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H. NYQUIST

PICTURE TRANSMITTING SYSTEM

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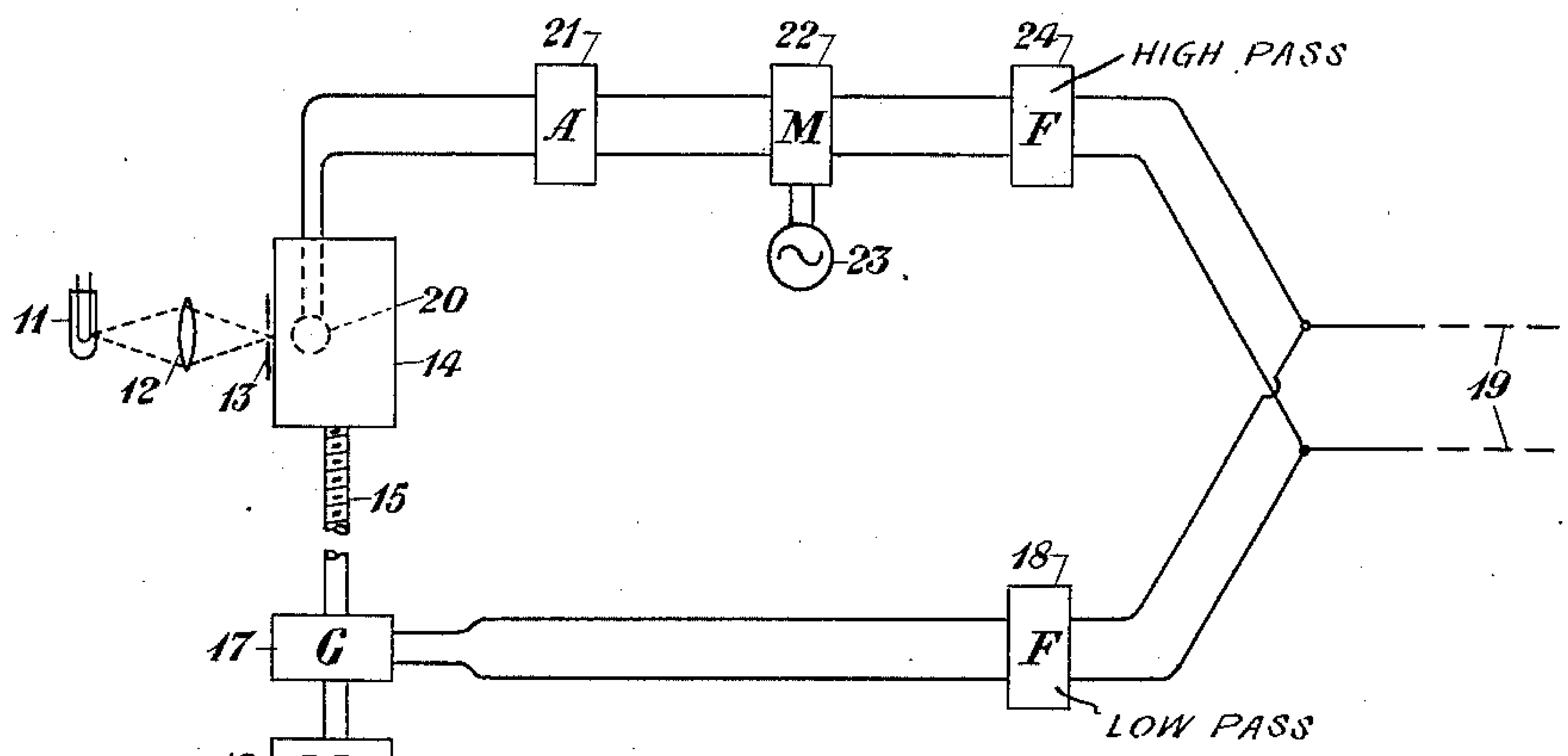

Fig. 1

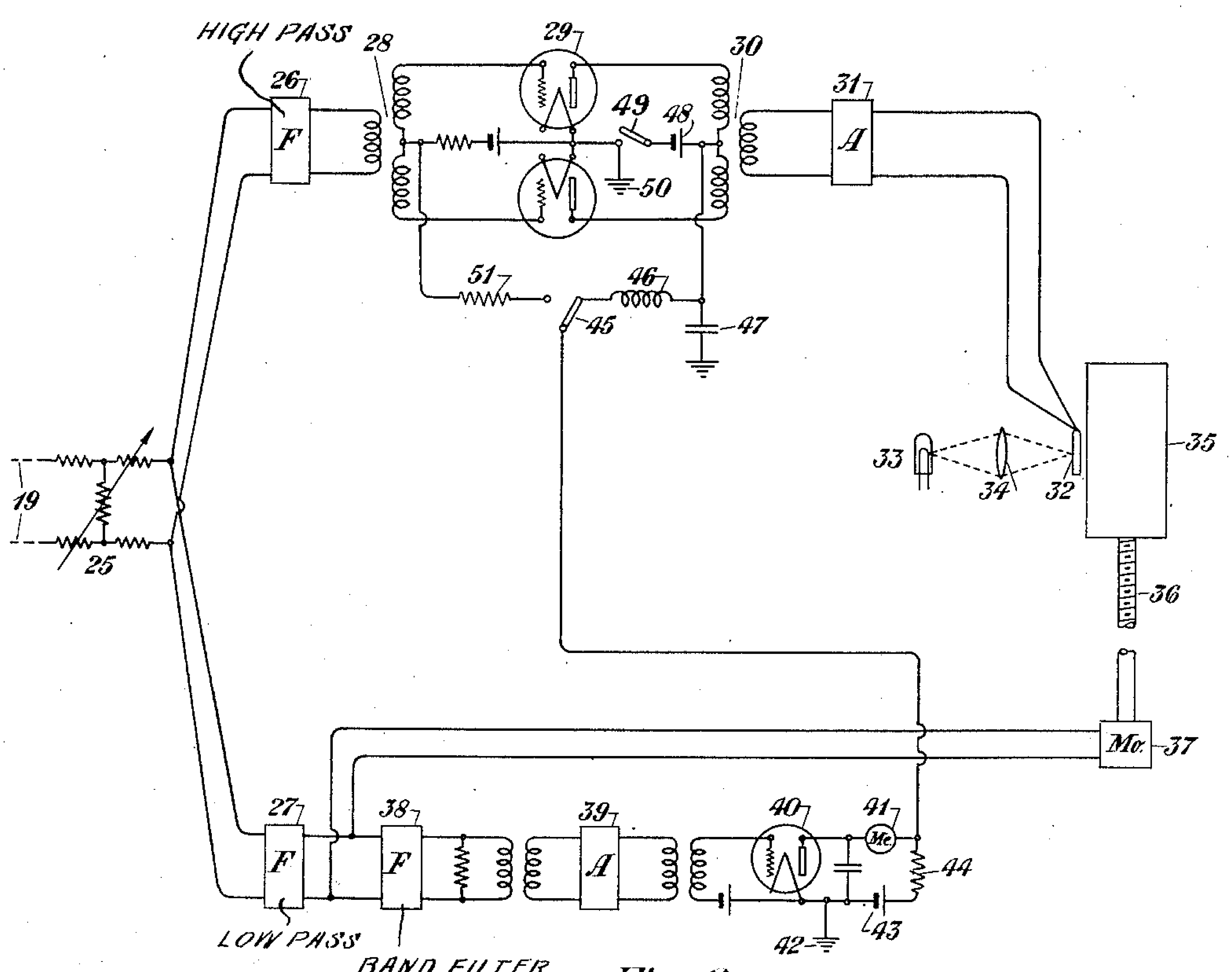

Fig. 2

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PICTURE-TRANSMITTING SYSTEM.

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This invention relates to maintaining a desired level of operating current at the receiving end of a signaling line, the level of the current over which varies. More particularly, the invention is concerned with level control in systems in which line current is employed to produce at a receiving point an image of an object located at the transmitting point, as for example, picture transmission systems.

In accordance with the preferred embodiment of the invention, the level of operating current at the receiver is controlled by line current or impulses which are used also for synchronizing purposes. Thus, in the form of the invention hereinafter described the current which is employed to synchronize the two drums of a picture transmission system is in part diverted at the receiver and the diverted portion automatically adjusts the level of the picture current which controls the light valve used in producing the image.

Referring to the drawings, Figure 1 is a diagram of apparatus at the transmitting end of the system and Fig. 2 is a diagram of apparatus at the receiving end.

Light from the source 11 is focused on the small opening in the screen 13 adjacent to the surface of the drum 14 around which the picture is wrapped in the form of a semi-transparent film. The drum 14 is mounted on an axial screw-threaded shaft 15 which is rotated by a motor 16 and caused to advance slowly along its axis with each rotation. Thus the spot of light on the film underlying the opening in the screen 13 describes a helical course on the film.

Within the drum 14 is a photo-electric cell 20 that receives the light passing through the opening of the screen 13 and the underlying film on the drum 14. According to the well known principle of the photo-electric cell, the current in its circuit varies in correspondence with the amount of light falling on it and this quantity of light depends on the degree of shade in the spot on the film adjacent to the opening in the screen 13. The varying current from the photo-electric cell 20 goes to the amplifier 21, and its output goes to the modulator 22, thus modulating the alternating current from the generator 23. The modulated output from modulator 22 goes through the high-pass filter 24 to the line 19.

The motor 16 that rotates the drum 14 also drives a low frequency generator 17, whose output is interrupted regularly and then goes through the low-pass filter 18 to the line 19. For example, the output of the generator G may be an alternating current of 400 cycles per second in interrupted wave trains each 1/120 second in duration, and 60 of these per second.

Thus the line 19 carries the low frequency synchronizing current wave trains from the generator 17 and the higher frequency current from the generator 23, modulated according to the degree of shade in the successive elements of the picture to be transmitted.

These currents coming in over the line 19 are passed through the artificial line 25 by which their intensity can be adjusted manually. The low frequency synchronizing currents go through the low-pass filter 27 and the higher frequency picture currents go through the high-pass filter 26. These picture currents then pass through the transformer 28 to the push-pull detector 29 whose output is applied through the transformer 30 and amplifier 31 to the light valve 32.

Light from the source 33 is focused by the lens 34 on the light valve 32, and in accordance with the degree of the opening of light valve 32 the light falls on the underlying spot of a sensitive film wrapped around the drum 35. The drum 35 is rotated by the motor 37 and traversed along its axis by the engagement of the screw threads on the shaft 36 with a suitable support. The motor 37 is driven synchronously by current received through the low-pass filter 27, and thus the result is secured that the drum 35 at the receiving station is rotated and traversed synchronously with the drum 14 at the transmitting station.

A branch circuit from the output of the low-pass filter 27 goes through the narrow band-pass filter 38, and the output of this last mentioned filter goes through the amplifier 39 to the detector 40. This detector 40 is adjusted with a high negative voltage on its grid.

Now suppose that for some reason the transmission efficiency of the line is increased so that an increased intensity of current goes through both the filters 26 and 27. The effect of the increased current through the filter 27 is to increase the output current for the detector 40. This increases the potential drop through the resistance 44 and decreases the current in the circuit from ground 42 through battery 43, resistance 44, inductance 46, primaries of transformer 30 and plates to filaments in audions 29 and thus to ground at 50. Whereas the same cause that increases the current through the filter 27 would tend to increase the current through the filter 26 and hence increase the output from the detector 29, the decreased current in the output circuit of this detector that has just been traced will counteract the tendency to increase, so that the output from the detector 29 will remain constant so far as variations in transmission equivalent of the line and other parts of the system are concerned.

The inductance 46 and the shunt condenser 47 are provided to supplement the filter 38 in smoothing out rapid variations in the current.

The output circuit of the detector 40 comprises an indicating meter 41 so that suitable adjustments can be made manually at 25 for large slow variations in line equivalent or when different lines are connected with the apparatus. The variations for which automatic adjustment is made, as herein disclosed, are often of somewhat transient character and not of very wide amplitude.

Instead of applying the current from the battery 43 to the output circuit of the detector 29, its electromotive force can be applied to the input side. This will be accomplished by throwing the switches 45 and 49 from the positions shown in Fig. 2. It will readily be understood how the decrease of current through the resistance 51 that goes with increased current received through filter 27 from the line will operate to decrease the output from the detector 29.

I claim:

1. In a signaling system employing current of two components, one for transmitting message signals, the other for synchronizing, the method of keeping the signal current at proper energy level, which consists in automatically adjusting it by the variation of the synchronizing component.

2. In a signaling system employing current of two components, one for transmitting message signals, the other for synchronizing, the method of keeping the received signal current at proper energy level, which consists in filtering the said components into separate paths and then adjusting the degree of amplification of the signal current inversely according to the intensity of the synchronizing current.

3. In a signal system, means to transmit a current of two components, one for message signals, the other for synchronizing, an amplifier for the signal current, a detector for the synchronizing current and means controlled by said detector to vary the amplification of the signal current.

4. In a picture transmitting system, a light valve at the receiving end of the system, means to apply the received picture shade current to operate said light valve, and means to vary the intensity of the current controlling the light valve inversely according to the energy level of the current received from the transmitting station.

5. In an image producing system, means to generate and transmit a current of two components, one for image production, the other for synchronizing, means at the receiving end to separate these components into respective paths, means to test the synchronizing component for intensity, and means to adjust the degree of amplification of the image producing component accordingly.

6. In a picture transmitting system, means to generate and transmit current of two components, one modulated for picture shades, the other for synchronizing, filters at the receiving end to separate these components to respective paths, an amplifier for the picture shade component, a detector for the synchronizing component and means to adjust the amplifier according to the intensity of the output of the said detector.

7. In a signaling system for producing images at a receiving point of an object at a transmitting point, the method of keeping the received operating current at proper energy level, which consists in transmitting a non-signaling current from the transmitter to the receiver and utilizing said current simultaneously for controlling the rate of scanning at the receiver and for adjusting the apparatus at the receiver to vary the degree of amplification inversely to changes in the energy level of the received image current.

8. A signaling system for producing images at a receiving point of objects at a transmitting point, which comprises means for transmitting image current impulses, means for receiving and amplifying said current impulses, means at the transmitter for transmitting non-signaling current impulses, means at the receiver for utilizing the received non-signaling current to control the rate of scanning, means at the receiver for detecting changes in energy level of the received non-signaling current, and means at the receiver to vary the degree of amplification of said amplifying means inversely to changes in the energy level of the received image current.

9. A signaling system for producing images at a receiving point of objects at a transmitting point which comprises means

for generating signaling current, means at the transmitter for generating non-signaling current, means for transmitting both of said currents from the transmitting to the receiving point over the same transmission line, filtering means at the receiving point for separating the signaling current and the non-signaling current, means for amplifying the said signaling current, means for utilizing the received non-signaling current to control the rate of scanning, means for detecting changes in energy level of the said received non-signaling current, and means at the receiver to vary the degree of amplification of said amplifying means inversely to changes in the energy level of received signaling current.

10. The method of maintaining uniform reception in an image transmission system which comprises controlling the intensity of light incident upon a receiving surface in accordance with changes in the transmission level of a line and independently of image current being received.

11. The method of maintaining uniform reception in an image transmission system which comprises controlling the intensity of the image producing light at the receiver in accordance with current level changes due to changes in a transmission characteristic of the transmitting medium and independently of image current being received.

12. In an image transmission system, a sending station, a receiving station, a transmission channel interconnecting said stations, means for sending image current over said channel, means for sending test current over said channel, a compensating device at the receiving station, and means responsive to the sending of said test current to cause said compensating device to maintain uniform contrast relation between the received image and the object whose image is transmitted.

13. In an image transmission system, a sending station, a receiving station, a transmission channel interconnecting said stations, means for sending over said channel current modulated in accordance with the tone characteristics of a picture or object, means for receiving said current, a source of light and a receiving medium therefor at the receiving station, a device at the receiving station adapted to control the amount of light reaching said medium, means for receiving testing current dependent upon the condition of said channel, and means responsive to said testing current for correspondingly varying the energy controlling the intensity of the light from said source.

14. In an image transmission system, a sending station, a receiving station, a transmission channel interconnecting said stations, a receiving surface and a source of light therefor at said receiving station, means for transmitting carrier current modulated according to the tone characteristics of a picture or other object from said sending station to said receiving station, means for sending unmodulated carrier current to test said channel, means at the receiving station for varying the intensity of the light rays from said source in accordance with the modulated current, and means at the said receiving station for varying the energy controlling the intensity of the light from said source in accordance with said test current.

15. In a signaling system employing means for transmitting message signals and means for transmitting synchronizing current, the method of keeping the received signal current at proper energy level, which comprises adjusting the degree of amplification of the signal current inversely according to the intensity of the synchronizing current.

16. A signaling system comprising means for transmitting signaling current, means for transmitting synchronizing current, signal amplifying means, means to test the synchronizing current for intensity and to utilize the changes in intensity to adjust the degree of amplification of said amplifying means.

17. In an image transmission system, a sending station, a receiving station, means for transmitting image current, means for transmitting test current, and means controlled by said test current for compensating for changes of level of transmitted current to maintain uniform contrast relation between the image and the object.

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

HARRY NYQUIST.