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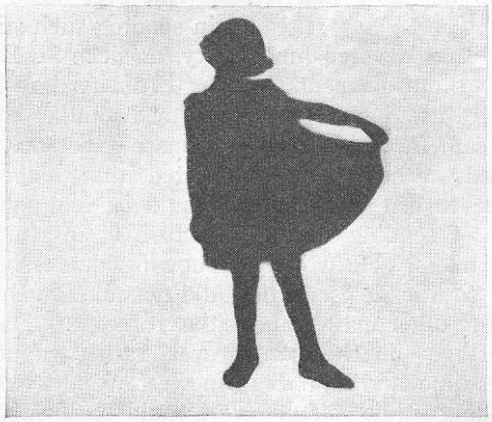


HOW THE MOVING IMAGE APPEARS ON THE SCREEN

The pictures projected upon the screen by the "teloramaphone," in their present early state of development, show figures in silhouette only.

"Motion Pictures" by Ether Waves

The home radio movie has arrived. We have now reason to hope that we will eventually sit at home and watch the world series exactly as it is played and hear the umpire and the crowd at the same time. People in the most isolated sections of the country will attend distant Fourth of July celebrations, or perhaps, the next presidential inauguration by radio, and see and hear more of it than if they were in the crowd in front of the speaker's stand."—C. Francis Jenkins.

By CHARLES ALLEN HERNDON

"COMING events cast their shadows before."

As this is written, I have just come from a shadow-show in the Washington suburban home of C. Francis Jenkins.

The figure that produced the shadows was on a motion picture film being projected in the inventor's laboratory in Washington. It was separated from the screen by six miles of city and suburban streets and houses.

While the little crowd of neighbors and friends watched a small screen which formed a panel in the receiving set, there suddenly appeared on it the silhouetted figure of a girl. There was no scenery. The details of the dancing figure were not shown. But the shadow-like figure moved—it danced. And those who were present seemed to realize that, simple silhouette though it was, it was really dancing at the wedding of the motion pictures with radio.

When you think of the great super-feature motion picture play with its thousands of actors, its elaborate sets and its faithful reproduction of infinite minute details, this simple silhouette of a lone dancer may seem disappointingly crude. But even the wonderful motion picture industry had its crude beginnings.

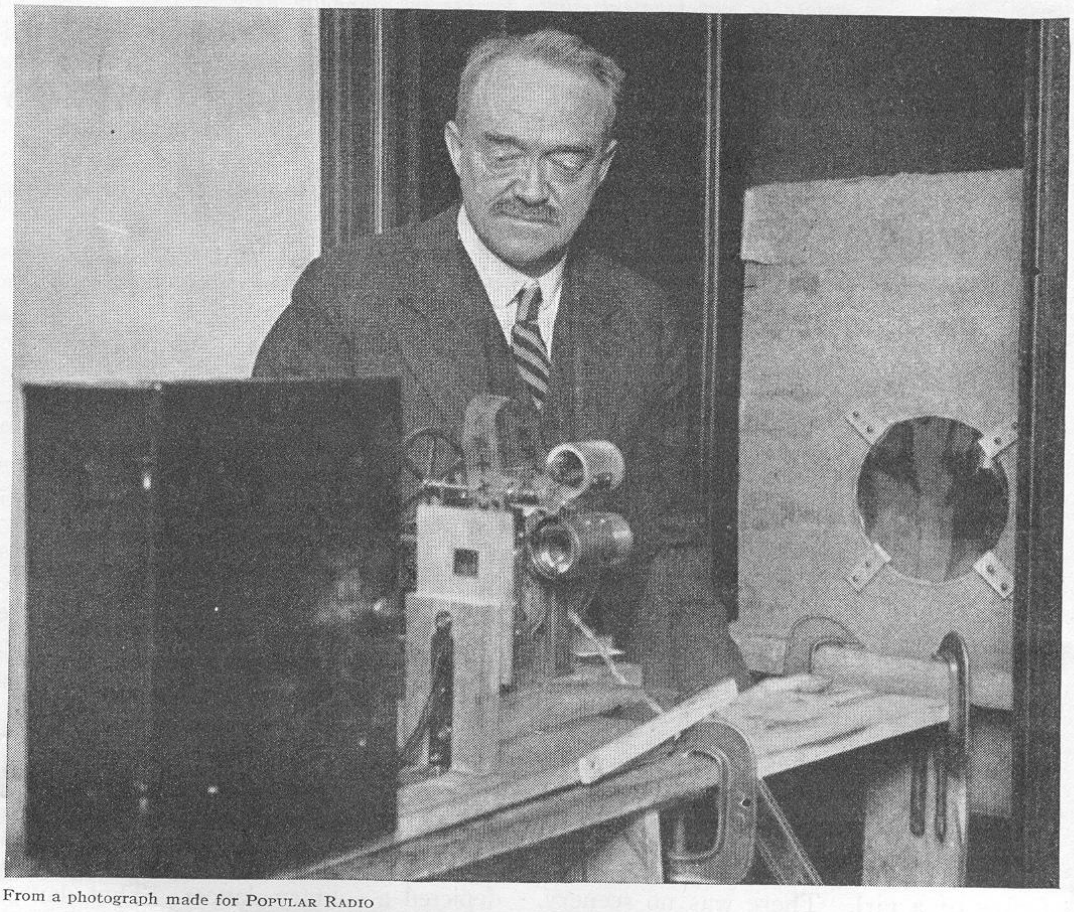
In fact, the first feature film (which was presented to the public at Richmond, Ind., in 1894, and projected from the first machine of the type now in general use throughout the world) also merely depicted a solitary dancer. That dancer of 1894 was probably directly responsible for the subject of the radio movie of 1925; for the inventor who made that first machine and gave that first motion picture performance was this same C.

Francis Jenkins, who has now married the movie to radio.

Ever since then, he has devoted much of his time to inventing improvements on motion picture apparatus, including a slow-motion picture camera which takes 4,000 pictures a second. When the radio came in, however, he turned enthusiastically to the problem of sending and receiving pictures by wireless. He worked out the only system so far devised for sending typewritten and other matter and receiving similar messages on the same machine at the same time and also the only system of sending radio pictures from a flat surface to a flat surface.

But ever since Mr. Jenkins succeeded in sending such still pictures in this country, or since M. Edouard Belin in France or Prof. Arthur Korn in Germany performed similar experiments abroad, imaginative persons have confidently predicted that some day motion pictures would be sent by radio. As the motion picture is just a series of still pictures showing successive phases of action, it did not take much mental daring to make the forecast. The prophets were, however, rather vague as to just when this newest wonder would start or just how it could be brought about.

It is easier said than done. In order to



From a photograph made for POPULAR RADIO

THE FIRST MOTION PICTURE MACHINE

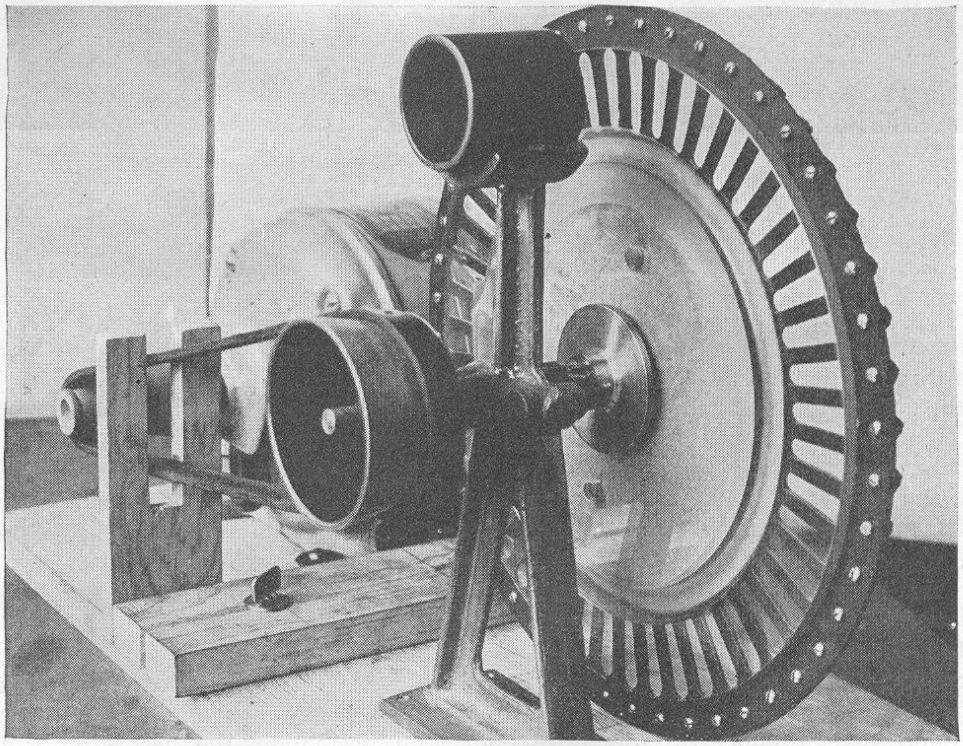
This machine—operated by its inventor, C. F. Jenkins— uses standard motion picture films. The changing pictures on the film are imaged on the flat surface of the large plano-convex lens at the right, which is held in place in the screen by four pieces of wood. The lens which projects these pictures onto the larger lens is the lower one of the two small cylinders directly in front of the inventor.

obtain the illusion of motion in a motion picture at least sixteen complete pictures must be projected every second. In order to send one complete still picture giving fine details by radio, it requires about six minutes by the best system now in use.

Six minutes seems short when you remember that the radio picture is knocked down, as it were, and then built up piece by piece at the receiving station. The lights and shades which make up the photograph must be translated into variations in an electric current, which in turn must be translated back again into lights and shades which make up the reproduction at the receiving end.

All systems of sending pictures by wire or wireless are based on the photo-electric or light sensitive cell. That is, certain substances used in these cells have the peculiar property of permitting current to flow through them more readily when they are illuminated than when they are in the dark. They act as electric valves. By simply varying the amount of light that reaches them, the current passing through them can be varied correspondingly.

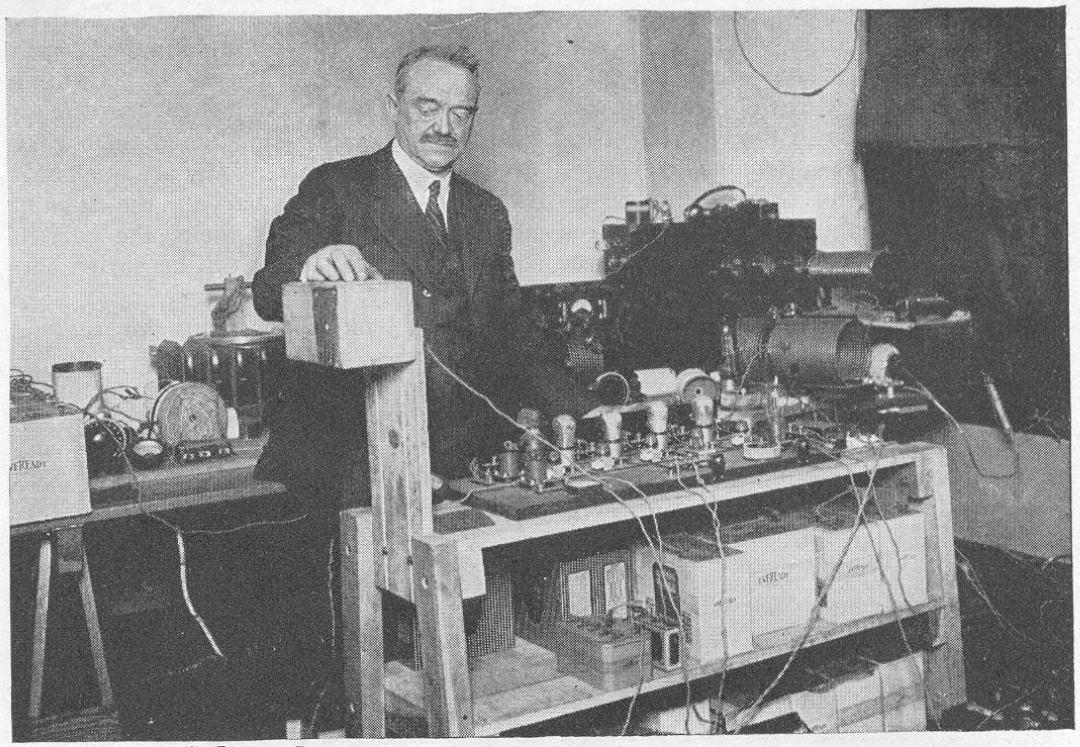
In the Jenkins apparatus for sending still pictures, for instance, the picture is placed in an ordinary stereopticon or magic lantern and its image is projected across the room so that one tiny corner of it strikes a hole in a box in which there is a thallium sulphide cell. If that tiny corner happens to be a shaded portion



From a photograph made for POPULAR RADIO

THE LATEST PRISMATIC DISC

The source of light is located in the round black box. This light is projected in succession by each lens located in the small openings around the periphery of the wheel onto a small motion picture screen. As the lenses rotate, each draws a line of light across the screen, but as the circular prism behind the lenses is constantly changing the angle between its faces, each line is drawn just under the last one until the picture is complete. Thus, for each revolution of the prismatic wheel one picture is placed upon the screen and as the disc rotates at a speed of 900 times each minute there are fifteen pictures a second produced on the screen.



From a picture made for POPULAR RADIO

THE RADIO UNITS FOR THE MOVING PICTURE TRANSMITTER

The inventor has his hand placed on the small square box that contains the light-sensitive cell which converts the pictures into electrical impulses for transmission by radio. This, when attached to the apparatus shown on page 108, will transmit moving picture films and when used in conjunction with the apparatus on page 112, will transmit pictures of living subjects.

of the picture, only a weak current can pass through the cell. If that little piece of the image represents a light part of the picture, a strong current is permitted to pass through the cell.

In order to send a picture, each part of it must be brought in front of the light cell, so that the variations in its lights and shades will produce corresponding variations in the current which pass on to the broadcasting apparatus and are picked up at the receiving station. At the receiving station, the variations in the radio waves produce variations in the light of an electric lamp.

The chief feature which distinguishes the Jenkins method of transmitting pictures from other methods is in the way these changes in the light are distributed on the photographic plate at the receiving end and the way the image of the original is brought piece by piece in front of the light sensitive cell at the sending end.

This is done by an ingenious arrangement of moving glass discs.

At the sending end a set of these discs is placed between the projecting lantern and the box containing the light sensitive cell. The edges of these discs are of varying thickness so that each part of the circumference of the discs acts as a different prism to bend at different degrees the light coming from the lantern. When these overlapping glass discs are placed in motion, the net result is the shifting of the entire projected image, slice by slice, across the light sensitive cell.

Beautiful half-tone photographs are picked into hundreds of pieces in this way in six minutes and broadcast piece by piece. At the receiving station a sim-

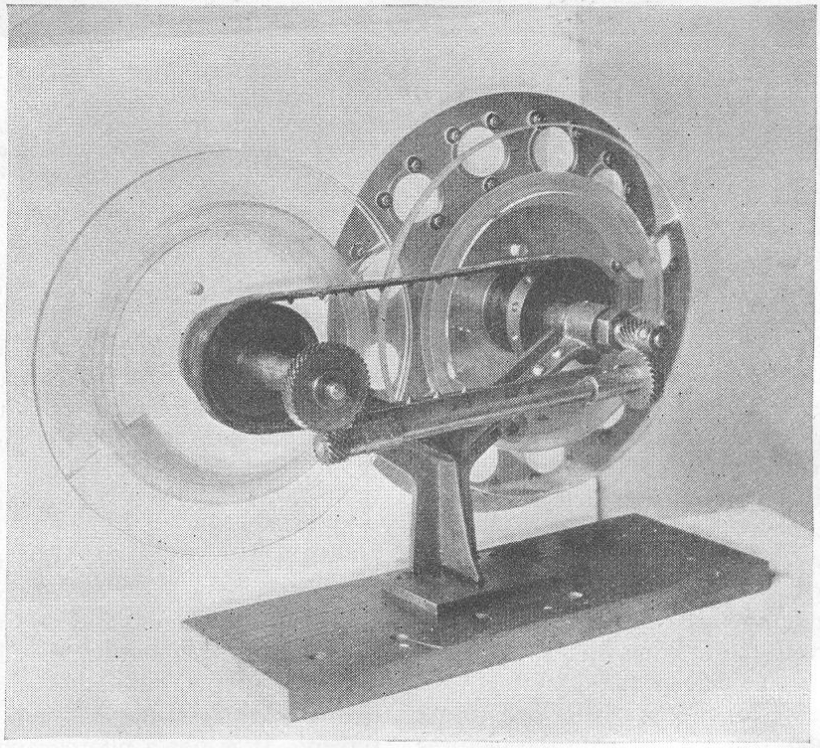
ilar set of glass discs is placed between the lamp controlled by the incoming waves and the photographic plate. The spinning of this set of discs at exactly the same rate as the set at the sending end distributes the flashes of light on the plate so that an exact reproduction of the original photograph is built up line by line.

One picture in six minutes is, however, a long way from sixteen pictures in one second. To send movies it is necessary to tear down and build up the pictures nearly six thousand times that fast. Obviously, since the speed at which such a picture is sent is determined by the rate at which the image is shifted in front of a single light sensitive cell, the glass discs which shift the image must be tremendously speeded up.

This Mr. Jenkins did. But with the arrangement of discs used for the still pictures, he could not get enough speed. So he devised a new disc, the edges of which are set with a number of tiny lenses, and with it sliced the image up much faster. But even this disc could not carry the image past the light-sensitive cell fast enough to send a complete picture in one-sixteenth part of a second.

Speed, more speed—vastly more speed—was needed. The disc could not be forced to make up the difference without danger of flying to pieces. It was necessary to jazz up other parts of the process.

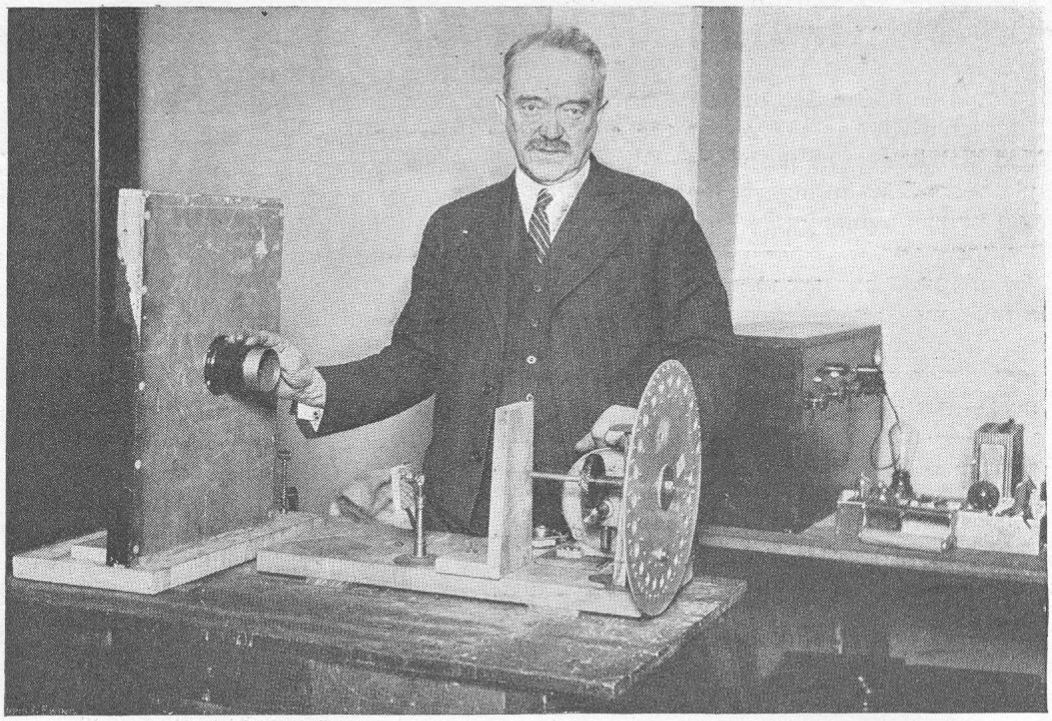
By multiplying the number of light-sensitive cells, Mr. Jenkins found that he could multiply the speed obtained by his disc. Instead of trying to send the entire image slice by slice from top to bottom, past a single light cell, he decided to project it against a box with four holes



From a photograph made for POPULAR RADIO

A DOUBLE DISC MACHINE

This model uses a double disc arrangement instead of a single wheel. The principle of operation is entirely the same as that explained in the caption of the machine shown on page 109. The two discs are used to throw a pencil of light across the screen in shifting lines until a whole picture is built up.



From a photograph made for POPULAR RADIO

THE TRANSMITTER FOR LIVING MOTION PICTURES

The large lens in the mask at the left images the picture of the moving object through the tiny lenses of the rotating wheel onto a large lens similar to that shown in the photograph on page 108. This literally cuts up the image of the moving object in a series of 15 or 16 pictures each second, thus preparing a series of pictures which can be converted to electrical impulses by the light sensitive cell shown in the wooden box on page 110.

in it leading to four separate light-sensitive cells. By this arrangement, while one-quarter of the image is being carried past one light cell, the other three-quarters are also being carried piece by piece past the other three light cells. The image is in this way picked to pieces in four places at once. The resulting current variations are distributed and broadcast as modulations on the one radio carrier wavelength in much the same way that four or more telegraph messages are sent over one wire at the same time.

But even multiplying the speed four times that obtained by the disc alone was not enough. Mr. Jenkins decided to get still greater speed by sending the pictures in larger pieces. Beautiful half-tone photographs must be sent in hundreds of very fine slices or pieces in order to bring out all the fine details. Pictures requiring less detail can be sent in larger pieces. As the silhouette is the simplest form of the human figure, it can be sent in the largest pieces.

The inventor, therefore, devised his "teloramaphone," as he has named it, to show silhouette pictures built up in four sections at once out of forty-eight pieces.

In this way he has achieved the seemingly impossible task of sending sixteen complete pictures a second by radio. So rapidly are these pictures built up as white silhouettes on a black background on the little screen of the teloramaphone that the mechanics of the thing is hardly noticeable. Yet these pictures are built up before your very eyes as you watch the screen. It is not a photographic process like the sending of still pictures has been. The little silhouettes are completely formed by spots of light from four small electric lamps, one for each quarter of the picture, flashing with lightning-like rapid-

ity and shifted on the screen by a revolving disc similar to the one at the sending station and tuned to the same speed with it.

In order to bring the silhouettes out clearly, the greatest contrast between light and dark was needed. Ordinary metal filament incandescent lamps could not be used, because the wires in them stay white hot between rapid pulsations of current. What was needed was a light which would go out the instant the current went off. Finally, after many experiments, Prof. D. M. Moore's glow lamp was adopted. Instead of a wire filament, this little electric lamp has a little well of gas which becomes incandescent when the current goes on, but instantly loses its incandescence when the current stops.

These glow lamps had to be manufactured in the desired size to furnish a spot of light of the proper proportions to build up the silhouette in the required time. In making a detailed photograph, these little lamps with smaller diameter gas wells are used. As other parts of the apparatus are speeded up still further, the smaller lamps can be substituted for those used to make the silhouettes and pictures can be built up in more and smaller pieces. As the smaller pieces are used greater detail will be brought out.

But that is in the future. What is here now is the Jenkins teloramaphone.

The teloramaphone as at present designed looks not unlike the usual large tube-set receiving cabinet. In fact, it is that and something more; for it contains a panel in which is a dark screen behind which flash the spots of light which are built up into the white silhouette upon a dark background.

On the same antennas which now catch the audible broadcast, we may soon receive the spoken and acted play as well as played and acted music. When the music is not to our ear, we can shut off the sounds and in the quiet of our home watch "the magic shadow shapes that come and go."

There on the little screen before us, we may find relief from the complexities of modern life in dainty, simple little white-shadow plays presented with a directness and vigor practically unknown in our more detailed photo and spoken drama today.

At least that is what we can expect if we can judge by the past. In Europe the silhouette drama was once a leading form of entertainment. In the twelfth and thirteenth centuries, the "shadow theater" produced actors which became renowned. Even down to 1850, the silhouette maintained a certain vogue; but in the latter part of the preceding century, the shadow theater probably reached its greatest popularity. Special plays were written for performance on its stage. In Paris, especially, it became the rage in high society.

Yet in all the shadow shows from King Tut's time on, the spectators had to go to the show. By the teloramaphone revival of the old art of pantomime, the show will come to the spectator. Radio waves will bring into homes throughout the country plays and dances. Bedtime stories will not only be illustrated, but told entirely in silhouette action without interfering with father reading the newspaper.

Some people, no doubt, will prefer the trip to the corner theater in order to see more detailed motion pictures. Yet there is also promise in this apparatus for them. The silhouette movie may reasonably be expected to repeat the history of those silhouette paper cut-outs and paintings on glass so popular in great-grandfather's day. As they were the pioneers for the cheap photograph, so the four-cell teloramaphone may be the pioneer not only of detailed movies but of radio vision.

For the motion picture film used at the broadcasting station is even now merely a convenience. Shadows of the moving hands or other things inserted between the light and the photo-electric cell are transmitted just as easily as the silhouette on the film. To get away from mere shadows, the teloramic process only has to be speeded up sufficiently.