March 10, 1931. R. D. KELL 1,796,030

TRANSMISSION AND RECEPTION OF PICTURES

Filed April 25, 1929

Fig. 1.

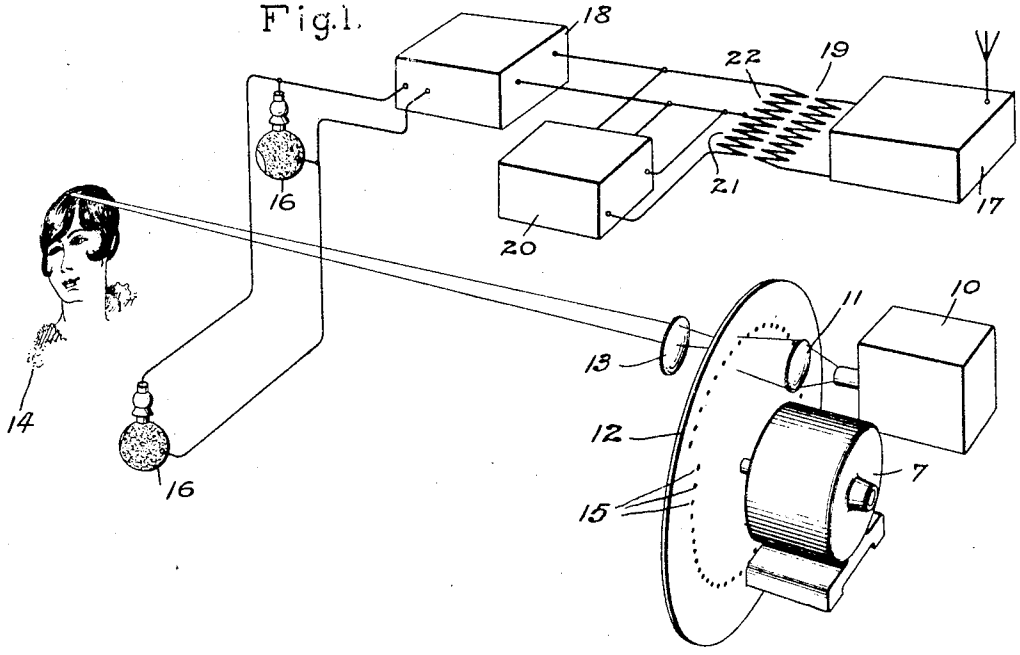


Fig. 2.

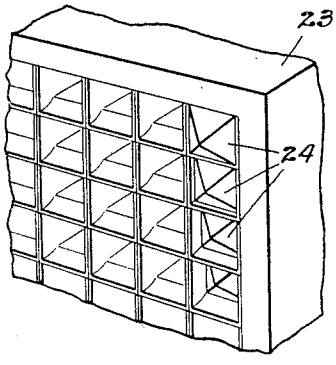


Fig. 3.

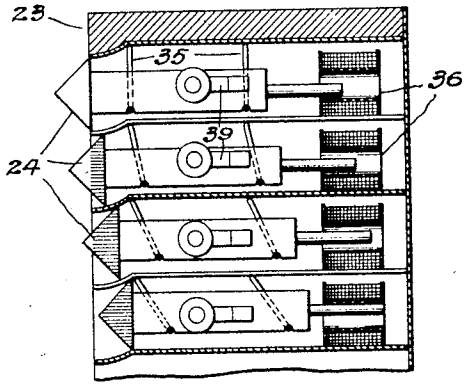


Fig. 4.

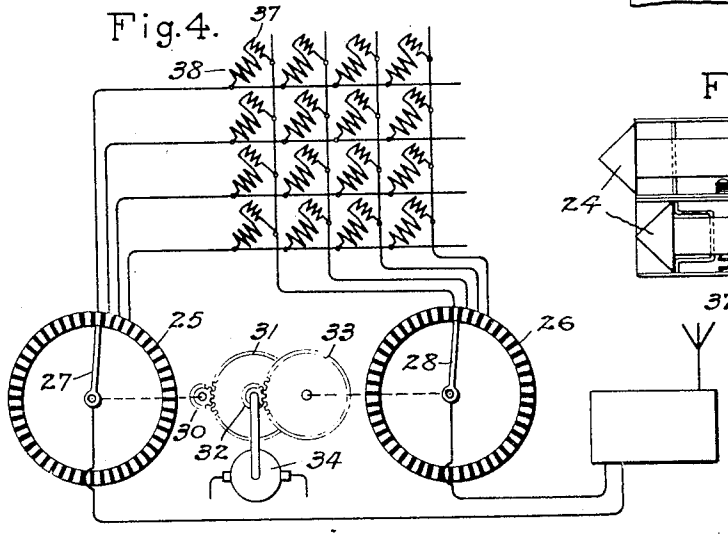
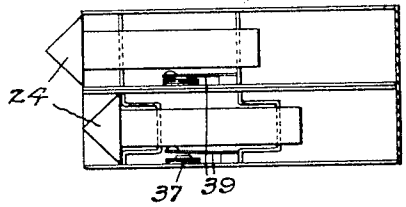


Fig. 5.



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UNITED STATES PATENT OFFICE

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TRANSMISSION AND RECEPTION OF PICTURES

Application filed April 25, 1929. Serial No. 358,078.

My invention relates to the transmission and reception of pictures, and has for its principal object the provision of an improved apparatus and method of operation whereby only the difference between the successive images of the picture or object is transmitted and received.

Various types of picture transmitting apparatus including either a radio transmitter and receiver or a transmitter and receiver interconnected by electrical conductors have been provided in the past. Many of these apparatus involve the use of both means for producing light dependent on the shade of successive elemental areas of the picture to be transmitted and means for converting such light into electrical impulses which must be reconverted into light at the picture receiving station.

It has been customary in the past to transmit successive complete images of the transmitted picture. This method of picture transmission requires a band of frequencies dependent on the number of picture elements and the number of images transmitted per second. Since only a limited band of frequencies are available for picture transmission, the fineness in the detail of the transmitted picture has therefore been determined by the number of picture elements and the number of pictures transmitted per second. In accordance with my invention, this difficulty is avoided by transmitting only the difference between the successve images of the object. By this mode of operation, no signal is transmitted when there is no change in the image of the picture or object and its fineness of detail is limited only by the speed of the action to be transmitted.

My invention will be better understood from the following description when considered in connection with the accompanying drawings and its scope will be pointed out in the appended claims.

Referring to the drawings, Fig. 1 illustrates a picture transmitting apparatus wherein my invention has been embodied; and Figs. 2 to 5 illustrate various details of an apparatus which may be utilized to receive the difference between the successive images of a picture or moving object.

The picture transmitting apparatus of Fig. 1 includes a light source 10 from which a beam of light is projected through a lense 11, a scanning member 12 and a lens 13 upon a field of view including the object 14, the image of which is to be transmitted. The scanning disk 12 is provided with a plurality of spirally arranged perforations 15 and with suitable driving means such as a motor 7. When this motor is rotated, the beam of light is utilized in a well known manner to scan the field of view containing the object 14 and light of an intensity dependent on the shade of the successive elemental areas of the field containing the object is reflected therefrom.

This reflected light is received by one or more light sensitive cells 16 which convert the light into electrical impulses of an intensity dependent on the shade of the successive elemental areas of the picture. These electrical impulses are applied to a radio transmitter 17 through an amplifier 18 and a transformer 19, a phase shifting device 20 of any suitable type, such as that disclosed by the United States patent of E. F. W. Alexanderson No. 1,655,037 being connected between the amplifier 18 and the transformer 19 for the purpose of preventing the transmission of electrical impulses between the amplifier and the radio transmitter when there has been no change in the position or shading of the object 14.

The phase shifting or time delay device 20 is connected between the amplifier 18 and one section 21 of the primary winding of the transformer 19. The other section 22 of this primary winding is connected directly to the amplifier 18. With these connections, the primary winding sections 21 and 22 are subjected to the same electrical impulses, the phase of these impulses being shifted before they are applied to the winding section 21.

The electrical impulses corresponding to the shade of the successive elemental areas of the field of view are thus applied to the winding section 22 at one time and to the winding section 21 at a subsequent time. The time

interval between the application of any given impulse to the winding section 22 and to the winding section 21 is of course determined by the adjustment of the phase shifting device 20. This adjustment is such that the electrical impulse corresponding to the shade of a given elemental area is applied to the winding section 21 at the same time that the winding section 22 is being subjected to the electrical impulse produced by the next subsequent scanning of this elemental area. The connection between the device 20 and the winding section 21 is such that the original and the delayed impulses produce opposing effects in the transformer. Under these conditions, the electrical impulses cancel one another when the shade of the given elemental area has not changed between successive scannings, and no signal is applied to the radio transmitter. When the shade of the elemental area changes, however, the impulses applied to the different winding sections are unequal and a signal corresponding to the change in shade is transmitted.

Under these conditions, a complete image of the object 14 is transmitted when it is first completely scanned and thereafter only the difference between successive images of the object is transmitted. Thus if there is no movement or change in the shading of the object 14, no impulses are transmitted by the transmitter 17 after the first complete scanning of the object; if the object moves only slightly so that there is a change in shade of certain elemental areas only of the field of view, electrical impulses due only to the change in shade of those areas are transmitted; and if the object changes to an entirely new position impulses corresponding to the image of the entire object are transmitted.

Any suitable apparatus may be utilized to receive the transmitted electrical impulses and to produce an image which is shaded in accordance with these impulses. One such apparatus is disclosed in a copending application of Augusto Bissiri, Serial No. 244,531, filed Jan. 4, 1928, and assigned to the same assignee as the present application. This apparatus includes a screen which is illuminated from the side and is provided with a plurality of elements arranged to be moved into the range of illumination to an extent determined by the intensity of the received electrical impulses.

Figs. 2 to 5 illustrate a screen 23 which is arranged to be illuminated by suitable light sources (not shown) mounted near its periphery and which is provided with a plurality of movable elements 24 arranged to have their position controlled by commutator or contact making devices 25 and 26 (see Fig. 4). The devices 25 and 26 are provided with contact members 27 and 28 which are connected to a radio receiver 29 and are mechanically coupled together through gears 30 to 33 for the purpose of maintaining a definite relation between their speeds of rotation. Power for driving the contact devices is supplied by suitable means such as a motor 34 mounted on the same shaft as the gear 32 and operated at a speed which bears a predetermined relation to the speed of the scanning disk 12 of the transmitting apparatus. Each of the squares in the screen 23 represents one of a plurality of elemental surfaces which are controlled by the commutators 27 and 28, and may be moved in a direction perpendicular to the screen surface for the purpose of varying the amount of light reflected from them. The actual construction of the screen is illustrated by Figs. 2, 3 and 5.

As indicated by these figures each elemental portion 24 of the screen may be made in the form of a pyramid, a cone or the like being supported on pivoted members 35 and arranged to be moved transversely to the surface of the screen by means of electro-responsive devices 36 which are energized in accordance with the current transmitted to them through the radio receiver 29 and the commutators 27 and 28. This current of course varies in accordance with the shading of the picture to be produced, and it will be readily understood that when the picture transmitting and receiving apparatus are properly synchronized, the magnitude of the currents supplied to the electro-responsive devices 36 controlling the various elemental portions 24 of the receiving screen 23 will be dependent on the shading of the corresponding elemental portions of the object, the image of which is to be transmitted. Under these conditions the position of each elemental portion 24 of the screen and the amount of light which each of these portions receives and reflects, is dependent on the shading of a corresponding elemental portion of the object.

The rapidity with which the electrical connections are changed from one to another of the electro-responsive devices 36 is dependent on the rotational speed of the driving motor 34 and ordinarily does not need to be faster than that required to complete the connections of all the electro-responsive devices more than once every one-sixteenth of a second. Thus assuming for example, that the screen 23 is square and contains 100 elemental surface portions, the commutator 28 should be driven at a speed of 160 revolutions per second and the commutator 25 should be driven at a speed of 1600 revolutions per second. Each of the elemental screen sections 24 is gripped by a spring 39 when the electro-responsive elements 36 are deenergized.

Each of the electro-responsive devices 36 includes a pair of coils 37 and 38, the coil 37 being utilized to release the corresponding screen element and the coil 38 being arranged to move this element to a position dependent

on the intensity of the electrical impulse applied to the coils. At the termination of each electrical impulse, the elemental screen section is gripped by the spring 39 and its position does not change until its electro-responsive device 36 is subjected to another impulse. Under these conditions the first complete scanning of the object causes the elemental screen sections 24 to assume positions dependent on the shade of the successive elemental areas of object. Thereafter no change in the position of the screen sections is produced unless the position or shading of the object is changed. When the position or shading of any part of the object changes, signals are transmitted and the corresponding elemental sections of the receiving screen are moved to positions dependent on the intensity of the impulses received by the electro-responsive devices 36.

The manner in which the reflected light is determined by the position of the elemental portions 24 of the screen 23, is indicated by Fig. 3, where four different positions of these elements are indicated. It will be observed that the maximum amount of light is reflected by the upper elemental surface, that a less amount of light is reflected by the next lower elemental surface, still less light is reflected by the next lower elemental surface and that the lowest elemental surface is substantially black. It will be apparent that all parts of the screen except the elemental surfaces are black; that these surfaces are white and that the screen is continuously illuminated in a plane parallel with its surface. Under these conditions the illumination and visibility of the image produced is altogether dependent on the position of the various elemental surfaces, these positions being determined by the shading of the object and being changed in accordance with the change in shading, which results from movement of the object. It will be apparent to those skilled in the art that the advantages of transmitting only the difference between the successive images of the object are not limited to the particular type of receiving apparatus illustrated and described but may be realized in connection with any suitable type of receiving apparatus.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A picture producing apparatus including means for scanning a field of view including a movable object, means arranged to generate electrical impulses dependent on the shade of the successive elemental areas of said field, and means operable after the first complete scanning of said field to permit the transmission of only the electrical impulses corresponding to those elemental areas of said field, which have changed shade subsequently to the previous scanning.

2. A picture producing apparatus including means for scanning a field of view including a movable object, means arranged to generate electrical impulses dependent on the shade of the successive elemental areas of said field, and phase control means operable after the first complete scanning of said field to permit the transmission of only the electrical impulses corresponding to the elemental areas of said field, which have changed in shade subsequently to the previous scanning.

3. The method of picture transmission which includes producing an effect dependent on the shade of all the successive elemental areas in a field of view including an object, and subsequently producing an effect dependent on the shade of those elemental areas only in said field whose shade has changed subsequently to the production of the first effect.

4. The method of producing a picture of a moving object at a distant point which includes transmitting electrical impulses dependent on the shade of all the successive elemental areas in a field of view including said object, and subsequently transmitting impulses from those elemental areas only whose shade has changed subsequently to the first transmission.

5. A picture producing apparatus including means for scanning a field of view including a movable object, means arranged to generate electrical impulses dependent on the shade of the successive elemental areas of said field, and phase control means arranged to cause neutralization of the electrical impulses which correspond to the shade of the elemental areas of said field whose shade remains unchanged.

6. Picture transmitting apparatus comprising means for successively scanning a field of view, means for generating electrical impulses dependent upon the shade of the seccessive elemental areas covered by the scanning means, means for producing from said impulses other impulses having a time delay equal to the intervals between the successive scannings, combining means arranged to cause the original and the delayed impulses to oppose each other, and transmitting means responsive to the resultant impulses.

7. Picture transmitting apparatus comprising means for succesively scanning a field of view, means for generating electrical impulses dependent upon the shade of the successive elemental areas covered by the scanning means, means for amplifying said impulses, a time delay device connected to said amplifying means constructed to produce a delay in the impulses equal to the intervals between the successive scannings, a transformer having a plurality of primaries, one of said primaries being connected to the output of the amplifying means and the other being connected to the output of said time

delay device, said primaries being arranged in opposition, and transmitting means connected with the secondary of said transformer.

In witness whereof, I have hereunto set my hand this 24th day of April, 1929.

RAY D. KELL.