

The Latest Advance Toward Television

By LUCIEN FOURNIER



Radiotelegraphy now sends not only news, but pictures to illustrate it. To receive and reproduce a moving scene with continuity of action, however, requires an apparatus which will cover ten complete images in one second. Prof. Belin's ingenuity has devised such.



THIS article is devoted to an explanation of recent experiments made by Edouard Belin for the purpose of determining the influence upon the "persistence of vision," of the length of time during which light is emitted. These experiments present a new point of departure in the attempt to solve the problem of practical television—which must be *radio* vision, because the lag caused by electrical conductors prevents the transmission by wire to great distances of modulated currents which are produced by extremely rapid variation in the luminous intensity of a point.

The art of invention may be compared to that of a prospector for gold, who drives

varying size obtained by reproducing the photograph through a very fine screen. The effect of light or shade is obtained by the use of very small or very large dots in the various areas of the illustration. It will be seen that by transmitting impulses in any regular order, each corresponding in its magnitude to that of one of the points between the white lines of the screen, it is possible to reproduce any picture in all its details at any distance. This is the fundamental principle of the transmission of pictures, first by land telegraphy and then by radio, which has so lately been placed on a regular commercial basis.—EDITOR.)

The luminous ray of the television appa-

18x25 millimeters (about the size of a postage stamp) composed of points divided by five lines to the millimeter (1/125 of an inch apart, about the fineness of the photo-engraving illustrations used in *RADIO NEWS*) will contain 11,250 points. All this must be transmitted in one-tenth of a second to produce in the eye the effect of a continuous image. To transmit a complete scene, in detail, perhaps double the number of points will be required; each of which must be recorded in 1/225,000 of a second.

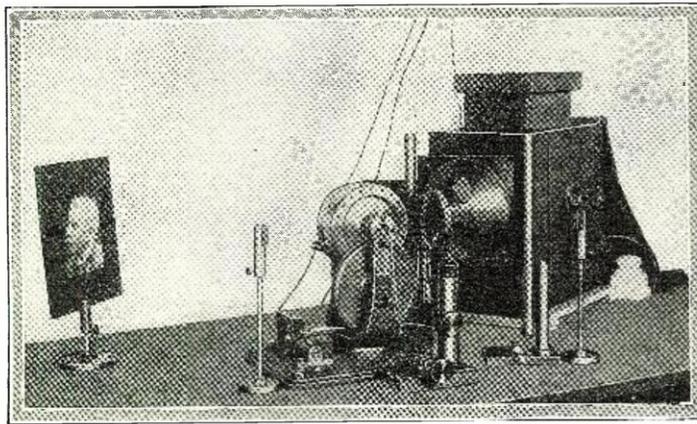
The effectiveness of so short an impression upon the retina might be doubted. It seems hard to believe that it would be perceptible by the optic nerve, and even more so that the effect should persist for a tenth of a second. The apparatus which we shall proceed to describe was especially devised with this end in view.

THE BELIN APPARATUS

The diagram, Fig. 1, is a schematic view of the mechanism illustrated on these pages. The interior of the projecting lantern contains an electric arc, A, a convex lens, and a slide carrier, O, into which an ordinary positive photograph upon glass is inserted, as if for projecting the image or picture upon a screen in the usual manner.

The rays from the arc pass through the positive slide and project its image through a second or objective lens upon a plane mirror, B, which is attached to a drum completely surrounded by such mirrors, those at the ends of each diameter being parallel. The drum is connected by gears to a motor, by which it may be rapidly revolved. When it is in a state of rest, the image from the lantern slide may be projected by reflection from the mirror B to a diaphragm or screen, C, on which it is reproduced with all its graduations of light and shadow.

If we make a hole, 1/25 of an inch in diameter, in this screen, a luminous ray will pass through it, and fall upon the fixed mirror, D. The point of light it forms will have a diameter larger than the perforation in the screen, because of the spreading of the rays: and the mirror itself will accentuate this effect. Accordingly we place another lens, E, in the path of the reflected ray, which is thus caused to converge. From this it passes to the mirror F, which again reflects it to the drum of mirrors. Here it



This apparatus is diagramed below: the projecting lantern at the right; the drum of mirrors, center; and the adjusting stands for diaphragm and fixed mirrors in front. At the left a continuous image appears on the screen, although only 1/25,000 of it is actually projected at any instant.

his pickaxe everywhere, until he uncovers the vein of gold of whose existence he has been certain. This is the present procedure in the endeavor to establish television. Our readers have doubtless heard how Edouard Belin succeeded, after patient and laborious research, in transmitting between two radiotelegraph stations, first the changes in a luminous point, and then a circle which was complete or broken in accordance with the variations at the transmitting station. This was the first positive result obtained, and was a direct accomplishment of radio vision.

ANALYZING THE VISUAL IMAGE

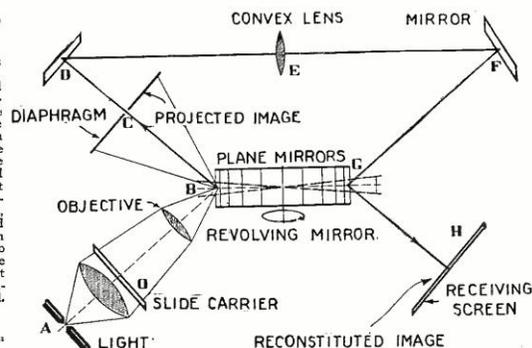
In viewing an ordinary moving picture, the impression on the retina lasts one sixteenth of a second. But, when we transmit the image of an entire scene, the whole of it cannot be covered at once by a ray of light. The scene or picture must be separated into distinct points; as if it were composed of a fine screen, over which a sharp brush would pass, covering one vertical line after another, parallel and extremely close, until every point has been covered.

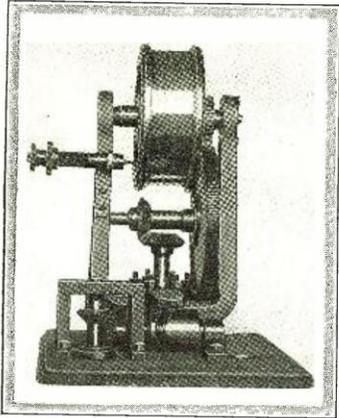
(An examination of the illustrations, or "halftones," used to reproduce photographs in this and other publications, will illustrate this idea. They are composed of points of

ratus moves in a similar manner; but, instead of leaving ink upon the image at the receiving end, as does the apparatus used to reproduce pictures, it only sweeps over the screen in vertical lines, each almost touching the next, at such a tremendous speed that it must cover the whole field in one-tenth of a second, or less.

An image whose surface is, for instance,

Fig. 1. This diagram is fully explained in the text. The cylinder is covered with plane mirrors, revolving downward on the side toward the lantern. One ray at a time, from 1/25,000 of the area of the image, passes through the opening in C. The fixed mirrors D and F send it back to the mirror G, opposite B on the cylinder, and it is finally reflected against H in a position corresponding exactly to the portion of the image from which it was first taken. The effect of continuous vision is produced.





This is a front view of the cylinder or drum of mirrors. It is turned by an electric motor, and at the same time swung from side to side by the gear at its base.

impinges on the mirror G, which is diametrically opposite to B, and thence finally to a screen H, where it appears as a luminous point, corresponding to that which fell originally on the spot on C through which we made the opening.

Now we start our motor and set the mirror-encased drum revolving: with what result? So long as the first mirror B remains stationary, the image which it projects upon the screen H is motionless; but when we set it in motion, in the direction indicated by the arrow, the image reflected by it will be deflected downward upon the diaphragm C. Over the hole in C all the points constituting a vertical line in this

image will pass, and be projected in succession upon the mirror B. Through the reflecting system which has been set up, these will be reproduced in succession upon the receiving screen H. Each mirror which succeeds B in position on the revolving drum will receive the image in the same manner and make it pass through the opening in the diaphragm C.

THE IMAGE REPRODUCED

We now are able to transmit a luminous vertical line, traversing the image from top to bottom, and always composed of the same succession of points. They will not be of equal intensity; because the ray will be very luminous when it represents a transparent portion of the slide on O, and more obscure when it passes through a part representing a darker portion of the image.

Now the problem is to cover the whole area of the image on the slide, by causing the luminous line to be displaced at each movement over the screen, taking a course very close and perfectly parallel to the preceding stroke. This is accomplished by giving the mirror-drum a horizontal movement, alternating from right to left; which is accomplished by the use of a double spiral cam attached to its base, which gives it the necessary reciprocal action from right to left and back. These movements, communicated to the revolving mirrors, deflect the image from side to side upon the diaphragm C. In this manner the image is made to cover the opening in this screen with every successive point of which it is composed. The revolving mirrors thus transmit to D and its train of reflection all the points of the projected image, in vertical lines, which by means of the oscillation of the drum, are delineated so close together that each practically touches the preceding one; and no perceptible portion of the image fails to be projected through the opening in C.

As the mirror G and those which succeed it reproduce, in reverse direction, the motions of B, the reflected ray at H reconstitutes one by one, in the same order, all the points of the image on C which pass over the opening in that screen. As the entire screen is covered in a tenth of a second, or less, the image will appear clearly upon the receiving screen, as if reflected over its whole surface at once.

This ingenious experiment has proved that every luminous emission of sufficient intensity which lasts for 1/250,000 of a second is perfectly registered by the retina, the impression on which persists for 1/10 of a second. This brings out clearly the curious property of the eye, "the persistence of vision," by which the sight of an image is preserved for a period of 25,000 times longer than the duration of the impression.

APPLICATION TO RADIO

To transmit the image by radio waves, we have only to replace the mirror D by a photo-electric tube, such as have already been described to our readers (See "The Vacuum Tube and Photo-Electric Cell," October, 1925, issue of RADIO NEWS.) All luminous points in the image will be projected upon the tube, creating impulses which will be transmitted by means of ethereal (Hertzian) waves through space. By means of a properly synchronized corresponding mechanism attached to a receiver, they will be reproduced and projected in the same order upon a screen corresponding to H, producing the phenomena of television.

It must be pointed out that the luminous ray is not displaced upon the mirror D of our diagram, any more than it will be upon the photo-electric tube. If it passed through transparent glass, instead of through the picture on the lantern slide, it would have an unvarying intensity, and the current transmitted would be a continuous one. It

(Continued on page 84)



The moving image on the fixed diaphragm (C).

tion of the ray in the apparatus from B to G is always the same, no matter to what portion of the image it corresponds.

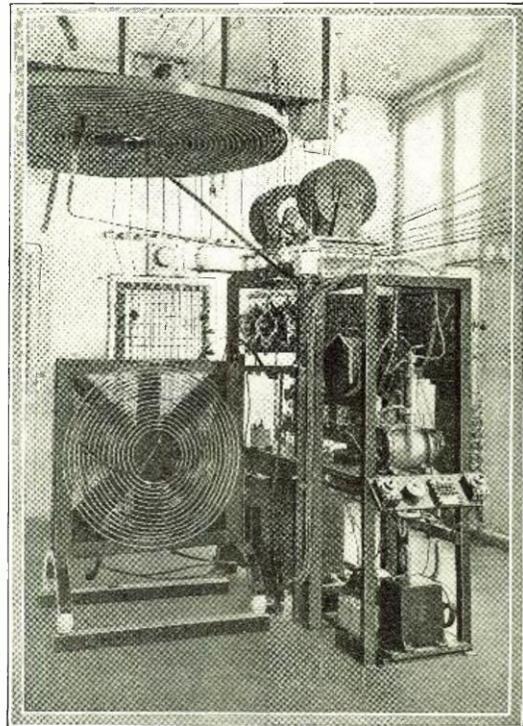


These motions, also, are reversed by the opposite motions of the parallel mirrors so that the entire image is reproduced in its proper form on H.

The illustration at the right shows the interior of the T. S. F. "wireless transmission" station at Malmaison, near Paris, which has been utilized by Prof. Belin in television experiments. Overhead is the large antenna coil; and the grid coil is beneath, in a vertical position. Above the frame at the right are shock coils; and just below them the modulating tubes. The screen for the reproduction of the image is just above the grid coil. In the center of the frame at the right is a reel of rubber tubing, through which cold water flows to cool the "Holtweck tube", shown in a vertical position, connected to a cylindrical "molecular" air pump just below. In the lower right is an oil-operated "fore pump" to which the molecular pump is connected; and between this and the grid coil, a case containing the antenna condenser.

Fig. 2. At the left are shown the successive positions of the reflected image upon the diaphragm C. The portion of the image indicated by the (greatly magnified) dot in the center passes through this to the train of succeeding mirrors. In the upper illustrations is shown the effect of the downward rotation of the mirror B. The image passes vertically from top to bottom of the screen, every point in the vertical line shown being successively transmitted to the final screen H. By reason, however, of the upward rotation of the mirror G, these points, instead of remaining in the center of the field, are reproduced in a similar vertical line from the top to the bottom of H. For when B reflects the point at the bottom of the image (as in the top view) down to the center of the screen C, G reverses the motion and throws it up again from the center to the top of the screen H; and vice versa. The position of the ray in the apparatus from B to G is always the same, no matter to what portion of the image it corresponds.

Fig. 3. This shows, in a similar manner, the effect on the image of the oscillation from side to side of the mirrors. It is swung from side to side on the perforated screen or diaphragm, until every part of it has been covered by the vertical lines traced by its movement over the central opening.



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kinds lose their tensile strength, as well. Guy wires work loose, supports become rotten and rickety, the ground connection may become loose, and the antenna may be in actual contact with nearby objects such as trees, roofs or other antennae.

The illustrations show some actual conditions which may exist in your antenna instal-



A lightning arrester which can be attached to the lead-in wire at some distance from the house. Illustration courtesy of Chas. A. Branton, Inc.

lation. Go over it carefully and convince yourself that you are getting the best results from your antenna.

If you are erecting an aerial for the first time, go over this article carefully first and make sure that you have all the necessary equipment. Don't be like the man who installed two steel masts, firmly embedded in the earth and strung a most beautiful aerial between them, composed of gold-plated wire, and entirely forgot the little matter of using insulators.

It is advised that the layman purchase a complete aerial kit, as these include all the essential equipment. A number of kits are illustrated in connection with this article.

Remember, "No radio receiver will function better than the antenna to which it is connected."

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is necessary to move the mirrors in order to cause the displacement of the entire image which they reflect over the aperture in the diaphragm. The slide remains fixed in the projecting lantern, and the magnified movements of its image are obtained by the rotation and oscillation of the drum. It would be theoretically possible to move the image in the lantern, or the screen C, to obtain the same result; but not practicable.

Let us wait but a little longer; and Edouard Belin will soon present to us practical television apparatus, although it may have very different features from the experimental system which this article has described.

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