Jan. 5, 1932. L. SILBERSTEIN 1,839,706

ELECTROTELESCOPY

Filed Feb. 15, 1929 2 Sheets-Sheet 1

Fig.1

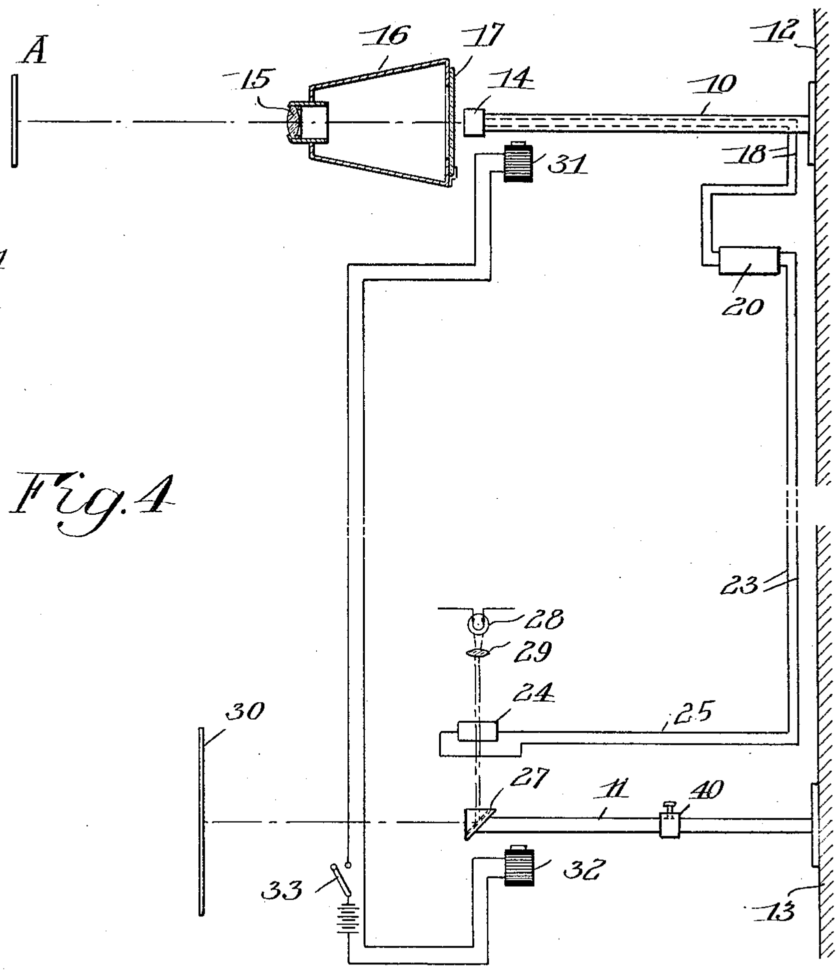

Fig.4

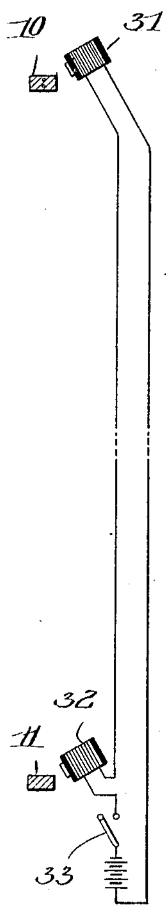

Fig.2

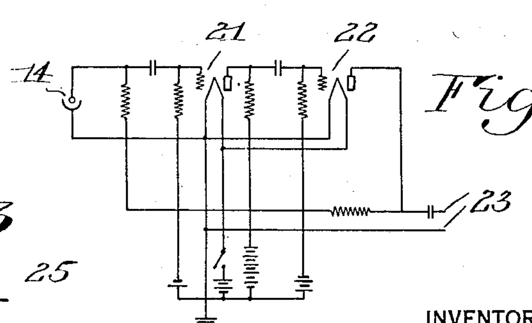

Fig.3

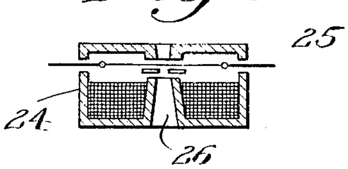

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Fig. 5

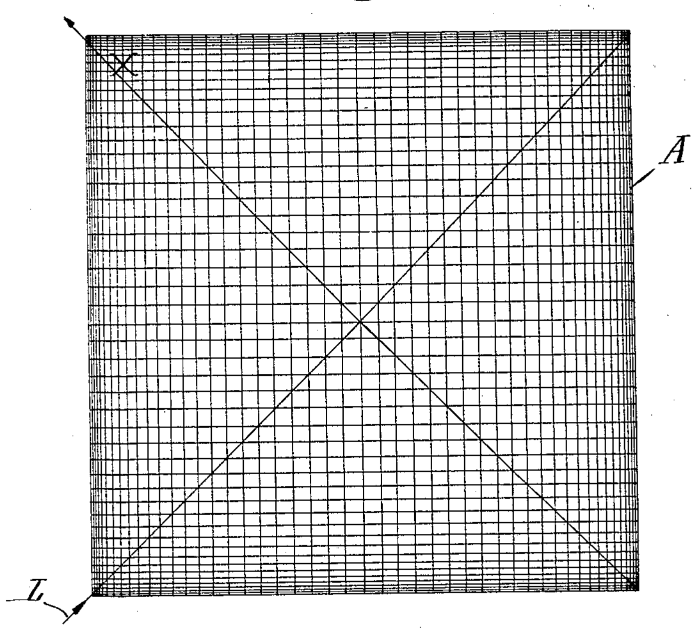
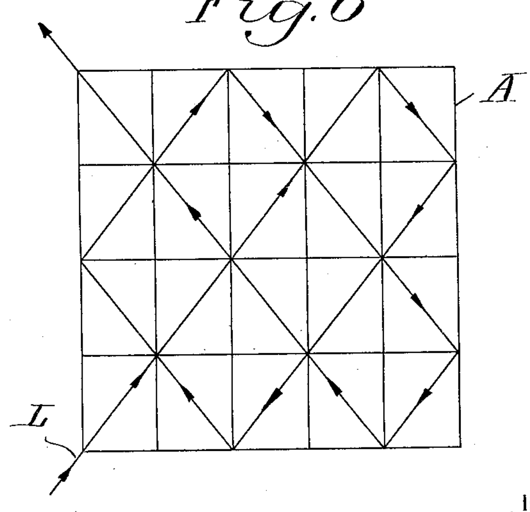


Fig. 6



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UNITED STATES PATENT OFFICE

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ELECTROTELESCOPY

Application filed February 15, 1929. Serial No. 340,198.

This invention relates to electro-telescopy (the electrical transmission of pictures or images over wire conductors or other channels), commonly known in the art as picture transmission or "television."

In the electrical transmission of pictures, as it is commercially practiced, it is necessary to have scanning discs, each provided with a series of holes spirally spaced around its periphery, one of which discs is located at the receiving end and the other at the transmitting end. These discs are rotated at great speed, preferably in the neighborhood of 1000 R. P. M. by motors at the transmitting and receiving ends which must operate in close phase synchronization and in addition there must be no fluctuation of speed of the motor at the transmitting end. Such equipment is highly complicated and difficult to maintain in efficient operating condition.

In accordance with one feature of the present invention it is proposed to replace the motor-driven scanning discs with their elaborate synchronizing means, by vibrating rods, one located at the transmitting end and the other at the receiving end. The characteristics of these rods are such that they vibrate in identical paths when once they have been started in motion.

Another feature of the invention relates to the use of a scanning element which has free vibrations of two different periods in two different directions, the ratios of the periods being expressed by rather large co-prime numbers differing from each other by a small number.

Another feature of the invention relates to the use of a scanning element which sweeps the area of the picture or image to be transmitted in a path corresponding to a Lissajous curve.

An additional feature of the invention is a scanning element which in its operation follows a path that is the resultant of two simple harmonic motions.

A further feature of the invention is the arrangement of the photoelectric cell or other scanning device so that it moves in precise contact with the optical image at all times during the transmission of the picture.

These and other features of the invention will be understood from the description and the claims when taken with the drawings in which Fig. 1 is a diagrammatic view of the invention representing a transmitting station and a receiving station; Fig. 2 is a diagrammatic showing of a photoelectric cell and a two-stage vacuum tube amplifier suitable for use in the system of Fig. 1; Fig. 3 is a view partially in section of a receiving element for use at the receiving station; Fig. 4 is a diagrammatic showing of the manner in which the scanning elements at the transmitting and receiving stations may be synchronized; Fig. 5 represents a picture or image to be transmitted which has been shown as comprising a plurality of rectangular picture areas with an incomplete Lissajous curve indicated thereon to define in part the path followed by the scanning elements; and Fig. 6 is a simplified diagram whose purpose is only to explain the manner in which the whole path or Lissajous curve is completed, whereas Fig. 5 shows only part of the path.

When an elastic rod, of rectangular section, clamped at one end is set in oscillation, it will have different vibration properties in different directions depending upon its cross-sectional dimensions. If the rectangular cross-section of such a rod has two periods of vibration such as T_1 and T_2 of component oscillations along the two sides of the rectangular section, which bear to each other a simple ratio such as 1:2 or 2:3, the free end will, when struck in the diagonal direction, vibrate in a simple closed Lissajous curve. When, however, this ratio becomes less simple the Lissajous curve becomes more complicated, for instance, if the ratio were 29 to 30 the curve would be extremely complicated and when the ratio is irrational such as

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the curve becomes infinitely entangled and the vibrating end will in the course of time come infinitely close to every point in the area of its vibrations, that is, it will practically sweep the entire area contained within the amplitude of the two component vibrations.

Furthermore, if two such rods are identical and both are set in motion by forces exerted in the same direction at the same instant, they will synchronously pass through corresponding points. If the actuating force on one rod is greater than that on the other, but the direction and point of impact are the same in both cases, one path will be similar to, only of less amplitude than the other. This furnishes a very accurate, simple and inexpensive means for use in "television" systems wherein the end of one rod serves to scan the image to be transmitted while the other acts as a reception instrument.

In the transmission of pictures it has been found that efficient results are obtained where the picture or image is considered as being made up of approximately 2500 small areas and then scanning each of these areas. In accordance with the principles of vibrating rods as outlined above it is proposed to have the ratio of the periods T_1 and T_2 of component oscillations bear the ratio of two large co-prime numbers differing from each other by a small number such as is represented by the ratio 49:50. The picture or image A of Fig. 5 comprises 2450 rectangles corresponding to the ratio 49 to 50 and laid out for tracing a Lissajous curve passing as a diagonal through each one of these rectangles. This curve L has been traced only in part on this figure since the complete curve would represent such a complicated pattern that it would be confusing, but the method of tracing such a Lissajous curve is well-known even to students of elementary physics. However, in Fig. 6 a simple picture comprising rectangles bearing the ratio of 4 to 5, is shown, which explains the matter simply. It will be noted that these diagonals of this curve cross each rectangle so that if a scanning device follows this pattern, every rectangular area of the image will be crossed.

In putting the invention into practical form as shown in Fig. 1, two rods or bars of rectangular cross-section such as 10 and 11 are provided, each mounted with one end rigidly fastened to a support such as 12 and 13. At the transmitting station the free end of the rod 10 is provided with a photoelectric cell 14. In this showing A represents an image to be transmitted which may be an illuminated transparency such as a positive or an image of an object or person projected by a lens 15 mounted in a camera. For focusing the image, a ground glass 16 may be used but it will be understood that this glass is removed during the transmission of the picture and that the photoelectric cell 14 is in precise contact with the actual optical image of the object A as projected by the lens 15. While the end of the rod 10 is shown provided with a light responsive photoelectric cell it will be understood that a perforated dark screen vibrated very close to the image plane may be substituted therefor to transmit light from the various areas of the image to a fixed photoelectric cell. The photoelectric cell 14 may be of any well-known type and is connected by conductors 18 passing through the center of the rod 10 to a vacuum tube amplifier designated 20.

While any well-known amplifier may be used the one shown in Fig. 2 is illustrative of one type. In this figure the photoelectric cell is represented at 14 and its output is connected to the first stage of the amplifier including vacuum tube 21, the output of which is coupled to the second stage of the amplifier including a second vacuum tube 22. It is unnecessary here to explain the operation of this amplifier since it is well-known in the art. It is sufficient to state, however, that the weak photoelectric currents developed by the photoelectric cell 14 are successively amplified by the two vacuum tubes 21 and 22 and delivered as amplified current to the conductors 23 leading to a light valve 24 at the receiving station.

This light valve transmits from a constant light source, placed at the receiving station, light of an intensity proportional, at any instant, to the intensity of the arriving photoelectric current. It may consist essentially of a narrow ribbon-like conductor 25 in series with the conductors 23, which conductor lies in a transverse magnetic field in such a position as to entirely cover a small aperture 26. The incoming current passing through the ribbon 25 is consequently deflected to one side by the interaction of the current with the magnetic field thus exposing and permitting light to pass through the aperture 26 at varying intensities. This light valve may be similar in form to that developed by E. C. Wente disclosed in Bell System Technical Journal, Volume IV, April 1925.

It has been mentioned that at the receiving station a vibrating rod 11 identical in characteristics with the rod 10 at the transmitting station, is provided. The rod 11 at its free end carries a mirror shown in dotted lines at 27 so that a source of light 28 and a lens 29 transmit light on the aperture 26 of the light valve so that if the ribbon 25 uncovers this aperture in response to control from the transmitting station varying light corresponding to the image thereat is projected on the mirror 27 where it is reflected onto a screen 30.

The rod 11 is adjustable into precise synchronism with the rod 10 at the sending station by simply shifting the position of a mobile mass 40 by means of a micrometric screw, along the receiving rod. In order to determine the exact synchronism of the sending and receiving rods the picture or image may be provided with a fiducial mark such as X (Fig. 5) in an obscure portion of the field, the weight 40 being adjusted until the reproduced mark X is distinctly seen.

It will be noted that an electromagnet 31 is provided at the transmitting station to set in vibration the rod 10 and a similar electromagnet 32 is provided at the receiving end to set in vibration the rod 11. These electromagnets are included in a series circuit which is controlled by a switch 33, and they are placed in the same position relative to their respective rods so that the magnetic fields of force operate along the diagonals of the cross-sections of the rods. The switch 33 is momentarily closed to cause them to continue oscillating for a certain time in a manner similar to the vibration of a tuning fork when it is struck a sharp blow. A series of single impulses at intervals of a few minutes may be sent if a continuous image of a moving object is to be transmitted. A rate of vibration of a few hundred to several thousand a second is easily obtainable, determined by the length, stiffness and cross-sectional dimensions of the rods which may be made of material such as high quality steel or invar as is used for tuning forks.

What is claimed is:

1. In a system for the electrical transmission of pictures, a single rod rigidly supported at one end, said rod having two different periods of vibrations in planes at an angle to each other, means controlled by the free end of said rod for translating varying light from a picture to be transmitted into varying electrical signals corresponding thereto, and means for setting said rod into free vibration to sweep over the entire area of said picture.

2. In a system for the electrical transmission of pictures, a single rod rigidly supported at one end, a photoelectric device controlled by the movement of the free end of said rod, and means for setting said rod into free vibration in two different directions.

3. In a system for the electrical transmission of pictures, a rod rigidly supported at one end, two lateral dimensions of said rod and therefore also the two corresponding periods of vibrations being expressed by two large co-prime numbers differing from each other by a small number, a photoelectric device controlled by the movement of the free end of said rod, and means for setting said rod into free vibration.

4. In a system for the electrical transmission of pictures, a rod supported at one end and carrying a light cell at its free end, said rod having two unequal cross-sectional dimensions, and means for setting said rod into vibration by an impulse applied diagonally to one side thereof.

5. In a system for the reception of pictures transmitted electrically, a single rod having two periods of vibrations in directions at an angle to each other rigidly supported at one end and provided with a mirror at its free end, means for projecting light on said mirror corresponding to the electrically transmitted picture, and means for flexing said rod diagonally to cause the end thereof to follow a path corresponding to a Lissajous curve.

6. In a system for the electrical transmission of pictures, a rod at the transmitting station clamped at one end and carrying a light cell at its free end, said rod having such characteristics that its free end follows a path corresponding to a Lissajous curve, means including a rod at the receiving station for reproducing a picture electrically transmitted from the transmitting end, said receiving rod being rigidly clamped at one end, and means including a mobile weight adjustable on said receiving rod for adjusting it into exact synchronism with first rod.

7. In a system for the electrical transmission and reproduction of pictures, a transmitting station comprising a single rod having unequal cross-sectional dimensions, said rod being rigidly clamped at one end and being provided at its free end with means for developing photoelectric signals, and actuating means for setting said rod into free vibration, a receiving station, means for transmitting said photoelectric signals to said receiving station, a single rod at the receiving station of like characteristics as said first rod rigidly supported at one end and provided at its free end with means cooperating in the translation of said photoelectric signals into varying light corresponding with the transmitted picture, actuating means for setting each of said rods into free vibration, and means for simultaneously operating said actuating means.

8. In a system for the electrical transmission of pictures, a transmitting station comprising a rod clamped at one end and provided with a photoelectric cell at its free end, actuating means for setting said rod into free vibration, a receiving station, means for transmitting from said photoelectric cell to said receiving station electrical signals varying in accordance with the intensity of light from the picture to be transmitted, means at the receiving station for translating said varying electrical signals into correspondingly varying light, a rod rigidly mounted at one end and provided at its free end with a mirrow supported in the path of light from said translating means, said rod having the same characteristics as the rod at the transmitting station, actuating means for setting into free vibration the rod at the receiving station, and means for simultaneously operating both of said actuating means.

9. A system in accordance with claim 1 wherein the rod has an oblong cross-section.

10. In a system for the electrical transmission of pictures, a rod supported at one end and carrying an optical instrument at its free end, said rod having two unequal cross-sec-

tional dimensions, and means for setting said rod into vibration by an impulse applied diagonally to one side thereof.

11. In a system for the electrical transmission of pictures, a rod rigidly supported at one end, said rod having two different periods of vibration in two different planes at an angle to one another, expressed by two large co-prime numbers differing from each other by a small number, an optical instrument controlled by the movement of the free end of said rod, and energizing means for setting said rod into free vibration.

12. In a system for the electrical transmission of pictures, a rod rigidly supported at one end, said rod having two different periods of vibration in two different planes at an angle to one another, expressed by two large co-prime numbers differing from each other by a small number, an optical instrument controlled by the movement of the free end of said rod, and means for momentarily flexing said rod diagonally.

13. A system in accordance with claim 11 wherein two similar rods are provided, the energizing means affects both, and one of said rods is furnished with means for slightly varying its period of vibration.

In witness whereof, the above specification is signed in the name of LUDWIK SILBERSTEIN, by

CHARLES W. MARKUS,
Committee of the Person and Estate of Ludwik Silberstein.