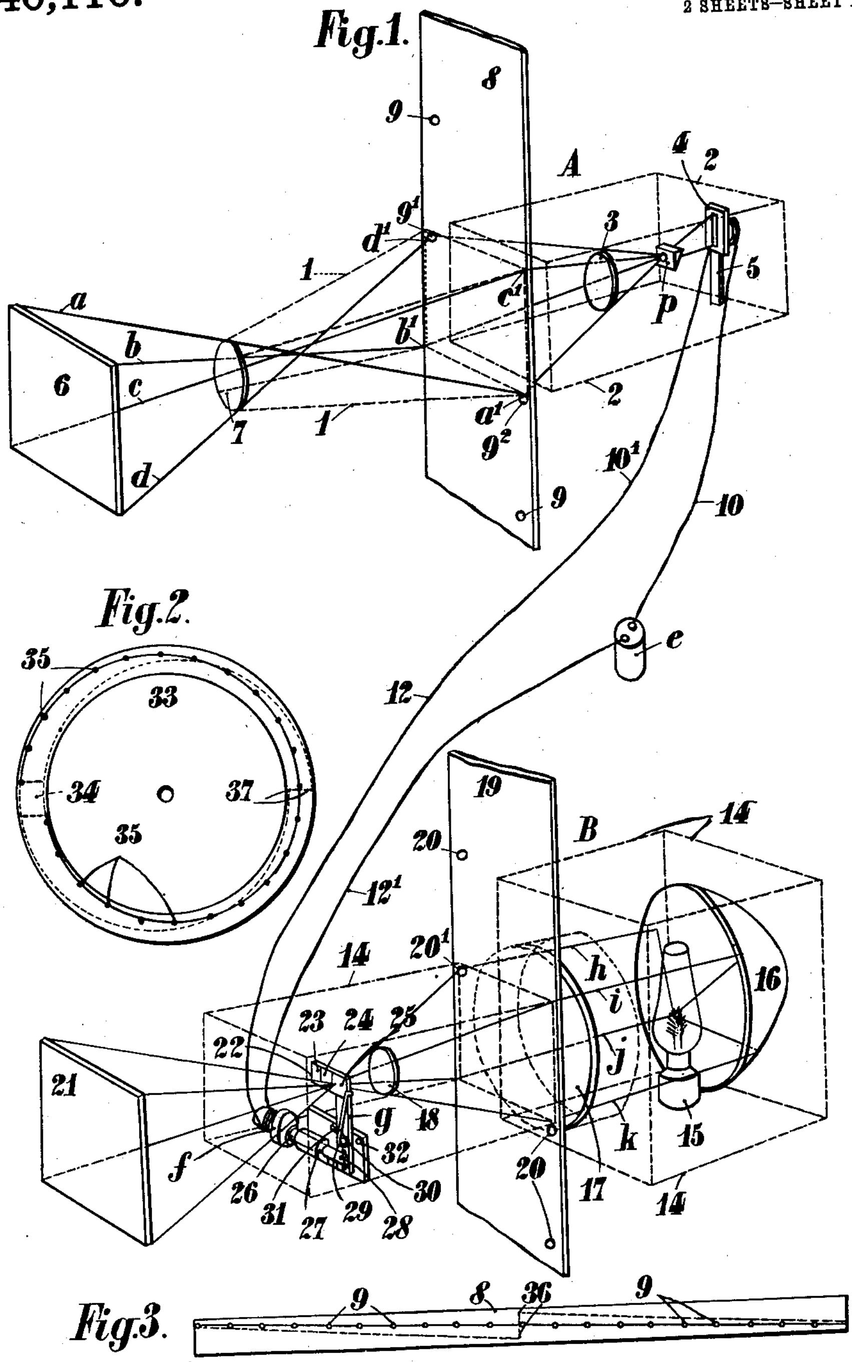
A. C. & L. S. ANDERSEN.
SYSTEM OF TRANSMITTING IMAGES TO A DISTANCE.
APPLICATION FILED DEC. 16, 1909.

1,040,110.

Patented Oct. 1, 1912.

2 SHEETS—SHEET 1.



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2 SHEETS—SHEET 2.

Fig.4.

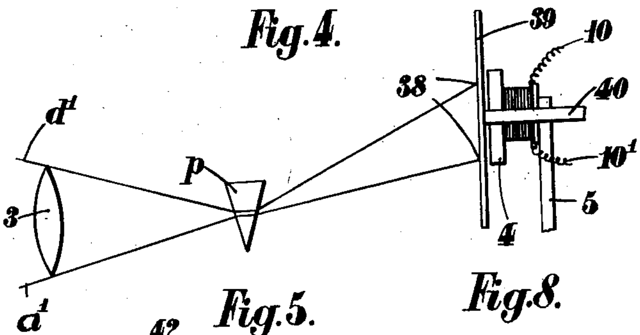


Fig.5.

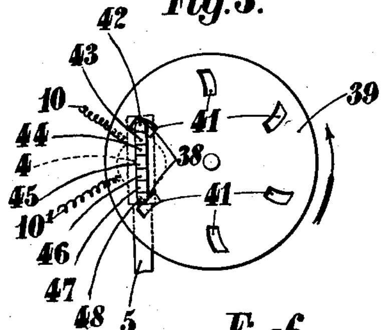


Fig.8.

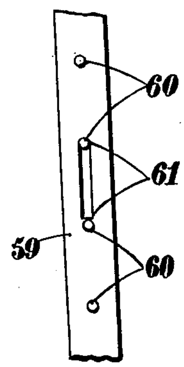


Fig.6.

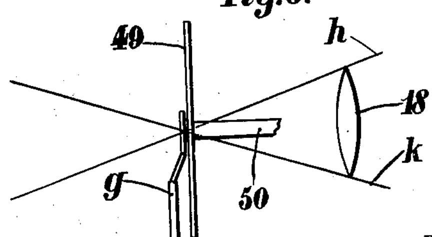


Fig.7.

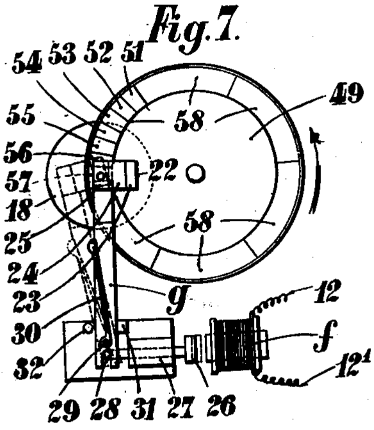
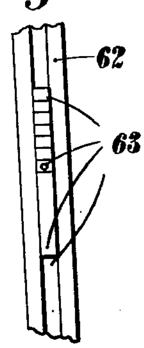


Fig.9.



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UNITED STATES PATENT OFFICE.

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SYSTEM OF TRANSMITTING IMAGES TO A DISTANCE.

1,040,110. Specification of Letters Patent. Patented Oct. 1, 1912.

Application filed December 16, 1909. Serial No. 533,472.

To all whom it may concern:

Be it known that we, ANDERS CHRISTIAN ANDERSEN and LAURITZ SOPHUS ANDERSEN, subjects of the King of Denmark, residing at Copenhagen, K, Denmark, have invented certain new and useful Improvements in Systems of Transmitting Images to a Distance; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The invention relates to an apparatus for transmitting to a distance, by means of electric conductors, the images of natural objects with their colors and movements.

One method of carrying out the invention is represented on the drawing in which:

Figure 1 shows the installation collectively, comprising a transmitting station and a receiving station connected by a line. Fig. 2 shows a disk which may be employed in place of a ribbon for intercepting the luminous rays. Fig. 3 shows a perforated ribbon. Fig. 4 shows a side view of an arrangement for the separation of the colored rays proceeding from the image in the dark chamber. Fig. 5 shows a front view of this arrangement. Fig. 6 shows a side view of an arrangement serving for the coloration of the rays which form the image. Fig. 7 represents a front view of the same arrangement. Fig. 8 represents a ribbon used in place of the disk for separating the colored rays of the image in the dark chamber. Fig. 9 represents a ribbon employed in place of a disk for coloring the rays forming the image.

The installation comprises two apparatus functioning simultaneously and operating the one as a transmitter and the other as a receiver: these apparatus are moved separately by a motor device; their movements are synchronous and the regulation is effected by an arrangement of electrically actuated clockwork utilizing the line of the apparatus.

The transmitter apparatus A comprises a dark chamber 1, at the back of which is arranged a casing 2 in which is placed a lens 3 which receives the rays issuing from the dark chamber. These rays, after being refracted, meet a small cell of selenium 4, placed behind a prism *p* and mounted on the support 5. The screen 6 represents an object (in reality farther removed from the chamber 1 and greater than the drawing indicates). The rays *a b c d* coming from the screen 6 after refraction in the lens 7 of the chamber, form upon the endless ribbon 8 a real image *a′ b′ c′ d′* reversed and reduced by the screen 6. This ribbon is flat, continuous, and opaque except at certain perforated points arranged according to a diagonal line (Fig. 3). The distances separating the holes 9 depend upon the size of the image in the dark chamber. These holes are spaced apart in such a manner that only one point can be located at each instant within the field of the image in the dark chamber. The ribbon 8 is displaced from above downwardly under the action of a motor mechanism with a convenient speed, between the chamber and the casing; it forms thus the end of the dark chamber and separates it from the casing 2. The luminous rays traversing the perforations of the ribbon fall upon the lens 3 and are received by the small selenium cell 4. Only one point comes at each instant within the field of the image as the figure shows, in which the point $9'$ is in the field, the point 9^2 being outside. The point $9'$ is the first and the point 9^2 the last point of the oblique line formed by the perforations of the ribbon. When the ribbon has been displaced the whole of its length and has passed the image in the dark chamber, each of the points of perforation has crossed the part of the image which is presented to view and is displaced from *a′* to *c′*. For example, if there is an illuminated point of the image which is located opposite the point $9'$ of the ribbon the luminous ray which arrives there traverses the ribbon and falls upon the converging lens of the small selenium cell; the same phenomenon is produced by all the points of the image and according as these points are more or less illuminated the selenium cell receives a quantity of light more or less great.

The method whereby coloration is obtained will be indicated below.

It is known that selenium presents an electric resistance which diminishes according as it receives a greater amount of light. If one causes the current coming from the battery to pass into the selenium cell by means of wires 10 and $10'$ there will be pulsations of current responding exactly to the variations of illumination of the selenium cell. The conductor 10′ is connected to the winding of an electro-magnet *f* placed at the receiving station B and from there the current returns through the conductor 12′ to the battery *e*.

The receiving station B consists of a projector apparatus 14 with a lamp 15 and a concave mirror 16 with two lenses 17 and 18, a magnet *f*, an arm *g* and an endless ribbon 19 absolutely similar to the ribbon 8 of the transmitting station A. This ribbon comprises the same number of perforations 20 arranged obliquely. These perforations combined with the electro-magnet *f* and with the arm *g* serve to separate the rays *h i j k* which proceed from the luminous source 15 and fall upon the screen 21. In front of the arm *g* is placed an arrangement (not shown) for producing the coloration of the image. The arm *g* is provided with a plate 22 comprising unequally transparent portions 23, 24, 25; the portion 25, which in the case shown in the figure is located at the focus of the rays *h i j k* is opaque, the portion 23 is completely transparent and the intermediate portion 24 has a transparency increasing gradually from the portion 25 up to the portion 23. The arm *g* is actuated by the magnet *f* by means of the core 26 of this electro-magnet; this core slides in the guide 27 and is connected to the arm *g* by a plug 28. The arm *g* is movable about an axis 29 to which is fixed a spring 30 which tends to apply the arm *g* against the stop 31; in this manner the opaque portion 25 is normally maintained at the focus. A stop 32 prevents the core from coming in contact with the yoke. The ribbon 19 is displaced by the motor device like the ribbon 8 of the transmitter 8 at an exactly similar speed.

The projection on the screen 21 of the rays which form the image is effected in the same order as the reception by the selenium cell 4 of the rays coming from the image in the chamber 1. The points 9′ and 20′ of the ribbons 8 and 19 are located at exactly the same spot in the field of the image in the dark chamber and in the opening in the projector apparatus.

Consequent on the simultaneous operation of the electro-magnet *f*, the arm *g* and the ribbon 19, the rays falling upon the plate 22 are more or less absorbed according as the corresponding spot is more or less dark. If for example there is in the image an illuminated point which comes opposite the point 9′ of the ribbon 8, the ray traverses the hole and reaches the selenium cell 4 which according to this illumination causes a current to pass, more or less intense, in the wire of the electro-magnet *f*. This electro-magnet attracts with a corresponding force the core 26 which causes the arm *g* to turn around the axis 29 (see Fig. 7). In this manner, according to the illumination of the cell, the corresponding portion of the plate 22 will be brought to the focus of the luminous rays. The ray *h* proceeding from the luminous source 15 passes across the hole 20′ and gives on the screen 21 an image of which the luminous intensity corresponds to that of the object.

The synchronous displacement of the ribbons produces the movement of the holes 9′ and 20′. Accordingly the selenium cell receives other rays which are reproduced at the receiving station with the same luminous intensity and the same phenomenon is repeated for all of the points of the image according as the movements of the ribbons bring their perforations of the projector apparatus. In front of these two apparatus the two ribbons are constantly displaced their entire length at a predetermined speed. The rays are continually distributed at a speed greater than that of the perception of the human eye. Thus all the movements of the man, animals, etc., the image of which is reproduced, are perceived.

The screen 21 is supposed to be more removed from the projector apparatus and greater than indicated in the drawing. The reversed and reduced image given of the object in the dark chamber 1 on the ribbon is reproduced by the aid of the ribbon 19 by the pencil of rays *h i j k* issuing from the lamp 15 and refracted by the lenses 17 and 18. There is thus formed on the screen 21 a true and enlarged image of the object. Without changing the method, wheels or disks 33 may also be employed for dividing up the image, instead of ribbons (see Fig. 2, in which the dotted square 34 represents the size of the image). The holes arranged on the disk following the points 35 are arranged on a discontinuous spiral line. The order of distribution of the points is the same as in the case of the ribbons 8 and 19; the distance of the holes depends on the dimensions of the field of the two apparatus. In this manner the points which are located at the same instant in the field of the two apparatus will be corresponding points. When the disks 33 have made a complete turn all the holes have traversed the fields absolutely as in the case of the ribbons. The dimensions of the ribbons 8 and 19 and of the disks 33 vary within limits and may be unequal in length and breadth in such a manner that the distances separating the holes may be also different while the number of points of perforation remain always the same. The size of the holes varies also according to the dimensions of the image to be reproduced. An image of reduced size can be obtained by employing ribbons or disks of smaller dimensions. Without changing the method one may arrange the perforations of the disks and of the ribbons so as to follow oblique or spiral lines more or less continuous (see Figs. 2 and 3 in which the dotted lines show the ribbon 8 and the disk 33 divided by two oblique lines 36 or by spirals 37). By reason of the employment of perforations dividing the images by oblique lines or by interrupted spiral lines, the continuous movement of the disk and of the ribbons in the same direction produces an overlapping; the rays coming from the luminous source 15 mix and crowd one upon the other; accordingly a continuous image is obtained.

The separation of the colored rays of the images and the corresponding coloration of the rays in the transmitter apparatus and the receiver apparatus are obtained by the arrangement represented in Figs. 4, 5, 6 and 7. Fig. 4 shows in a side view the arrangement serving to separate the rays of the different colors forming the image before causing these to strike the selenium cell; for this purpose amounts of deviation are utilized given through the prism by the rays of different colors.

In the receiver apparatus A a prism *p* is employed on which all the rays *d'*, *a'* fall, coming from the lens 3. After refraction the different rays form a spectrum 38 on a disk 39 which receives a movement of rotation from the motor apparatus. Opposite the spectrum 38 and against the disk 39 is placed the selenium cell 4 on the support 5 and connected to the conductor wires 10 and 10'. The disk 39 is opaque but on its edge it is provided with cavities or holes 41 (see Fig. 5 which shows in a front view the disk 39 with the spectrum 38 and the selenium cell 4). The width of the holes 41 corresponds to the width of each colored band while their distance corresponds to the total length of the spectrum 38. There is thus only one hole which can be located at each instant in front of the spectrum. The distribution of the colors of the spectrum is produced by the prism *p* according to the indices of refraction of the different rays in the following order: violet 42, indigo blue 43, blue 44, green 45, yellow 46, orange 47, red 48 which are obtained by the decomposition of white light. Natural objects do not emit one single color but several. For the transmitting apparatus A it is assumed that at each instant the light proceeding from a single point of perforation is sent toward the lens 3.

The luminous pencil of rays is dispersed through the prism *p* according to the rays which compose it and following the order indicated above. This pencil of rays is received by the disk 39. The disk 39, the holes 41 of which permit the rays to pass to the selenium cell, turns in the direction of the arrow with a speed such that the hole which is in the spectrum 38 traverses the whole spectrum during the period of emission corresponding to one point of the image in the chamber; according to the simple colorations forming the image of the point (red, orange, yellow, green, blue, indigo blue or violet) the elementary colored rays are sent to the selenium cell 4 in proportion as the hole of the disk is presented in front of them. When the hole has traversed the whole of the spectrum 38 another hole of the disk enters into the spectrum and the same thing is repeated for all the points of the image.

The arrangement employed for the coloration of the rays forming the image is seen in side view in Fig. 6 which shows a disk 49 mounted on the axis 50 and placed at the receiving station B at the focus of the rays *h k* proceeding from the luminous source and issuing from the lens 18; the disk 49 is placed behind the arm *g* and the plate 22 (see Fig. 7, which shows a front view of the disk 49, the lens 18 and the arm *g* as well as the electro-magnet *f*). On the disk 49 are placed colored and transparent bands, which by their coloration and their arrangement correspond exactly to the solar spectrum. The order in which they are placed is: red 51, orange 52, yellow 53, green 54, blue 55, indigo blue 56, violet 57, and the same colors are presented again in the same order on the whole periphery of the wheel; after violet comes red, and so on.

The disk 49 is divided into six colored spectra 58 the number of spectra should in fact correspond to the holes 41 of the disk 39 which also are six in number. The separating disks 39 and 49 turn with exactly the same speed in the direction of the arrows. In this manner if a hole of the disk 39 comes in front of a definite color of the spectrum 38 and thus causes a ray of this color to fall on the selenium cell, the corresponding color of the colored spectrum of the disk 49 is at the same moment placed at the focus of the receiving station. Further, the electro-magnet *f* attracts the core 26 with a force corresponding to the illumination, and this brings the corresponding portion of the plate 22 into the focus of the rays. In this manner the ray which has issued from the luminous source 15 and is received on the screen 21 corresponds exactly as to color and luminous intensity to the ray proceeding from the image in the dark chamber. The greater part of the points of the image in the dark chamber are formed by several colors but all the elementary rays are combined at the same point on the receiving screen; the time required for the passage of the spectrum is equal to the time required for the distribution of the rays which have issued from the point. The image is thus transmitted more quickly than the human eye is able to distinguish it; the images appearing enlarged and undergoing various changes caused by the movements of the men, animals and objects, by the variations of light and of coloration. The images thus obtained will be altogether similar to the natural objects.

For separating the colored rays of the images endless ribbons 59 shown in Fig. 8 can be employed instead of the disks 39 and these ribbons are separated from one another, as in the case of the holes 41, by an interval equal to the length of the spectrum 61. The disk 49 can also be replaced by an endless ribbon 62 serving for the coloration (Fig. 9), this ribbon following the colors of the spectrum 63 arranged as the spectrum 58.

The comparison of luminous intensities of diversely colored rays is somewhat arbitrary, since it is difficult in the practice to appreciate the equality of brightness of two spots of different colors, say violet and red. For this reason it has been proposed to define the luminous intensity of a number of rays by means of the action on a selenium cell, but this definition is not adopted and if the ordinary and imperfect definition is accepted, it may be admitted that the red rays have a greater effect on the selenium. In every case, the operation and the construction of the described apparatus are not directly connected to the solution of this question. In fact, if the red rays diminish the resistance of the selenium more than the violet rays, the emission of current will be greater for the red rays than for the violet rays, but, it suffices to make the red band 51 darker than the violet band 57 for realizing an exact reproduction of the red and violet colors. The same is true for the other colors. In practice, the toning of the bands 51—57 is determined by trials until satisfactory results are obtained.

The apparatus described above may if necessary be placed near the telephone. One can then, if one possesses the corresponding apparatus, see at the same time, with their living movements and their colors the image of the person to whom one is talking. By means of an interrupter it will be possible either to see or to talk by employing only the telephone wire. Finally this apparatus can be employed for verifying documents for exhibiting samples, machines in movements, objects and various merchandise and for every kind of control. It can also be very well employed in the army, not to mention passing events and theatrical representations.

We claim:

1. The method of transmitting colored images to a distance, which comprises projecting an image of the object, point by point, on a selenium cell, separating the rays falling on said cell, as regards their color, projecting rays on a screen in correspondence with the aforesaid projection of the image, varying the intensity of such light rays in accordance with the changes in the selenium cell, and varying the color of said rays in correspondence with the aforesaid separation of the rays.

2. The method of transmitting colored images to a distance, which comprises projecting the image point by point on a selenium cell, projecting light rays on a screen in correspondence with the aforesaid projection, varying the intensity of the rays on the screen in accordance with the effects produced in said cell, and varying the color of said rays in accordance with the coloring of the rays falling on said cell.

3. In apparatus for transmitting images to a distance, a selenium cell, means for projecting an image, point by point, on said cell, a screen, means to throw light rays on said screen in correspondence with the aforesaid projection of the image, a shutter to vary the intensity of the rays falling on said screen, an electro-magnet to operate said shutter, and a connection between said electro-magnet and said selenium cell.

4. In apparatus for transmitting colored images to a distance, a transmitting station having a selenium cell, and means to project rays thereon, means to separate the colored rays falling on said cell, said means comprising a movable perforated member placed in front of said cell, and a receiving station having ray projecting means, means controlled by said cell to vary the intensity of the rays, and ray coloring means comprising a multi-colored transparent member movable in consonance with said first named member.

5. In apparatus for transmitting colored images to a distance, the combination with color separating means at the transmitting station, including a prism, and a movable perforated member through which the rays are projected from said prism, of ray coloring means at the receiving station comprising a multi-colored transparent member movable in consonance with said first named member.

In testimony whereof we affix our signatures, in presence of two witnesses.

ANDERS CHRISTIAN ANDERSEN.
LAURITZ SOPHUS ANDERSEN.

Witnesses:
ANTON HENRIK KIANDER,
DEAN B. MASON.