A. SINDING-LARSEN.

TRANSMISSION OF PICTURES OF MOVING OBJECTS.

APPLICATION FILED JUNE 10, 1911.

1,175,313.

Patented Mar. 14, 1916.

2 SHEETS—SHEET 1.

Fig.1.

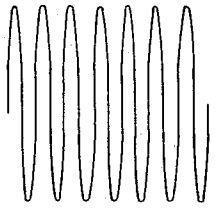


Fig.2.

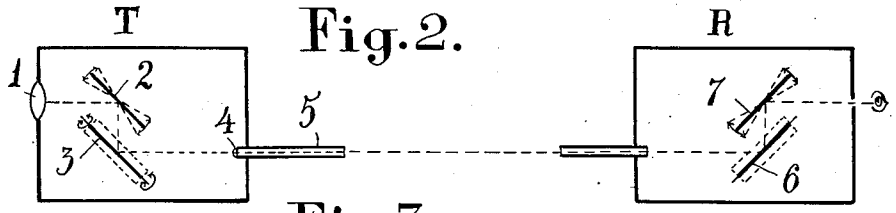


Fig.3.

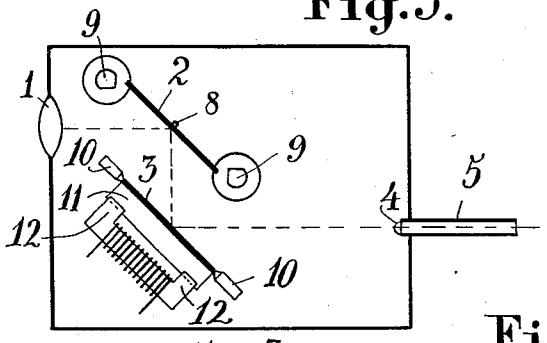


Fig.5.

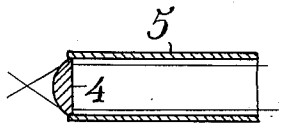


Fig.4.

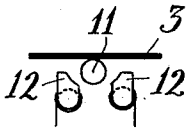


Fig.6.

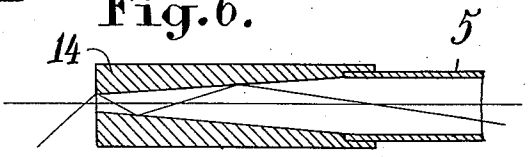


Fig.8.

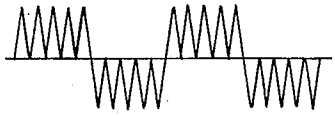
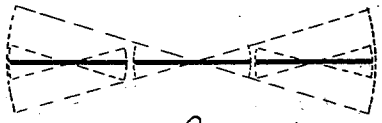


Fig.9.



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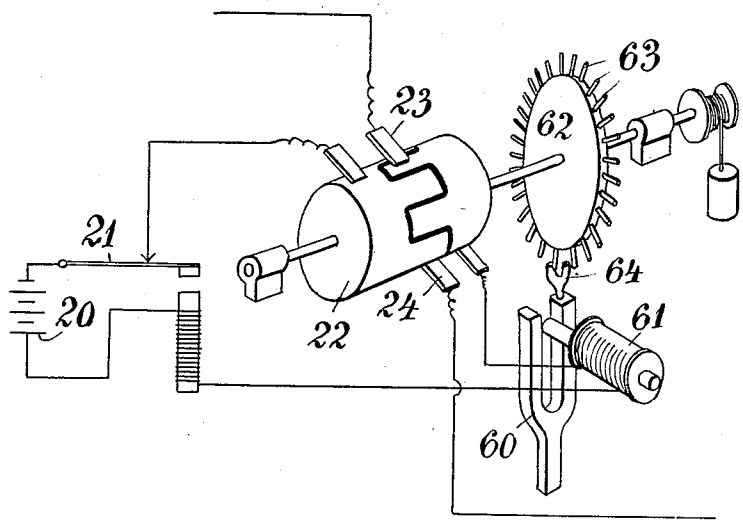
2 SHEETS—SHEET 2.

Fig. 7.



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UNITED STATES PATENT OFFICE.

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TRANSMISSION OF PICTURES OF MOVING OBJECTS.

1,175,313. Specification of Letters Patent. **Patented Mar. 14, 1916.**

Application filed June 10, 1911. Serial No. 632,410.

To all whom it may concern:

Be it known that I, ALF SINDING-LARSEN, a subject of the King of Norway, residing at Christiania, Norway, have invented certain new and useful Improvements in and Relating to the Transmission of Pictures of Moving Objects; and I do hereby declare that the following is a full, clear and exact description of the same.

My invention relates to the art of transmitting over long distances pictures of moving objects, and consists in improvements in the method or system as well as in the means and in the combinations of devices for carrying out the invention.

In the devices hitherto proposed for transmitting pictures through conductors a principle common to all of them is, that the picture to be transmitted is decomposed into a series of points or elements by devices performing two linear movements perpendicular to each other, said elements being successively transmitted to the receiver, in which, by corresponding linear movements, the pictures are recomposed. This necessitates two absolutely synchronous movements at the transmitter and the receiver. In the graphical transmission of pictures (for instance according to the Korns system) in which the duration of each movement is not limited, it is not difficult to establish such synchronism, but in the transmission of moving pictures, where every light point or picture element has to be repeated before the light impression on the eye has ceased, (between one tenth and one hundredth part of a second) which requires a very rapid performance of each single movement, such a motion system is very difficult to accomplish. A prior inventor (British Patent 27570/07) has tried to overcome this difficulty by making use of a picture decomposed in the transmitter, comprising two rotary polyhedral mirrors the axes of which are perpendicular to each other and which rotate at different speeds. The recomposing device in the receiver, however, does not consist of a similar mirror system with a corresponding motion, (a scheme which would have been impracticable on account of the absolute accuracy of synchronism necessary), but it is proposed to effect the recomposing of the picture in these systems by means of electrical current impulses, created by the rotating systems, which impulses cause synchronous linear movements in "oscillographs," especially in the so called "Braun's tubes," known from the scientific study of electrical waves. In other words, in these systems synchronous movements are sought to be established between devices of wholly different natures, a scheme which may be considered practically impossible to realize. The use of polyhedral mirrors for the purpose is moreover, in itself, disadvantageous, as each mirror is only partially utilized, the mirrors entering the field of rays successively, and again successively leaving said field. Another drawback is that the picture elements may become intermixed, as a reflection may take place simultaneously from two surfaces of the polyhedron.

In contradistinction to this old system my invention consists in a system for the transmission over long distances of pictures of moving objects in which an absolutely synchronous motion is practically realized by arranging the transmitter and the receiver in such manner that the movements required for the decomposing devices and those required for the recomposing devices are of the same character.

One important point in my invention is that the decomposer at the transmitting station and the recomposer at the receiving station both have a double oscillating motion, that is to say, they perform oscillations in two different planes, and that the synchronism of these oscillations is insured by the action of oscillating bodies having free vibration and kept in motion by a common source of driving force.

Having indicated the nature of my invention as regards the principle employed for enabling me to secure a synchronous action of the decomposing and the recomposing devices, I shall now explain some examples of how the invention as a whole may be carried out, and describe some of the devices which I have made use of, in order to prove the possibility of practically utilizing my invention. An image of the object is taken up by a kind of camera, in which, however, the image does not fall directly upon the rear image surface, or focal plane, but in which a mirror is mounted between such plane and the object lens, said mirror reflecting the light to another mirror from which the light finally falls upon the image surface. These two mirrors are associated with tuning forks or like freely vibrating devices, having different frequency of vibrations. The axes

of oscillation of said mirrors may be perpendicular to one another, or form some other angle, while their planes should be parallel when in the middle position. These tuning forks, one of which may have a vibration frequency of N for instance 100 in a second, and the other a frequency of N^2 or 10000 in a second, may now be kept in steady motion by means of a suitable electromagnetic arrangement. By means of this device every point of the image formed is in its turn transmitted to one and the same point on the image surface. At this point a light opening is arranged, and immediately behind this opening is the light receiving device which transmits the light to the receiver.

The receiver is constructed in a manner quite similar to the transmitter. It comprises a device emitting through a small light orifice the light coming from the transmitter, or emitting the light from a local light source, the light given off through the light orifice varying in intensity in accordance with the simultaneous intensity of the light passing through the light orifice of the transmitter. The variable light point thus formed in the receiver is looked upon through a system of reflectors corresponding to that of the transmitter, and oscillating synchronously with this latter system.

For transmitting the pictures directly I make use of a narrow tube with strongly reflecting inner surfaces, which tube is arranged with its rear opening behind the light orifice in the transmitter. The tube is preferably made of silver, gold, copper or other metal having a refraction coefficient lower than that of air. The optical system forming the image is arranged in such a manner that the rays forming the individual image points cross one another at a very acute angle. By this I am enabled to cause the light taken up in the mouth of the tube to be transmitted through the tube without being materially weakened in its passage to the other end of the tube and the image surface of the receiver. In order to maintain the greatest possible reflecting angle of the light rays during passage through the tube, the tube should have a very small sectional area and its curves or bends be of the greatest possible radius.

The synchronous movement of the mirrors is effected by coupling in series the electromagnets serving to keep the mirrors moving. The same tube that transmits the light rays may serve as conductor for the electric current. All these oscillating parts may be made to work in a vacuum in order to avoid disturbing noise and possible disadvantages resulting from air damping.

When the transmission of the picture is effected directly, that is, when the light is conducted through reflecting tubes, these latter may be kept filled with a gas adapted to preserve the reflecting surface against oxidation, such for instance, as hydrogen. The tube may also be evacuated.

To insure constant and complete uniformity between the oscillations of the tuning forks and of the mirrors associated with said forks, I make use of the following arrangement: The electromagnets actuating the tuning forks in the transmitter and receiver are coupled in series and are thus driven from a common source of current; while the quickly oscillating tuning forks or the magnet armatures mounted upon them are unpolarized, so that the direction of current in the electromagnet having a very soft iron core is of no consequence. The slowly oscillating tuning forks or their armatures are polarized in such a manner that the direction of oscillation is dependent upon the direction of current in the magnet. A third tuning fork arranged in the transmitter or receiver and having the same frequency of vibration as the above-mentioned slowly oscillating ones, serves to control the rotation of a commutator inserted in the battery circuit, which by means of suitable segment arrangement transforms the direct current into alternating current, whose periodicity is in accordance with the periodicity of the slowly oscillating tuning forks. It is obvious that the slowly oscillating, polarized tuning fork arranged in the receiver and transmitter when acted upon by an alternating magnetic field of its own periodicity produced by this alternating current, is compelled to maintain quite consonant and coincident oscillations. And it is also quite clear that the quickly oscillating tuning forks in the transmitter and receiver which are acted upon by one and the same interrupted current corresponding with their periodicity of oscillation are also compelled to maintain quite coincident oscillation. The rotation controlled by means of said third tuning fork may also act to directly produce the alternating current necessary, so that a battery may be superfluous. For these arrangements, as well as for those above-described, other bodies with a free vibration or self-oscillating capacity may be employed, instead of tuning forks. In the transmitter and in the receiver an electromagnet may be employed for the purpose of driving both tuning forks. The conductor or conductors employed for the transmission of pictures may also be used for the purpose of telephoning or transmission of telegrams.

I shall now describe some forms of apparatus used by me in carrying out my invention.

Referring to the drawings, in which like parts are similarly designated—Figure 1 is a diagram of motion. Fig. 2 is a side

view of a transmitter and a receiver illustrating means for carrying out the invention. Fig. 3 is a longitudinal section on an enlarged scale through the transmitter. Fig. 4 is a detail showing a cross section through one of the mirrors. Figs. 5 and 6 are details. Fig. 7 is a diagrammatic perspective view of a generator for interrupted alternating currents. Fig. 8 is a current diagram. Fig. 9 shows a modification of the mirror arrangement.

Reference being had to Figs. 2–6, T represents the transmitting apparatus and R the receiver; they are supposed to be connected by a reflection tube 5. 1 is the object lens of the receiving station camera, in which is placed two mirrors, 2 and 3; the mirror 2 oscillates very fast on an axis perpendicular to the plane of the drawing, while the mirror 3 oscillates more slowly on an axis lying in the said plane and is perpendicular to the axis of oscillation of the mirror 2. By these means the elements of the image formed by the lens 1 are in succession following a continuous zigzag line, transferred to the focus of a lens 4 placed in the opening of a reflection tube 5, said lens parallelizing the rays which meet the image point. In the receiver two similar mirrors 7 and 6 oscillating synchronously with the mirrors 2 and 3 respectively, throw the train of rays emerging from the reflection tube to the eye of the observer as indicated, or to the object lens of a camera or projection apparatus. The synchronous vibration of the respective pairs of mirrors is insured by means of the tuning forks and is maintained by means of electromagnets receiving current from the same source; this current may, for one of the pairs of mirrors, be an interrupted current, and for the other pair an alternating current, or it may be simultaneously interrupted and alternating, in which case it is not necessary to have a separate circuit for each pair of mirrors. The breaking or the alternation of the current for each pair of mirrors corresponds with the frequency of the free vibration of the mirrors. This principle of resonant adjustment of the oscillating systems is found to be an absolute condition for obtaining the synchronism necessary for the correct transmission of the pictures; it enables me also to have these movements established with a minimum of power, a fact which is of no little importance. But the greatest advantage of the system is that the synchronism is in this manner self adjusting, because if the mirrors are by some outer force brought out of their regular motion, they will immediately, when left to themselves, reassume their synchronous motion. The system therefore enables me to control an unlimited number of stations from a common central.

In the drawing I have shown two sets of mirrors in each station. I may also make use of any other means for decomposing and recomposing the picture in the manner described. The main feature of this part of the invention being that the oscillatory movements used for the decomposition and recomposition of the picture are "tuned" so as to be in resonance with the free vibration of the swinging bodies.

The rapidly swinging mirrors 2 and 7 may suitably be driven by interrupted current supplied to electromagnets with unpolarized armatures, and the mirrors 3 and 6 may be driven by alternating current by means of electro-magnets the armatures of which are polarized. If the transmitter and the receiver are driven by interrupted direct current, and the light transmission is effected by means of the described reflection tubes, it will be seen that only two electric conductors are needed for the transmission of the picture, and as one of these may be the reflection tube and the other the earth, no other connection than the tube is necessary between the two stations. I have found that a tube of an inside diameter of 2 millimeters and an outside diameter of 3 millimeters is suitable. Instead of tubes I may make use of wires or strings of a material of little light absorbent quality, or of tubes filled with fluids of this nature. In order that as little light as possible shall be absorbed by the walls of the tube it is preferable that the lens 4 shall have a short focal length.

The mirror 2 (see Fig. 3) may be made of iron, polished and silver plated on the front face and have its back fixed to a piano string 8 which has a free swing or vibration. The tension of the string is so adjusted that a suitable free vibration frequency is secured by the combined action of the mass of the mirror and the forces of torsion of the string. The piano string may be so mounted that it is prevented from having transverse vibration, which latter would disturb the picture.

9 represents an electro-magnet creating a field in which the mirror acts as an armature. The windings of the electro-magnet are connected with an interrupted current circuit the frequency of which corresponds with the free vibration frequency of the mirror.

The mirror 3 is pivoted on the pins 10, 10, and on its back is secured a permanent magnet 11, the poles of which extend into the fields created by the alternating current magnets 12, 12. This mirror has a relatively slow vibratory motion, the frequency of which is made to correspond with the frequency of the alternating current by adjustment of its mass and of a spring, which tends to keep it in its intermediate position.

For generation of an interrupted alternating current suitable for the purpose of my

invention I may employ a device such as shown in the diagram Fig. 7; 20 represents the source of current, for instance a battery, 21 is a Wagner hammer with a stiff spring having a distinct free vibration, and 22 a motor-driven commutator giving off current to the brushes 23, 24, connected in series or in parallel with the transmitting and receiving apparatus and rotated, preferably, so as to send current impulses in synchronism with the free vibration of the suspenders for the mirrors. The commutator 22 is driven by a weight operated motor governed by an escapement mechanism consisting of an escapement wheel 62 having pins 63 coöperating with the detent 64 carried by an arm of tuning fork 60 which is kept in vibration by the magnet 61. According to the frequency of the interrupter relatively to the number of alternations caused by the commutator, current-curves of different form will be obtained. If the frequency of the interruptions is greater than the frequency of the alternations, as supposed in the apparatus above described, the curve will be as shown in Fig. 8. Of course the number of variations in each positive and negative part of the wave will be much greater than shown. In order to increase the intensity of the light transmitted there may be arranged two or more light-transmitting and light-receiving devices at the transmitter and receiver, respectively, said devices coöperating with each other and transmitting simultaneously different points of the picture, either directly or indirectly as described; of course care must be taken that the said devices are placed at the same distance and in the same relative position to each other at both stations.

If the transmitter and receiver have great dimensions, it may be unsuitable to use mirrors of the above-described arrangement, because the air may have too great a retarding action on mirrors of great dimensions swinging with great velocity. In such a case I may make use of mirrors formed in sections like window blinds or louvers, as shown in Fig. 9. The sections, although having a very slight peripheral movement, will perform the same work as a continuous mirror, having the same angular motion. These mirrors move on their axes synchronously and are vibrated by like means as described with respect to mirrors 2 or 3.

Instead of a lens, as shown in Fig. 5, I may use an arrangement such as that shown in Fig. 6. The end of the tube is in this case provided with a mouth piece 14 having a polished conical inner surface. The rays entering the small orifice of this mouth piece will be repeatedly reflected, so as to finally take a direction about parallel to the axis of the tube. It is preferable that the light rays enter the tube at a slight angle, for example, not over 10°.

I claim—

1. In the method of transmitting pictures of moving objects to a distance, the step which comprises forming an image of the object, breaking up the image into minor elements by oscillating reflectors having a freely vibrating suspension, and maintaining the vibration of said suspension by imparting to said reflectors impulses in phase with the vibration of said suspension.

2. In the method of transmitting pictures of moving objects to a distance, the step which comprises forming an image of the object, breaking up the image by double reflection to oscillating reflectors having freely vibrating suspensions, and maintaining the vibration of said reflectors by imparting impulses thereto substantially in synchronism with the fundamental of the suspension.

3. In the method of transmitting pictures of moving objects, the step which comprises forming an image, breaking up the image by double reflection first to a rapidly oscillating reflector having a freely vibrating suspension and thence to a slowly vibrating reflector also having a freely vibrating suspension, and maintaining the vibration of said suspensions and reflectors by imparting impulses thereto substantially in synchronism with their fundamental.

4. Mechanism for transmitting moving pictures, comprising a sending station and a receiving station, each station having mirrors to produce double reflection, and a reflecting tube connecting the stations, said mirrors having freely vibrating suspensions and means to produce a magnetic field for each mirror in synchronism with the vibrations of said suspensions.

5. Mechanism for transmitting moving pictures, comprising a sending station and a receiving station, each station having two reflectors vibrating at an angle to one another, freely vibrating suspensions for said reflectors, and electro-magnetic means to maintain said mirrors in vibration, and means to simultaneously send current impulses to said electro-magnetic means in synchronism with the vibrations of said suspensions.

In testimony that I claim the foregoing as my invention, I have signed my name in presence of two subscribing witnesses.

ALF SINDING-LARSEN.

Witnesses:
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