Aug. 20, 1935. R. THUN 2,011,737

APPARATUS FOR PICTURE TRANSMISSION

Filed May 12, 1930 2 Sheets-Sheet 1

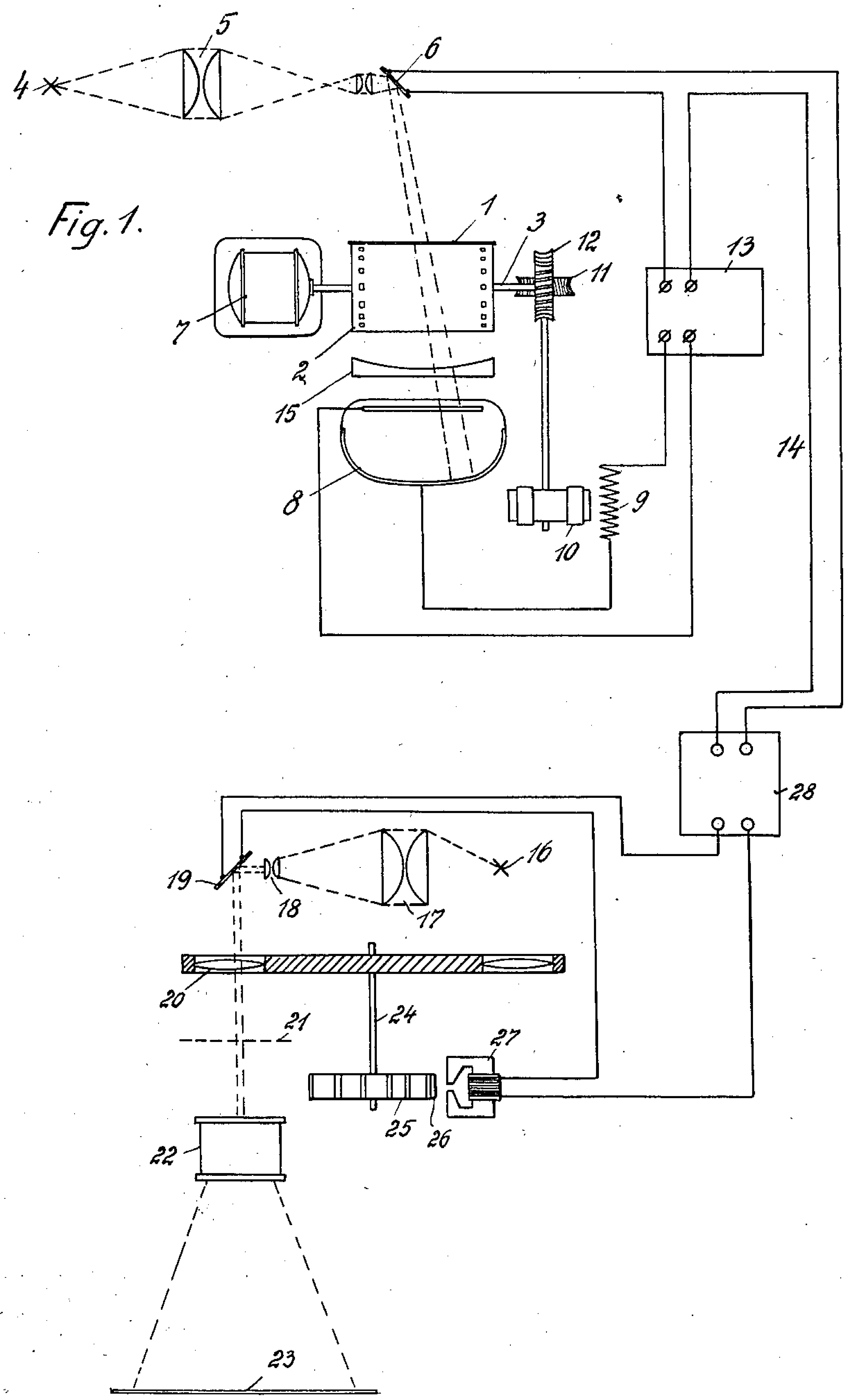

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Fig. 2.

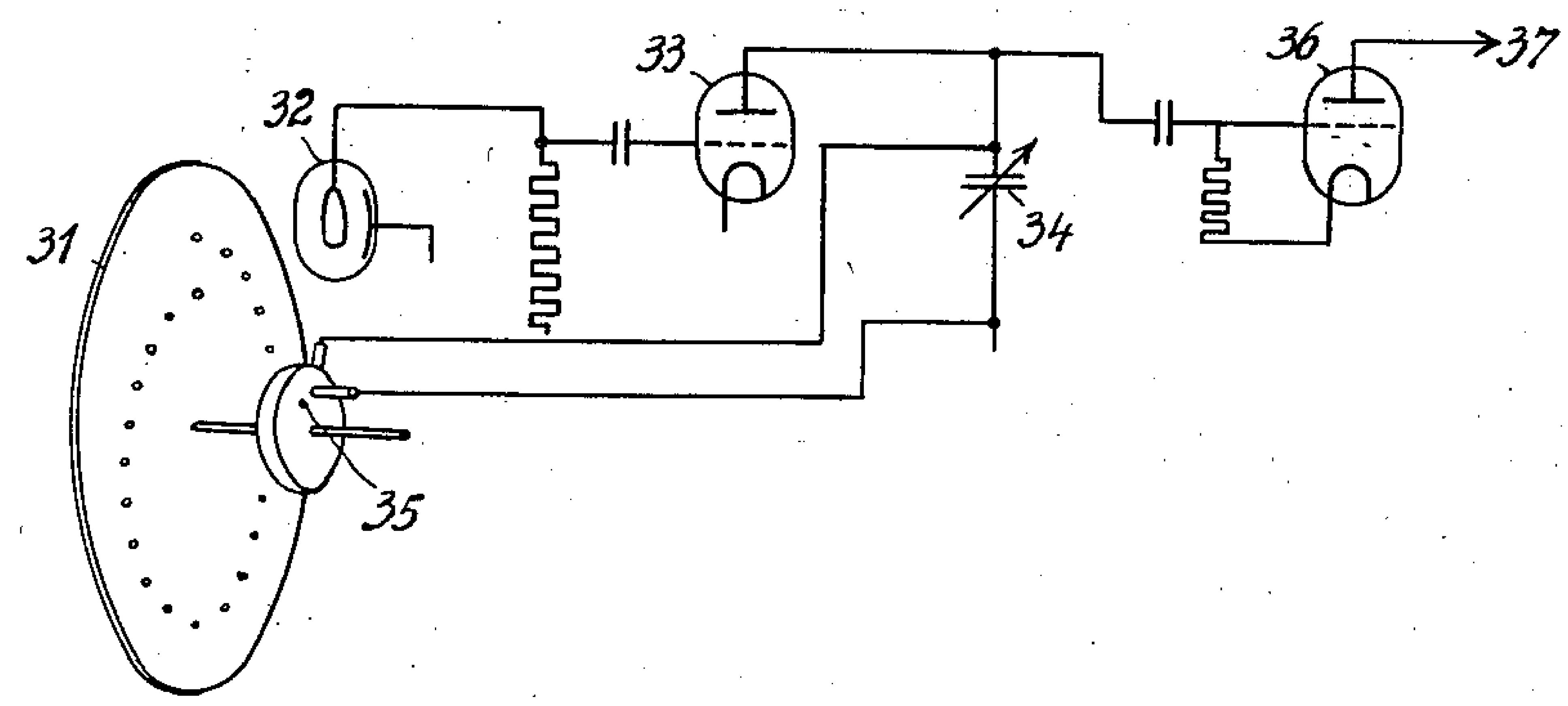
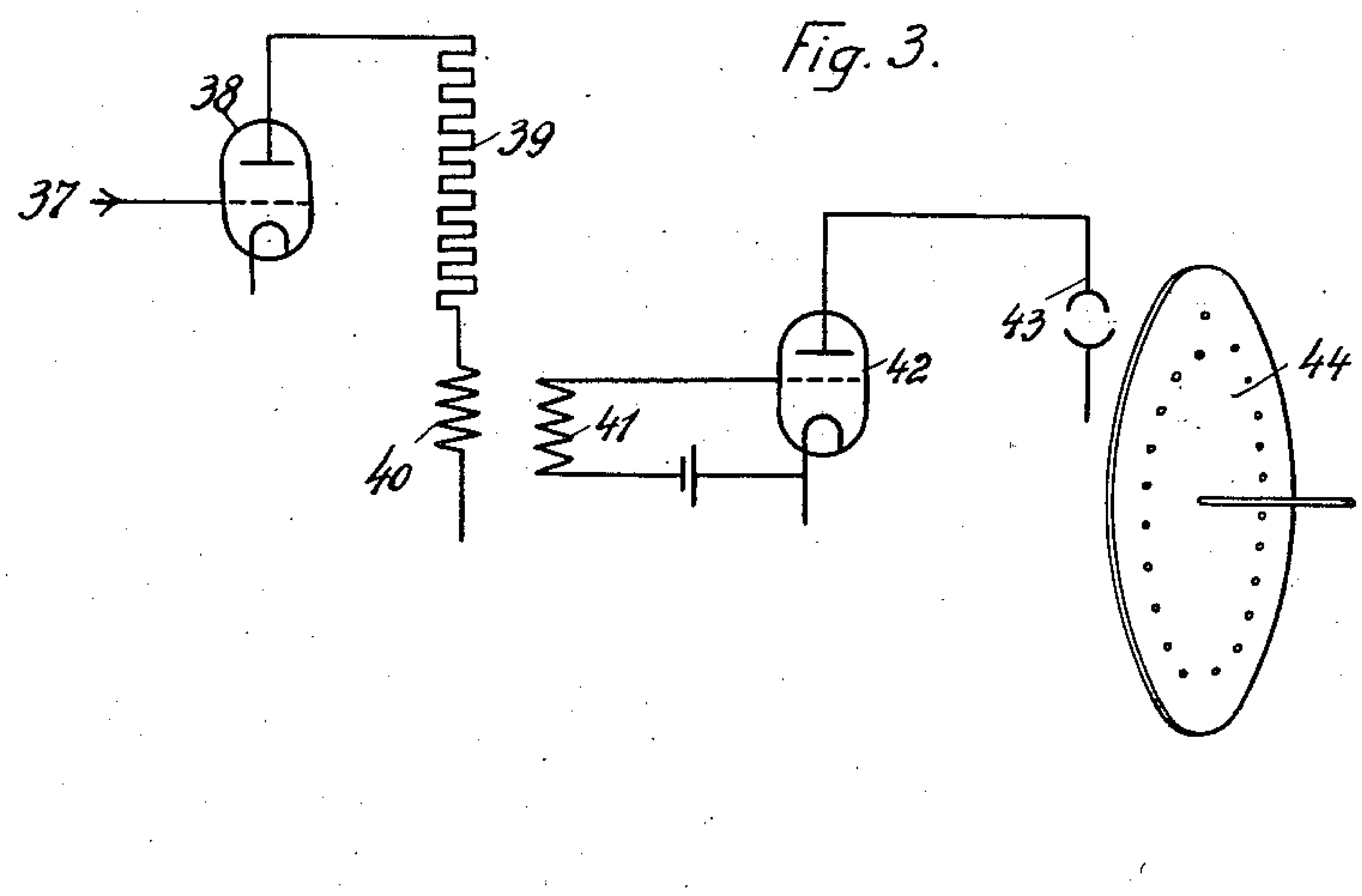


Fig. 3.



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2,011,737

APPARATUS FOR PICTURE TRANSMISSION

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7 Claims. (Cl. 178—6)

My invention relates to a method of and apparatus for, the transmission of pictures in television, telephotography, telecinematography, variation of the character of the picture by electrical means and for similar purposes. In all such methods the pictures to be transmitted are split up into spots whereupon the varying light intensity of such spots is converted into variations of electric energy. Such variations or oscillations are transmitted to a receiver where they are re-converted into variations of light intensity, and the several spots are re-combined into pictures.

It is an object of my invention to provide an improved method and apparatus for the purposes specified with a view to obtaining increased fineness of subdivision. In the methods and apparatus as heretofore devised, the fineness of the subdivision is uniform throughout the area of the picture, or substantially so. However, it has also been suggested to increase the velocity of splitting-up toward the edges of the picture, but here the variation of the splitting-up velocity is not determined by the general character of the picture. According to my invention, on the other hand, the splitting-up velocity is regulated during the transmission in accordance with a property of the picture elements which in turn varies with the character of the pictures.

Any desired property of the picture elements may be selected as the determining factor for the splitting-up velocity. For instance, the frequency of the currents transmitting the light variations may be used as such factor.

The problem may be solved in various ways, for instance, by arcuating relays through the medium of resonance circuits which in turn influence the splitting-up velocity. The means for performing my method may include a control strip like the strips or bands which are used in the copying of cinematograph films or for the shuttle control in looms. The control strip may bear a copy or reproduction of the pictures to be transmitted, for instance, a copy which is without the perfect definition of the original, or a raster copy.

In the following specification I shall describe by way of example an apparatus in which the light intensity of the several picture elements is utilized for controlling the splitting-up velocity, the velocity being normally decreased with the intensity of the elements. This is in accordance with the psychological function of vision as the picture elements will attract the attention of the spectator in proportion to their intensity. However, the velocity may also be increased with the intensity if the character of the picture renders this desirable.

In the simplest form of an apparatus for performing my invention the splitting-up velocity is regulated by a strip which is a copy of the picture to be transmitted. The variation of the splitting-up velocity may be impressed on a fundamental oscillation which may serve for synchronization at the same time.

The last-mentioned method may be modified as follows: At the receiver the intensity of the picture-generating spot remains constant but the spot is moved at higher speed across the darker elements and at lower speed across the lighter elements. The apparent intensity of the picture elements is then inversely proportional to the velocity of the spot, that is, it is a function of the differential coefficient

$$\frac{db}{dt}$$

in a diagram in which the velocity b of the light spot is plotted against time t.

This last-mentioned method differs fundamentally from all known methods in which the variation of the ordinate in the diagram is constant per unit of time, at least for the same picture elements, while the light intensity of the spot is varied. In the novel method, however, the light intensity is maintained constant, and the variation of the ordinate per unit of time is varied. According to the fundamental idea of my invention the splitting-up velocity is a function of the properties of the picture elements, as will be understood from the following consideration: In the old methods the modulation to be transmitted was a function of the variation of intensity related to the ordinate, while in my method which may be termed the "coordinate control", the modulation to be transmitted is the integral of this function. If this function is dissolved in accordance with a Fourier series the amplitude of the members of higher order is smaller than in the old method which may be termed the "intensity control", as in consequence of the integration the several members must be divided by their order number.

However, instead of the originally given function, or its integral, I may transmit any other function derived therefrom, for instance, the differential quotient.

In the drawings affixed to this specification and forming part thereof systems in which my method may be performed are illustrated diagrammatically by way of example.

In the drawings:

Fig. 1 is a diagram of a system including a sender and a receiver,

Fig. 2 is a diagram of a modified sender, and

Fig. 3 is a diagram of a receiver for this sender.

Referring now to the drawings, and first to Fig. 1, 1 is the film to be transmitted, 2 is a feeding drum on a shaft 3, and 7 is a motor or other mechanism for imparting rotation to the drum 2. 4 is a source of light of constant intensity, 5, 5 are condensers, and 6 is a mirror of a galvanometer which projects the light rays from the condenser system 5, 5 onto the film 1. 8 is a photo-electric cell to which the light is projected through the film 1. 9 is a coil in the circuit of the cell 8, and 10 is a magnet wheel for inducing voltage in the coil. 11, 12 is a worm gear by which rotation is imparted to the wheel 10 from the shaft 3. Energy is induced in the coil 9 as often as the film 1 has been moved for the width of one row of picture elements, this being termed the "primary splitting-up". 13 is an amplifier in the circuit of the galvanometer which controls the mirror 6. 15 is a filter which may be inserted between the film 1 and the cell 8 in order to compensate the variation at the reserving points of the voltage, the density of the filter being suitably selected.

14 is a system connecting the sender with the receiver. 28 is an amplifier at the end of the system 14. 16 is a source of light, 17, 18 are condensers, and 19 is a mirror of a galvanometer. 20 is a rotary disc on a shaft 24 which is equipped with a system of lenses or mirrors for optical compensation. An aerial picture is generated at 21 and projected onto a screen 23 through the objective 22.

Rotation is imparted to the system 20 through the medium of a wheel 25 on the shaft 24 with magnets or iron poles 26. 27 is a magnet which cooperates with the wheel 25.

Current from the system 14 which, if desired, is amplified at 28, flows through the coils of the galvanometer which controls the mirror 19 and through the coils of the electromagnet 27, the coils being connected in parallel or in series. The wheel 25 which acts as a synchronous motor, is rotated so as to combine into an area the light from the source 16 in accordance with the primary splitting-up of the film 1 at the sender.

Suppose that the film 1 is perfectly transparent the mirror 6 oscillates in conformity with the alternating voltages induced in the coil 9 as the resistance of the cell 8 is a minimum, the cell being permanently influenced by the full flow of light. The amplifier 13 must be adjusted so that the light rays from the mirror 6 handle the entire width of the picture. This operation is similar to that of mere splitting-up systems without regulation.

Suppose now that there is a dark line on the film 1, the current is weakened and the oscillation velocity of the galvanometer which operates the mirror 6 is reduced in proportion until the voltage induced in the coil 9 has attained a correspondingly higher value. The following lighter area of the film is handled at a correspondingly higher velocity on account of the reduced resistance of the cell 8. It will be understood that the dark elements cause slow variations of the current, while the light elements cause rapid variations of the current.

At the receiver the mirror 19 performs the same movements as the mirror 6 at the sender. When the picture displays a dark element at the sender, the light at the receiver moves slowly across the corresponding part of the picture. On the other hand, if a light element is displayed at the sender, the light at the receiver moves rapidly across the corresponding part of the picture. In accordance with this variable velocity of the light spot the several parts of the picture appear light or dark. If the picture at the sender is a negative the picture received at the receiver will be a positive.

In the example described the degree of fineness is adapted to the character of the picture only during the secondary splitting-up, but it may also be adapted to the primary splitting-up by intensifying the reaction of the induced voltage on the generator so as to appreciably influence its velocity. Preferably, in this case the rotary disc 20 with its system of lenses is replaced by any other suitable means having minimum inertia, for instance oscillograph means.

If only the rising or descending branch of the alternating voltage is utilized, preferably both branches are arranged at a different average gradient, with the branch for effecting the splitting-up having the smaller gradient.

Referring now to Figs. 2 and 3, 31 is a splitting-up element, for instance, a Nipkow disc, 32 is a photo-electric cell, and 33 is a tube under the control of the cell 32. The tube 33 charges a condenser 34 which by contacting means 35 is short-circuited as often as a row of the picture has been split up by one of the holes in the Nipkow disc 31. The voltage at the condenser 34 controls a tube 36 which directly or indirectly influences the transmitting system 37. By the condenser 34 the intensity values of one row are integrated and at the end of each row the integral value is reduced to zero, so that the integration can be re-started at the beginning of the next row.

Referring now to Fig. 3, 38 is a tube which is controlled by the modulation transmitted through the system 37. The anode current of this tube flows through an ohmic resistance 39 and a transformer coil 40, the coils 39 and 40 being connected in series. 41 is a coil which is inductively connected with the transformer coil 40 and by its voltage controls a tube 42. This tube in turn controls a glow lamp 43 the intensity variations of which are combined into a picture by means of the Nipkow disc 44.

As compared with the inductive resistance of the coil 40, the ohmic resistance 39 should be high, and the grid current of the tube 42 should be small as compared with the anode current of the tube 38. In this case the current in the coil 40 and consequently the magnetic field of the coils 40 and 41, is proportional to the modulation transmitted, i. e. proportional to the integral of intensity related to the coordinate, or to the time in the case of synchronization. The voltage induced in the coil 41 is the differential of field intensity related to time, and consequently equal to the intensity to be transmitted. The modulation at the tube 42 is therefore equal to the modulation effected by the photo-electric cell 32 or the tube 33 so that the glow lamp 43 in combination with the Nipkow disc 44 operates like any one of the usual television receivers with intensity control.

This arrangement has a two-fold advantage as compared with the usual direct transmission of the modulation of intensity: By the integration the convergence of the series representing the original function is increased and the width of the frequency band is reduced, or for a given width of the frequency band, more details can be transmitted. The second advantage is that by the integration the amplitude of the harmonic corresponding to the row-frequency is very much increased so that the modulation supplied by the tube 38 is particularly suitable for operating a synchronizing apparatus of known type.

As compared with the method described with reference to Fig. 1, the novel method has the advantage that the equipments of the sender and the receiver are the same as are used for the known methods of intensity control and only require completion by the additional amplifier means described. It is also possible to adapt the method described only to the receiver or only to the sender, so that amplifier means having a lower range of frequency may be used. In this case the equipment including the tube 33, the tube 43 and the intermediate parts, is arranged either at the sender or at the receiver and that part of the amplifier means which is undesirably influenced by the frequency, is arranged intermediate the tubes 36 to 38. With such equipment at the receiver side the condenser 34 may be short-circuited in accordance with the movement of the Nipkow disc 44 or by any known throw-over switch, or if exceptionally high receiving amplitudes are encountered. The latter system will particularly be adapted if a synchronous signal is transmitted at exceptionally high amplitude.

It is understood that the apparatus described only embodies examples and that my method may be applied to other television apparatus, in which, for instance, splitting-up is effected by the Weiller mirror-wheel, or oscillograph means. The method last described, to wit, rendering practicable the adaptation of an intensifier element which is influenced by the frequency to an undesirable extent, may be used also in connection with the amplification of other modulations, for instance, the modulation of sound.

Generally I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described for obvious modifications will occur to a person skilled in the art.

I claim:—

1. An apparatus for transmitting pictures at a distance by splitting-up and recombining, comprising a sender at a transmitting station, and a receiver at a receiving station, a photo-electric cell at the transmitting station, means for continuously moving past said cell the picture to be split up, a circuit connected to said cell, means connected to said circuit for projecting a pencil of light through the picture onto said cell, means in said circuit adapted to impart continuous movement to said projecting means and to be influenced by the conductivity of said cell under the varying intensities of light admitted to said cell, for varying the velocity of the continuous movement of said projecting means in conformity with the tone of the picture, and means at the receiving station adapted to be controlled by said regulating means for operating the receiver in synchronous relation to the sender.

2. The method of transmitting pictures over a distance which comprises developing a light beam, scanning a picture with a continuously moving light beam, converting the light impulses into an electrical impulse and varying the velocity of the scanning light beam at the transmitter and receiver in accordance with the tone value of the picture.

3. The method of transmitting pictures over a distance which comprises developing a light beam, scanning a picture with a continuously moving light beam, converting the light impulses into an electrical impulse and varying the velocity of the scanning light beam at the transmitter and receiver in accordance with the tone value of the picture, the electrical control of said light beam being effected in dependency upon the value of an electrical quantity, the instantaneous value of which depends upon the instantaneous deflection of the beam and the first derivative with respect of the time of which is proportional to the tone of the picture.

4. The method of transmitting pictures over a distance which comprises developing a light beam, scanning a picture with a continuously moving light beam, converting the light impulses into an electrical impulse and varying the velocity of the scanning light beam at the transmitter and receiver in accordance with the tone value of the picture, the electrical control of said light beam being effected in dependency upon the value of an electrical quantity, the instantaneous value of which depends upon the instantaneous deflection of the beam and the first derivative with respect of the time of which is proportional to the tone of the picture, the values of the electrical quantity being transmitted to the receiving station and the light beam at the receiving station being controlled by the values of the quantity.

5. An apparatus for transmitting pictures at a distance by splitting-up and recombining, comprising a sender at a transmitting station, and a receiver at a receiving station, scanning means for splitting up the pictures at the sender, scanning means for recombining them at the receiver, means for imparting continuous movement to said scanning means at the sender and at the receiver, and means at the transmitting station controlled by the tone of the picture for varying the velocity of the continuous movement of said scanning means at both transmitting and receiving stations.

6. An apparatus for transmitting pictures at a distance by splitting-up and recombining, comprising a sender at a transmitting station, and a receiver at a receiving station, scanning means for splitting up the pictures at the sender, scanning means for recombining them at the receiver, means for imparting continuous movement to said scanning means at the sender and at the receiver, and a current generator at the transmitting station controlled by the tone of the picture for varying the velocity of the continuous movement of said scanning means at both transmitting and receiving stations.

7. An apparatus for transmitting pictures at a distance by splitting-up and recombining, comprising a sender and a receiver, scanning means for splitting up the pictures at the sender, scanning means for recombining them at the receiver, means for imparting continuous movement to said scanning means at the sender and at the receiver, a photo-electric element at the transmitting station which is controlled by the tone of the picture, and means controlled by the photo cell for varying the velocity of the continuous movement of said scanning means at the transmitter and receiver.

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