May 22, 1928.

1,670,375

H. NYQUIST

PICTURE TRANSMITTING SYSTEM

Filed Dec. 17, 1924

2 Sheets-Sheet 1

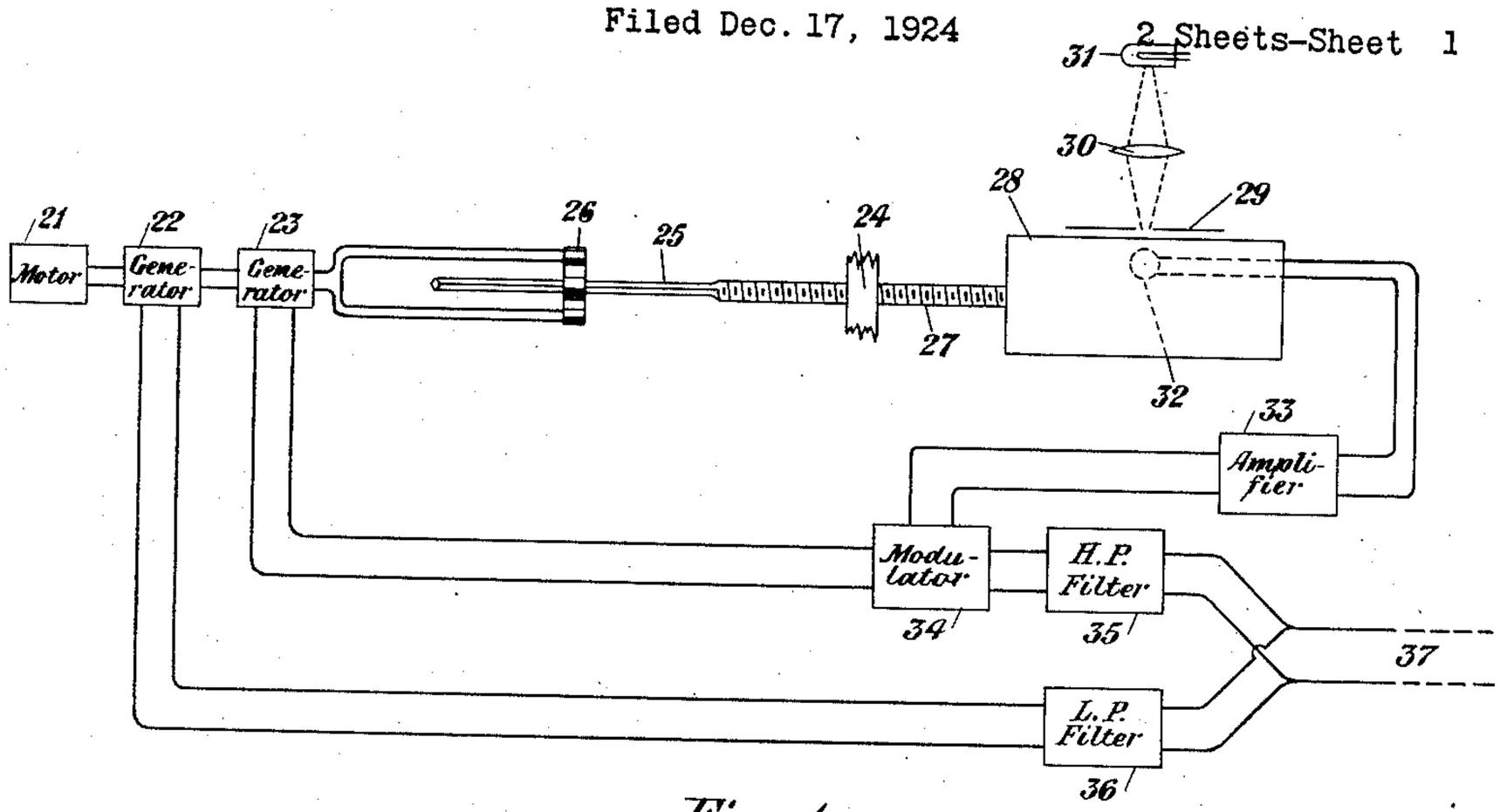

Fig. 1

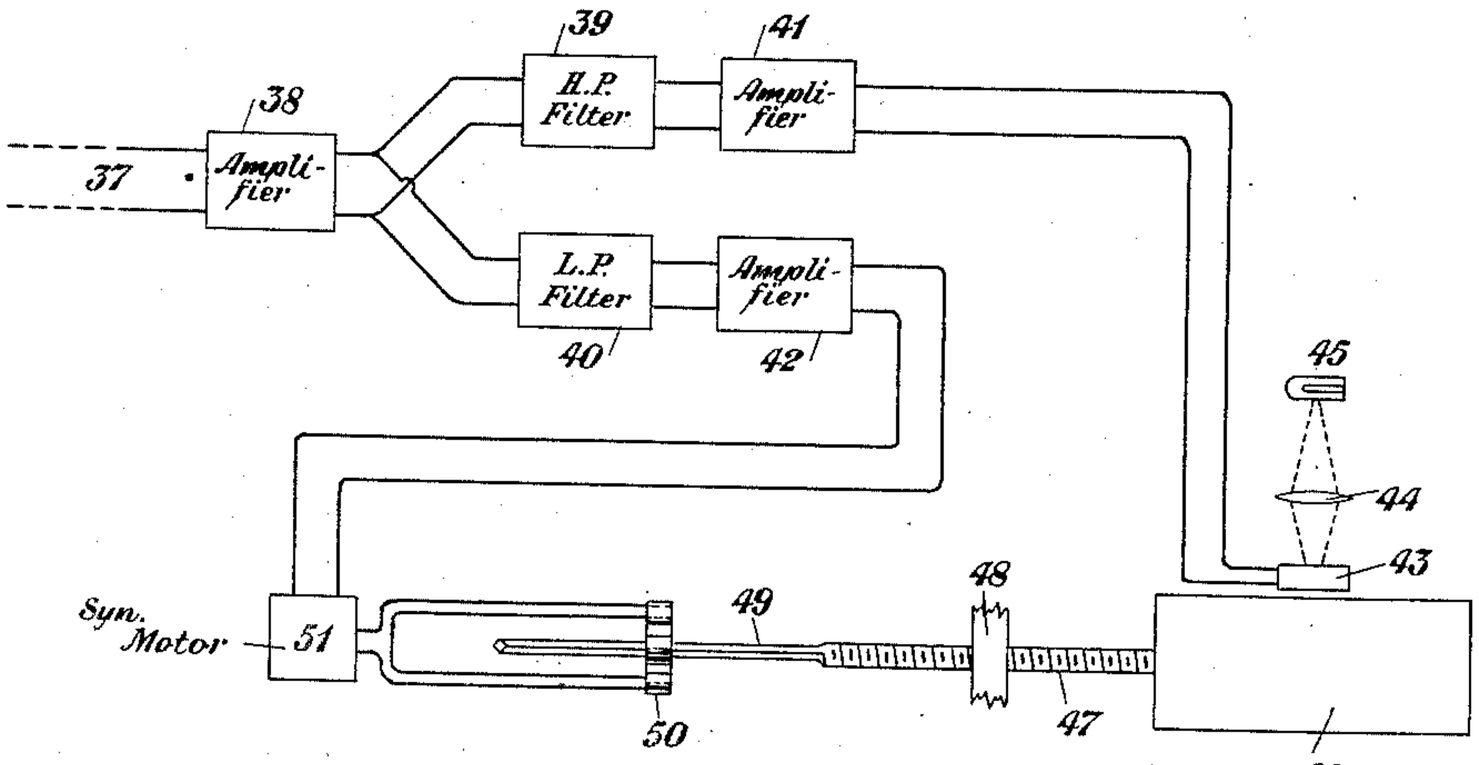

Fig. 2

INVENTOR
H. Nyquist
BY
ATTORNEY

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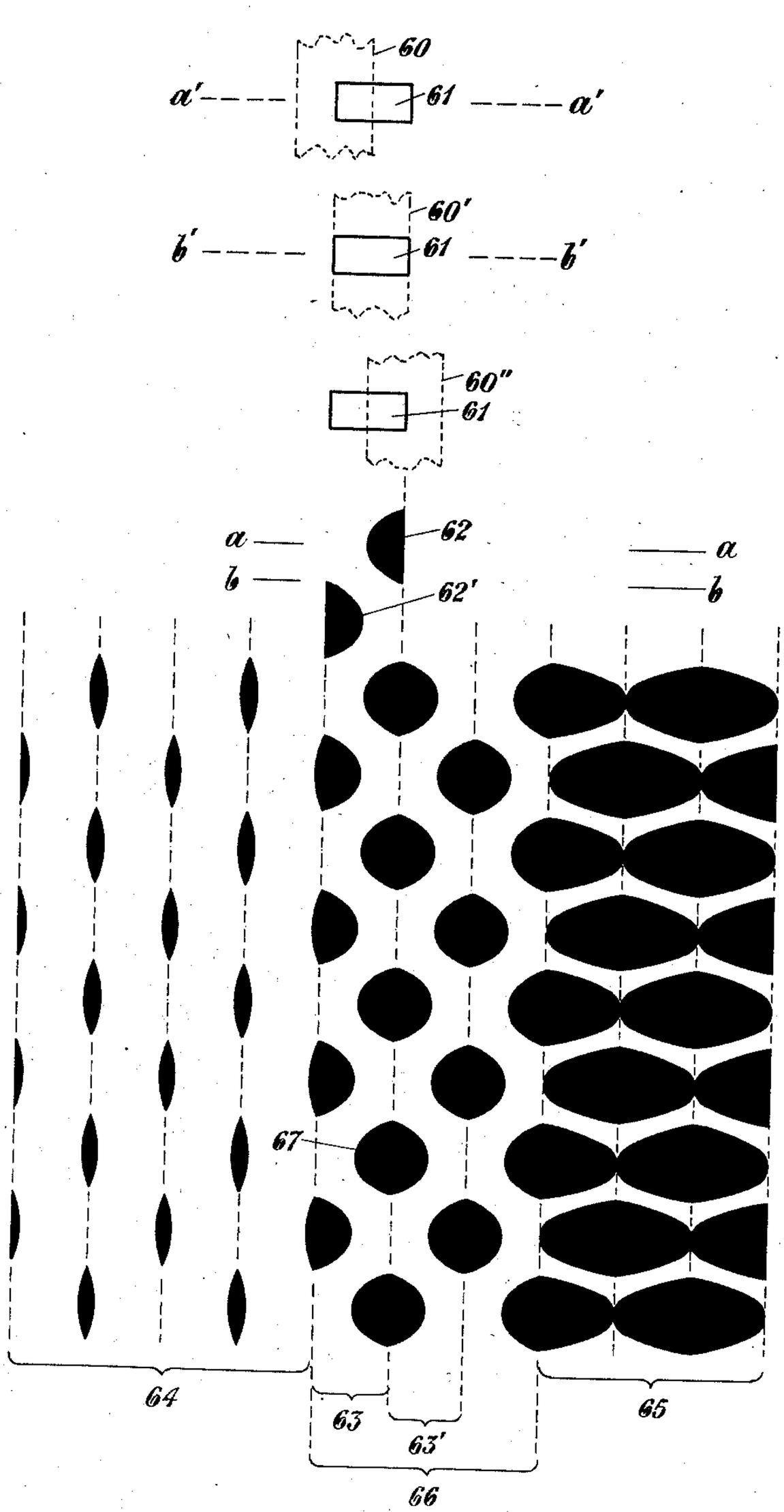

Fig. 3

INVENTOR
H. Nyquist
BY
ATTORNEY

Patented May 22, 1928. 1,670,375

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 December 17, 1924. Serial No. 756,569.

An object of my invention is to provide a new and improved system for transmitting pictures electrically. Another object of my invention is to provide for recording a received picture in such a system in "half-tone" dots. Another object of my invention is to send a picture on a carrier current and to utilize the carrier current half-waves to record respective "half-tone" dots in the received picture. These and various other objects of my invention will become apparent on consideration of an example which I have chosen for disclosure in the following specification, taken with the accompanying drawings. It will be understood that the description which follows relates to this example of the invention and that the invention will be defined in the appended claims.

Referring to the drawings, Figure 1 is a diagram of a transmitting station embodying my invention; Fig. 2 is a diagram of a corresponding receiving station; and Fig. 3 is a diagram illustrating the production of the half-tone record at the receiving station.

The cylindrical drum 28 at the transmitting station has the picture wrapped about it in the form of a semi-transparent film. This drum 28 is mounted on the axial screw-threaded shaft 27 in engagement with the screw-threaded support 24, so that as the drum 28 rotates it is traversed slowly in the direction of its axis. It is driven by the motor 21 through the sliding connection 25, 26.

The same motor 21 drives two generators 22 and 23. The generator 22 produces a low frequency current which goes through the low pass filter 36 to the line 37. The generator 23 produces a high frequency current which goes to the modulator 34.

The light from the source 31 is focused by the lens 30 on an opening in the screen 29 adjacent to the film on the drum 28. Accordingly, the quantity of light falling on the photoelectric cell 32 will be varied in correspondence with the degree of shade in the spot of the film underlying the opening in the screen 29.

In accordance with the principle of the photoelectric cell, the current therefrom will vary in accordance with the quantity of light falling on it and this current goes to the input of the amplifier 33 whose output goes to modulate the carrier current applied to the modulator 34. This modulated output then goes from 34, through the high pass filter 35 to the line 37.

At the receiving station the incoming currents on the line 37 go through the amplifier 38 and thence to respective branch circuits as determined by the two filters in parallel, one of them the high pass filter 39 and the other the low pass filter 40. The low frequency current from the low pass filter 40 goes through the amplifier 42 and drives the synchronous motor 51. This current is the current whose frequency is determined by the generator 22 at the sending station.

The high frequency current from the high pass filter 39 goes through the amplifier 41 to the light valve 43.

Through the sliding connection 49, 50 the receiving drum 46 is rotated by the synchronous motor 51 in synchronism with the drum 28 at the sending end. The axial shaft 47 carrying the drum 46 has screw-threaded engagement with the support 48 so that the drum 46 not only rotates but is traversed in synchronism with the drum 28 at the sending end.

Light from the source 45 is focused by the lens 44 on the light valve 43. This light valve consists of a shutter 60 (see Fig. 3) which normally stands across an opening 61 as indicated at 60′. This shutter 60 is deflected to one side or the other by the magnetic action of the current to the light valve. When this current is an alternating carrier current of varying amplitude, then the light valve vibrates, opening first one side and then the other of the orifice 61, and for small amplitudes these side openings will be slight but for large amplitudes they will be great, the maximum opening being the entire width of the orifice 61.

Suppose that the picture to be transmitted has an area of intermediate shade passing under the opening in the screen 29 at the sending end, so that the current to the light valve 43 in Fig. 2 is of intermediate amplitude; then the shutter 60 will vibrate from the extreme position shown at the top of Fig. 3 through the position indicated at 60′ to that indicated at 60″ and back, and so on. When the shutter is at the position 60 in Fig. 3, the sensitive film represented in the lower part of Fig. 3 has the line *a*—*a* directly under the light valve opening 61, as indicated by the line *a′*—*a′*, and the exposed

portion of the film is 62 for the opening of the right-hand end of the orifice 61. When the shutter returns to the median position shown at 60′, the film has moved on so that the line *b*—*b* is directly under the closed orifice 61 as indicated by *b*′—*b*′. Then the shutter swings to the right as shown at 60″ and for the corresponding opening of the orifice 61, the record on the film is shown at 62′.

In this way the series of staggered half-dots are recorded along the range 63 which represents a single linear helical element of the receiving film passing under the orifice 61.

The next adjacent linear helical element of the receiving film is designated 63′ in Fig. 3 and this passes next under the orifice 61, and assuming that the picture shade continues the same, another series of staggered half-dots is made as shown within the brace 63′ on Fig. 3.

The synchronism is established so that the half-dots at the left in the range 63′ register with the half-dots at the right in the range 63, making complete dots as, for example, at 67. The ranges comprehended by the brace numbered 66 all correspond to an intermediate picture shade. The ranges within the brace 64 correspond to a light picture shade in the receiving film; here the amplitude of the vibration of the shutter 60 is very slight, corresponding to a small amplitude for the carrier current. On the other hand, within the ranges embraced by the numeral 65 the amplitude of the vibration of the shutter is a maximum, corresponding to a dark shade in the receiving film.

It will be noticed that the half-tone dots in Fig. 3 lie most closely together along diagonal lines at 45 degrees to the vertical or horizontal, which is desirable in half-tone pictures. In accordance with the present invention, the received film is a half-tone film ready for use in the half-tone printing process, not requiring the use of a ruled screen or other such expedient to get half-tone dots.

It will be seen that the system must be devised and adjusted so that the synchronizing current shall have a definite constant frequency relation to the carrier current. This is secured by operating the generators of the two currents from the same motor 21 as in Fig. 1 and also driving the sending drum 28 from the same motor and driving the receiving drum from a synchronous motor.

I claim:

1. The method of transmitting a picture, which consists in modulating a carrier current according to the degree of shade of successive picture elements, applying the modulated carrier current to operate a light valve, and passing a sensitive film under said light valve at a speed such that the successive operations of said valve corresponding to successive half-waves of carrier current will be recorded as separate half-tone areas.

2. The method of transmitting a picture, which consists in modulating a carrier current according to the degree of shade of successive picture elements, applying the modulated carrier current to operate a light valve, and passing a sensitive film under said light valve at a speed such that the successive openings of said valve corresponding to successive half-waves of carrier current will produce dot records of magnitude corresponding to the amplitude of the carrier current.

3. The method of transmitting a picture, which consists in sending current impulses corresponding to the degree of shade of successive picture elements, applying these current impulses to operate a light valve, alternately and successively opening the two opposite ends of the light valve orifice, and moving a sensitive film at a definite rate with respect to the rate of operation of said light valve to produce on said film discrete half-tone dots corresponding to successive sending current impulses and in area corresponding to the magnitude of the respective current impulses.

4. The method of transmitting a picture, which consists in modulating a carrier current according to the degree of shade of successive picture elements, applying the modulated carrier current to operate a light valve, alternately and successively opening the two opposite ends of the light valve orifice, and passing a sensitive film under said light valve in successive adjacent linear ranges, so that staggered half-dots are recorded on the film in each range and the half-dots of each range register with the half-dots of the adjacent ranges.

5. In combination, means to generate a carrier current, means to modulate it according to the degree of shade of successive elements of a picture to be transmitted, a light valve to which the modulated current is applied, a sensitive film, and means to move said film past said light valve at a speed so related to the carrier current frequency that the distance moved per half-cycle shall be of the same order as the maximum amplitude in the light valve.

6. In combination, means to generate a carrier current, means to modulate it according to the degree of shade of successive elements in helical order of a picture wrapped on a cylindrical drum, a line to carry such modulated current, means to generate a synchronous current definitely related to the movement of the said drum and put it also on said line, means to move a cylindrical receiving film in helical order and in synchronism determined by the synchronizing current received from said line, and

light valve operated by the received modulated carrier current adapted to record halftone dots of varying sizes on the said receiving film.

7. In combination, means to generate current impulses corresponding to the degree of shade of successive elements of a picture, means to apply said currents to operate a light valve, alternately and successively opening the two opposite ends of the light valve orifice, and means to move a sensitive film under said light valve at such a speed that its openings will record discrete halftone dots corresponding to the said current impulses to make the received picture.

In testimony whereof, I have signed my name to this specification this 15th day of December 1924.

HARRY NYQUIST.