Television An Accomplished Fact

By A. DINSDALE

This authorized description of the television apparatus invented by J. L. Baird will be of the greatest interest to those who wish to keep abreast of radio's latest developments.

FOR the last twenty years the editor has published from time to time, various articles on Television, beginning first in MODERN ELECTRICS in 1908, and during the past few years through RADIO NEWS.

All these articles were of a theoretical nature, as Television was not at that time an accomplished fact. The editor came in for a good deal of criticism and was termed visionary on account of these articles.

Our faith in Television, however, was sufficiently persistent; and we believe that we will not be contradicted if we say that RADIO NEWS, in connection with its associated magazines, has published more articles on Television than any other agency.

And now, Television is an accomplished fact. The art has progressed to such an extent that it is possible to see a moving face at a distance and to actually, visually, witness a thing that takes place at a distance. This is true Television. The editors themselves were skeptical when they first heard about the Baird Television Apparatus and commissioned Mr. Dinsdale, who is a member of the Radio Society of Great Britain, to get the actual facts on it, which we now publish in an authoritative form.

Without trying to be over-enthusiastic or visionary, we wish to say now that Television will change our entire mode of living just as the Telephone, the Telegraph, and the Railroad changed our lives when they came into general use.

FOR some years past we have beocme accustomed to "listening in" by radio to audible sounds produced at some distant point, which may be anywhere up to several thousands of miles away. How long will it be before we are able also to "see in" by radio, and thus witness scenes and events at places similarly distant from us? In view of the vast progress recently made in this direction, the writer ventures to express the opinion that it will not now be very long before this comes to pass.

The cinematograph has been developed within the last twenty years or so, till today it is a highly-efficient and marvelous means of entertainment; but it is one-sided. Its appeal is to the eye only. We see a great actress speak, but we cannot hear her words. Many inventors have been working for years to make this possible, but it is not yet a commercial accomplishment.

As with the cinematograph, so with broadcasting as we know it to-day. We can hear a great man speak, but we cannot see his gestures and facial expressions. It is the province of Television to overcome this disability. By combining television with ordinary broadcasting, we shall, in the near future, not only hear the performance of a play, but also see the actors, the scenery, the entire stage.

REPRODUCTION OF SIGHT

That is the function of television. It must not be confused with telephotography, which is something totally different. Telephotography, or phototelegraphy as it is sometimes called, means the telegraphic transmission of a single "still" picture from one place to another.

In Webster's dictionary television is confused with phototelegraphy, and if such an authority is in confusion, there is no wonder that the public—even the technical section of it—does not possess clear ideas on the subject. It needs no apology, therefore, to commence an article on television with an attempt to define exactly what television is, and for an authoritative statement, we cannot do better thon quote the British patent office, whose business it is to define and catalogue such terms.

In the patent office library we find classed, under the heading "Television," "Apparatus for transmitting instantaneously to a distance images of views, scenes or objects by telegraphy (either wire or wireless.)" In other words, Television means seeing at a distance by telegraphy.

Until recently, our only means of extending our range of vision beyond normal distances was the telescope; and the range of this instrument is distinctly limited. The development of television will enable us to see scenes and objects at distances as great as those over which we are now accustomed to communicate telegraphically and telephonically.

Capt. O. G. Hutchinson, president of Television, Ltd., is shown at the left; while above is an unretouched photograph of Mr. Hutchinson's image taken at the receiving screen of Mr. Baird's television apparatus.
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Mr. Baird demonstrating the receiver of his television apparatus, seen in the circle.
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HISTORY OF DEVELOPMENT

Both phototelegraphy and television are no new ideas. The latter is but a development of the former; and the inspirations for both date back to 1873, when May, one of Willoughby Graham's assistants, communicated to the Society of Telegraph Engineers the details of his discovery of the photo-electric properties of selenium.

It was not long before this discovery led to the construction of selenium cells by Siemens, Graham, Bell and others. These, as all the world knows, are devices for transforming light impulses into electrical impulses; and the idea soon occurred to a number of investigators that they might be utilized to give to the eye what telephony had given to the ear, and render it possible to see by telegraph.

Ayrton and Perry, Senlee and several others actually described systems which were to accomplish this; and nearly fifty years ago it was confidently predicted that in a very short time it would be possible for us to see one another over the telephone line!

These optimistic inventors had, however, entirely overrated the capabilities of selenium to respond to the immense speed of signalling involved; and their predictions came to nought, as far as practical results were concerned. Considerable progress was made in phototelegraphy, however; for time is a secondary consideration in the transmission of a single still picture, and the various other problems in connection with this accomplishment are considerably easier of solution.

At the present time many investigators in various countries have demonstrated their ability to transmit and receive still pictures, either by wire or radio; among whom may be mentioned C. Francis Jenkins in the United States, Thornton Baker in England, Fournier and Belin in France, and Dr. Korn in Germany. Also worthy of mention is the more recent achievement of Captain Ranger of the R. C. A., who succeeded in sending a photographic copy of a check from London to New York in 25 minutes.

Phototelegraphy, therefore, is not only a definitely accomplished fact; it is also a commercial proposition. Television, however, has not made anything like such progress; for only one inventor has so far succeeded in giving an actual demonstration of "seeing at a distance."

SOME PROBLEMS OF TELEVISION

Most of the systems in use for transmitting still pictures make use of the cylinder method; in which the picture to be transmitted is transferred to a film, which is wrapped round a cylinder of glass. As this cylinder is rotated, a spot of light is caused to cover the

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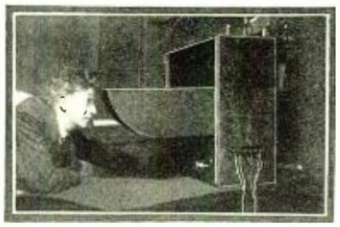

Mr. Baird "seeing-in" on one of his experimental televisors.

film from end to end in a series of finely separated lines. The intensity of the light which passes through the film depends upon the latter's density at different points; and the varying light beam, after passing through the film, is focused upon a light-sensitive cell, of one or another type. This cell transforms the light variations into electric-current variations, which are sent over a wire or by radio to the distant receiver.

At the receiving end the process is reversed, the incoming current variations being caused to vary a source of light which is focused upon a photographic film wrapped around a rotating cylinder. This film becomes covered with fine lines of varying density, which, when developed in the usual manner, make up the complete picture.

Obviously, this system is inapplicable to television, for a scene, or even the image of it, cannot be wrapped around a cylinder. Some means, therefore, had to be found which would enable a picture to be transmitted directly from a flat surface. This can be done by moving the light beam instead of the picture. By rotating a suitably-designed and arranged series of prisms between a fixed light source, and a fixed flat-surface picture, the beam of light is made to traverse the picture from side to side, moving slowly across it as it does so, so that ultimately the entire surface is covered.

This, very roughly, is the operating principle of television apparatus, but only as applied to the transmission of a single picture or image.

From the transmission of a single picture from a flat surface to television is a far cry, however; and, to understand something of the tremendous obstacles to be overcome, let us consider the cinematograph. When witnessing a movie performance, we think we see a smoothly flowing animated scene. Actually, we are looking at 16 separate and distinct pictures every second, but, owing to the persistence of human vision, we do not receive this impression from the sense of sight.

The one and only similarity between the movies and television is that, in both cases, the scenes are projected upon a screen. In order to make television a success, it is necessary to transmit and receive something like 16 complete pictures per second, in order to give the witnesses an impression of lifelike movement.

THE BAIRD SYSTEM

The most successful inventor of apparatus for the achievement of television is John L. Baird, a young Scottish engineer. He is 35 years of age, and the son of a Presbyterian minister at present living in Edinburgh. After studying at the Royal Technical College, Glasgow, Mr. Baird "served his time" as an engineer at a motor works near Glasgow; after which, in 1912, he commenced his experiments in television. Faced with many difficulties, he persevered until, in 1923, he succeeded for the first time in sending shadows which were flickering and coarse in outline, but unmistakable. About a year later he was successful in transmitting the image of objects by light reflected from them; and so he progressed until, early in this year, he was able to transmit a recognizable image of a human face, and demonstrated his invention before the Royal Institute, one of England's leading scientific societies.

The apparatus used by Mr. Baird to attain these results may be described as follows:

At the transmitting end, a battery of powerful lights shine upon the scene to be transmitted. Light reflected from this scene is collected by means of a lens, in much the same fashion as a camera lens collects the light reflected from a scene to be photographed. In the television transmitter, however, instead of a sensitive photographic plate, as in a camera, the reflected light is focused upon a light-sensitive cell.

Between the focusing lens and the cell, however, there are interposed two rapidly revolving discs. One of these discs has a number of lenses mounted upon its face in spiral fashion, as shown in Fig. 1. The function of these lenses is to cause the image of the transmitted scene to sweep across the light-sensitive cell in such a manner that the image is divided into fine parallel lines. The rotation of the disc gives the horizontal motion (*i.e.*, draws the lines), while the movement into focus of the next lens (set a

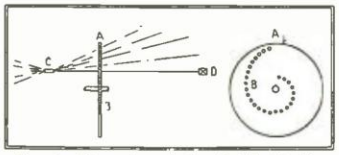

Fig. 1. The action of the Baird television transmitter: A is a rotating disc carrying spirally-arranged lenses. B, through which shines light reflected from scene, and collected by lens C. Movement of disc causes light beam to traverse light-sensitive cell D in two directions, horizontal and vertical.

trifle nearer the center of the discs) gives the necessary vertical motion to ensure that the lines do not over-lap. Reference to Fig. 1 will assist the reader to understand the action.

In this manner the entire image is flashed across the light-sensitive cell in the space of one-tenth of a second. The light reflected from the high lights of the scene to be transmitted is, of course, very bright, while that reflected from the dim shadows of the scene is very dim. The light-sensitive cell transforms these light variations into electric-current variations, which are then amplified and transmitted over the circuit to the distant receiver.

SPEEDING UP THE TRANSMITTER

The second disc referred to above is a serrated one, and its purpose is simply to interrupt the light at high frequency. By this means Mr. Baird found it possible to eliminate the inertia of selenium, and cause it to respond at a speed great enough to enable him to transmit a sufficiently large number, of complete pictures per second, to give to the observer at the receiving station the effect of a smoothly-animated scene.

Another advantage of interrupting the source of light is that the output of the light-sensitive cell takes the form of a unidirectional current, interrupted at high frequency, instead of a fluctuating D.C. as would otherwise be the case. A steady D.C. cannot be amplified by ordinary vacuum-tube amplifiers, whereas interrupted D.C. can. As the output current of a light-sensitive cell is extremely feeble, such amplification is necessary before transmission over a wire or wireless circuit can be accomplished successfully.

At the receiving end of the circuit Mr. Baird uses apparatus which, though similar in essentials to that used at the transmitting end, has been reduced to the simplest possible form. There is a source of light and a ground glass screen, and between the two rotate discs similar to those used at the sending station. The incoming current impulses are caused to vary the intensity, or brilliancy, of the light source, in accordance with the strong and weak currents delivered by the light-sensitive cell at the transmitter.

The rotating-lens disc then breaks up the beam of light and throws it on the screen as a complete moving picture. The discs at the transmitting and receiving stations are in each case driven by electric motors, and in order to achieve success, it is necessary that the motors at all receiving stations shall be in exact synchronism with the transmitting motor. This is accomplished in the Baird system by transmitting, in addition to the picture impulses, a low-frequency alternating current, by means of which all motors are kept in step.

AN ACTUAL DEMONSTRATION

Having dealt so far with the nature and general problems of television, and outlined

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Capt. Hutchinson and Mr. Baird discussing part of the latter's television apparatus.
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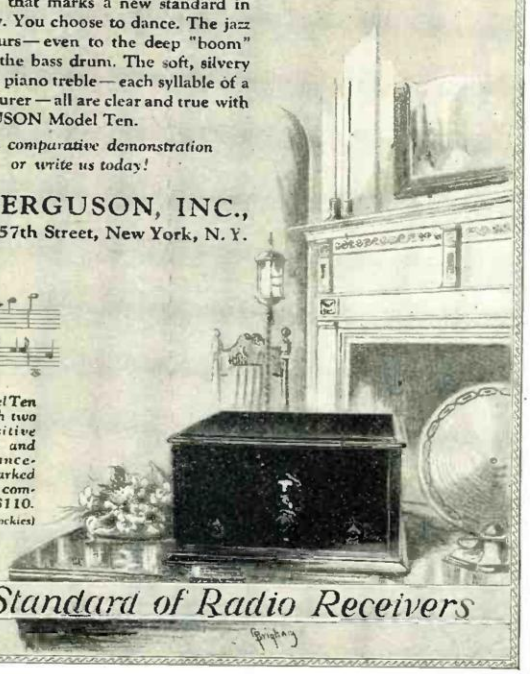

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they are incorporated. Still the first outcry of the fans has been remembered, and the designing engineers have been endeavoring to produce a condenser of this type which will take up on the panel no more space than the ordinary condenser of the old S.L.C. type.

In the "phantom" or "X-ray" drawing accompanying this article is shown an S.L.F. condenser which, when the plates are separated as far as possible, takes up only 3¾ inches on the panel. Instead of having plates which are curved on one edge and straight on the other, this condenser employs rectangular plates. As may be seen from the drawing, a cam is attached to the dial on the front of the panel. This cam is held in place by two pegs that slide in grooves in the bakelite base of the condenser. In the two posts to which the plates are attached, are springs that hold the pegs running on the cam tight up against it. When the dial is rotated the cam throws these pegs to the outer edge and the plates mesh; when the cam is turned in the opposite direction the force of the springs is exerted and the plates spread apart.

However, the pressure of the springs is just enough to keep the pegs close against the cam, when the condenser is mounted in a horizontal position. (See top page 221).

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roughly the methods used by Mr. Baird to achieve it, let us now turn to his actual accomplishments.

While in London recently, the writer was privileged to witness a demonstration of Mr. Baird's apparatus in working order. The great inventor was much interested to learn that readers of RADIO NEWS were anxious to learn something about his work; and readily acceded to the writer's request for a demonstration.

Leading the way to the transmitting room, Mr. Baird moved over several switches. Behind a light-proof partition, where were located the revolving discs and the light-sensitive cell, a motor could be heard to start up. In the center of the partition was the large collecting lens, around which were mounted a battery of powerful lights, screened from the lens by means of reflectors which concentrated the light upon the scene to be transmitted.

Next, Mr. Baird marshalled before me several members of his office force, and told me to take a good look at them so that I should be able to recognise them again. This done, Mr. Baird led the way downstairs to the receiving room on the next floor, and seated me before the "Televisor," as he calls his receiving apparatus. Before me was a wooden cabinet, in the middle of which was a screen. Mr. Baird threw over some switches, made some adjustments, and then switched out the light, leaving the room in total darkness except for a flickering sepia-colored light on the screen.

Picking up a microphone, Mr. Baird instructed one of his assistants to seat himself before the transmitter. The reply came back through a loud speaker, and immediately an image appeared upon the screen.

There was no mistaking it. It was the head and shoulders of one of the men I had just seen upstairs. True, the image was flickering somewhat, and looked rather out of focus. The best description I can give of it is to compare it with the earliest forms of cinematograph. Nevertheless, the image was there, in smooth gradations of light and shade, bright high lights, dark shadows, and

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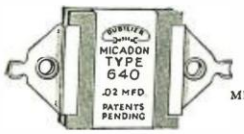

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half tones, and perfectly recognizable beyond all question or doubt.

Mr. Baird then handed me the microphone and suggested that I should ask the sitter to perform various actions. I did so, and before my eyes the image moved, the eyes and mouth opened and closed, a hand rubbed the chin, and so on, exactly in accordance with my telephonic requests to the transmitting room.

As a final acid test, I requested the sitter to repeat certain words into the microphone at his end. He did so, and as these words issued from the loud speaker in the receiving room, I was able to follow distinctly the movements of the speaker's lips on the screen of the Televisor.

The other members of the staff whom I had seen came before the transmitter in turn, and I was able to recognize each one without difficulty.

TRANSMISSION PROBLEMS

During the above demonstration, transmission from the one room to the other was effected over a wire circuit, and Mr. Baird explained that the question of distance is an entirely minor problem of an ordinary telephonic character. Given any circuit, wire or wireless, however long, which will convey intelligible speech, Mr. Baird states that he can transmit television over it. He has already accomplished this by wire and radio over varying distances in England.

If the transmitted impulses are listened to, two sounds are heard. One is a low note, like that of a trombone, caused by the synchronising current, and the other a high note, similar to a piccolo's, caused by the rapidly-interrupted picture impulses. Asked if these transmitted impulses could be made inaudible, so that one carrier wave could be utilized to convey the words of a speaker, in the usual broadcast fashion, and also television impulses which would render the speaker visible to his audience, Mr. Baird replied that this is perfectly feasible. To accomplish this would simply mean raising the frequency of the transmitted impulses to a frequency band above the audible limit. Mutual interference can, in such a case, be prevented by means of suitable filter circuits.

In actual fact, Mr. Baird has been aiming to do just this—utilize the carrier wave of a single broadcasting station to broadcast not only the usual programs, but also a continuously-animated picture of what is occurring in the studio at the transmitting station. In other words, just as we now *hear* what is happening before the microphone, Mr. Baird intends that we shall soon be able to *see* what is happpening as well.

With this end in view, the inventor has devoted considerable thought to the simplification of the Televisor, or receiver. His aim has been to make it a piece of apparatus no more complicated than a loud speaker, which can be attached to the output terminals of an ordinary broadcast receiver, just as the loud speaker is, and in addition to it. This aim he has already achieved, and he is at present devoting all his energies to the further improvement of the transmitting apparatus which is progressing rapidly.

EFFECTS OF INTERFERENCE

In television, as at present demonstrated, the received image is liable to electrical distortion if not properly adjusted; and its effects are almost as distressing as distortion in a loud speaker, only that, instead of the music, it is the image which suffers. The image or face may appear flattened out as in a concave mirror, or a twisted effect may be produced, so that the face seen on the screen may have a flattened nose and a chin higher on one side than the other.

Fortunately distortion in the televisor is easily remedied, much more so than with a loud speaker. Adjustment is rendered easier as each effect can be *seen*, and the eye is a more reliable measuring instrument than the ear.

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