May 3, 1927. 1,627,111

H. NYQUIST

PICTURE TRANSMITTING SYSTEM

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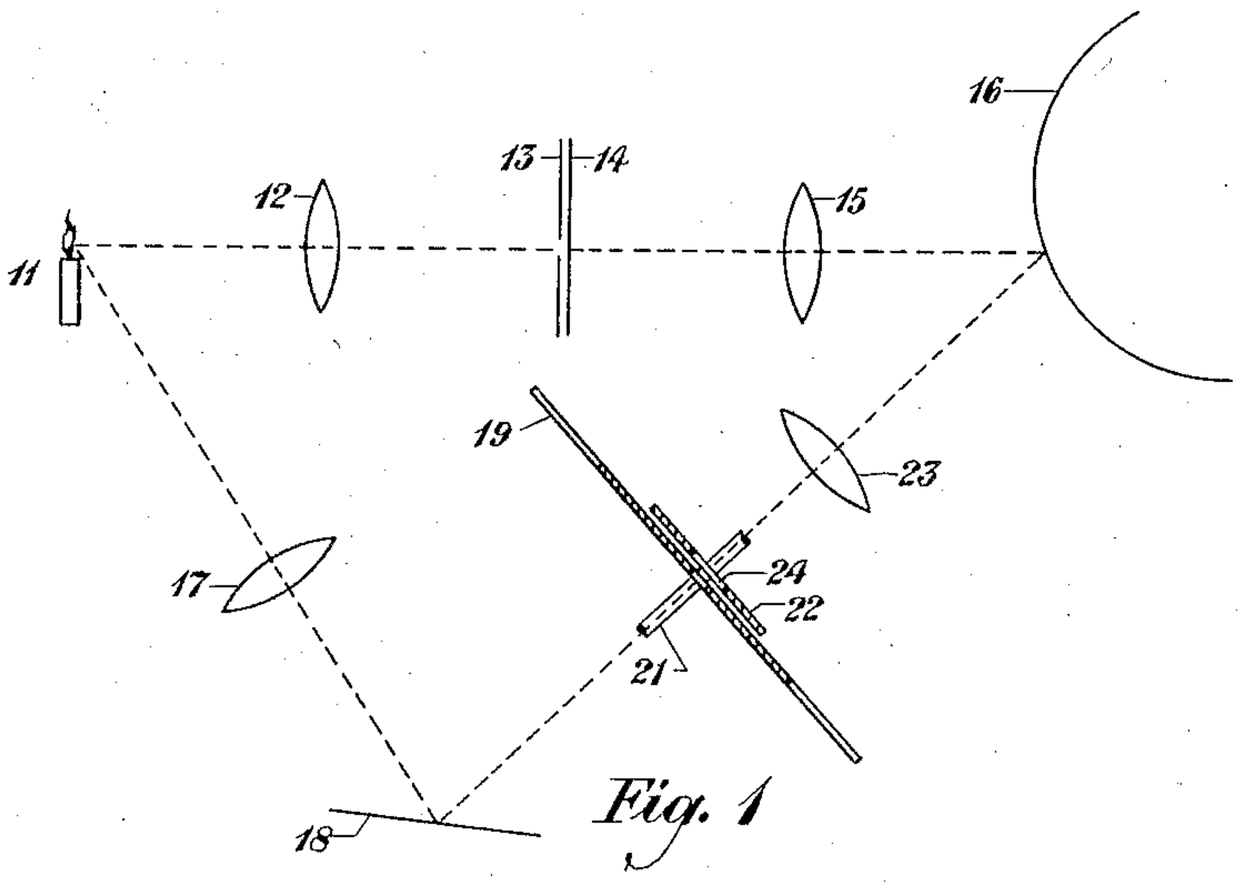

Fig. 1

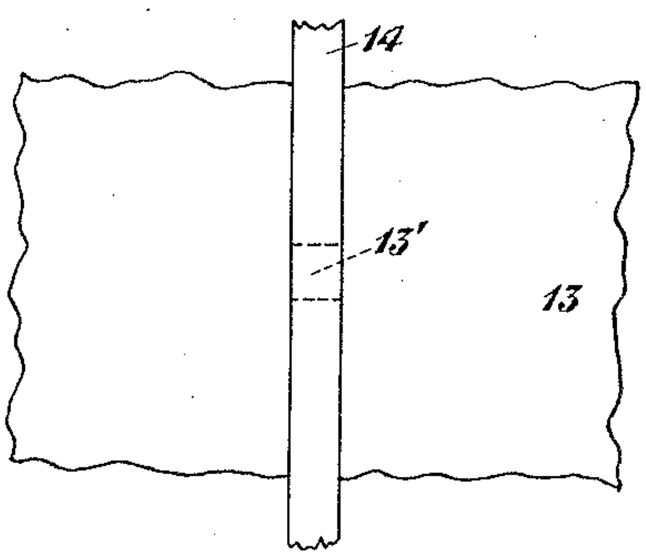

Fig. 1a

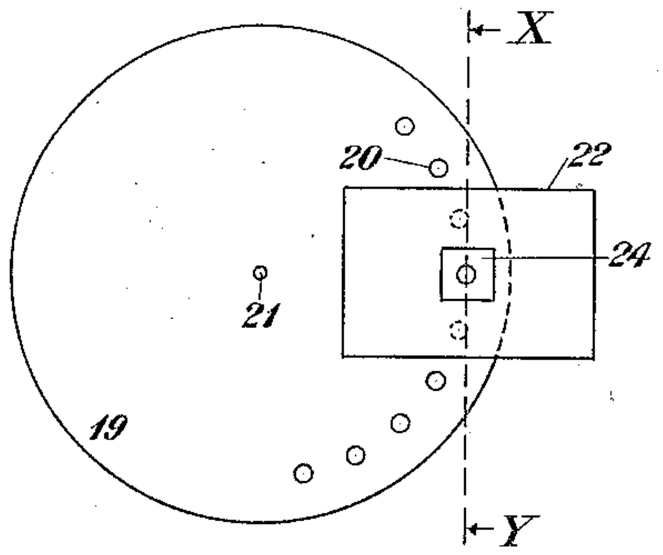

Fig. 2

Fig. 3

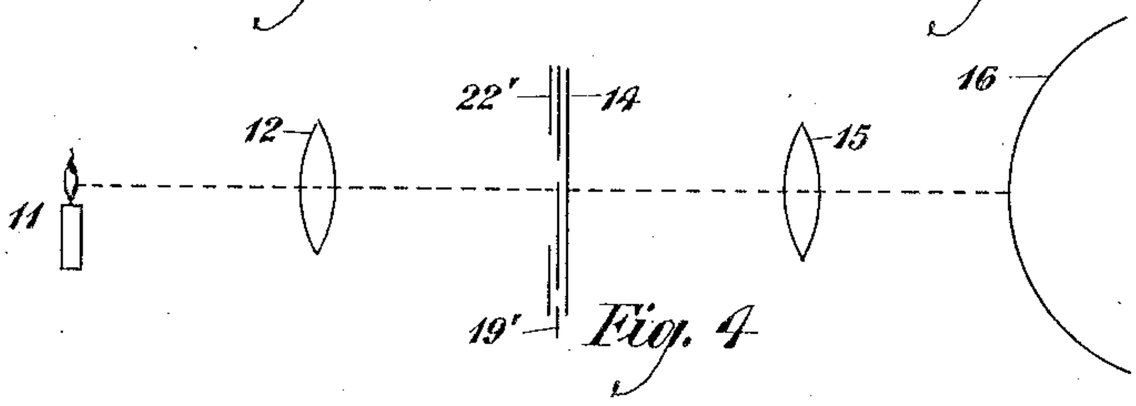

Fig. 4

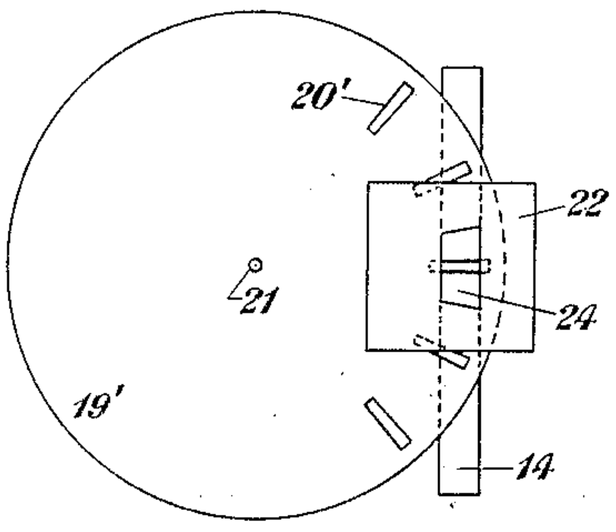

Fig. 5

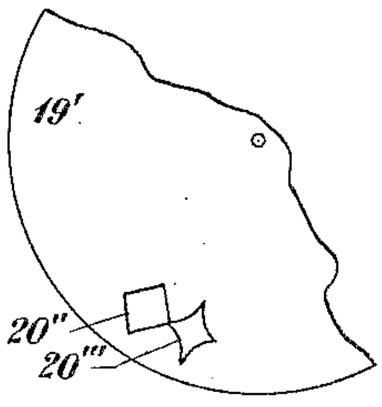

Fig. 6

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Fig. 7

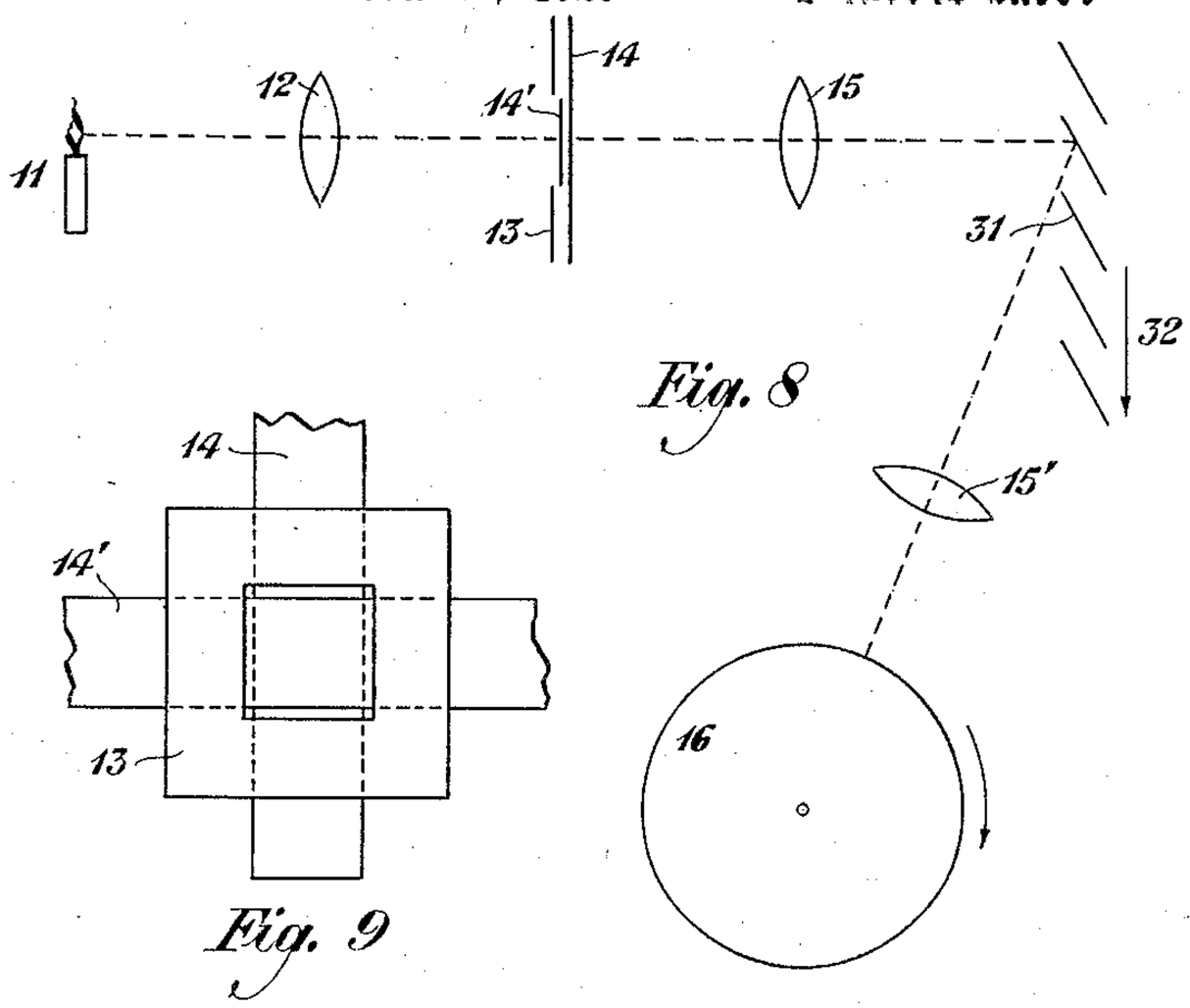

Fig. 8

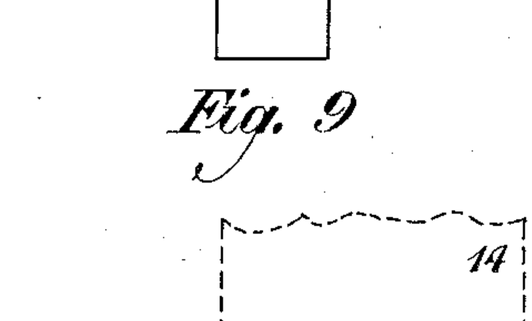

Fig. 9

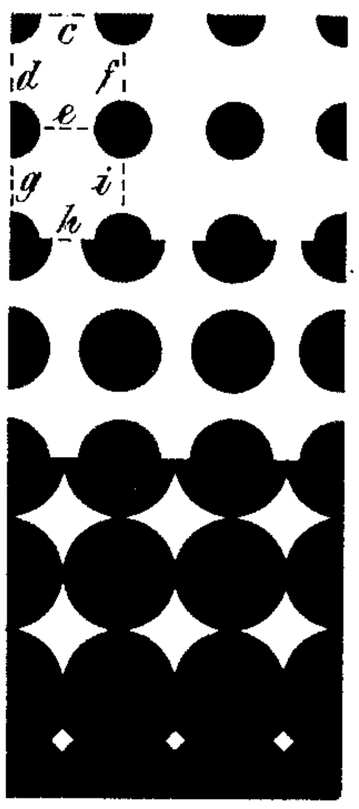

Fig. 10

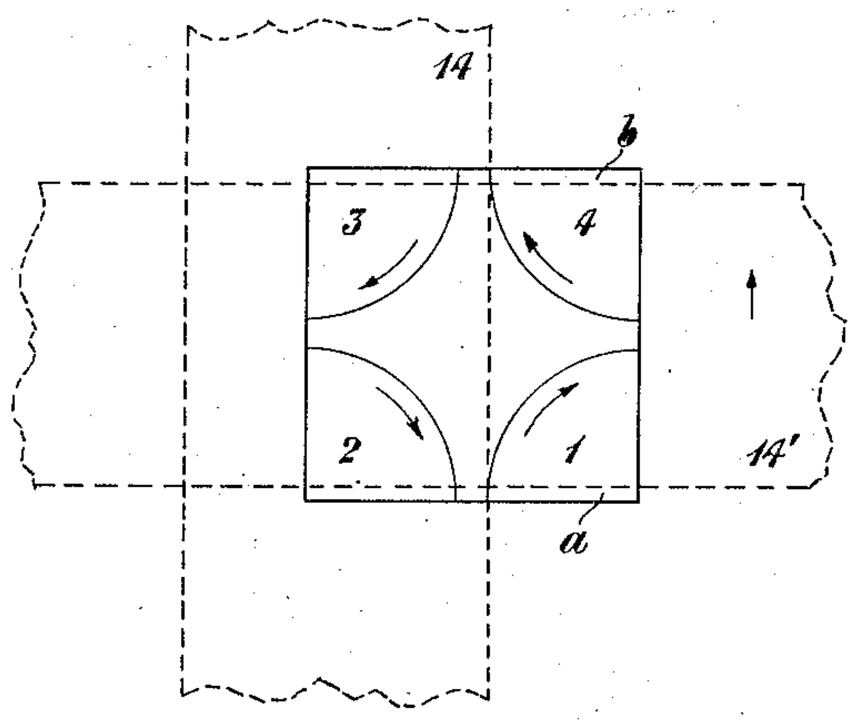

Fig. 11

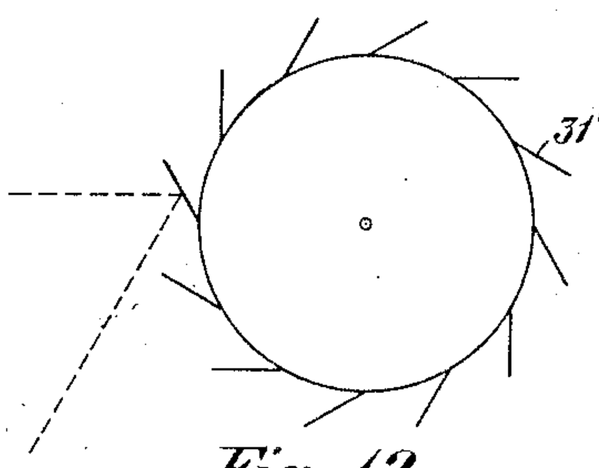

Fig. 12

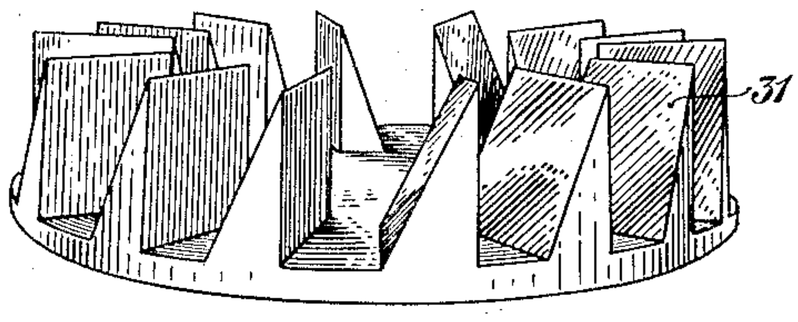

Fig. 13

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Patented May 3, 1927. 1,627,111

UNITED STATES PATENT OFFICE.

HARRY NYQUIST, OF MILLBURN, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

PICTURE-TRANSMITTING SYSTEM.

Application filed January 23, 1925. Serial No. 4,352.

An object of my invention is to provide a picture transmitting system in which the received pictures will be recorded in suitable half tone for newspaper reproduction. Another object of my invention is to provide for producing a pattern of light half tone dots in the areas of the received picture of lightest shade without interfering with the character of the half tone record in other parts of the picture. Another object of my invention is to produce a light half tone dot pattern on the picture receiving surface in a picture transmitting system, making this by locally generated means and then superposing the received picture in its varying shades so as to cover up the dot pattern in all except the lightest shades of the picture. These and other objects of my invention will become apparent on consideration of a limited number of specific embodiments of the invention which I have chosen by way of example to illustrate its character. It will be understood that the following description refers to these examples of the invention and that the invention will be defined in the appended claims.

Referring to the drawings, Figure 1 is a diagram of receiving apparatus embodying my invention; Fig. 1[a] is a detail front elevation of a light valve seen in side elevation in Fig. 1; Fig. 2 is an elevation of a shutter shown in section in Fig. 1; Fig. 3 is a diagram illustrating the half tone record obtained with the apparatus of Fig. 1; Fig. 4 is a diagram illustrating a modification; Fig. 5 is an elevation of the shutter of Fig. 4; Fig. 6 is a detail showing modified shutter openings; Fig. 7 is a diagram showing the character of the half tone picture record with the apparatus of Fig. 4; Fig. 8 is a diagram illustrating another modification; Fig. 9 is a detail elevation of the light valve employed in the apparatus of Fig. 8; Fig. 10 is a diagram showing the kind of record made on the picture receiving surface with the apparatus of Fig. 8; Fig. 11 shows a modified light valve; and Figs. 12 and 13 are detail sketches showing modified mirror systems that may take the place of the mirror system shown in Fig. 8.

Referring to Figs. 1 and 2, light from the source 11 is focused by the lens 12 on the small opening in the screen 13. A stretched ribbon of magnetic material 14 normally lies across the opening 13′ in the diaphragm 13 (see Fig. 1[a]), but it is displaced laterally by the magnetic effect of the received picture currents. Thus the diaphragm 13 with its hole 13′ and cooperating ribbon 14 constitute a light valve which opens in degree according to the intensity of the received picture carrying currents.

The light passing through this light valve is focused by the lens 15 on a spot of a sensitive film wrapped on the rotating drum 16. This drum 16 is on a shaft having screw-threaded engagement with a support, so that it is advanced slowly along its axis as it rotates. Accordingly the spot of the film which receives the light from the light valve describes a helical course on the film, and the developed film will show a line of varying width determined by the extent of the opening of the light valve. The width of this line in its successive turns of the helix gives the shade for the corresponding part of the picture. The system is arranged so that for the lightest shade the valve 14 will be quite closed, and the line will not appear on the receiving film.

Light from the same source 11 is also focused by the lens 17 and reflected by the mirror 18 on the window 24 of a diaphragm 22. A shutter 19 is provided in the form of a disc rotating on the axial shaft 21 and with peripheral holes 20 which pass successively across the window 24 in the diaphragm 22. When one of these holes registers with the window 24, the light is transmitted and focused by the lens 23 on a spot of the film on the drum 16.

The disc 19 is rotated in such a direction and at such a speed that the spot of light due to the light transmitted through one of its holes moves with the film 16; in other words, the spot of light on the drum 16 due to light through one of the holes of the moving disc 19 is relatively stationary on the film on the drum 16.

Thus it will be seen that as each hole 20 of the disc 19 passes across the window 24, it registers a dot on the film on the drum 16, and successive dots in helical order on this film will be registered for the respective successive holes 20 of the disc 19.

The drum 16 and the disc 19 are driven by inter-related mechanism, so that the spacing of the dots on the film is kept uni-

form and so that the dots on successive turns of the helix will be in staggered relation, as shown at the lower part of Fig. 3.

As already stated, these dots will appear on the film on the drum 16 only when the light valve 14 is closed, except that there will be a case when both the line and the dots will show, namely, when the line is very fine. When the light valve 14 is open, a line of varying width will be registered on the film, and this line will cover the places where the dots are registered. In Fig. 3 the lines appear in three degrees of width representing corresponding shades, and a lighter shade than any of these is given by the dots at the lower part of Fig. 3.

In the modification shown in Figs. 4 and 5, the window 22′ is placed adjacent to the light valve 14, and the disc shutter 19′ is placed between them, and only one path of light from the source 11 to the receiving drum 16 is involved. Here as before, the movement of the disc 19′ is synchronized with that of the drum 16, so that the spot of light corresponding to each opening 20′ in the disc 19′ follows the movement of the film on the drum 16.

In this case the light valve is adjusted, so that it will have a degree of opening even at the lightest shade. Thus a picture will be printed in rows of dots whose width varies with the degree of shade, as shown in Fig. 7. With the openings as shown at 20′ in Fig. 5, the recorded dots of Fig. 7 are all of the same dimensions up and down, and the shutter 19′ and the drum 16 are geared together, so that the dots will be staggered in successive rows, also as shown in Fig. 7. Thus each dot of Fig. 7 is a rectangle, these rectangles all having the same height but a varying width according to the shade. However, if desired, other shapes may be given to these dots by other shaped openings in the disc 19′, such as at 20″ and 20‴ in Fig. 6.

In the modification of Fig. 8, instead of a perforated shutter, such as 19′, a system of moving mirrors 31 is employed to cause the beam of light to remain stationary relatively to the moving film on the drum 16. The mirrors are shown diagrammatically in Fig. 8, but they may be mounted on a cylinder as shown in Fig. 12 or on a disc as shown in Fig. 13.

Another distinctive feature in Fig. 8 is that two light valve ribbons 14 and 14′ are employed at a right angle to each other and both lying normally across the valve opening in the diaphragm 13 as shown in Fig. 9.

If the two valve members 14 and 14′ are actuated by the picture current in the same phase, then the valve openings will be made only at two diagonally opposite corners of the square opening in the screen 13. If the received picture current is a carrier current of a certain frequency with varying amplitude according to the varying shade of the picture, and if the incoming picture current is split in phase and the two components are applied 90° apart to the respective valve members 14 and 14′, and if the drum 16 is rotated at the proper speed relative to the carrier current frequency, a record will be made such, for example, as that shown in Fig. 10.

During the time of one complete cycle of the carrier current, the receiving film on the drum 16 may be thought of as relatively stationary to the light valve. Let us take the beginning of this cycle as shown in Fig. 11 with the valve member 14 at the extreme left of its travel (the amplitude depending on the shade) and the valve member 14′ at the middle of its range and moving up as shown by the arrow. The small thin nearly rectangular areas *a* and *b* will be exposed. The upward movement of the valve member 14′ will shut off the area *b*, but the combined movement of the two valve members 14 and 14′ will expose the quadrant numbered 1. Thereafter the quadrant numbered 2 will be exposed, then 3 and then 4, thus completing a cycle of the carrier current.

Thereupon the mirror system 31 of Fig. 8 will have moved so far that a new mirror will come into action, and a successive adjacent square on the film will be involved. Referring to Fig. 10, the exposure for one position will give the four quarter dots within the dotted line square whose sides are *c*, *d*, *e* and *f*, and the next succeeding exposure will give the four quadrants within the dotted line square whose sides are *e*, *g*, *h* and *i*. Going along down in Fig. 10 it will be seen how with increasing amplitude of the carrier current the quarter dots are increased in size, so that the half tone shade gets deeper and deeper.

The rotation of the drum 16 and the mirror system 31 are synchronized with the incoming carrier current, so that the successive exposed areas of the turns of the drum 16 will register side by side. Thus the various quadrant dots that have been described will be assembled to make complete dots as shown in Fig. 10.

I claim:

1. In a picture transmitting system, a picture receiving apparatus comprising a source of light, a picture receiving blank, a light valve responsive to transmitted currents for controlling said light to reproduce the picture by variably exposing said blank to the light source, and means separate from said valve acting upon the light from said source to superpose a uniform dot pattern on the entire area of said blank.

2. In a picture transmitting system, a picture receiving apparatus comprising a source of light, a movable picture receiving blank, a light valve responsive to trans-

mitted currents for controlling the amount of light from said source to reproduce the picture by variably exposing said receiving blank to said light, and a mechanical device movable in the path of the light from said source for superposing a uniform dot pattern on the entire area of said receiving blank.

3. In a picture transmitting system, picture receiving apparatus comprising a light valve, means to operate it by received picture transmitting currents, a picture receiving element adapted to be moved relatively to the light valve, a source of light, means to form a beam of light from said source directed to the surface of said element, means to move the beam to hold it on a spot of said surface temporarily and to reform the beam on another spot and so on to expose successive spots and form a half-tone dot pattern on the surface of said element

4. The method of producing a faint half-tone dot pattern in the areas of lightest shade in a received picture of a picture transmitting system which consists in moving a picture receiving surface relatively to a source of light and moving a beam of light therefrom with said surface and on a spot thereof fixed relatively thereto, and regularly reforming said beam of light on successive spots of the moving film.

5. In a system for transmission of pictures by electricity, means to modulate a carrier wave in accordance with the tone value of the elemental areas of the picture, a light controlling valve, means to impress said modulated current on said light controlling valve, a light sensitive element exposed in accordance with the operation of said light valve for reproducing the dark areas of the picture as lines of varying width, and an optical system operated independently of said light controlling valve for reproducing dots in the white areas to form a printing structure.

6. In a system for the electrical reproduction of a picture by means of current having a characteristic varying in accordance with the tone value of elemental areas of the picture, a source of light for producing a beam of light controlled by the incoming current, means for producing an auxiliary beam of light, and a light sensitive element upon which said light beams are impressed to cooperatively produce the desired image.

7. In a system for the electrical reproduction of a picture by means of current having a characteristic varying in accordance with the tone value of elemental areas of the picture, a source of light for producing a beam of light controlled by incoming currents, means for producing an auxiliary beam of light, means for periodically interrupting the beam of light from said auxiliary light source, and a light sensitive surface upon which said light beams are impressed to cooperatively produce the desired image.

In testimony whereof, I have signed my name to this specification this 16th day of January, 1925.

HARRY NYQUIST.