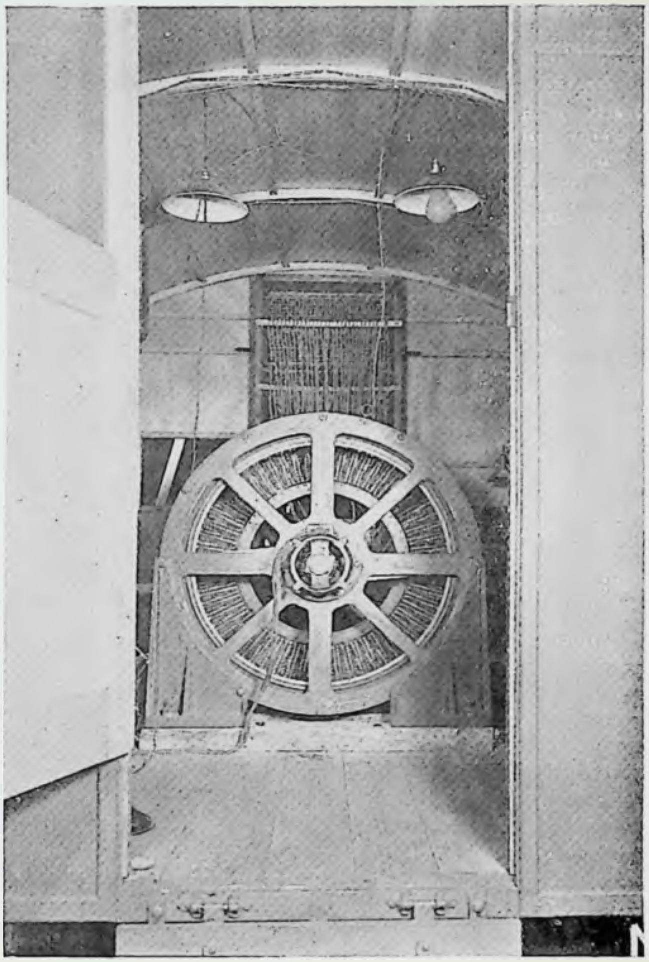

FIG. 1—Inside the Lamp Screen Caravan, showing the Commutator Switch.

I could continue to add to this string of successful extended scene transmissions, but I think enough has been said to convince the most rooted sceptic that television has, as a form of entertainment, finally established itself, and will continue to progress together with the development of the new technique which has arisen inevitably from the point of view of producing these television plays, and we can look forward with confidence, happy in the knowledge that the art will grow apace.

LARGE SCREEN PROJECTION.

The next point that I want to take up is television on a large screen. Dealing with the subject generally, we are justified in saying that, at present, there are three primary methods for projecting images upon a large screen.

The first method which was shown by the American Telephone and Telegraph Company in 1927 consisted of a screen built up from a continuous neon tube, different areas of which were activated in sequence by means of a commutator.

The second method was demonstrated in England by Mr. Baird, in America by the G.E.C., and in Germany by the Telefunken Company, and depended upon the projection of a spot of light on to a screen, the spot of light being made to traverse the screen by means of one of the usual forms of scanning device.

The third method consists of the now famous bank of lamps, and is fundamentally different from the two preceding methods. In the bank of lamps we had a receiving screen built up from 2,100 tiny metal filament lamps, each lamp being set in a cubicle so that the screen resembled somewhat a gigantic honeycomb with 2,100 cells, the centre of each being the small electric lamp. In front of these cells was a sheet of ground glass, while each lamp was connected to a separate bar of a gigantic commutator whose function was to switch on only one lamp at a time, and as the contact of the commutator revolved each of the lamps was switched on in succession. The whole of the 2,100 lamps were switched on and off in just over one-twelfth of a second, and, since the selector brush revolves at 750 revolutions per minute, it will be seen that 26,250 contacts are made every second.

In operation, the incoming television signal is first of all amplified, and this powerful current is then fed to the revolving commutator, where the lamp switching takes place. As in normal television working, the current is strong at the bright parts of the image and weak at the dim parts, so that the small lamps are bright or dim accordingly, and the image is evolved or built up from this mosaic of bright and dim lamps, and of course the intermediate shades.

Of these three methods, the first has the disadvantage of expense, while the second method has the advantage of comparatively simple construction, but in the early days suffered from the disadvantage that it was difficult to obtain sufficient brilliance adequately to illuminate a large screen. This, however, has been counteracted by Mr. Baird's latest invention, the modulated arc, about which I shall have more to say later on.

The third method has the disadvantage of expensive construction, but the advantage that any degree of illumination up to the most intense brilliance can be secured, and also the further advantage that I mentioned a few moments ago, that owing to the phenomenon of illumination persistence, image flicker can be greatly reduced.

FIG. 2—This photograph gives an excellent impression of how the artiste appeared on the Baird Lamp Screen when it was shown at Stockholm.

The lamp screen was designed originally to receive the standard Baird transmissions now being sent out through the B.B.C., and as these transmissions are limited by regulations governing sound transmissions, the screen had, accordingly, only a limited number of lamps. There is nothing, however, to prevent a screen of any desired magnitude being built for theatrical or other purposes, and it is a public fact that the Baird Company built up a lamp screen using twice the number of lamps for experimental purposes.

Brilliancy of the screen will become a more acute question as the quality of the transmission channels improves, since the greater the number of elements the picture contains the less is the brilliancy where a travelling light-spot is employed. This is because the light-spot becomes proportionately smaller in relation to the screen as the number of elemental areas contained in the picture increases.

ZONE METHODS.

One way of overcoming this particular difficulty is to transmit the picture in zones, using a plurality of light-spots, but the complexity of this method for wireless purposes is a serious practical drawback. Where landlines are concerned, however, there is no difficulty in transmitting a series of zones.

On January 2nd, 1931, three zone television apparatus were demonstrated to the Press at the Baird Laboratories. The images were shown projected on to a small glass screen, and full-length figures of as many as eight persons were seen, together with an impromptu tea party, a boxing match, and demonstrations of cricket strokes. These pictures were made up of three sections transmitted side by side, and an examination of the transmitter revealed the fact that its essentials were a large mirror-drum with 30 mirrors which, revolving rapidly, caused a succession of images to be moved over three different apertures admitting light to three separate photo-electric cells. Each of these cells transmitted one-third of the total scene, the picture being split up into three adjacent zones.

At the receiving end was an apparatus arranged so that the light from three neon tubes was controlled by the current from the corresponding cells at the transmitter. Spots of light from these neon tubes were made to traverse the ground-glass screen building up an image of the scene in front of the transmitter. In effect, there is really no limit to the number of zones that can be utilised in this way. Obviously, the larger the picture the greater the number of zones, and unfortunately the greater the complication and the expense.

These last two items are, however, not serious matters where a public service, such as a theatre, is concerned, and it is for this purpose that zone television, in its present form, is primarily adaptable. It is noteworthy to record that the system was described in one of Mr. Baird's patents taken out as far back as 1925, but has only recently been developed, as it is unsuitable for wireless broadcasting since several communicating channels are required.

DAYLIGHT SCENES BROADCAST.

The apparatus which was demonstrated had one rather noteworthy feature, an ordinary flood-light was used in place of the moving light-spot with which we are so familiar. This suggests immediately the great advantage that the demonstration another development made its appearance in the form of daylight television.

The first daylight television demonstration was made as far back as June, 1928, but the apparatus employed then differed considerably from that used in the later experiments. It was on Friday, May 8th, that an actual street scene was transmitted by television. Unfortunately the weather was of the

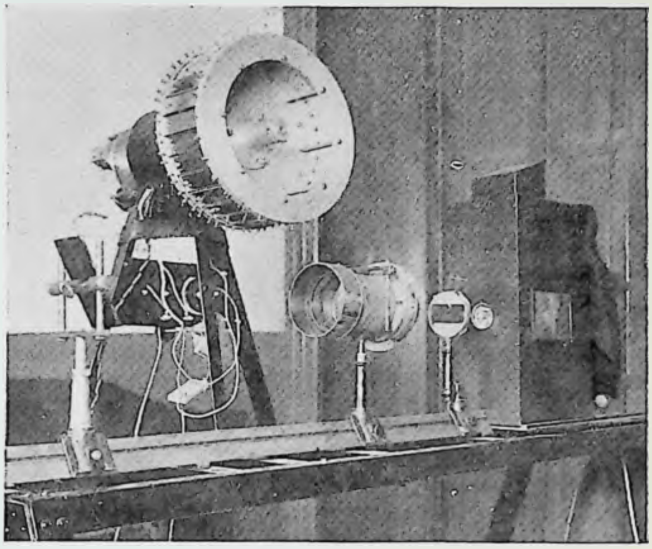

FIG. 3—The optical side of the Baird modulated arc apparatus, showing the mirror drum, lenses, etc.

apparatus can be used with ordinary daylight, and no doubt members of the audience will remember that a short time after this zone television usual fickle character associated with that month, but even with an overcast sky it was possible to see Covent Garden porters, policemen, and the usual business people walking up and down Long Acre in the small screen of the Baird commercial "Televisor."

The transmitting apparatus was housed in a grey caravan, and from the van's open door the scene was picked up through the medium of a mirror-drum revolving at a speed of 750 revolutions per minute. By this means a succession of images of the scene being transmitted was projected upon a special photo-electric cell, and in this way a conversion into an equivalent form of varying electric current was effected.

A few days prior to this an experimental transmission was made through the B.B.C. of a scene on the roof of Long Acre, and it reflects great credit upon the Baird Company's engineers that they were able to concentrate on this apparatus and perfect it in such a manner that it was capable of producing these daylight scenes. No doubt the audience will recall that in the early days of Baird television, it was pointed out that the application of the principles would enable such scenes as the Derby to be televised, and critics used this fact to pour scorn on the whole scheme. But June, 1931, saw that promise fulfilled.

This was the first experiment of its kind to be made in the history of the science, and was carried out by the Baird Company in conjunction with the B.B.C. By the side of the rails at Epsom, opposite to the Grand Stand, the same caravan was erected on a wooden stand, and it was possible on that great day to see the parade of the horses, first in one direction, then in the other, and finally watch both horses and jockeys flash by the winning-post.

To secure a change of vista, a very ingeniously contrived mirror was fitted on the caravan side farthermost from the course, and, when turned, this reflected different pictures of the adjacent activities. It was these reflected images that were scanned by the revolving mirror-drum. Housed in the caravan were powerful amplifiers, which handed on the vision signal to Post Office lines passing under the racecourse, and were then linked up to other lines passing through to Long Acre. From thence they passed to Savoy Hill, from Savoy Hill to Brookman's Park, and were finally broadcast into the ether to be received and watched by anyone possessing a "Televisor."

THE KERR CELL and MODULATED ARC.

Let me now pass to Mr. Baird's latest invention, namely the modulated arc. To anyone interested in television it has been apparent for some time past that if the scope and size of television images are to be increased to any appreciable extent, a more powerful source of modulating light had to be evolved. A television image is, in effect, really built up from a single small spot flying across the screen so rapidly that the eye does not dwell on the mechanism of the process, but receives the impression of an evenly illuminated area.

It is obvious, therefore, that the spot must be of great intensity, and whereas the present area of the spot in the Baird image is two thousand one hundredth of the screen, if the detail is to be increased this ratio will go up proportionately, as will the necessary intrinsic brilliancy of the spot. Apart from the lamp screen, only two forms of light have been used for television with any success. These are the neon tube with its comparatively faint red glow, with which you are all no doubt familiar, while the other device is known as the Kerr cell. In the case of the Kerr cell, although this has been working in the Baird Laboratories for some time past, it is not yet of the highest efficiency.

The light from an arc is first polarised by a Nicol prism, and then is passed between two metal plates immersed in nitro-benzene. If this resultant Kerr cell is followed by a Nicol prism crossed with respect to the first prism, no light will pass, but should a potential be applied to the plates of the cell a rotation of light is secured, causing it to pass through the second prism. In this way, the arrangement becomes in effect a light valve, but, since only about 20 per cent. of the light actually gets through this system, the remainder being absorbed in the cell and prisms, it will be appreciated that in the present state of the art this does not afford the best solution to our problem.

Now, the most intense light source known is the electric arc, and this form of illumination immediately suggests itself, but when one tries to put it into practice it is found that the simple arc is not capable of varying its intensity with anything like sufficient rapidity for our purposes. The work of Duddell and Ruhmer in connection with varying the light of an arc in proportion to speech currents from a microphone is, no doubt, familiar to most of you, but it has remained for the staff of the Baird Television Laboratories to evolve a new form of arc which can be modulated over a sufficiently wide frequency band, and with the necessary consistency and accuracy, to make it suitable for television purposes.

This has now been done, and it is possible with the modulated arc to obtain a brilliantly illuminated image which can be projected successfully on to a large screen.

This was demonstrated publicly for the first time last month at the British Association Meeting in the section devoted to Mechanical Aids to Learning.

The public were at liberty to examine both receiving and transmitting apparatus, the latter taking the form of a standard light-spot transmitter to which I made reference earlier in this lecture. At the transmitting end behind the screen was seen the mirror drum with each of its thirty mirrors set at a slightly different angle from the preceding one. Before this drum was a lens concentrating the light from the Baird modulated arc on to the mirrors, and, as the drum revolved, the light-spot was made to traverse a screen in a succession of 30 parallel lines, the light from the arc lamp flickering in and out corresponding to the light and shade of the image, being bright at the high lights and dim at the shadows, the whole process being really in principle very similar to that of the ordinary Baird "Televisor."

Since the arc equipment was arranged parallel to the screen, it was necessary to include a large mirror to turn the light beam through an angle of

90 degrees. I regret that the present moment is not opportune to dwell further on this most important invention, but I hope that at some later date I shall have the privilege of giving complete details. Suffice it to say that, having solved the very acute problem of a powerful light source which can be modulated successfully for television purposes, it is reasonable to hope that further development will be rapid, for the brilliancy question is one that has hitherto stood in the way of successfully projecting television images directly upon a large screen.

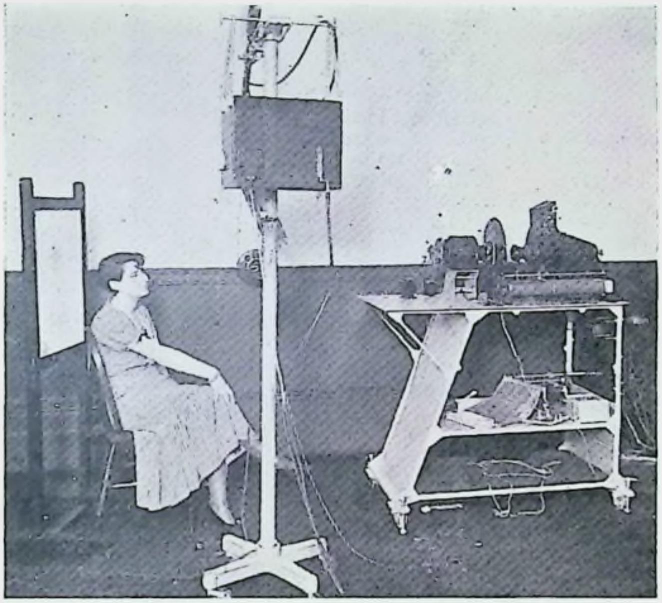

FIG. 4—At the transmitting end, a Baird light-spot transmitter was used to send signals to the modulated arc.

TELEVISION AND THE B.B.C.

There are just one or two other items I should like to mention before concluding this lecture. The first is the much closer co-operation which now exists between the B.B.C. and the Baird Company.

A portable transmitter was installed in No. 10 Studio some months ago, and was used on several occasions for transmitting television images direct from that building. The success achieved in that direction is reflected in the announcement which was made public a few days ago, namely that television at long last is to come within programme hours.

Starting from to-morrow night, Thursday, there will be a weekly half-hour transmission from No. 7 Studio at Savoy Hill, this transmission commencing at 10.50 p.m. The first subject to be televised will be Jack Payne conducting his B.B.C. Dance Band. In this connection it should be noted that since the usual broadcast of Jack Payne's Dance Band takes place on the London Regional wavelength of 356 metres, the accompanying vision will be broadcast on the London National wavelength of 261 metres.

This transmission, which it is hoped will be extended in the very near future, will take the place of the two previous weekly midnight transmissions, and should serve to stimulate an enormous interest owing to the improvement in the time question.

In addition, experiments are now being made by the Baird Company, in conjunction with the B.B.C. engineers to ascertain whether the landline link can be used to convey the television signal in sufficient strength and purity to enable the North Regional Station at Slaithwaite to repeat the television transmissions of Brookman's Park.

These tests are now well in hand, and I do not think I am betraying a confidence when I say that so far they have proved most promising. This will afford television enthusiasts in the North of England an opportunity for pursuing their hobby under more favourable conditions than have hitherto existed as, according to reports which I have seen, the London Regional Station does not give the best of results in the northern localities.

In conclusion, I feel it only right to add that a debt of gratitude is due to the Baird Company for having provided a television service free of charge for such a long period of time. I do not propose to discuss questions of finance in television, but I would point out that at present you are getting something for nothing, and if only it was possible for, say, one per cent. of the present B.B.C. licence money to be handed over for television development and service, then progress would be more rapid.

DISCUSSION.

Dr. C. Tierney, the Chairman, thanking the lecturer for a very excellent review of the progress of television in this country, said he thought they might take some amount of just pride in it, for after all Baird was the pioneer of television study, both in its inception and application, and none knew better than the members of the Society the opposition that he had to face all along, both from those who ought to have known better and from those who did not.

It was interesting to know the future that lay before it in connection with its application to our public service of broadcasting.

From what he knew of the recent applications of the Baird modulated arc he could amplify the lecturer's observations and say that progress was likely to be a good deal more rapid than the average person conceived. Those who had not already got vision apparatus installed would certainly be wise to study the matter seriously during the coming session, so that they might take advantage of the broadcast during the somewhat more reasonable hours that were now coming into force.

There was one question he would like to ask, and that was if it was contemplated to apply the modulated arc system to reception in domestic sets apart from public receiving stations? Perhaps, also, Mr. Barton Chapple could give them some idea as to whether any such development was contemplated in the near future.

Mr. Barton Chapple, in reply, said there were a number of developments going forward in the laboratories with the object of finding ways and means of getting more advanced methods of projection in order to make them suitable for what Dr. Tierney called the "domestic apparatus." The problems were not easy of solution and it would be fatal to attempt to put any form of vision apparatus on the market until it had been thoroughly and efficiently tested in order to see that it was going to stand the strain of commercial application. The present Baird domestic model was not the beginning and end, and they could rest assured that intensive development work was taking place in order to produce more advanced models at the earliest possible moment. The nature of those developments he could not at the moment disclose.

Mr. W. G. W. Mitchell congratulated Mr. Barton Chapple on his very interesting survey of the progress made, and said that, like everyone there that evening, he would like to know more about the modulated arc. Was it the crater or the flame of the arc that was focussed on the screen and was any control, magnetic or otherwise, applied to keep the flame centrally placed?

It occurred to him that some of them might have seen the demonstration at the British Association and were perhaps struck with the very "liney" effect on the screen. Personally he did not think that had much to do with the arc, but attributed it to the mirrors. Having seen something of the back of the apparatus, as it was set up on this occasion, he thought 99 per cent. of it was due to the mirrors because the apparatus was mounted on a very unsteady table. He hoped they would not be disappointed in the modulated arc for that reason.

He would like to ask Mr. Barton Chapple whether some such light source as the "Pointolite," which after all was more under control than an open arc, could be modulated in some way or other?

Mr. Barton Chapple, in reply, said Mr. Mitchell was quite right in saying that their difficulties at the British Association meeting were not in the arc but in the optical system, also the mounting of the mirror-drum was not quite right. Unfortunately in experimental work there were a few pieces of apparatus which had to pass from hand to hand. A piece of apparatus could not be allowed to stay "put" for long before someone else wanted it for another job, with the result that by the time it had passed from hand to hand it was not in the same state of efficiency as at the start.

With regard to the Pointolite, theoretically there was no reason why that particular light source should not be perfected. Nearly every lamp had been tried, but he did not regard them as holding out as much promise as the arc. He would like to be able to tell them how it worked. He was not suggesting that he did not know, but they would agree with him that to disclose prematurely the details of an invention which stood a chance of establishing British Television as making one of the biggest advances of the age would be unfair. Later on he would be glad to tell them all about it and if possible give a demonstration.

Mr. H. S. Ryland asked what steps were being taken to overcome the very serious limitation of the frequency band, because that was a very definite limitation. They had no doubt been progressing, but the great obstacle in their road was the frequency band difficulty. After all, in the limit, the dot system of consideration was a true criticism. He looked forward to the day when the whole system of television would be changed.

In the early days of radio telephony they were limited by the crystal, just as in television they were now limited by the frequency band. Their President, Sir Ambrose Fleming, had seen that difficulty and limitation, and it was mainly due to his work on the thermionic valve that we had broadcasting as we knew it to-day. Sooner or later someone would do something for television which would overcome the limitation of the frequency channel, and was analagous to the thermionic valve of Fleming.

Was anything being done in that direction?

He could, said Mr. Barton Chapple, join issue with Mr Ryland on the suggestion that the dot theory was a true analysis of a television image. No doubt they could spend the rest of the evening arguing that point.

With regard to the question of the frequency band, he could say quite definitely that steps were being taken to overcome that difficulty. Several suggestions had been put forward, some of which had been tried. One was to have double or triple spiral discs. Another was to go down on the short waves. Experiments were being conducted by the sister company in Germany, the Fernseh A.G., in order to see what results could be obtained.

Unfortunately they had met rather a bad stumbling block on the short waves through the restriction of the area over which the short waves would serve adequately. If they went down on to the ultra-short waves, then, according to reports so far received, the station must be within direct sight of the transmitting station. For that reason, a short time ago the Crystal Palace towers were mooted as being a possibility for working a transmitter on the ultra-short waves to serve one of the most densely populated areas in London. Experiments on the short waves would be tried out in order to see whether it was possible to increase the frequency side bands to any great extent, for wrapped up in that question was image size, the amount of flicker and the amount of detail.

Under present conditions, if they wanted to overcome the small amount of flicker present with 12½ pictures a second, they would have to give up something else—detail, or be content with a smaller picture. He had seen images by land-line that theoretically required a frequency channel five, six, seven or even ten times that at present used, and they were certainly wonderful images. It was reasonable to hope that by one of those methods they would be able to increase the image size, reduce the flicker and also increase the amount of detail. It was extremely unfortunate that present transmissions had to conform to the nine kilocycles waveband for work in the laboratory also had to be made to conform to that standard. At the moment there was no means of getting a bigger sideband on the broadcast wavelength, although it was hoped that at the convention next year the problem of television would be assessed at its worth and not restricted by the limitations which were imposed for sound broadcasting and were laid down long before television, in the nature of a broadcast service, was thought of.

A vote of thanks to the speaker, coupled with the promise of a very warm welcome when he came to tell them something of the modulated arc and how it worked, concluded the meeting.

Difficulties encountered in Transmitting Pictures over Telephone Circuits*

By E. S. RITTER, M.I.E.E.

SUMMARY.

Production of electrical energy from the light and shade of the picture to be transmitted.

Standard dimensions and speeds of rotation of the picture drum as laid down by the C.C.I.T. at Berne, May, 1931.

Size of the light spot in relation to the rate of rise of current.

The relation between the dimensions of the sending and receiving light spots and the definition of the received picture.

The production of a current suitable for transmission over a telephone circuit.

Two-wire and Four-wire repeatered circuits.

Attenuation and phase distortion; the building up of a sine wave current of various frequencies at the receiving end of a long coil loaded circuit, with and without phase correction. Transmission time.

Carrier current and radio circuit characteristics.

Synchronisation of the sending and receiving apparatus.

Receiving systems and photographic problems.

PRELIMINARY REMARKS.

IN order to make the lecture as simple and easily understood as possible, long mathematical explanations and formulæ relating to the phenomena presented will be avoided.

Both picture transmission and television involve the scanning of the subject in strips, and the sending of electrical energy from the sending apparatus to the receiving apparatus proportional to the light and shade of the subject. In what follows, picture transmission only will be referred to, but it will be seen by those having experience of television transmission that the problems and difficulties involved are very similar.

(1.) THE PRODUCTION OF ELECTRICAL ENERGY FROM THE PICTURE TO BE TRANSMITTED.

The picture to be transmitted in the form of a transparency on film, or a photograph or document on paper, is mounted on a drum, which is rotated on its axis. A spot of light is projected on the drum and the transmitted light in the case of a transparency, or the reflected or scattered light in the case of a photograph, is allowed to fall on the active coating of a photo-cell. The light falling on the photo-cell produces a minute electric current proportional to the amount of light falling on the coating and therefore proportional to the light and shade of the picture to be transmitted.

(2.) THE DIMENSIONS AND SPEED OF ROTATION OF THE PICTURE DRUM RELATIVE TO THE PITCH AND VELOCITY OF SCANNING.

The light spot projected on the drum is moved along the drum axis as the drum rotates, so that the picture is covered in the form of a long spiral or screw thread.

* A Paper presented at the Fourth Meeting of the Session, on February 10th, 1932, at University College, London.

Let :—

p be the pitch of the screw thread or scan in mm., so that $1/p$ is the number of lines or threads per mm.

D millimetres be the diameter of the drum.

C millimetres the drum circumference.

n the revolutions per second of the drum.

L millimetres the length of the drum.

v millimetres per second the scanning velocity.

It therefore follows that :—

The length of the circumference $C = \pi D$ millimetres.

The scanning velocity $v = nC = n\pi D$ millimetres per second.

The area scanned per second may be expressed as :—

$pv = pnC = pn\pi D$ square millimetres per second.

The drum of length L mm. will be completely scanned in L/p revolutions or L/pn seconds.

The relation D/p is known as the modulus of co-operation and picture systems having the same or very nearly the some modulus of co-operation can work together providing the drums have the same speed of revolution per second.

THE C.C.I.T. STANDARD DRUM.

In order to secure co-operative working between the different systems, the Committee Consultative International Telegraphs laid it down at a meeting held at Berne in May, 1931, that amongst other things :—

(1) The standard drum diameter should be 66 mm. (with an alternative of 88 mm.).

(2) The pitch of the scanning should be $5\frac{1}{3}$ lines per mm. for the 66 mm. diameter drum and 4 lines per mm. for the 88 mm. diameter drum.

This makes $p = 3/16 = 0{\cdot}1875$ mm. for the 66 mm. drum;

and $p = 1/4 = 0{\cdot}25$ mm. for the 88 mm. drum.

(3) That the standard speed should be one revolution per second exactly or 60 revolutions per minute. Should other speeds be required then they should be 20, 40, 80 revolutions per minute, and higher speeds should be integral multiples of 60 revolutions per minute.

(4) For transmission over light loaded telephone lines, the carrier frequency should be approximately 1300 cycles per second, and the highest modulation frequency should not exceed 550 cycles per second. The essential transmission frequencies thus extend from 750 to 1850 cycles per second.

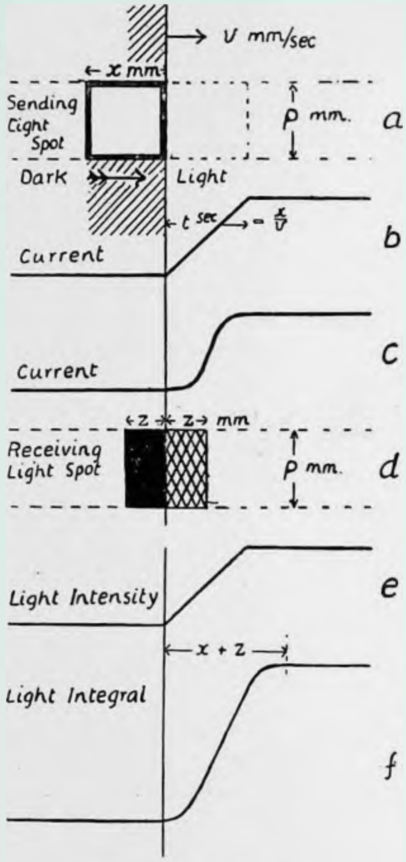

FIG. 1—(a), (b)......(f).

(5) The standard picture sizes should not be greater than 180 mm. × 130 mm. for the 66 mm. drum and 250 mm. × 180 mm. for the 88 mm. drum. This allows a certain tolerance on the circumference for the clips, etc.

Tables I and II. gives particulars of the sizes, scanning velocities, etc., of the two C.C.I.T. sizes of drum.

TABLE I.

Sizes, Speed of Transmission, etc. of C.C.I.T. Standard Picture Drums, as agreed at Berne, May, 1931.

Specified.	Standard Drum	Alternative Drum.
Diameter D	66 mm.	88 mm.
Screen $\frac{I}{p}$ Revolutions of drum per millimetre of traverse ...	5⅓	4
Modulus of Co-operation $\frac{D}{p}$ ...	352	352
Revolutions per min. of drum $= 60_n$	60	60
Other speeds if required should be 20, 40 or 80, or integral multiples of 60 revolutions per min.		
Comparison frequency sent over the line for synchronisation (cycles per sec.)	1020	1020
Accuracy of synchronisation after adjustment	1 in 10^5	1 in 10_6
Length of Drum—Not less than twice the diameter, L not less than $2D$		
Standard Picture—Width in direction of Scanning ...	180 mm.	*(240) mm.
Length along axis Millimetres ...	130	*(173)
Carrier frequency—Cycles per sec.	about 1300	about 1300
Maximum Modulation frequency—Cycles per sec.	550	550

* Note—The figures in brackets show the size the picture would be if sent from the smaller and received on the larger drum. That is a linear enlargement in the ratio of 3 to 4. The standard size on the larger drum is 250 by 180 mm. respectively, which would be received on the smaller drum as a picture 187 by 135 mm.

TABLE II.

Derived and Calculated Figures.

Derived.	Standard Drum.	Alternative Drum.
Pitch of traverse p millimetres per revolution	0·1875	0·25
Drum Circumference $C = \pi D$ millimetres...	208	276
Scanning Velocity $v = nC = n\pi D$ millimetres per second at the standard speed of 60 revolutions per minute	208	276
Drum area scanned per second at the standard speed. Square millimetres $vp = nCp = n\pi Dp$	39	69
Length in mm. scanned per half cycle of carrier current	0·08	0·10
Length in millimetres scanned per half cycle of modulation frequency	0·188	0·25
(Note—This is approximately equal to p)		
Time of transmission of full drum in minutes $\frac{L}{60pn}$		
when $L = 130$ mm. Standard Drum	11·6	
$L = 180$ mm. Alternative Drum		12
Total length of scan in metres $\frac{CL}{1000p}$ ...	143·5	198·5
Skew of received picture in millimetres per 100 millimetres length of drum for a speed difference of 1 in 100,000	1·1	1·1

(3.) THE SIZE OF THE LIGHT SPOT AND ITS RELATION TO THE RATE OF RISE OF CURRENT IN THE CIRCUIT.

The height of the light spot should be equal to the pitch of the scanning lines, or p mm. Let the breadth, or the dimension in the direction of the scanning, be x mm. The illumination as a first approximation will be considered constant over the area of the spot. In practice the illumination is not constant owing to fringing of the light at the edges, etc., the illumination increasing from nothing outside the spot to a more or less uniform value near the centre.

Fig. 1 (*a*) represents a light spot passing from a black portion of a picture to a white portion, the junction of the black and white part being considered as a sharp edge. The time t seconds of the spot passing over the black-white boundary is x/v secs. The current-time graph is shown in curve (*1b*). The sharp edges of this curve will be rounded off as the light spot boundary is indefinite, and the black and white boundary is also indefinte, the curve will then approximate to a half sine wave as in *Fig.* (*1c*). As the time for half the sine wave is x/v seconds, the corresponding frequency is $v/2x$ cycles per second; this frequency may be regarded as the highest frequency due to the light and shade of the picture. It will be shown later that where this current is used to modulate a carrier current there is nothing to be gained in having this frequency higher than half the carrier frequency. Taking the C.C.I.T. proposal of 550 cycles per second as the modulating frequency, the size of the light spot will now be calculated.

The time for half a cycle will be the time for the light spot to pass a black and white boundary. The time of half a cycle is $\frac{1}{2 \times 550}$ or $\frac{1}{1100} = 0{\cdot}91$ milliseconds.

Now $t = x/v$, hence $x = tv = 0{\cdot}91 \times 10^{-3} \times 208$
$= 0{\cdot}189$ say $0{\cdot}19$ mm.

for the 66 mm. drum or 0·252 for the 88 mm. drum. Referring to Table II. for p, it will be seen that the light spot should be approximately square. Had the modulation frequency been higher, say half the carrier, the x dimension would have been smaller, say 0·8 of the p dimension.

(4.) THE RELATION OF THE SIZE OF THE SENDING AND RECEIVING LIGHT SPOTS TO THE DEFINITION OF THE RECEIVED PICTURE.

At the receiving end, a light spot having its illumination controlled by the intensity of the received current is projected on to a drum, similar in size and length to that at the sending end, and rotating at exactly the same speed. A photographic film will be mounted on the drum when receiving a negative and a piece of bromide paper if receiving a positive. Assuming that a weak current is sent for black and a strong current for white on the original, then in the case of the reception of a negative, the stronger the received current, the greater must be the light intensity of the spot. On the other hand, if a positive print is being received, the maximum intensity of the light spot must occur with the weakest received current, and the minimum intensity of the light spot with maximum current. The height of the light spot will be equal to the pitch of the scanning, that is p mm. Let the width be z mm. (See *Fig. 1d.*) Considering the receiving light spot intensity (*Fig. 1e.*) as being directly controlled by the strength of the sent current, the light spot will cover a distance of $x + z$ mm. in rising from a minimum to a maximum intensity or vice versa. (*Fig. 1f.*) If this was the only consideration involved, the best definition would be when the dimension z was a minimum, but the following considerations, amongst others, enter into the question. The maximum intensity it is possible to obtain is governed by the design of the optical system and the brightness of the filament of the lamp producing the light. A certain quantity of light is necessary for the proper exposure of the photographic film or paper. In some picture systems, of which the Bell and Siemens-Karolus are examples, the intensity of the light spot varies twice per cycle in proportion to the strength of the carrier current, and in this case the spot width is related to the scanning velocity and the frequency of the carrier current. On the other hand, with the Belin system the carrier current is rectified, and this consideration does not apply.

It may, therefore, be concluded that the minimum loss of definition in a received picture in the direction of travel of the drum is at least equal to the sum of the widths of the sending and receiving light spots. In general the receiving light spot width is from 0·75 p to 1·0 p. It will be seen later that there is an additional loss of definition due to the transmission over a long circuit caused by the slow rise and fall of the current at the receiving end.

(5.) THE PRODUCTION OF A CURRENT SUITABLE FOR TRANSMISSION OVER A TELEPHONE CIRCUIT.

The majority of pictures are transmitted over telephone circuits in loaded and repeatered cables. Generally such circuits only transmit efficiently currents lying between 200 and 2000 cycles per second.

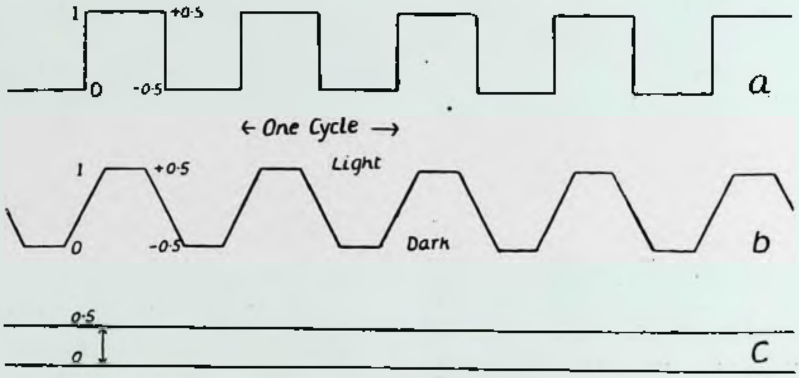

FIG. 2—(a), (b) and (c).

It is not possible to transmit a direct current varying in amplitude or modulated by the picture density. It is therefore necessary to produce a carrier current about the middle of the above range of frequency and modulate it, or vary its amplitude, in accordance with the picture density.

The carrier frequency may be produced in the two following ways:—

(1) Projecting interrupted light into the photo-cell, the light being modulated by the picture density and the frequency of the light interruptions corresponding to the carrier frequency.

(2) Alternating current produced by an oscillator is modulated by the amplified picture current in a thermionic valve.

Considering the first of these methods, light from a lamp is passed through holes or teeth in a

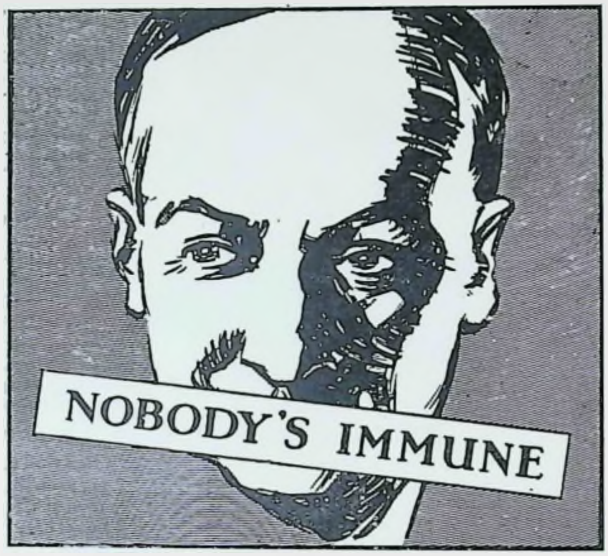

FIG. 3.

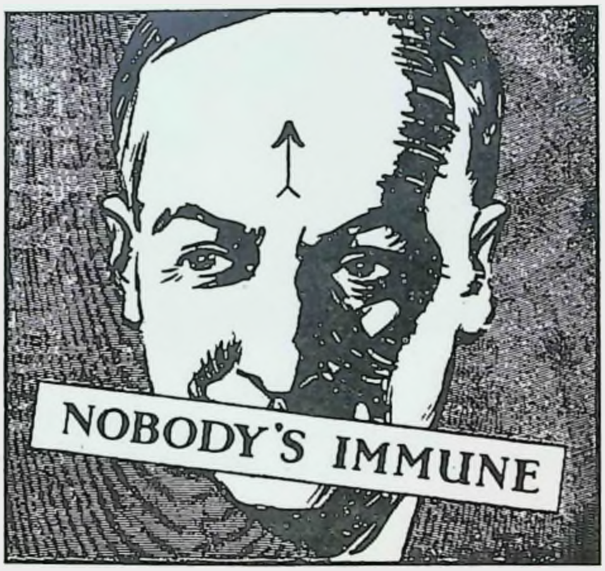

FIG. 4.

rotating disc, the light is then either reflected from the picture or transmitted through the picture into the photo-cell. If in the first instance the light is considered to be of rectangular wave form (*Fig. 2a*), this is resolvable into:—

(1) A constant light of half the maximum amplitude. (*Fig. 2c*).

(2) A sine wave of the interruptor frequency.

(3) A sine wave of three times the frequency of (*b*) and one-third the amplitude.

(4) A sine wave of five times the frequency of (*b*) and one-fifth the amplitude;

and odd harmonics of (2) and the harmonic fraction of the amplitude.

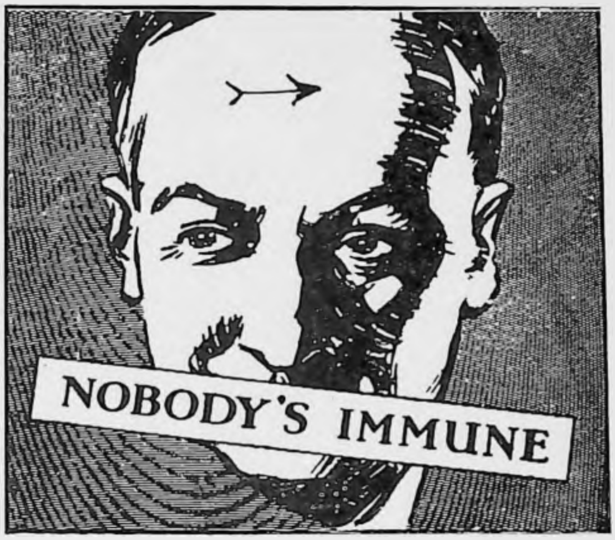

FIG. 5.

Each of these components is modulated or varied in accordance with the picture density. Let q cycles per second be the frequency of the light interruptions, and r the maximum frequency of the picture modulation.

Then the modulation products are as follows:—

(a) Fixed light modulated by r.

(b) Sine wave light of frequency q modulated by r.

(c) Sine wave light of frequency $3q$ modulated by r.

(d) Sine wave light of frequency $5q$ modulated by r.

etc., etc.

It is important that the frequency range of (*a*) should not overlap into the range of (*b*), hence *r* should not exceed one half *q*; (*c*) will in general be outside the range of frequencies transmissible over the line. In general, it is necessary to put in a high pass filter to stop (*a*) entering the line circuit, and possibly a low pass filter to stop (*c*) entering the line.

In actual practice, the interrupted light is not of rectanglar wave form. (See *Fig. 2b*). The sharp corners are rounded off and the wave form approaches that of a sine wave with a constant component of half the total amplitude, so that the higher frequency modulation products are reduced. The modulation product (*a*) of zero frequency, and the modulation product of the carrier frequency (*b*) being the only important frequency bands to be dealt with.

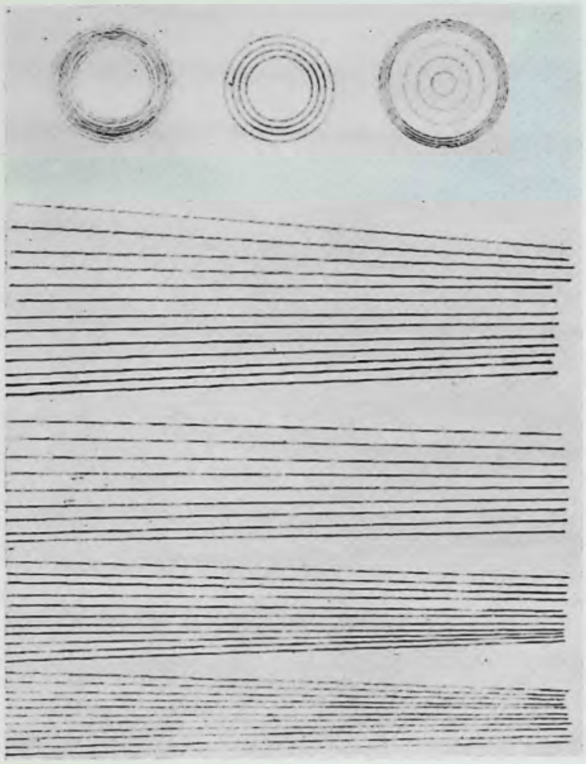

Fig. 6.

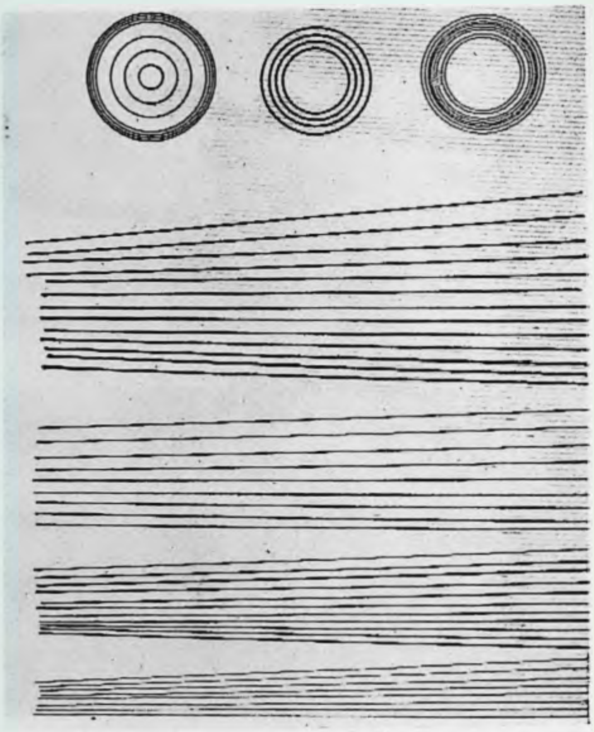

Fig. 7.

In the second method where the oscillator produced carrier current is modulated by the amplified picture current, usually in a valve, a band pass filter is inserted to limit the frequencies passing to the line circuit.

Some rather interesting effects take place when the picture contains lines close together and producing frequencies near the maximum modulation frequency. New frequencies and beat frequencies are then produced as shown in *Figs. 3, 4* and *5*. *Fig. 3* is the original. *Fig. 4* is the result of scanning vertically in the direction of the arrow, and in *Fig. 5* the result of scanning across is shown. As the lines on the picture are curved, the effect of the interference is shown up rather well.

Figs. 6 and *7* show the effect of lines at a slight angle. In *Fig. 7*, a coarse screen has purposely been used to exaggerate the effect.

A somewhat similar effect takes place in preparing blocks for printing where the picture is photographed through a screen.

(6.) THE TRANSMISSION OF THE CARRIER CURRENT OVER THE LINE.

The loaded and repeatered telephone circuits used for picture transmission are of two general types. *Fig. 8* shows

(a) a two-wire circuit with three repeaters;

(b) a four-wire circuit with five repeaters and an echo suppressor.

A two-wire circuit transmits over the same wires in both directions. The telephone repeaters *AA* having duplex balances *BB* inserted, so that the outgoing repeated energy in one direction is prevented from sending back energy in the reverse direction.

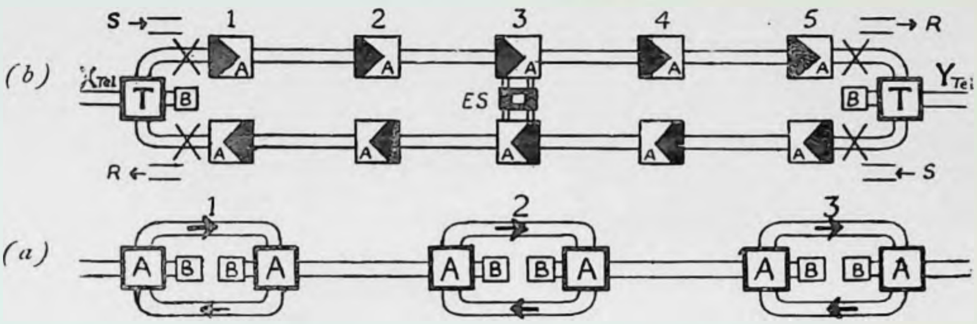

Fig. 8—(a) Two-wire circuit (b) Four-wire circuit.

A four-wire circuit consists of three parts, viz., two wire ends, *TT*, and a circuit for transmitting in one direction only, together with a circuit for transmitting in the opposite direction. The circuit is sometimes fitted with echo suppressors, *ES*, which act so as to suppress speech currents passing in the opposite channel to that in which they were started. As the echo suppressor is fitted about half-way along a circuit, speech passing from *X* to *Y* cuts the reverse channel from *Y* to *X*, so that circulating currents round the loop are stopped. When used for picture transmission, the two wire ends are usually cut away and the go and return circuits terminated at the picture apparatus at *RS*. When used for simultaneous both-way transmission, it is necessary to have any echo-suppressors cut out of circuit as the picture current in one direction, for example the " go " direction, would suppress the current in the opposite or " return " direction. Many of the long continental circuits radiating from London have a two-wire section in the sea cable. They can only be used for one-way picture transmission at a time.

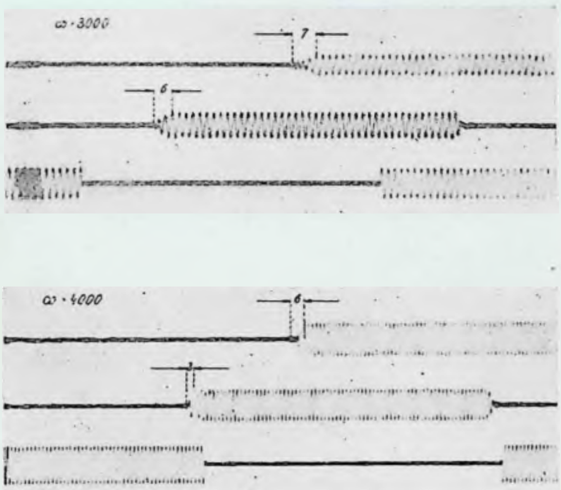

Fig. 9.

The cable circuit, without amplifiers or repeaters, has an attenuation loss which increases with frequency. In consequence each repeater has associated with it an equalising network which can be adjusted so as to keep all the frequencies leaving the repeater at the same level. The network attenuates the lower frequencies more than the higher ones, thus compensating for the unequal losses in the line. If a line is badly equalised, the rate of building up or falling away of the picture carrier current is retarded.

PHASE DISTORTION.

In addition to attenuation distortion in a coil loaded cable, phase distortion also exists, causing a slow build up of the carrier frequency when its amplitude is changed. The reason for this is that the different frequencies travel over the line with different velocities, and the higher the frequency, the less is the velocity. This effect is proportional to the length of the line and the " heaviness " of the loading. The lower the " cut off " frequency, the more pronounced is the effect. Phase correcting networks may be inserted into the line to minimise the effect. Some oscillograms of carrier frequencies started and stopped over a long line, with and without phase correctors, are reproduced in *Figs. 9—13*. The long build up time at the higher frequencies should be noticed.

In all the oscillograms, the bottom curve represents current sent, the centre curve the current received without phase correction, and the top curve the current received with phase correction. The Table below gives the frequency in radians and cycles per second, and the building up time in milli-seconds for each frequency, with

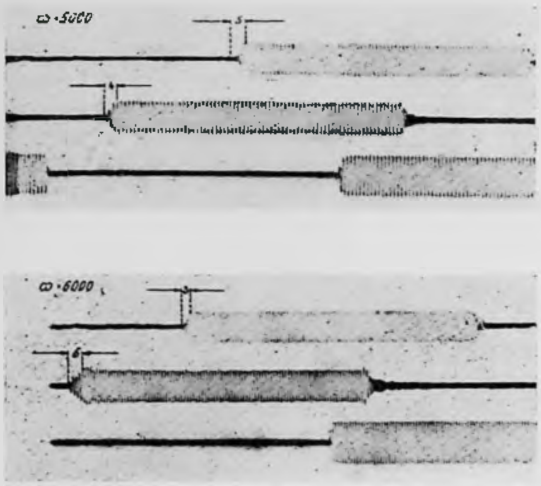

FIG. 10.

and without phase correction. It will be noticed whilst at the lowest frequencies which are not corrected, the building up time is worse than when corrected, at the middle and upper frequencies the effects of phase correction are apparent.

Fig.	Frequency per second. Radians.	Cycles.	Built up time uncorrected.	Built up time with correction.
9	3000	480	6	7
	4000	640	3	6
10	5000	800	4	5
	6000	960	5	3
11	8000	1280	13	5
	9000	1440	20	5
12	10000	1600	25	5
	11000	1760	32	6
13	12000	1760	46	16
	13000	2080	63	20

Fig. 14 is an example of the effects of phase distortion in a long telephone circuit.

The propagation time in a picture circuit may be measured by looping back to the sending end, either over the return leg of a four-wire circuit or over a similar circuit in the case of a two-wire circuit. The one side of a picture is sent over the line and the other portion over an attenuator having the same loss as the line, but no propagation time. The propagation time is obtained by measurement of the displacement between the two parts of the picture and a knowledge of the speed of scanning.

Interruptions of a circuit are indicated by the black lines on a received print indicating white on the received negative, or no current coming in. A change in amplification, either in the line or the amplifiers associated with the sending or receiving apparatus (such as a bad or variable contact) gives rise to variations in intensity of the received picture.

SYNCHRONISATION OF THE SENDING AND RECEIVING APPARATUS.

Two conditions are necessary for the reception of good pictures; the first is that the drum at the receiving end must revolve at the same speed as that at the sending end, and included in this condition is that the speed must be uniform. The second condition is that the drums at the two ends must be set so that the picture clips are in the same relative position, that is the clips on the receiving

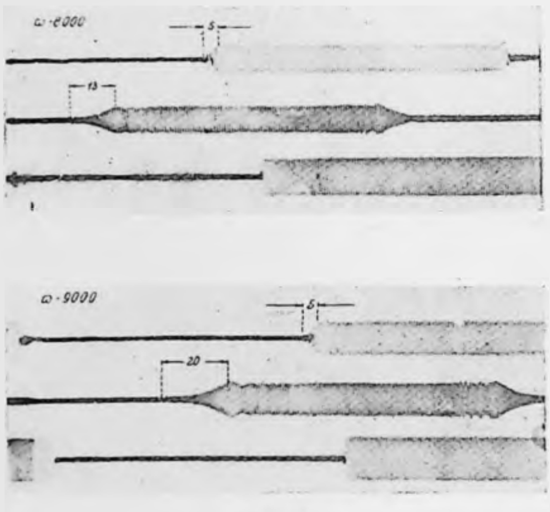

FIG. 11.

drum must be passing the receiving light spot when the currents are arriving due to the clips of the sending drum passing the light spot at the sending end. The first condition will be referred to as synchronisation and the second as phasing.

In some systems, a current differing in frequency from the picture carrier current is sent over the line with the picture current, separation being secured with electrical filters. Examples of this are the Bell and Nippon systems. Great care has to be taken in order that the synchronising and picture currents are at such relative strengths that they do not interfere with one another.

In other systems such as the Belin, Siemens Karolus and Marconi Wright, the receiving apparatus and the sending apparatus are driven independently, the speed being controlled by means of a current produced by valve driven tuning forks. In the case of the first two systems mentioned, a frequency of 1020 cycles per second is sent over the line preparatory to the transmission of a picture, and the receiving end tuning fork frequency is adjusted to be within one part in one hundred thousand of the frequency received. This is done by making the received current light a neon lamp and observing a stroboscopic disc (with black and white lines) driven from the receiving drum. The disc should appear to stand still when the two speeds are the same.

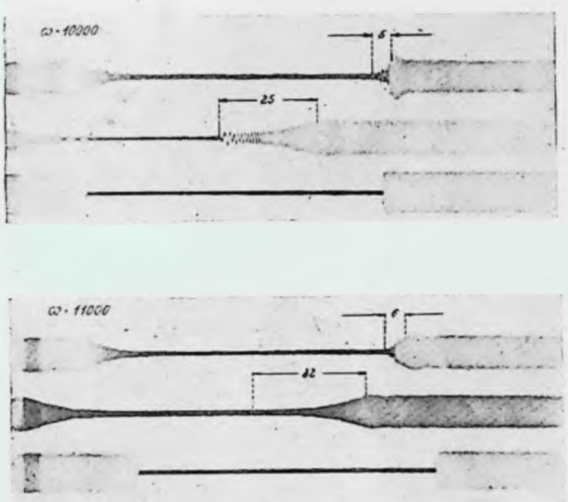

Fig. 12.

PHASING.

In some systems, the sending and receiving drums start off together from the same relative position by means of a signal sent over the line. In other systems, the drums are continuously rotating, and in this case it is necessary to set the relative positions of the two drums. This is accomplished by sending a signal over the line once per revolution of the drum and setting the position of the receiving drum so that it is in the correct position when the signal is received. In order to secure co-operation between the two systems, the C.C.I.T. have laid down the following conditions. First that with those systems employing the automatic start signal, the drum at

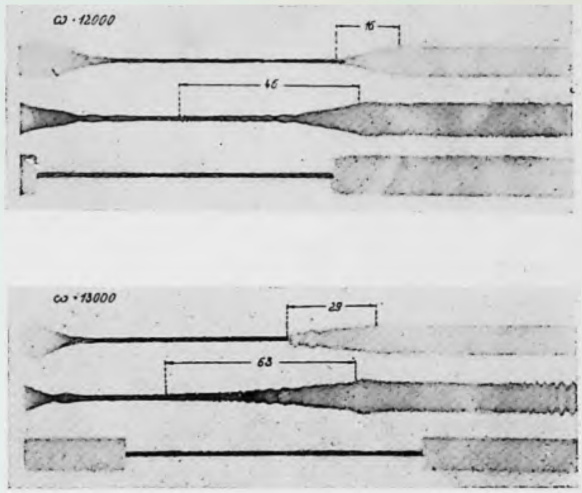

Fig. 13.

the sending end must only start from one position of the rotating mechanism. Second, that it must start from the position where the sending clips are opposite the light spot. Thirdly, that in those systems employing the continuously rotating drum, the signal must be sent when the clips are passing the sending light spot. In this way, in sending from one system to the other, the phasing signal in one system becomes the start signal in the other system, and as the sending drum in the automatic start system starts off from the same position each time, the rotating system once set for the first picture is correct for the reception of subsequent pictures. Difficulties occur when pictures have to be sent over certain types of radio and carrier current systems, and these will be dealt with later.

CARRIER CURRENT AND RADIO CIRCUITS.

Carrier current (that is currents of frequency above the audio range) sent over wire circuits and radio circuits offer certain difficulties. In certain carrier current and radio systems, the carrier current is suppressed at the transmitting end and re-inserted at the receiving end by means of an oscillator. In most systems there is no guarantee that the frequency of the oscillator at the receiving end is exactly the same frequency as the original carrier. The reproduced audio frequency at the receiving end will then differ from that sent, by the difference of the original carrier and the oscillator frequencies. Synchronisation by sending a frequency over the circuit is thus impossible. This defect may be overcome by sending two frequencies over the circuit and using the difference for synchronisation purposes, for although each frequency will be in error, the difference will remain constant. An example of this type of circuit is the long-wave Transatlantic telephone circuit. Short wave radio circuits are subject to fading and difficulties occur in transmitting tone pictures, where the tone is dependent on the strength of the received current. Black and white pictures only are possible in such a case, and any tone effects are produced by sending long and short signals. Further, short wave radio circuits may have more than one path of differing length, so that a succession of pictures arrive superimposed; this has been illustrated in a paper recently read before this Society.

PHOTOGRAPHIC PROBLEMS.

The light and shade in a photographic negative is not directly proportional to the time of exposure and the intensity of the light, the density (within limits) being proportional to the logarithm of the exposure. In order to secure correct tone reproduction in the received picture, the intensity of the receiving light spot must density, within limits, being proportional to the received current unless some correction has been introduced at the sending end or elsewhere. In the Belin and Nippon systems, correction is secured by the received current causing a mirror to tilt, the angle of tilt being proportional to the received current. The light is then sent through a specially shaped aperture which is designed to give the desired relation between received current and the amount of light which is to fall on the photographic film or paper. The shape of this aperture will differ according to whether the original is a negative or positive (though in most systems a positive is used for transmission) and also as to whether a negative or positive is received. In the Belin system, the picture carrier current is rectified, so the motion of the mirror is proportional to the rectified current. In this case, the characteristics of the rectifying valve have to be allowed for. In other systems, the light is shut off twice per cycle of the picture carrier current, and then a further complication arises as the receiving drum is rotating and the actual exposure is not only affected by the intensity of the light spot but also by it being intermittent. In the case of the Siemens Karolus system, the light spot is controlled by means of a Kerr Cell using polarised light. Here the light passed is not directly proportional to the voltage on the Kerr Cell, and correction at the receiving end is very nearly impossible. However, by a suitable choice of film and papers for printing, and in spite of these difficulties, very fair results are possible and are obtained in practice. Further difficulties arise from "halation" and scattering of the light over the film. Here again suitable choice of the film as regards thickness of emulsion, etc., tends to mask or reduce the bad effects. Important settings are the focussing and the adjustment of the width of the spot so as to cover the width of the pitch of the scanning. In addition, in those systems where the received current is not rectified, the length of the light spot in relation to the speed of the drum and the carrier frequency is also important.

FIG. 14.

PUBLIC PICTURE SERVICES.

The British Post Office has a picture transmission set in London, and provides a public service to Berlin, Munich and Frankfort in Germany, Copenhagen for Denmark, Oslo for Norway, Stockholm for Sweden, Rome for Italy and Vienna for Austria. In France, the Belin apparatus has a service from Paris to various towns, and can also send to Berlin to the modified Siemens apparatus. Working with French stations using the Belin apparatus, will be possible when the Siemens apparatus which is installed at places where a public service is given, is modified in accordance with the C.C.I.T. proposals. Public services also exist in Japan, in

Australia between Sydney and Melbourne, and in America between certain of the larger centres. A radio service also exists between London and New York.

In conclusion, as it might be inferred from the difficulties enumerated in the lecture that it was well nigh impossible to transmit good pictures, a few specimen untouched prints of pictures transmitted on different systems over various circuits were shown, and from these the audience were able to judge for themselves the degree of perfection now attainable, in spite of the difficulties encountered.

Finally, the author wishes to thank various firms and individuals for the supply of information, illustrations and slides, without which this lecture would not have been possible.

DISCUSSION.

Mr. Wm. C. Keay (Hon. Treasurer), after thanking the Lecturer very warmly for his extremely interesting paper, asked which was the best system of picture-telegraphy?

The Lecturer: To answer Mr. Keay's question is difficult, and is very similar to answering the question "Which is the best motor car?" and in more respects than one the answers are the same. In the case of cars, some are closed, others are open; some large and expensive, others small and cheap; some economical to run, some fast, etc. In all cases, the cars require cleaning, oiling, etc., and, if accidents are to be avoided, careful driving. In the same manner, most of the picture systems in use are capable of giving good transmissions over suitable circuits. More important than the system is the need of skilled operation and the maintenance of the electrical, mechanical, optical and, last but not least, photographic side, in proper adjustment.

Mr. W. G. W. Mitchell, B.Sc., asked if the Lecturer would give a few particulars of the Bart-Lane Process of picture transmission? What was the time taken by this system compared with others for the transmission of unit area of picture?

In reply to Mr. Mitchell's question, the Lecturer said: The Bart-Lane system was not mentioned as it is used for sending pictures over a telegraph circuit in contrast to telephone circuits, which have been dealt with in the lecture.

At the transmitting end, a perforated paper tape is prepared, having six lines of perforations each cross row a tenth of an inch apart. One line of small holes is used to engage with a driving sprocket. The other five (any one or more of which may be punched) represent the characters in the five unit telegraph code. Each cross row of holes represents the density of a spot on the picture which is to be transmitted. A special combination—holes one, three and five repeated twice—is the indication of the end of the line.

Originally, the first hole punched represented a dark tone on the picture and each additional hole punched a lighter tone, all five holes representing white. Thus six tones can be transmitted—no punched hole representing black. The roll of prepared tape is sent to a Telegraph Office equipped for transmitting five unit code from tape. At the receiving Telegraph Office an identical tape is automatically prepared from the received signals and is sent to the picture station.

The tape is prepared at the transmitting picture office in the most recent type of machine, by means of punches operated from telegraph type relays. The control current governs the operation of the relays coming from the amplified output of a photo-cell, the photo-cell output being in turn controlled by the reflected or scattered light coming from a spot on the picture. In the most recent type of transmission, more than six tones are transmitted by utilising combinations of the punched holes to represent tones.

At the receiving end, light is projected through the punched holes of the tape on to a film. Thus the light going through one hole will be less intense than that going through all five, so that the light through one hole will leave a weak deposit on the received film and the light through all five a strong deposit. As one punched hole at the transmitting end represented a dark portion of the picture and at the receiving end a light portion on the film, a negative is produced at the receiving machine. A picture of about 4in. by 3½in. is made up of about 54,000 spots and is represented by about 450 feet of punched tape. The time of transmission over the line depends on the telegraph signalling speed of the cable. As the ordinary systems are incapable of transmitting over a telegraph channel, an exact comparison of transmission speeds is difficult.

First, taking a telephone circuit suitable for picture transmission, it ought to be possible to use the same circuit for a 12 channel voice frequency telegraph apparatus, each channel carrying a telegraph speed of 66 bauds or 720 letters per minute in five unit code. So that the total speed is 8,640 letters per minute. On the Bart-Lane picture the size of the spots are 0·339 by 0·509 millimetres, so that there are 583 per square centimetre. The line should therefore carry 8,640 divided by 583, or 14·8 square centimetres per minute. This compares with 22·5 square centimetres for the Siemens-Karolus System with a scanning pitch of 0·2 millimetres, or 28·3 square centimetres per minute for the Bell system, with a scanning pitch of 0·25 millimetres. Over an Atlantic Cable, the transmission speed varies from say 180 in the older cables to 1,620 letters per minute in the most modern cable, giving a speed of from 0·307 to 2·77 square centimetres per minute.

In spite of the relatively slow speed on long cables, the system has the following points. Firstly, capability of reproducing a test picture at the transmitting end identical in quality with that received. Secondly, of being able to cut up the picture or tape in lengths and transmit each length separately. Thirdly, the possibility of interrupting the transmission in order to send more urgent telegraph traffic, continuing the transmission where it was interrupted. Fourthly, the capability of transmitting pictures where no other method is possible.

Mr. W. S. Newton, B.Sc. (Daily Express Newspaper) asked:—

(1) What was the precise effect of bad equalisation of the telephone circuit on picture transmission?

(2) Is it better to transmit from a film transparency or prints?

(3) Should not the comparative times of transmissions take into consideration the time of "handling" at both transmitter and receiver?

The Lecturer:—

(1) Bad equalisation of the telephone circuit, or in other words the circuit having different losses at each frequency, is liable to cause a slow or irregular build up of the picture carrier current, thus rendering the transition from a black to a white portion of the picture blurred.

(2) The lecturer hesitates to answer this question, as he has had experience of the transmission from prints; on the other hand, Mr. Newton works with transparencies. When transmitting from prints, it is possible to send directly from any size of print so long as it does not exceed the size of the drum. In the case of transmission from transparencies, it is necessary to prepare the transparency from the print, the transparency having to fit the transmitting drum or holder *exactly.* The lecturer is satisfied with sending from prints.

(3) The principal cost in picture transmission is the line time. In considering the "over-all time" of transmitting a picture between sender and receiver, it is, of course, necessary to take into account the time taken up by the necessary processes of development and printing in addition to the transmission over the line and the delivery time. In most cases the processes take up the major portion of the time.

Mr. C. R. Keith (Western Electric Co. Ltd.) asked:—

(1) Have there been satisfactory transmissions of positive to positive?

(2) Is the use of the shaped aperture in the Belin system to correct for photographic curvature or for non-linearity in the transmission characteristics?

The Lecturer, in reply, said:—

(1) Positive to positive transmissions of reasonable quality can be obtained with the Siemens-Karolus system provided suitable adjustments are made at the transmitting and receiving ends. The apparatus is not normally used in this manner as, in general, more than one copy is required at the receiving end, and it is therefore more convenient to receive a negative. With the Belin system excellent positives are received, and at least one Newspaper uses the System in this manner for normal transmission. The Lecturer understands the Nippon system also gives good results when used in this way.

(2) The shaped aperture in the Belin system is used to correct for the non-linearity of the photographic system, and also for any non-linearity in the receiving amplifier, as well as a non-linearity caused by the light beam at the receiving end having a finite width. It is not used to correct for faulty transmission over the line.

Mr. G. E. Carr (G.P.O.) understood the Lecturer to say that the transmission in the Bart-Lane system is by signals represented by the letters of the alphabet. There are twenty-six letters in the alphabet (combinations of the five-unit code)—in that case, can twenty-six different tone shades be transmitted by the Bart-Lane system?

Replying to Mr. Carr, the Lecturer said: In the Bart-Lane system it would be possible to *transmit* twenty-six tones, but it is difficult with the existing receiving arrangements to *reproduce* twenty-six tones. As arranged at the present time, the lecturer understands that sixteen are reproduced. The method of reproducing is to arrange that light of different intensities is passed through each of the holes in the tape at the receiving end, combinations of the holes producing different intensities. The difficulty is that the light adds arithmetically, whilst the tone value on the negative is a logarithmic function of the light falling on it.

DEVELOPMENT.

ULTRA-SHORT WAVE TELEVISION, LONDON.

A successful public demonstration of ultra-short wave television was given on Friday, April 29th, at Messrs. Selfridges' Stores in Oxford Street, London. The transmitter was situated on the roof of the laboratories of Baird Television Ltd., in Long Acre, London, W.C. 2., the wave-length used being 6·1 metres. An interesting feature of the transmission was that although sent out on ultra-short waves, the images could still be received easily by possessors of the ordinary Baird "Televisor" and wireless sets of normal type designed for the present B.B.C. television transmissions. To do this, the only extra apparatus required was an ultra-short wave adaptor, which virtually converts any normal receiver into a super-heterodyne. The demonstration given on April 29th is the first public demonstration of the possibilities of ultra-short wave television to be given anywhere in the world, and marks a further stage in the development of the art.—*Nature,* May 7th, 1932.

GERMANY.

The new German ultra-short wave transmitter has just been completed and the results so far are surprisingly good. The power is about 15 Kw., and the wave-length about seven metres. The transmitter will be put into regular use about the middle of the summer and will be used mostly for television. It was specially built with this aim in mind, as it gives a band-width of over 300 Kc. The Fernseh A.-G. have just constructed a Disc-type receiver and transmitter for 120 lines, with 19,200 elements. With picture repetition frequency of 25 per second, it is said to work very well.—Communicated in a letter dated May 5th, 1932.

THE DERBY TO BE SEEN ON CINEMA SCREEN IN LONDON.

The announcement is made in the Daily Press that the Baird Company will again attempt to televise the "Derby" on June 1st. This year the received picture will be shown on a large screen, 12ft. in width, made of a wax composition, in the Metropole Cinema, Victoria, London, S.W. 1. The total cost of the experiment is stated to be £500, the rent of the telephone lines alone costing £120. —Daily Press, May 15th, 1932.

*Round the Exhibitions**

THE apparatus described below was shown at the Physical and Optical Societies' Exhibition and also at the Science Masters' Meeting last January.

MODEL FOR DEMONSTRATING TELEVISION
and also for
TESTING CHARACTERISTICS OF AMPLIFIERS, etc.
Designed and Built by Capt. R. Wilson and Mr. A. A. Waters.

This model was designed with the fundamental idea of demonstrating television in an effective but simple form, primarily for use in schools, etc. The following points were considered and kept in view in the design:—

1. Portability, simplicity and compactness.
2. Reduction of flicker without increasing speed by using sequential multi-spiral scanning discs.
3. Fixed synchronisation by placing two discs on a common shaft.
4. Periscopic lens system, with adjustable mirror feature to give a larger field of view. (*Fig. 1.*)

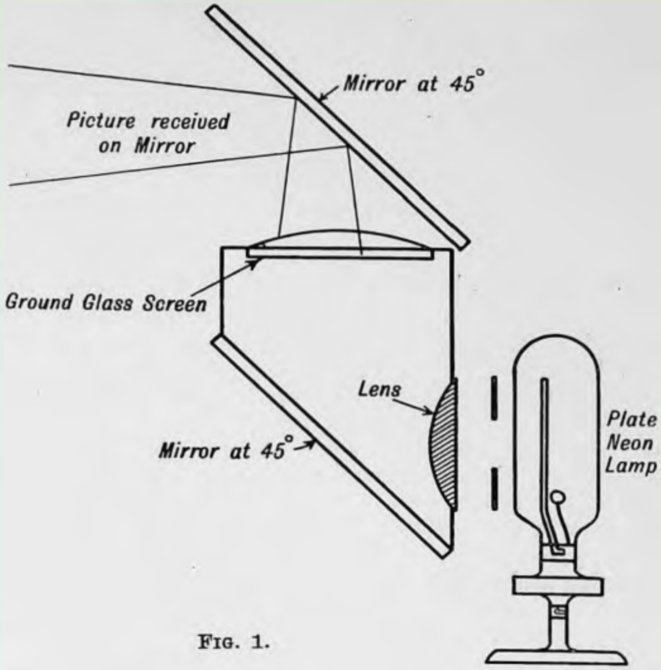

FIG. 1.

As seen in the accompanying diagram (*Fig. 2*), the discs are mounted on one shaft and are of small diameter, approximately 12 inches. There are three spirals with 45 holes on each, and the ratio used was 5 : 6. A Zeiss automatic-feed arc lamp was used, giving about 1,000 c.p., and the beam was projected through a three-inch focus lens and thence through a right-angle prism, which could be adjusted to vary the angle of scan on the subject.

One large Caesium photo-cell was employed, which was housed in a metal box together with one screen-grid stage of amplification, followed by the remaining intermediate and power stages. The whole amplifier was battery operated. At the receiver, a standard plate-type neon tube was used, and the current passing through this was about 40—50 milliamps. The resultant image was considered sharp, free from distortion and of good half-tone quality. Speed was 750 revs. per min.; size of magnified image, 3 inches by 2½ inches.

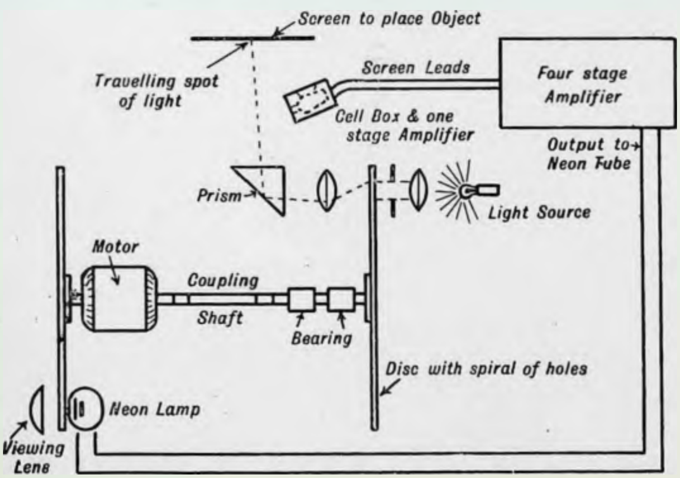

FIG. 2.

EDUCATIONAL EXHIBIT:
Built by Mr. R. W. Corkling (Fellow).

The apparatus has been designed to illustrate the fundamental principles of television, and the image is provided in this instance by means of a cinematograph film and projector. The image thus formed is disintegrated by a Nipkow disc and is directed on to a photo cell as shown (*Fig 3.*) The fluctuating current, after amplification, is superimposed on a low voltage gas discharge lamp of the Mercury-Neon type. The light is then directed on a mirror drum, which in turn builds up the image again by projecting it on to a translucent screen. A feature of the design is that a thin, stainless steel strip is used for the elements of the mirror drum. Working parts of the apparatus were demonstrated at intervals.

[Continued on page 135.]

* The accompanying Illustrations Figs 1—4 reproduced through the courtesy of the Editor and Publishers of the *School Science Review*

*Television in the U.S.S.R.**

By PAUL SHMAKOV (Fellow).

Report on the progress of Television in Russia during 1931.

IN 1931, television research work in the Soviet Union left the laboratory stage. Television work is being directed along the following lines: Development of television broadcast apparatus, screen television, the tele-cinema, increasing the number of picture elements and the development of auxiliary devices, such as photo-current amplifiers, wireless receivers, photo-electric cells and neon lamps. In regard to its character, research in the subject of television has been, and is being conducted in the direction of mechanical scanning and cathode-ray scanning.

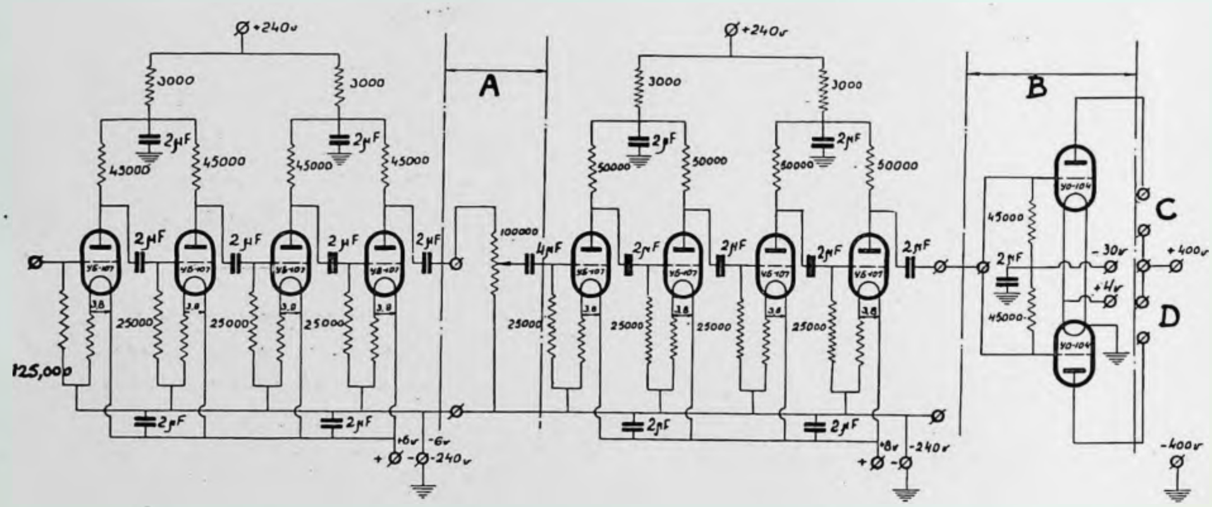

FIG. 1—Amplifier for Television (3rd modification). *A* denotes amplification control, *B* power control, *C* neon tube, *D* synchroniser. The valves used are shown according to Russian classification.

For the purposes of television broadcasts, a provisional standard has been adopted in the U.S.S.R. for 1932: Number of bands 30, number of pictures per second 12·5, shape of picture 3 by 4, positive synchronisation (f_s = 375 cycles), horizontal scanning for the cinema (from the left to the right and from the top to the bottom) and vertical scanning for living persons, wireless transmission being by positive.

A standard apparatus is being prepared for 1933: Number of bands 48, number of pictures per second 25, shape of picture 3 by 4, positive synchronisation (f_s = 1200 cycles).

The All-Union Television Conference, which was held in Leningrad at the end of December 1931, reviewed the laboratory work for 1931, which substantially consists in the following:

I. THE ALL-UNION ELECTRO-TECHNICAL INSTITUTE.

(*Shmakov*).

1. A standard photo-electric cell has been developed, the diameter of the bulb being 10 cm. The cell is a potassium, gas-filled cell with a sensitivity of 150 to 200 micro-amp./lumen

* Translation of a manuscript received 24th March, 1932.

(Timofeyev). A cæsium photo-electric cell has now been obtained with a sensitivity of 40 micro-amp./lumen in vacuo (Khlebnikov).

2.—A standard neon lamp has also been developed. It has a flat cathode 3 × 4 cm., and a surface brightness of 0·2 candle power. The first specimens of alkali neon lamps for televisors with mirror helix have also been obtained (Shemaev).

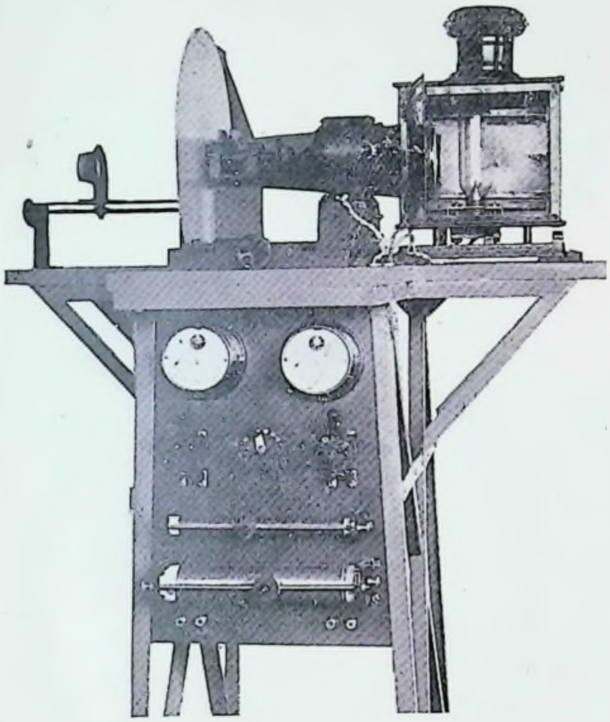

FIG. 2—Television Transmitter.

3.—An amplifier for photo-electric currents has been developed. The circuit of this amplifier is shown in *Fig. 1*. The voltage amplification is up to 7×10^6 with a flat characteristic up to 50×10^3 cycles (Ash).

4.—A television transmitter (*Fig. 2*) has been developed in which the Nipkow discs may easily be exchanged for transmitting pictures by means of a different number of scanning elements (Arkhangelsky and Orlov). The first television test was broadcast with this apparatus.

5.—A disc televisor for individual use has been developed in accordance with the 1932 standard (*Fig. 3*), employing positive synchronisation (Lacour wheel) and mechanical phase-adjustment by the displacement of the neon lamp in front of an additional spiral of holes. The dimensions of the picture (without magnification) are 21 × 28 mm. for square holes of 0·7 mm. side. The diameter of the disc is 33 cm. (Barakan).

6.—Since October 1st, 1931, television broadcast tests with 1200 elements (f_{max} = 7500 cycles) have been conducted regularly from the studio of the Moscow Radio-Technical Centre and transmitted by the *MOSPS* Station (λ = 379 m.) and the Experimental Transmitter (λ = 720 m.). Reports of good visibility have been received from Leningrad, Minsk, Kiev, Odessa, Kharkov, Tomsk (3800 km. = about 2,300 miles) and other places.

In addition, television transmissions have been made along international lines up to 600 km. (360 miles) (Arkhangelsky and Korchmar).

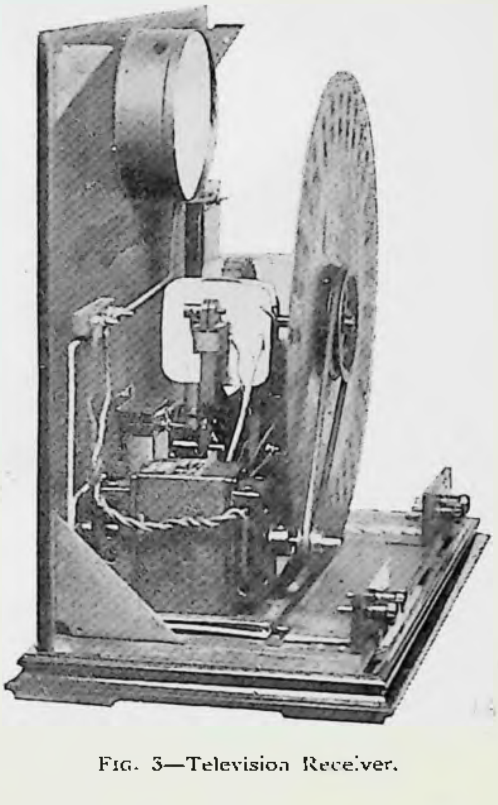

FIG. 3—Television Receiver.

At the present time, laboratory work is being carried out on screen television by direct vision, employing apparatus with analysis of the pictures into 10,800 elements and cathode television in the transmitter and receiver.

II. ELECTRO-PHYSICAL INSTITUTE.

(*Chernyshev*).

1.—A disc television transmitter has been developed for 4,000 picture elements with 19 pictures per second (Ryftin) employing a suitable photo-electric amplifier and photo-electric cells. The diameter of the disc is 710 mm., and the number of holes is 64. The holes are square with a 0·5 mm. side. *Fig. 4* shows a detail of the transmitter, namely, the fitting for the photo-electric cells. The chambers of the cells are mounted on ball and socket joints so that the photo-electric cells can be put in any position relatively to the object being transmitted.

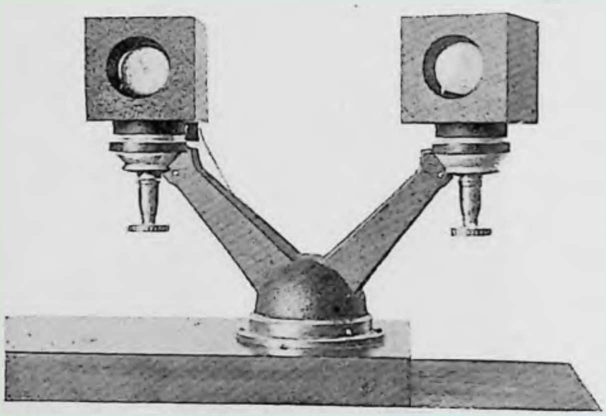

FIG. 4—Holder for the photo-cells.

2.—A television receiving apparatus which has been developed has a Nipkow disc designed for 4,000 elements and having 1½ spirals of holes (phase adjustment is mechanical). Synchronisation is positive, but instead of employing a phonic wheel the disc itself is used, being provided with iron poles on its periphery (*Fig. 5*). The armatures of the coils are fixed to a frame adapted to rotate relatively to the disc with phase adjustment by magnet (Ryftin).

At the present time, work in the laboratory is being carried out on apparatus having an improved quality of picture, this being effected by increasing the number of elements and by means of double scanning in two directions at right angles to each other, and also on receiving devices employing cathode scanning.

III. THE KOMINTERN WIRELESS FACTORY.

(*Mintz*).

A commercial type of vision receiver applied to the 1932 standard has been developed *Figs. 6, 7, 8*). Synchronisation is positive by the Mihaly system with a local stabilising oscillator, the frequency of the oscillations of which is obtained by means of synchronising signals from the transmitter. Phase adjustment is by displacement of the neon lamp in two directions by means of the two middle knobs, which are mounted on spindles situated one within the other. In addition, by means of a system of levers connected to one of these spindles, the neon lamp can be turned into the horizontal position for reception in the other observation window (Zatvarnitsky).

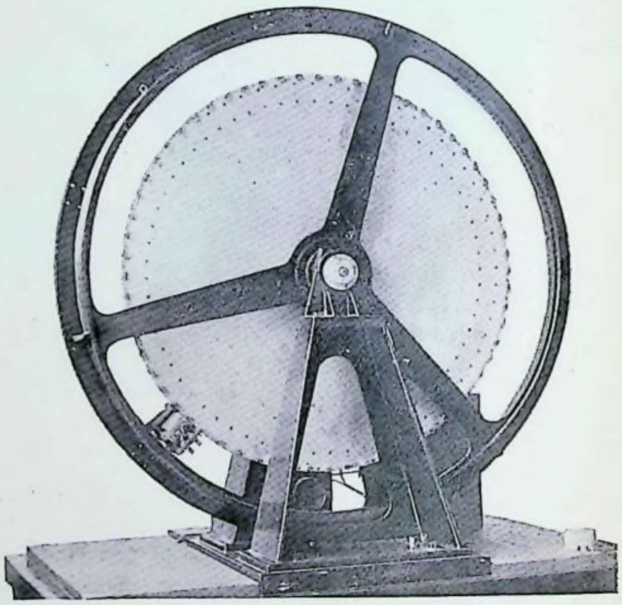

FIG. 5—Receiving disc showing iron poles on its periphery and phase adjustment.

A commercial type of televisor according to the 1933 standard and special transmitters for television on short and ultra-short waves are now being developed.

IV. CENTRAL LABORATORY FOR COMMUNICATION BY WIRE.

(Shorin).

1. A tele-cinema transmitting apparatus for sound films (*Fig. 9*) has been developed. The scanning device employed is a Weiller mirror wheel having its mirrors so placed that scanning proceeds by alternate bands. This allows the visual part of the film to be transmitted at the rate of 12 pictures per second and the sound part at the rate of 24 pictures per second. The source of light is a 25-watt incandescent lamp. The model in question is designed for 36 bands.

2. A picture synthesis apparatus employing a Weiller mirror wheel has been deve'oped for reception on a large screen. The light modulator is a Kerr cell (*Fig. 10*). The present model has 36 mirrors. Synchronisation is automatic by means of synchronous motors fed at a constant frequency from tuning fork generators.

Duplex television by wire is now being developed.

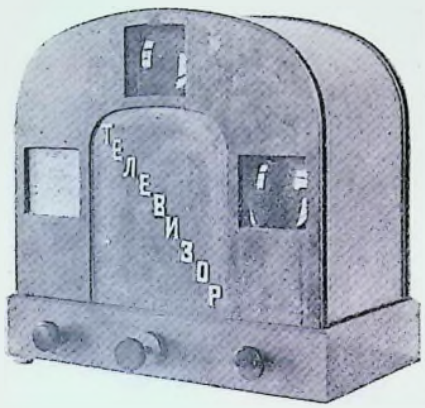

FIG. 6 (above).—Commercial type of vision receiver.

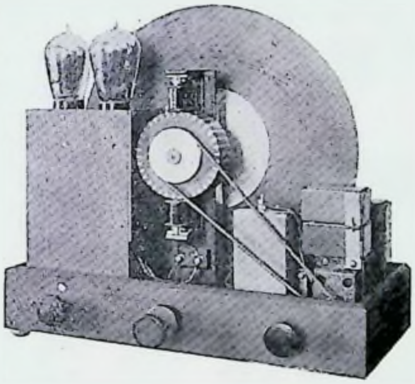

FIG. 7 (on right).—Front view with case removed.

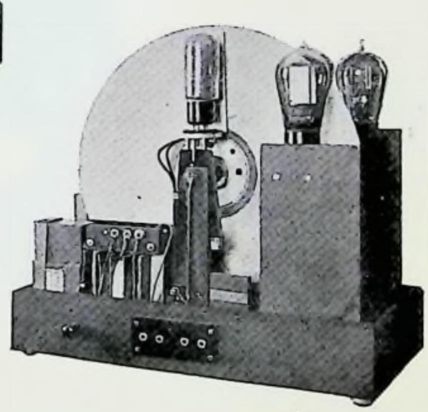

FIG. 8 (below).—Back view of vision receiver showing method of positioning neon lamp for different types of transmission.

V. GENERAL.

In addition to what has been stated in the foregoing, research work on television is also being conducted in a number of laboratories, viz., The Central Radio Laboratory (Gourov), Investigation of some new methods of television; The Laboratories of the People's Commissariat for Communication (Mark and Goron), Experimental television broadcasting and duplex television; The Central Scientific Research Institute of Signalling and Communication of the People's Commissariat for Ways of Communication (Khalfin), Two-channel system of daylight television.

Television tests are broadcast by the Moscow Radio Stations on the 3rd, 5th, 8th, 10th, 13th, 18th, 23rd and 30th of each month: MOSPS (λ = 379 m.) from 00·00 to 01·00 Moscow time (22·00 to 23·00 Central European time) and the Experimental Transmitter (λ = 720 m.) from 00·30 to 01·00 Moscow time (22·30 to 23·00 Central European Time. In addition, television broadcasts will be commenced this year from Leningrad, Odessa and Novosibirsk.

Owing to the fact that, at the present time, the standards for television broadcast apparatus are the same in U.S.S.R. and in Germany, we are following the transmissions from Germany with intense interest. The effect would be enhanced still further, however, if it were possible to follow the television transmissions from England and other countries with the same receiving apparatus.

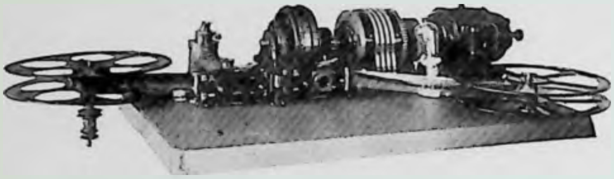

FIG. 9—Tele-cinema Transmitter (Central Laboratory for communication by wire).

Consequently, with a view to speeding up the development of television, widening the effective range, increasing the number of amateurs and giving them greater satisfaction, it is highly desirable that an international standard for television broadcasting should be established. This could be accomplished either by arranging a special conference or by bringing the question

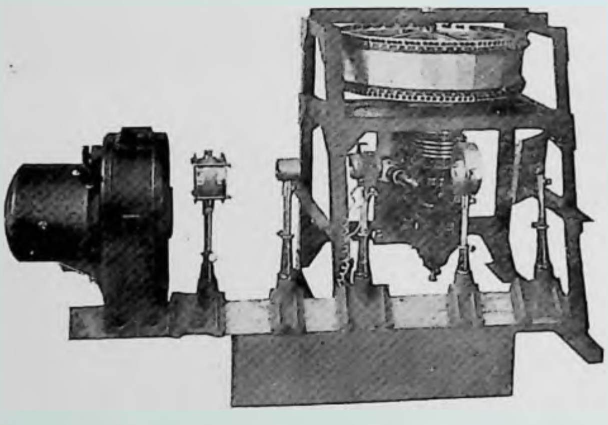

FIG. 10—Mirror wheel with Kerr cell.

before the International Advisory Committee. It would be very agreeable if the initiative in this matter were to be taken by the Television Society as being the pioneers in the diffusion of scientific technical knowledge relating to the subject of television.

CURRENT LITERATURE.

"FERSEHEN UND TONFILM" (Television and Sound Films); Vol. 3, No. 2. April, 1932. Berlin.—CONTENTS: Attempts at television using ultra short waves (G. Krawinkel and K. Ziebig); Technical progress in sound films during 1931 (P. Hatschek); On the way towards projected television pictures—Observations on an article by A. Dinsdale in Vol. 2, No. 4 (F. Kirschstein); The lens disc (E. Busse); The Braun tube for television (Hudec and Perchermeier); The standard of brightness at the transmitter (R. Möller; Light integration with a proposed television system (W. Friedel); The minimum illumination in television apparatus (R. Thun); Cost of building television apparatus (E. Kadena); Sound-horn dimensions in sound film work (A. Neuburger). REVIEWS. CURRENT LITERATURE (With note on JOURNAL of The Television Society, Vol. 1, No. 3). PATENTS.—Price 3 marks.

LA RIVISTA DI TELEVISIONE (The Television Review); Vol. 1, No. 1. Jan., 1932. Milan.—CONTENTS: Editorial introduction; How to modulate the plate neon and maintain synchronism in television (F. Strada); Solved and unsolved problems in television (G. G. Caccia); Baird—Inventor of television and noctovision (W. MacDonald); Pioneers—The superheterodyne is an Italian invention; The short-waves—An open letter to the Minister of Communications (D. Bolaffi); Apparatus tested; Bibliography.—Price 3 lire.

FOREIGN EXPERIMENTAL TRANSMISSIONS.—The following details are given of experimental television transmissions from (1) ROME: Vision from Station, Santa Palomba, on 441·2 metres (75 kw) and sound from Prato Smeraldo on 25·4 metres (12 kw). Vertical image measuring 30 × 40 mm., 60 lines; picture repetition frequency, 20 per sec. Times irregular. (2) BERLIN: Vision of 144 metres (5 kw) and sound on 93·31 metres (2·5 kw), 30 lines, horizontal framing; picture repetition frequency, 12·5 per sec. Week-days, 8.30 to 10.30 a.m.

SIGHT AND SOUND: A quarterly review of modern aids to learning; published under the auspices of the British Institute of Adult Education; Vol. 1, No. 1. Spring, 1932. London.—CONTENTS: The Case for a National Film Institute (A. C. Cameron); School Broadcasting: What has it achieved? (Mary Somerville); Showmanship and Scholarship (F. A. Hoare); New methods in Teaching, Mechanised aids to Living Thought (A. E. Heath); Captions and their Faults (J. Fairgrieve); The new Language Teaching (A. Lloyd James); The Cinema and the Empire (J. Russell Orr); Publicity by Film (H. R. Payne); Music for the Many (V. Hely Hutchinson); Films you Ought to See (C. A. Lejeune); Experiments of To-day, Making your own Teaching Films (Ronald Gow); Children at the Pictures; Television and Education (Wm. C. Keay); Technical and Trade Reviews.—Price One Shilling.

In the first number of this excellent and well printed quarterly review, Mr. Wm. C. Keay, our Hon. Treasurer, contributes a well reasoned plea for including television in the schools of the future, pointing to the value of "sight at a distance" as an aid to learning additional to the cinema film. A strong case is made out for the establishment of a National Film Institute—that is an

[Continued on page 136.]

Fourth Annual Report of the Council and Balance Sheet.

YOUR Council has pleasure in presenting the Annual Report as follows: On the whole, the year under review from January—December, 1931, has been one of steady progress. The two Committees of the Council appointed last year, namely the Research and the Papers and Publications Committees, are now working smoothly and have already done much valuable work. Throughout the year the Society has continued to enjoy the hospitality of University College for its monthly meetings, and the thanks of the Society are hereby conveyed to Professor Andrade and the College authorities for this privilege.

MEMBERSHIP: 1931.

The present position with regard to the membership is not so encouraging. A larger percentage of members than usual are in arrears with their dues, and although repeated calls have been made these have not brought in the response desired. The present position is indicated approximately by the following table:—

	Fellows.	Associates.	Students.	Total.
Jan. 1st, 1929	115	192	18	325
Jan. 1st, 1930	215	295	67	577
Jan. 1st, 1931	227	309	82	618
Dec. 31st, 1931	185	326	88	599

showing a net decrease of 19 on the figures for 1930.

Having regard to the serious financial crisis through which the country has been passing, your Council has given the closest attention to matters of economy. After a most careful scrutiny of the expenses involved in the management of the Society's affairs, a resolution was brought before an Extraordinary General Meeting held on December 9th, 1931, whereby the subscriptions payable in future by all members as from January 1st, 1932, are as follows:—

Fellows	20/- per annum.
Associates	15/- per annum.
Students	10/- per annum.

It was also resolved that the admission fees were to remain unaltered (viz., Fellows 10/6, Associates 5/-, Students 2/6), but the *Journal* is in future to be distributed gratis to every member and student whose subscription is not in arrear.

Another undesirable feature of the membership figures is that a larger number than usual of letters are being returned through the Post Office from members who have changed their addresses and cannot be traced. It is regretted that members do not always advise the Secretaries of their change of address.

In the interests of economy, a revised printed List of Members has not been issued during 1931.

LECTURES and MEETINGS.

The following is a list of the Lectures and Meetings held during the year:—

Jan. 14th.—" Television Progress in Europe and America during 1930," being papers contributed by Capt. R. Wilson, Mr. E. G. Lewin, M.Sc., G. M. Neale and J. H. Owen-Harries.

Feb. 11th.—" The Stenode Radiostat System of Wireless Reception and its Application to Television ": Lecture and Demonstration by E. L. Gardiner, B.Sc.

March 11th.—At the Annual General Meeting: A short Paper by Professor E. V. Appleton, M.A., D.Sc., F.R.S., on " The Effect of the Heaviside Layer in Television."

April 15th.—Third Annual Exhibition at University College, London.

May 13th.—" The Development of Cuprous Oxide Photo-Electric Cells ": Lecture and Demonstration by H. Wolfson, B.Sc.

Oct. 14th.—" Recent Advances in Television ": Lecture by H. J. Barton-Chapple, Wh.Sch., B.Sc., A.C.G.I., D.I.C., A.M.I.E.E.

Nov. 11th.—" Cathode Ray Television ": being a Series of Papers devoted to purely electrical methods of Television: Professor J. T. McGregor Morris, Manfred von Ardenne, E. H. Traub (Student), and C. E. C. Roberts (Student).

Dec. 9th.—" Echo Signals in Trans-Atlantic Picture Telegraphy ": Lecture by H. M. Dowsett, M.I.E.E., F.Inst.P., M.I.R.E. (Fellow).

A visit was paid to the National Physical Laboratory on Saturday, July 18th, through the kindness of the Director.

THE JOURNAL.

The Council fully realises that the Society's official publication, *The Journal of the Television Society*, is the only means that many country members have of keeping in touch with the monthly meetings held in London. It will be the policy of the Council to maintain a high standard of publication, and in their desire to increase the range of usefulness of *The Journal*, the Council intends to include in future issues an Index of current literature relating to Television.

EXHIBITION.

A full and critical report of the Third Annual Exhibition was printed in *The Journal* (Part II., June, 1931) and the Council feels that it cannot usefully add to this report except to express in this Annual Report the Society's thanks to the following firms who kindly loaned apparatus, thereby considerably enhancing the value of the Annual Exhibition: H.M.V. (The Gramophone Co.), The British Radiostat Corporation, The General Electric Co. Research Labs., The Tungsram Valve Co., The Photo-Telegraphy Section of the G.P.O. The Council also wishes to convey the Society's thanks to all who contributed to the success of the Exhibition, as well as to those gentlemen who kindly acted as judges for the award of the " Tuke " Cup, namely Professor F. J. Cheshire, Dr. James Robinson and Mr. Ll. B. Atkinson.

RESEARCH COMMITTEE.

(Members: R. W. Corkling, T. M. C. Lance, E. Phillips and Capt. Wilson).

It has not as yet been found practicable to make substantial progress with the scheme of local group working initiated in September, 1930. Your Council believes this to be due to some extent to the general depression in trade, which has undoubtedly re-acted unfavourably on the private experimenter. Other reasons are probably to be found in the difficulty which is often experienced in securing reasonably-priced components for such experimental work and the scarcity of experimental transmissions of vision signals at times suitable to the general body of members of the Society.

A Society exhibit was arranged by the Committee in connection with the Physical and Optical Society's Annual Exhibition in January, 1931 (reported in *The Journal*, Part II.), and at the Annual Meeting of the Science Masters' Association, Mr. J. J. Denton gave a valuable lecture on behalf of the Society, being assisted by practical demonstrations provided through the energy and enthusiasm of Capt. Wilson and Mr. A. A. Waters. The Council wishes to express its satisfaction in knowing that Mr. T. M. C. Lance, who has done so much work in connection with this Committee, is now recovering from the illness which has laid him aside for several months during the year.

PAPERS and PUBLICATIONS.

(Members: G. P. Barnard, E. G. Lewin, J. C. Rennie, W. G. W. Mitchell).

This Committee has recently been strengthened by the appointment of Mr. G. P. Barnard, Grad. I.E.E., whose special responsibility is that of securing members' co-operation in the scheme for publishing an *Index of Current Literature*. The Committee invites the co-operation of members willing to assist in this important side of our work. Early in the year, Mr. E. G. Lewin was ordered abroad for reasons of health, and his valuable services have in consequence not been available to the Society.

GENERAL.

The Council is not unmindful of its responsibility in the matter of pressing for more frequent experimental television transmissions through the official broadcasting channels. The position at the moment is a somewhat delicate one to handle, but it is the Council's considered opinion that important developments are taking place which may have a far-reaching effect on the progress of television, and it is part of our policy to keep in touch with these developments and maintain the closest liason with the commercial side of the science, and at the appropriate time to press for such further facilities as we believe will help our members and the advancement of the science of television generally.

THE TELEVISION SOCIETY.

BALANCE SHEET at 31st December, 1931.

Liabilities.

	£	s.	d.	£	s.	d.
Sundry Creditors—						
Messrs. Blacket Turner and Co. Ltd. for Printing ...	41	5	0			
University College for Hire of Lecture Room	2	6	6			
Telephone	4	15	5			
Typewriting	1	0	6			
Secretary for Postages		9	10			
				49	17	3
Capital—						
Balance at 1st January, 1931	72	10	11			
Less Balance of Income and Expenditure Account ...	35	11	2			
				36	19	9
				£86	17	0

Assets.

	£	s.	d.	£	s.	d.
Office Furniture at cost less amounts written off				3	10	0
Subscriptions in arrears				25	0	0
Stock of Badges				10	0	0
Rent Paid in advance				2	2	0
Cash in Bank	39	5	2			
Cash in Secretary's hands	6	19	10			
				46	5	0
				£86	17	0

Report of the Auditor to the Members of the Television Society.

I have examined the above Balance Sheet with the Books and Accounts of the Society, and have obtained all the information and explanations I have required.

In my opinion, the Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Society's affairs according to the best of my information and the explanations given to me and as shown by the Books of the Society.

22 and 23, Laurence Pountney Lane,
London, E.C.4.
24th February, 1932.

DAVID FINNIE,
Chartered Accountant,
Auditor.

INCOME and EXPENDITURE ACCOUNT for the Year ended 31st December, 1931.

Expenditure.

	£	s.	d.	£	s.	d.
Rent, Light, Heating and Telephone				54	10	9
Hire of Lecture Room				18	3	0
Printing and Reporting Proceeds	82	3	8			
Printing Notices, etc.	33	16	0			
				115	19	8
Postages and Carriage				31	15	7
Stationery and Duplicating ...				10	15	8
Exhibition and Lecture Expenses				22	10	3
Bank Charges				1	1	3
General Expenses				2	9	2
				£257	5	4

Income.

	£	s.	d.
Entrance Fees	10	0	6
Subscriptions	207	10	8
Magazines	3	11	0
Badges		12	0
Balance of Expenditure over Income carried to Balance Sheet	35	11	2
	£257	5	4

Report of the Fourth Annual Business Meeting

THE Fourth Annual General Meeting of the Television Society was held at Brooklyn Hall, Bush House, Aldwych, London, W.C.2, on Wednesday, March 9th, 1932, at 6.30 p.m. Dr. Clarence Tierney, F.R.M.S., Chairman of the Council and Executive Committee, being in the chair.

Apologies for absence having been read, the minutes of the last annual meeting were read and confirmed. A draft of the Annual Report having been circulated to all members by post previous to the meeting, Dr. Tierney gave a summary of the progress of the Society during the past year. There was nothing sensational in the report, he said, but it was the record of sound work carried out by the officers in active co-operation with the members of the Society. He hoped they were building the Society on firm foundations. The Society had been in existence four years, and during that time they have never failed to look ahead to the future—to the time when the Society would be recognised as the leading scientific body on television matters. He referred to the value of the *Journal* as a record of progress and as a means of disseminating knowledge especially among those members living out of London and even abroad.

The Hon. Treasurer, Mr. Wm. C. Keay, presented the audited accounts. He stressed the need of members paying their dues early in the year, otherwise the Council was unable to budget for their yearly expenditure, and in consequence much important work had to be put aside.

The adoption of the annual report and accounts was proposed from the chair, seconded by Mr. A. H. Bird, and carried *nem. con.*

The election of officers and Council then took place, Mr. P. C. Philpot proposing, and Mr. A. H. Bird seconding the motion. Messrs. Finnie Ross and Co., chartered accountants, were elected as auditors for the ensuing year and thanked for their past services. On the motion of Mr. A. A. Waters, seconded by Mr. P. C. Philpot, the officers and auditors and the retiring members of Council were thanked for their past services to the Society. The motion was cordially accepted and responded to by the Chairman on behalf of the Council.

The Lecture Secretary, Mr. W. G. W. Mitchell, then raised the question of the advisability of holding the Annual Exhibition in April. He said that very little support was forthcoming at that time, and the Exhibition was, according to present arrangement, to take place one month hence. It would be advisable either to postpone the holding of the Exhibition until September or, better still, to wait until next year when conditions might be better. Several members having expressed views in agreement, it was decided to leave the matter for the consideration of the newly-elected Council. The latter subsequently decided to hold over the Exhibition until April, 1933.

The business of the meeting being concluded, the Chairman introduced *Mr. R. P. Howgrave-Graham, M.I.E.E.*, who had brought apparatus weighing over three-quarters of a ton with which to illustrate his lecture on *Experiments with High Voltage Oscillatory Discharges—A Chapter in the Development of Radio.* In the setting up of the apparatus and throughout the evening, the lecturer was assisted by Mr. B. Abell, who most kindly gave his services.

The lecturer discussed early experiments leading up to the development of the condenser and transformer. Then followed experiments on the charge and discharge of Leyden Jars and on the production and behaviour of magnetism resulting from electric currents, followed by explanations of the manner in which a Leyden jar and a coil of wire provide, in an electrical circuit, forces which correspond to the mechanical forces required to obtain natural mechanical vibrations. Methods for the production of electrical vibrations of unimaginible rapidity were described, and, to give some idea of the frequencies obtained, they were compared with the sound frequency of a high-pitched whistle adjusted to about 30,000 vibrations per second—a note like that of a bat and only audible to the younger members of the audience.

By the aid of large condensers and inductances actuated by heavy high frequency currents, the energised space around was shown to be capable of exciting circuits to emit large sparks, to light glow lamps and to melt metals. A sheet of galvanised iron coarse-mesh netting rapidly glowed and the zinc burnt off in luminous blue flames as it was held in the lecturer's hand.

Long high-tension discharges were then utilised to demonstrate the scintillations of a carbon filament bombarding its particles on the side of a glow lamp, and finally the glow lamp was melted by the discharge. The heating effect of the discharge was made evident by passing the discharge through a block of wood and through the branches of a tree.

Many beautiful effects were demonstrated by exposing vacuum tubes of different degrees of exhaust to the radiant energy in the space amidst the audience and surrounding the lecture table. The lecturer raised his body to thousands of volts high potential and to show that these currents were comparatively harmless caused discharges to issue from his nose and fingers, and finally he appeared with a halo round his head.

A vote of thanks, proposed by the Chairman and seconded by Mr. W. G. W. Mitchell, who paid a tribute to the valuable help of Mr. B. Abell, was most heartily responded to by the audience.

ROUND THE EXHIBITIONS

[Continued from page 125.]

Among the many eminent visitors who attend the Physical and Optical Exhibition each year, we noticed our President, Sir Ambrose Fleming, F.R.S., on this occasion. After witnessing a demonstration, he commented very favourably on Capt. Wilson's apparatus. Throughout the Exhibition, Miss Denton assisted by being the "subject" at the transmitter, and we take the opportunity now afforded of expressing our appreciation of her services to the Society in this and other ways.

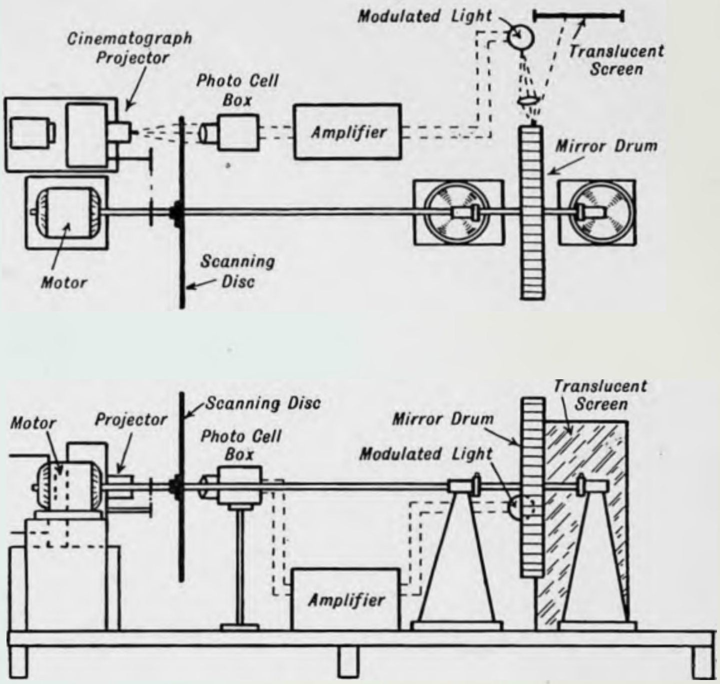

FIG. 3—Diagrammatic view of Mr. R. W. Corkling's apparatus as seen from above and side view.

Mr. J. J. DENTON'S LECTURE AT THE SCIENCE MASTERS' MEETING:

"HOW TO MAKE A SELENIUM CELL."

In the course of a valuable paper given by Mr. J. J. Denton, A.M.I.E.E., covering the whole field of television (which can be read in *The School Science Review* for March, 1932), the light sensitive properties of selenium cells were demonstrated. Mr. Denton had much experience in the early days of television in making these cells, and his description of a simple form of cell will be read with interest. The lecturer recommended Kahlbaum stick selenium, which can be obtained from Messrs. Griffin and Tatlock, Kingsway, London, W.C.2. The base of the cell is a slab of unglazed earthenware, 1 in. × ¾ in. × ¼ in. approximately. The top surface is rubbed over with blacklead, and about eight scratches are then made through this with a knife, cutting into the earthenware. There is then no electrical connection between the ends of the slab, and the gaps are filled with selenium in the following way. The slab is heated on an electric iron, and a stick of selenium rubbed on the surface. The little globules which form on melting can then be smoothed off with a visiting-card. The cell is now ready for annealing, which is done by building up sheets of asbestos round the iron and allowing the iron to cool slowly, reducing the current over a period of five minutes by a 6-ohm rheostat in series with the iron. The whole can then be mounted on a strip of ebonite and fitted with terminals as in the diagram. (Fig. 4.)

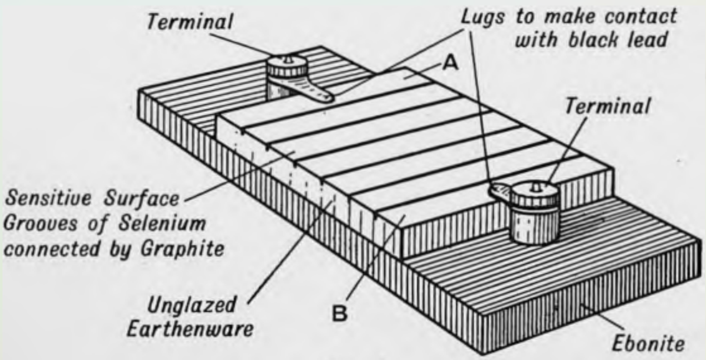

FIG. 4.

CURRENT LITERATURE

[Continued from page 130.]

organisation "which can introduce coherence into the fragmentary and spasmodic beginnings of exploiting the film as a medium of education." (Notes of the Quarter and article by A. C. Cameron). The suggestion is made that a small proportion of the takings of every Sunday cinema show should be set aside for the promotion of educational and cultural films. It is pointed out that the somewhat negative aspect of film censorship might be supplemented with a positive contribution to the solution of the problem of providing better films. An amendment to the Sunday Cinema Bill, incorporating the foregoing suggestion, is the line of action to be adopted.

MULTI-CHANNEL TELEVISION USING KERR CELLS.

In a paper read recently before the INSTITUTION OF ELECTRICAL ENGINEERS, Mr. C. O. BROWNE, B.Sc., describes an experimental television system designed expressly to examine the conditions necessary for the transmission and reception of comparatively good pictures. Five picture channels are used, which accommodate a frequency band sufficient to produce an image composed of 15,000 elements. The received picture is projected on to a screen measuring 24 inches by 16 inches, and is scanned at the rate of 12½ times per sec. The best operating condition for the Kerr cells of the receiver are very fully investigated in the paper, and the effects of geometric, non-linear and frequency distortion are examined. The Author reaches the following conclusions: "Although it is difficult to stipulate the number of picture points which should be provided in order to compose a good television image, the 15,000 points provided in the system described were sufficient to show details of a moderately pronounced character as contained on average cinematograph photographs. Whereas sub-titles were resolvable, some smaller details were definitely rather obscure. The method of limiting the field comprised in each photograph and scanning only the centre of attraction, was ruled out on account of the loss of interest which would thereby be introduced.

Further, any attenuation in the transmission or receiving system at the higher frequencies which would cause the system to cut off below the scanning limit of resolution, has a detrimental effect upon the received picture. This effect is not pronounced in cases where the original picture is devoid of small detail.

The arc and Kerr-cell receiving system satisfactorily illuminates by transmission a ground-glass screen measuring 24 in. by 16 in., although if desired these dimensions may be increased—with a corresponding decrease in the brilliance of the received image.

Comparatively small amounts of distortion only are permissible in the Kerr cells, since this distortion is characterized by a change in colour in parts of the received picture where the distortion takes place, rather than by erroneous degrees of shade.

The scanning speed of 12½ pictures per second is insufficient, the large received picture augmenting the effect of the flicker at this speed.

Very steady pictures are obtained using 50-cycle 3-phase mains as a synchronizing medium, provided that mechanical filters are included between the scanning apparatus and the driving mechanism. In cases where synchronized mains are not available and a phonic motor is used, damped mechanical filters containing two sections appear to be necessary.

THE TELEVISION SOCIETY.

President: Sir Ambrose Fleming, M.A., D.Sc., F.R.S.
Chairman of the Executive Committee:
Clarence Tierney, D.Sc.

Hon. Secretaries :—
J. J. Denton, A.M.I.E.E. (Business Communications and Membership), 25, Lisburne Road, Hampstead, London, N.W.3.
W. G. W. Mitchell, B.Sc. (Editorial Communications and Lectures), "Lynton," Newbury, Berks.

CHANGE OF ADDRESS.

Members are requested to keep the Secretary informed promptly of any change in their *permanent* address. Letters addressed to the following Members have been returned through the Post Office; any information which will enable them to be communicated with will be appreciated :—

G. D. Bonner, Blackhall, Midlothian
P. R. Browning, Wheatley, Oxon.
W. E. Browning, Wheatley, Oxon.
W. Burrows, Wavertree, Liverpool.
E. J. Manners, Thorpe Bay, Essex.
N. McIntyre, London, S.W.7.
W. J. McKibbin, Isle of Man.
J. Scott, South Chingford, Essex.
M. F. Woodroffe, London, W.C.1.

The Journal of the Television Society

is published THREE times yearly. Payment of the annual subscription entitles Fellows, Associate Members and Students to one copy of each number of the JOURNAL issued during the period of Membership. Members may obtain extra copies at ONE-HALF the published price. The JOURNAL is sold to Non-Members at an Annual Subscription of 15/- post free.

Editorial Notice.

The Papers Committee of the Council will give careful consideration to contributions of a scientific nature submitted by Member and Non-Member contributors for publication. Contributors should prepare their manuscripts as concisely as possible, special care being given to the legibility of mathematical formulæ. A short summary should accompany the paper.

The Society does not necessarily endorse the views and opinions expressed by individual writers in the JOURNAL. The right to reprint limited portions or abstracts of the papers, discussions and notes appearing in the JOURNAL is granted subject to the usual courtesy recognition. Diagrams or photographs published in the JOURNAL may not be reproduced without special permission.

All contributions and Editorial communications should be sent to W. G. W. MITCHELL, B.Sc., "Lynton," Newbury, Berkshire, England.

Forms of proposal for Membership, and further information regarding the Society, may be obtained on application to the Business Secretary, J. J. Denton, A.M.I.E.E., 25, Lisburne Road, Hampstead, London, N.W.3.

Journal of the Television Society.

CONTENTS OF VOL. I., PART I. JANUARY, 1931.

CONTENTS OF VOL. I., PART II. JUNE, 1931.

CONTENTS OF VOL. I., PART III. DECEMBER, 1931.

PRICE: FIVE SHILLINGS NET EACH.

Published by THE TELEVISION SOCIETY

Back Numbers may be had on application to the Editor—W. G. W. MITCHELL, B.Sc., "LYNTON," NEWBURY, BERKSHIRE, ENGLAND.

BLACKET TURNER & CO. LTD., PRINTERS, NEWBURY.