

Oct. 12, 1937.

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2,095,391

TELEVISION SYSTEM

Filed April 11, 1927

3 Sheets--Sheet 1

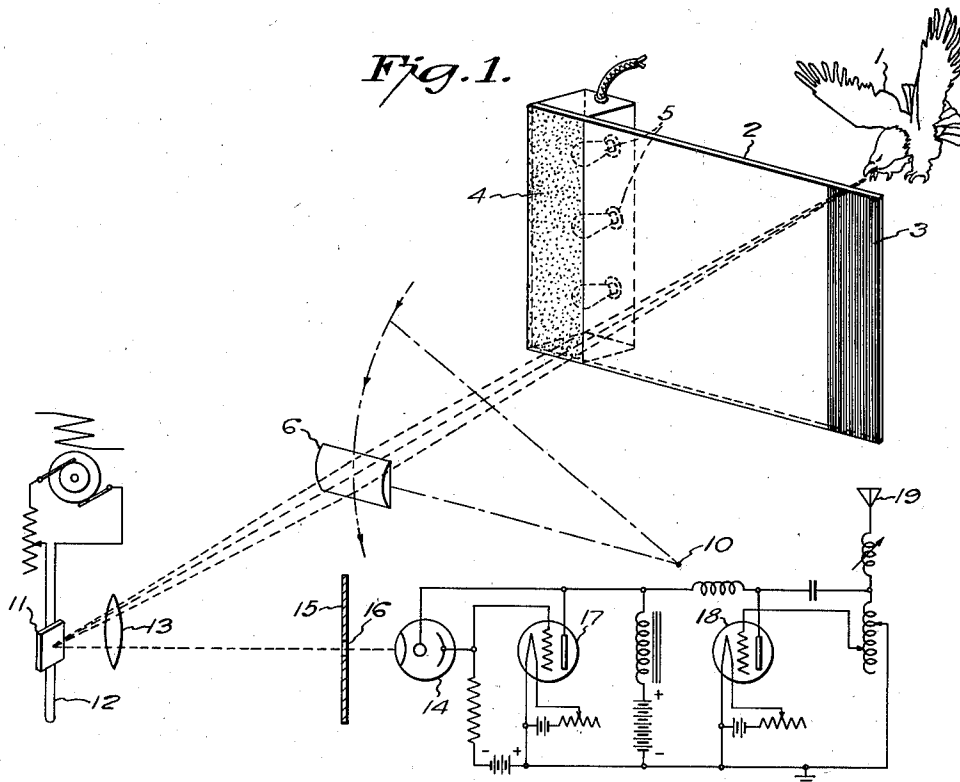
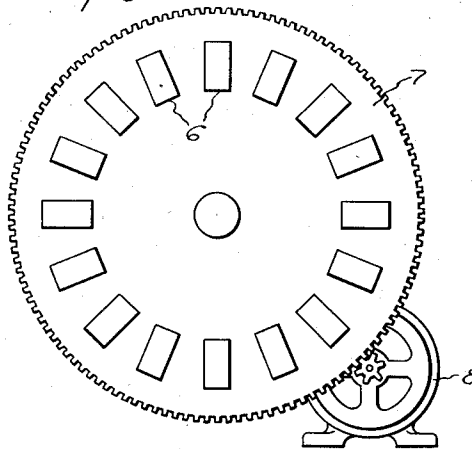


Fig. 2.



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3 Sheets-Sheet 2

Fig. 3.

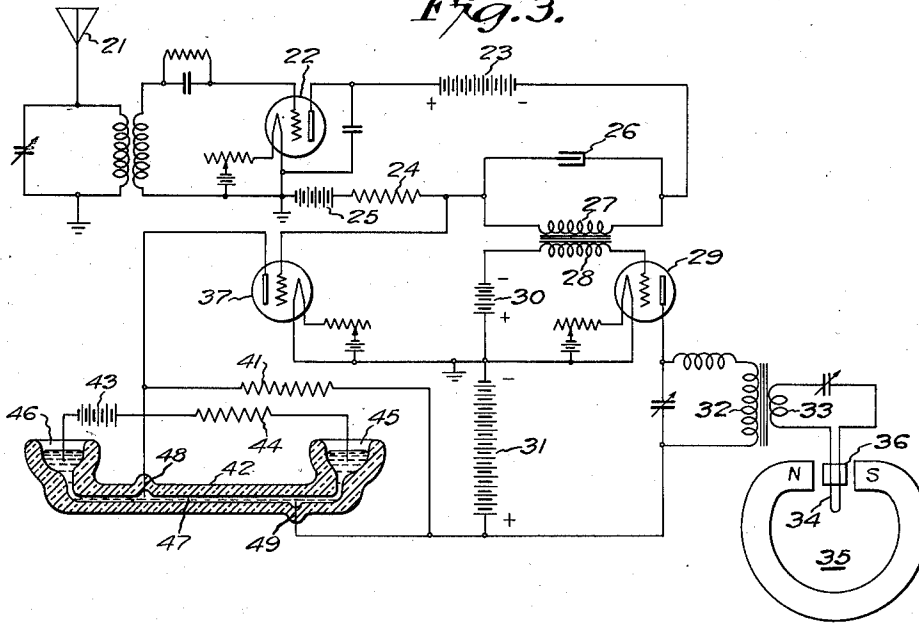
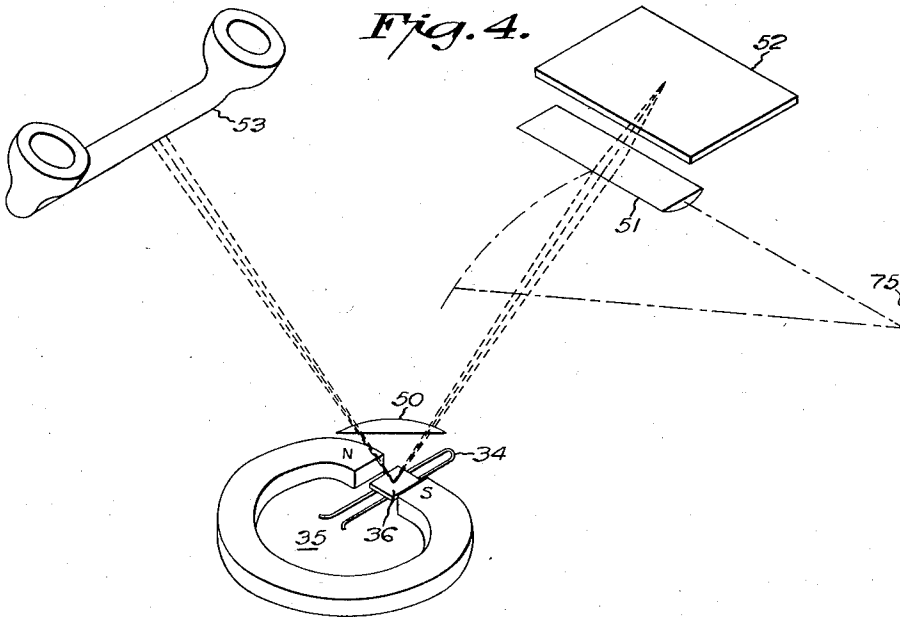


Fig. 4.



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3 Sheets-Sheet 3

Fig. 5.

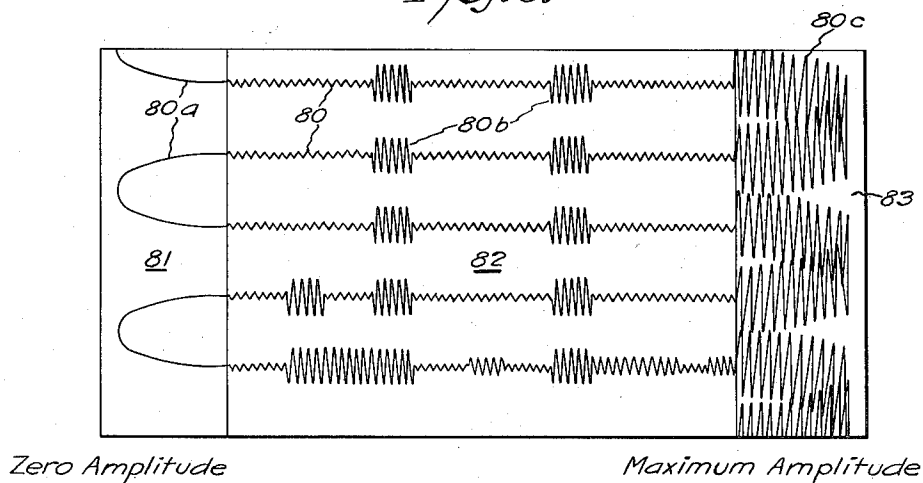


Fig. 6.

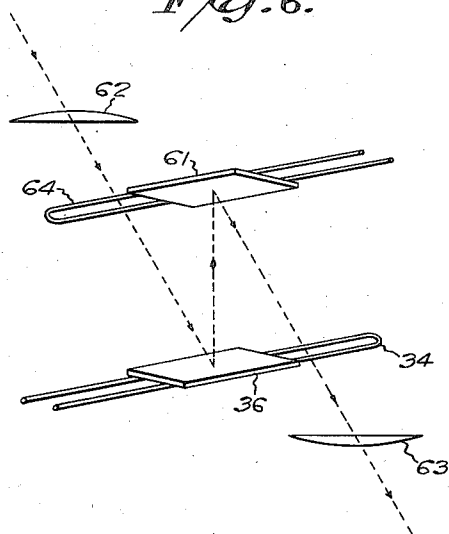
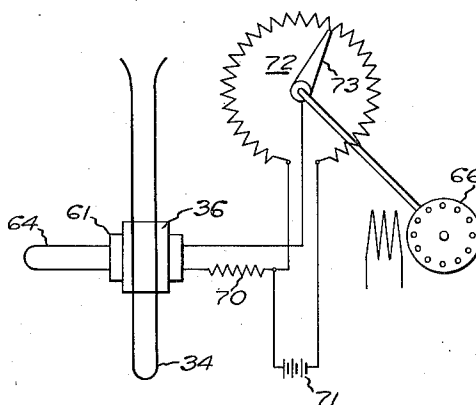


Fig. 7.



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TELEVISION SYSTEM

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Application April 11, 1927, Serial No. 182,651

33 Claims. (Cl. 178—6)

This invention relates to systems for the transmission of views by communication systems, such as radio.

It is an object of this invention to produce synchronism between the scanning and reproducing devices without requiring an additional communication channel for this purpose.

It is a further object of this invention to combine a synchronizing means with the view to be transmitted.

It is a further object of this invention to send over the communication channel a characteristic impulse at corresponding phases of each traverse of the view by the scanning device and to automatically position the reproducing device in accordance with said phases of the traverse by means of said impulses.

It is a further object of this invention to produce an optical system in which the only parts required to move rapidly shall be the mirror system of an oscillograph.

It is a further object of this invention to provide a light source the intensity of which may be rapidly varied in accordance with the illumination of successive points in the view to be transmitted.

It is a further object of my invention to provide a linear light source which, by means of a cylindrical lens, may be made to give a well-defined point of light.

It is a further object of my invention to provide a variable source of light in which the brilliancy shall be controlled by an impressed potential.

It is a further object of my invention to produce a conductive column of vapor to emit light and to control the brilliancy thereof by varying the potential along it.

It is a further object of my invention to combine a linear source of light with an optical system, including a moving part, in such a manner that successive portions of said source may be brought, in turn, into operative relation to the optical system.

Other objects of my invention will be apparent from the following detailed description and the accompanying drawings in which,

Figure 1 is a diagram, partly in perspective, illustrating the scanning apparatus,

Fig. 2 is a diagram illustrating the movable mounting of the lenses shown in Fig. 1,

Fig. 3 is a diagram, partly in section, illustrating the receiving apparatus,

Fig. 4 is a diagram, in perspective, illustrating the optical parts of the receiving apparatus,

Fig. 5 is a diagram to assist in the explanation of the operation of the transmitting system,

Fig. 6 is an illustration of a modification of the optical system in either the receiving apparatus or the scanning apparatus, and

Fig. 7 is a diagram illustrating a means for producing a slow movement of one of the optical parts shown in Fig. 6.

As shown in Fig. 1, an object or a view 1 is visible through a window 2. Although the drawings are intended to suggest that the view 1 is out of doors and the optical apparatus in a house, it will be obvious that a small box may enclose the optical parts and the window 2 will then be an opening in one wall of the box.

At one side of the window, the wall is opaque and dark, as indicated at 3. At the opposite side of the window a portion of the wall is brightly illuminated, as indicated at 4. The illumination may, for example, be accomplished by lamps 5 and, if desired, the surface of the wall flush with the window and with the dark surface 3 may be covered with ground glass or other means for rendering the brilliancy uniform thereover.

The scene to be scanned by the optical system in Fig. 1 includes the bright surface 4 and the dark surface 3, as well as the view or objects beyond the window 2.

On the side of the window opposite the object or view 1, a plurality of lenses 6 are positioned. Preferably, these lenses are, as shown in Fig. 2, numerous and comprise a large circle of lenses, whereby first one lens and then another may be brought into position in front of the window without requiring a high rate of speed for the movement of the lenses. In the specific form of mounting, indicated in Fig. 2, the lenses are secured in a disk 7 which is driven by an electric motor 8. Suitable reduction gearing may be employed to give the proper speed to the wheel 7, and suitable openings in the disc 7 provide for the passage of light through the lenses 6.

On Fig. 1, the direction of movement of the lenses 6 is indicated by an arc having a center 10 which, in actual construction, would be the center of the wheel 7. For the sake of clearness, the wheel is not shown in Fig. 1.

The lenses 6 are cylindrical, their geometric axes being arranged radially of the disc 7 and their optical axes being perpendicular to said disc. For the short distance that any one lens 6 moves while in operative relation to the rest of the optical system, the motion may be regarded as pure translation at right angles to both axes. The lens 6 is between the window 2 and a mirror

11 which is mounted on a device that causes the mirror to oscillate rapidly.

Any suitable means for producing rapid oscillation may be employed. I prefer to support the mirror upon the movable conductors 12 of an oscillograph and to send a high-frequency current, produced in any familiar or suitable manner, through the oscillograph to oscillate the mirror. When the oscillations are produced in this way, it is preferable that the natural period of the vibrating system shall be the same as that of the current supplied. Between the mirror 11 and the lenses 6, a lens 13 is provided.

The ribbon of light which arrives at the mirror 11 from the lenses 5 from a point on view 1 is reflected, passing a second time through the lens 13, and reaches a photo-cell 14. A shield 15, having a small vertical opening 16, is provided in front of the photo-cell 14 in order to give definiteness to the point in the scene 1 corresponding to the instantaneous position of the optical system.

The lens 13 focuses the light from the mirror 11 and lens 6 upon the window 16. The quantity of light entering the photo-cell is, therefore, that from a larger area in the view 1 than the size of the opening 16 would command if unaffected by the lens. If desired, additional concentration may be afforded by another lens between window 16 and photo-cell 14.

The light from the scene passes through the lenses 6 and 13 and is reflected by the mirror 11. Only the light from a definite point in the scene will, however, pass through the window 16. Light from other points will be stopped by the screen 15. Thus, at each moment, a definite point in the scene is correlated to the window 16. This point changes from moment to moment, one co-ordinate thereof being dependent on the motion of the mirror 11 and another upon the motion of the lenses 6.

The photo-cell 14 is connected to any well known or desired form of transmitting system whereby the radiations sent out by the transmitter shall be modulated in accordance with the illumination of the photo-cell 14, the amplitude of the radiation corresponding at each moment to the illumination of the cell.

A conventional radio transmitting system is illustrated in the drawings for the purpose of showing how the photo-cell 14 may control the amplitude of the radiations. The actual structure of the vacuum-tube circuits is not a feature of my invention. In the circuits illustrated, the photo-cell 14 controls, in the usual way, a modulator tube 17 which acts to divert more or less energy from the oscillator tube 18. The oscillations from the tube 18 are radiated by the antenna 19.

In Fig. 3, the receiving antenna 21 is tuned to the frequency of the oscillations generated by the tube 18 at the transmitter. A detector 22 is connected, in any usual or desired way, to the antenna 21. The output circuit of the detector includes a plate battery 23 and a resistor 24. Preferably, a second battery 25 is inserted between the resistor 24 and the filament of the detector 22. A condenser so small that it is of large impedance to all except the very high frequency, may, if desired, be connected across the output of the detector to ensure that the high frequency components of the plate current shall not affect the apparatus. Between the battery 23 and the resistor 24, a condenser 26 is provided in parallel with an inductor 27. The inductor 27 is also the

primary of a transformer, of which 28 is the secondary. The condenser 26 and the inductor 27 together constitute a network interposed in the circuit from the plate to the filament of the tube 22. The frequency, to which the network or parallel-resonant circuit is tuned, is the frequency of the movement of the mirror 11 in Fig. 1.

One terminal of the secondary 28 is connected to the grid of a tube 29, and a battery 30 is connected between the other terminal of the secondary 28 and the filament of the tube 29.

The plate current of the tube 29 is supplied from a battery 31. If desired, the battery 25 may be replaced by a portion of the battery 31. This can be done by connecting the left-hand terminal of resistor 24 to an intermediate point of battery 31. The plate circuit includes the primary 32 of a transformer, the secondary 33 of which is connected to the moving conductors 34 of an oscillograph 35. The moving conductors 34 carry a mirror 36. If desired, a condenser may be shunted across the primary 32 for tuning, and an additional inductance, for further control of the tuning, may be inserted in series with the primary 32. A tuning condenser large enough to compensate for the inductance 33, and also for the inductance of the receiving device 34 may, if desired, be included in the secondary circuit.

The battery 31 serves to supply also the plate circuit of a tube 37. By properly proportioning the potential of the battery 23 to that of the battery 25, the average potential of the grid of the tube 37 is determined. The potential also depends on the drop across the resistor 24 and the effect of the network 26—27.

The plate circuit of the tube 37 includes a resistor 41 which, if desired, may be a heating coil for maintaining the mercury in the tube 42 at a temperature near its boiling point. A battery 43, in series with a resistor 44, is connected to the mercury by means of cups 45 and 46 which are parts of the lamp 42. The resistor 44 may also serve as a heating coil to maintain the capillary column 47 of the lamp in a vaporized condition. The two terminals of the resistor 41 are connected to sealed-in electrodes 48 and 49 near each end of the capillary portion of the lamp.

Although I have illustrated a mercury tube having open ends, other forms of mercury lamp may be used, such as mercury-arc tubes having a low pressure of mercury vapor. The portion of the capillary tube 47 between the electrodes 48 and 49 will not generally have liquid therein, but will be filled with the glowing vapor. It is not essential that, even when the lamp is cold, the capillary be filled with liquid. The lamp may be started by a current through the ordinary mercury vapor if preferred.

The optical portion of the receiving system includes mirror 36, a lens 50 for bringing to a focus adjacent the lens 51, the light from the lamp 53 which is reflected by the mirror 36. The optical system also includes a plurality of lenses 51 mounted in a disc. The optical system is best illustrated in Fig. 4, wherein the screen 52 receives light from the lamp 53 through said optical system. The screen 52 may be a photographic plate for recording the transmitted view or it may be a ground glass or a projection screen or an imaginary plane on which is focused an eye piece, or ocular to be observed by the eye, or through an ocular.

In Fig. 4, for clearness, the several directions are taken perpendicular to one another, but the invention may be used with oblique directions.

The lamp 53 is shown as horizontal and extending away from the reader and toward the right. The axis of movement of the mirror 36 is shown parallel to, and below and to the right of, the lamp. For further simplicity of description, it will be assumed that the center of the mirror is in the plane perpendicular to the lamp at its center, although this feature is not essential to the invention. The axis about which the lenses 51 revolve is vertical and, preferably but not necessarily, in the plane just mentioned. The screen 52 is horizontal, above the lenses 51 and, preferably, has one pair of edges parallel to said plane and on opposite sides thereof.

The movement of the mirror 36 causes a movement of the reflected beam parallel to said plane. The movement of the lens 51 over a small arc near said plane may be regarded as parallel to the length of the lamp and to the other pair of edges of the screen. The reflected light is brought, by the lens 51, to a focus upon the under side of the screen 52.

In Fig. 6, a modification of the optical system is shown, two mirrors being employed instead of a mirror and a plurality of lenses. The mirror 36 is intended to be oscillated at high frequency by the conductors 34, as already explained. The mirror 61 is intended to oscillate at a lower frequency, the oscillations of the mirror 61 being produced by the means illustrated in Fig. 7. Two lenses 62 and 63 are provided for focusing the light upon the screen. The mirror 36 is mounted upon the conductors 34 of the oscillograph 35. The mirror 61 is mounted upon the conductors 64 which, in this modification, are a portion of the same oscillograph. In Fig. 7, the conductors 64 and the mirror 61 are shown below the conductors 34 and the mirror 35. It will be evident that the position may be reversed if desired and that it is not necessary to have the mirrors horizontal.

In Fig. 7, a synchronous motor 66 is shown which is intended to be driven by the same power system as the motor 8 in Fig. 2. Corresponding frequencies in the movement of the wheel 7 and the rotor of the motor 66 are thus obtained. The conductors 64 have a high resistance 70 in series with them, whereby the mirror 61 is essentially a potential-responsive device. A battery 71, feeding a circular potentiometer 72, supplies the potential for the conductors 64. The moving member 73 of the potentiometer is connected to one terminal of the conductors 64 and is driven by the rotor of the motor 66.

In the operation of the device, the movement of the mirror 11 in Fig. 1 causes the window 16 of the photo-sensitive instrument to be associated in succession with a line of points extending horizontally across the view. The movement of the lens 6 causes the window 16 to be associated in succession with points at different heights in the window 2.

The movement of the mirror 11 is much more rapid than that of the lens 6. During any one swing of the mirror 11, first one end, then an intermediate portion, and then the other end of the lens 6 is operatively related to the mirror 11 and the window 16. Only a small portion of the whole lens 6 is operative at any one instant. This portion is of small enough axial length to cause the difference between it and a spherical lens to be without substantial effect. The illumination of the window 16 by the light from the spot in the scene corresponding to the instantaneous position of the optical system is substan-

tially the same as it would be if the portion of lens 6 corresponding to the position of the mirror 11 at that moment were spherical instead of cylindrical.

The combined effect of the motions of the mirror 11 and the lenses 6, therefore, causes the window 16 to be associated, in turn, with every point of the scene 1. When a lens 6 passes out of operative position, and the next lens 6 enters operative position, the point in the scene associated with the window 16 changes abruptly from the bottom to the top of window 2.

No such abrupt change occurs in connection with the motion of the mirror 11. In the position in which the mirror associates the window 16 with the brightly lighted left-hand margin of the scene, the mirror is moving slowly. Again, at the right-hand end of its swing, when it is associating some point in the dark surface 3 with the window 16, the mirror is moving slowly. The rate of change in the mirror's motion is greatest at the points in the swing where it is moving slowly. Over the mid-portions of the swing, the mirror is moving nearly, although not absolutely, at a uniform velocity. Consequently, there will be, in the reproduction, but little distortion of the illumination resulting from the fact that the mirror 11 sweeps more rapidly over some parts of the view 1 than over other parts.

In the extreme positions of the mirror 11, either the brightly illuminated space 4 or the dark space 3 is associated with the window 16. Since each of these two spaces is of extreme and comparatively uniform illumination, the change in rate of movement of the mirror in these parts of the swing is unimportant.

As the mirror 11 swings, the illumination of the cell 14 is at first very great, then varies in accordance with the illumination of the several points of the view and finally becomes zero. Both the zero illumination and the very great illumination differ greatly from the illumination of any point in the view 1 seen through the window 2. Thus, at the extreme left-hand position and at the extreme right-hand position of the mirror 11, the cell 14 is subjected to a very different degree of illumination from that during the rest of the traverse.

When the mirror 11 is in such position that the window 16 is optically associated with a point in the dark surface 3, the photo-electric cell 14 is of great resistance. The grid of the tube 17 is, consequently, so strongly negative that the tube 17 becomes non-conductive. No energy is then diverted from the tube 18, and the radiations of the antenna 19 attain their maximum amplitude. On the other hand, when the position of the mirror 11 is such that light from a spot in the illuminated area 4 reaches the photo-cell 14, the cell is highly illuminated, and, therefore, sufficiently conductive to cause the potential of the grid of the tube 17 to be more nearly positive. Consequently, a considerable amount of energy is diverted from the vacuum tube 18, and the oscillations either cease entirely or become very small. Practically no energy is radiated by the antenna 19 under these circumstances.

In any other position of the mirror 11, the illumination of the photo-cell 14 corresponds to the brilliance of some point in the view 1. Consequently, the photo-cell 14 is illuminated to an intermediate degree. Some energy is, therefore, diverted from the tube 18 but not sufficient to

cause the amplitude of the radiations to become zero.

Preferably, the constants of the apparatus are so chosen that the change in the conductivity of the photo-cell 14 will occur on the straight-line part of the characteristic curve of this cell. Likewise, the changes in the current, through the tube 17 and in the amplitude of the radiations, preferably have a straight-line relation to the changes in the illumination of the cell 14 as the mirror sweeps over the portion of the scene constituting the view 1. The darkness of the surface 3 and the brightness of the surface 4 are intended to greatly exceed the changes in the view, whereby the changes in the amplitude of the radiation at each end of the swing of the mirror 11 greatly exceed the changes during the middle portion of said swing.

It is permissible for these extremes to extend beyond the straight-line part of the characteristic, but no advantage results from having them extend very far beyond it.

Fig. 5 is an attempt to indicate the changes in amplitude of the radiations with changing positions of the optical system. The left-hand portion 81 of Fig. 5 corresponds to the brightly illuminated surface 4. The right-hand portion 83 corresponds to the dark surface 3, and the middle portion 82 corresponds to the window 2.

The combined action of the mirror 11 and the lens 6 will cause the point in the scene optically associated with the opening 16 to explore the scene by a path which crosses the scene rapidly from side to side, entering the illuminated surface 4 at one side and the dark surface 3 at the other side. The curve 80 in Fig. 5 is intended to illustrate how the point corresponding to the window 16 moves, and the accompanying changes in radiation. The serpentine character of the curve, causing it to extend across the figure many times between the right and left edges and only once between the top and bottom edges, corresponds to the progress of the point.

The sinuosities of the curve are intended to represent the oscillations constituting the radiation. It will be recognized that the wave length of these oscillations is very much shorter than illustrated by Fig. 5. A drawing to scale would show these oscillations of so short a wave length that they could not be recognized.

The distance which these sinuosities extend away from the mean position of the serpentine curve corresponds to the amplitude of the oscillations.

In the portion 81 of Fig. 5, the curve has no sinuosities. This is illustrated at 80a. In the portion 82 of Fig. 5, the curve has sinuosities of changing amplitude. This is illustrated at 80b. In the portion 83, the amplitude is a maximum, as illustrated at 80c.

Throughout the region 81 and the region 83, the rate of movement of the mirror 11 is changing rapidly, but, since the brightness of the surface 3 is always zero and that of the surface 4 is uniform, the amplitude is uniform (and minimum) in the region 81 and also uniform (and maximum) in the region 83. The change in rapidity of movement of the mirror 11 is, therefore, without effect upon the outgoing radiations. Over the region 82, the rate of movement of the mirror 11 changes only slowly. Very little distortion will, therefore, be produced by the circumstance that the mirror passes more quickly over certain portions of the scene than over other portions.

The radiations are received upon the antenna 21, represented in Fig. 3, which is so tuned that other frequencies are of little effect upon the grid circuit of the tube 22 which acts to detect the signals.

The plate current of the detector 22 will vary in accordance with the amplitude of the radiations. Consequently, the plate current will vary irregularly while radiations corresponding to the region 82 in Fig. 5 are being received, and will show a large and abrupt change when the exploring point enters the region 3, and a large and abrupt change in the opposite direction when the window 16 is correlated to a point in the region 4.

The tuned circuit 26—27 is thus subjected, at the instants of each end of the traverse, to impulses due to the sudden change in the character of the plate current. The impulses are of one character when the mirror 11 is at one end of its swing and of the opposite character when it is at the opposite end of its swing. They, therefore, set the circuit 26—27 into oscillation at its natural period. This period is adjusted to correspond to the period at which the mirror 11 is oscillated. The impulses caused by the bright surface 4 and the dark surface 3 thus insure that the phase of the current circulating in the network 26—27 will always agree with the phase of the movement of the mirror 11.

The tube 29 delivers to the primary 32 a current which is controlled by the secondary 28, and which, therefore, agrees in phase with the movements of the mirror 11. To add still greater certainty to the synchronizing effect, the plate circuit of tube 29 may be tuned by a condenser in parallel with the primary 32. Preferably, the inductance in the tuned circuit is not all included in the primary, but a portion, in series with the primary, is added for convenience in adjusting the tuning.

The secondary 33 is energized from the primary 32 to deliver current to conductors 34, which causes the mirror 36 in the oscillograph 35 to move. The provisions just described for insuring the synchronism cause the movements of the mirror 36 to agree accurately with those of the mirror 11. The position of a selected point in the view 1 corresponds accurately, so far as its right and left co-ordinate is concerned, with the position of the corresponding point of screen 58 determined by the mirror 36.

The vertical coordinate of the point in the view 1 optically associated with the photo-cell 14 depends upon the position of the lens 6. This position is changed by the rotation of the disc 7, which, being driven by the motor 8, may be made very regular, depending only upon the frequency of a commercial power supply. Similarly, the movement of the lens 51 in the receiving apparatus shown in Fig. 4 may be produced by a motor similar to the motor 8 and fed from the same power supply. The center of the wheel or disc carrying the lenses 51 is indicated at 75 in Fig. 4.

The movement of the lenses is slow, as compared with the movements of the mirrors 12 and 36. It is, therefore, feasible for an operator to adjust the position of one set of lenses 6 or 51 relative to the other, if the appearance of the reproduced picture shows that such an adjustment is needed.

The light for the receiving apparatus is supplied from a linear light source 53. In one extreme position of the mirror, 36, light from this source is reflected to a point near one end

of a lens 51. As the mirror 36 swings, the light is directed to successive portions of the lens 51 until, at the other end of the swing, it is reflected to a point near the other end of said lens.

As the lens 51 passes across the screen 52, successive portions of the linear light source 53 are concentrated to a point on the screen 52. When the lens 51 passes out of operative position and the next lens 51 enters operative position, the illuminated point on the screen 52 changes abruptly from one side of the screen to the other.

The movement of the mirror 36 causes the spot of light to travel lengthwise of the screen 52; that is, between the two edges shown in Fig. 4 as short edges. The movement of the lenses 51 causes the illuminated point to travel between the edges shown as long edges in said figure. The movement of the illuminated point in response to the motion of the mirror 36 is preferably greater than the length of the screen 52. Consequently, the bright surface 4 and the dark surface 3 are not represented upon the screen 52.

The changes in the intensity of the light received from the several points throughout the scene 1, 3, and 4, Fig. 1, cause changes in the magnitude of the current in the plate circuit of the tube 22, Fig. 3. The potential drop across the resistor 24 is thereby varied, with the result that variations occur in the plate circuit of the tube 37 and cause corresponding variations in the potential drop across the resistor 41. The potential across the resistor 41 is impressed between the electrodes 48 and 49. This is added to the potential across this portion of the arc in the mercury vapor or other vapor already established by the source 43 and controlled by the stabilizing resistor 44.

If the changes in radiation and in the plate circuit from the tube 22 are in such direction that the potential difference across the resistor 41 increases for bright portions of the picture, the battery 43 will be arranged to give a potential along the capillary tube in the same direction as the potential across the resistor 41, but, if the changes in the potential across the resistor 41 are in the opposite direction to the changes in illumination of cell 14, the battery 43 will be connected in the opposite direction. Consequently, whether the electrodes 48 and 49 add to the potential across the portion of the capillary between them or diminish it, the result, in either case, is that the instantaneous potential across this part of the capillary is greater when the point in the scene 1 which, at the moment, is correlated to the window 16, is brighter. The potential along the capillary determines the brightness of the light emitted by the vapor therein. Consequently, the light source is more brilliant when the corresponding point in the scene 1 is bright.

Another way of enabling the changes in illumination on the screen 52 to certainly be always in the same direction as the changes in the scene is to replace the grid leak and condenser at the tube 22 in Fig. 3 by an adjustable C battery. The tube can then be adjusted to either the lower curved part or the upper curved part of the characteristic. This will cause the sense of the changes in the output current to depend upon the adjustment.

The movement of the mirror 36 and of the lenses 51 always associate some portion of the light source 53 with a point in the screen 52 cor-

responding to that point in the scene 1 determined by the position of the mirror 11 and the lenses 6. Since the mirrors 11 and 36 always move in synchronism, and the lenses 6 and 51 always move at the same speed and are readily adjusted to synchronism, the illuminated point on the screen 52 always corresponds to the point in the scene 1 optically associated at that moment with the window 16. The result is that a reproduction of the scene 1 is obtained upon the screen 58.

The speed of the lenses 6 and 51 is so chosen that the vertical co-ordinates of the corresponding points on the screen and in the scene are varied throughout their amplitude rapidly enough to cause persistence of vision to make the picture on the screen 52 appear to represent the actual movements of the moving objects in the view 1.

The rate of movement of the mirrors 11 and 36 is great enough to cause the horizontal co-ordinate of the corresponding points to vary throughout their amplitude many times during one cycle of the variation of the vertical co-ordinate; as many times as there should be lines in the picture to give a satisfactory "grain".

Thus, if the picture is to have 60 lines to the inch, the mirror 11 must make 30 complete vibrations for each movement of the lens 6 over one inch, and the lens 6 must move at such a speed that the complete vertical height of the picture is traversed by it in at least a tenth of a second.

In the operation of the optical system illustrated in Figs. 6 and 7, the moving lenses 51 are replaced by a mirror which moves more slowly than the mirror 11 or the mirror 36. The movement of the slowly moving mirror is controlled by a rotating potentiometer. The arm of this potentiometer, being driven by a synchronous motor, moves at a constant speed. Motors for driving the potentiometer arms may be used at both the sending and the receiving station, or a wheel carrying lenses may be used at one station and a potentiometer at another. In either case, equality of speed is insured by connecting the motor to a common power supply.

As the arm 73 traverses the potentiometer 72, the potential impressed upon the oscillograph conductors 64 gradually increases, causing the mirror 61 to swing farther and farther. As the arm 73 passes from one end of the potentiometer 72 to the other across the adjacent ends of the resistor, the potential impressed upon the conductors 64 changes abruptly. The movement of the mirror 61, therefore, will closely simulate the action of the lenses, comprising a gradual movement in one direction and then an abrupt return to the opposite extremity of the swing.

It will be readily apparent to those skilled in the art that many variations of the devices herein illustrated and described may be made without departing from the spirit of this invention, and I, therefore, do not wish to be limited except as required by the prior art and recited in the claims.

I claim as my invention:

1. In a television system, a scanning device, a reproducing device, means adjoining a subject to be scanned for impressing on the scanning device an intensity effect differing from that of substantially any found in said subject, means controlled by said differing-intensity producing means, for producing a characteristic impulse at each traverse of said subject by the scanning de-

vice and oscillatory means controlled by said impulses for producing a corresponding position of the reproducing device.

2. In a television system, a sending instrument including means for delivering carrier energy, a scanning device adapted to make traverses of a subject to be scanned and means adjoining said subject for producing a characteristic modulation of said carrier energy during portions of each traverse by the scanner where subject elements are absent and a receiving instrument including an oscillatory member adapted to move in accordance to said modulation, whereby the traverses in the receiving instrument will be maintained in fixed relation to those in the scanning device.

3. In a television system, a sending instrument including means for delivering carrier energy, a scanning device adapted to make traverses of a subject to be scanned and means for modulating the carrier energy in accordance with the intensity of the elemental areas of said subject covered by the scanning device during said traverses, means for presenting to said scanning device at the extremity of each traverse an intensity differing from that of substantially all the elemental areas in said subject, whereby a corresponding difference in the modulation is produced and a receiving instrument including an oscillatory member responsive to said different modulation.

4. In a television system, a sending instrument including means for delivering carrier energy, a scanning device adapted to make traverses of a subject to be scanned and means for modulating the carrier energy in accordance with the intensity of the elemental areas of said subject met by the scanning device during said traverses, means for impressing upon the scanning device between traverses of said subject an intensity differing from that of any of the elemental areas in the subject, whereby a corresponding difference in the modulation is produced and a receiving instrument including an oscillatory member responsive to said different modulation and means for preventing response of said member to the modulation corresponding to brightness of the scene.

5. In a picture reproducing device, a linear source of light, a screen and means for projecting the light from successive portions of said source upon the screen, said portions being in a line corresponding to change of one coordinate in the picture to be reproduced and means for deflecting the light in a direction at an angle to said line.

6. In a picture reproducing device, a linear source of light, a cylindrical focusing device, means for directing the light from successive portions of said source progressively upon successive portions of said focusing device and means for moving said focusing device at an angle to its length.

7. In a television system, a scanning device, means for producing radiation comprising a carrier wave modulated in accordance with the intensity of the elemental areas of a subject selected by the scanning device, means independent of said subject and scanned by said scanning device for producing a characteristic modulation of said carrier wave upon each traverse by said scanning device, a reproducing device including means for producing a scanning medium of an intensity corresponding to said elemental area modulation and means controlled by said characteristic modulation for directing said scanning

medium in accordance with the movement of the scanning medium at the transmitting end.

8. In an optical system for view-transmission, a lens having a cylindrical surface, means for moving said lens at an angle to the axis of said surface, whereby successive positions of said axis lie in a plane, a mirror and means for oscillating said mirror about an axis forming an angle with the normal to said plane.

9. In an optical system for view-transmission, a lens having a cylindrical surface, means for moving said lens at an angle to the axis of said surface, whereby successive positions of said axis lie in a plane, a mirror and means for oscillating said mirror about an axis parallel to said plane.

10. In an optical system for transmission of views, a plurality of cylindrical lenses, a carrier therefor, means for moving the carrier to bring said lenses successively into the same position, a mirror, and means for causing said mirror to oscillate about an axis substantially parallel to the plane of rotation of said lenses.

11. In an optical system for transmission of views, a plurality of cylindrical lenses, a carrier therefor, the lenses being mounted thereon in a circle with their several axes radial thereof, means for rotating the carrier about the center of said circle, a mirror, and means for causing said mirror to oscillate about an axis substantially parallel to the plane of rotation of said lenses.

12. In an optical system for transmission of views, a plurality of cylindrical lenses, a carrier therefor, the lenses being mounted thereon in a circle with their several axes radial thereof, means for rotating the carrier about the center of said circle and a mirror mounted to oscillate in such direction that it will sweep lengthwise over one of said lenses.

13. In a picture-reproducing system, a linear source of light, a screen, a vibratory mirror, a plurality of cylindrical lenses and means for causing said lenses to successively pass intermediate said vibratory mirror and said screen, whereby the light from successive portions of said source is caused to fall upon said screen.

14. In a view-transmission system, means for transversely scanning a subject, means adjacent to said subject cooperating with said scanning means for the production of periodic electrical impulses representative of the rate of scanning, oscillatory scanning means at a receiving station, and means whereby said oscillatory scanning means is constrained to vibrate in synchronism with said periodic electrical impulses.

15. In a television system, a transmitter comprising scanning means including a ray of energy, a reproducing device comprising similar scanning means, means exclusive of a subject to be scanned and disposed within the range of operation of said ray for producing, in combination with the scanning means, a characteristic impulse at a definite frequency in the energy output of said transmitter and means for utilizing said characteristic impulses for producing corresponding momentary positions of the scanning means of said reproducing device.

16. In a system of the television type, means for scanning a subject, means adjacent to said subject and adapted to be scanned by said scanning means throughout the scanning period for the production of a continuous train of periodic electrical impulses representative of the rate of scanning.

17. In a system of the television type, means

for scanning a subject and means associated with said subject and periodically scanned by said scanning means during substantially the entire period of scanning whereby periodic changes in the energy output of said system may be produced for synchronizing purposes.

18. In a system for the transmission of electrical impulses to produce pictures, an area of varying light reactive value arranged in effective position to be scanned with the object to be pictured, and means for scanning said area coordinately with said object, for producing electrical impulses of scanning frequency.

19. In a system for the transmission of electrical impulses to produce pictures, an area arranged in effective position to be scanned with the object to be pictured, and means for scanning said area coordinately with said object for producing electrical impulses of scanning frequency, the elementary units of said area having a light reactive value which is a function of their position in said area.

20. In a system for the transmission of electrical impulses to produce pictures, an area arranged in effective position to be scanned with the object to be pictured, and means for scanning said area coordinately with said object for producing electrical impulses of scanning frequency, the elementary units of said area having a light reactive value which is a function of the effective position of said area with respect to said object.

21. In a system for the transmission of electrical impulses to produce pictures, an area arranged in effective position to be scanned with the object to be pictured, and means for scanning said area coordinately with said object for producing electrical impulses of scanning frequency, said area having a light reactive value varying in accordance with a system different from the picture.

22. In a system for the transmission of electrical impulses to produce pictures, a shaded border arranged to be effective as if bounding the object to be pictured, and means for scanning said border coordinately with said object for producing electrical impulses of scanning frequency.

23. The step in the method of synchronizing a transmitter and receiver of electric impulses for the production of pictures which comprises scanning an area of varying light reactive value coordinately with the object to be pictured.

24. The method of producing a scanning component in a current for the production of pictures which comprises bounding the object to be pictured with a shaded border and traversing said border and object by a scanning means associated with a transmitting means.

25. The method of synchronizing a transmitter and a receiver of electrical impulses for the production of pictures which comprises bounding the object to be pictured with a shaded border, producing a current corresponding to the illumination from successive elementary units of said object and border, and utilizing the current corresponding to said border to control the frequency of a receiving scanning system.

26. In a system for the transmission of electrical impulses to produce pictures, a shaded border arranged as if bounding the object to be transmitted, means for scanning said object and said border to produce a current varying with the illumination from successive elementary units of said object and border, means for transmitting

said current to a receiving apparatus, and means in said receiving apparatus for utilizing the part of said current corresponding with the border to synchronize a receiving scanning means.

27. In a receiver for use with a transmitter of impulses alternately of picture and scanning frequencies, means for detecting a low frequency component of the transmitted impulses, means for filtering out substantially all but the fundamental frequency of said component, and means for utilizing said fundamental frequency to actuate a receiving scanning means.

28. In a system of the television type, a subject to be scanned, a scanning ray, means for causing said ray to scan said subject for causing energy to be modulated according to the light intensity of the elemental areas of said subject, and means disposed beyond the boundaries of said subject but within the operating range of said scanning ray for impressing upon said energy a periodic characteristic impulse for synchronizing purposes.

29. In apparatus of the television type, a subject to be scanned, a scanning ray, means for causing said ray to sweep across said subject and beyond at least one of its edges and means disposed beyond the area of said subject but within the operating range of said ray for producing a periodic characteristic impulse in the output energy of said apparatus.

30. A television synchronizing system including a photoelectric cell, screening means of varying optical density for optically modulating the same so as to produce a sinusoidal electric wave form, alternately with the signals produced by scanning each line of the picture, means for transmitting this wave form, means for receiving this wave form, means for separating it from other wave forms due to signals present on the same transmission channels, and means for applying it to effect the synchronization of said television system.

31. In television transmitting apparatus electro-optical apparatus means for the production of synchronizing signals, between groups of picture signals, each of said groups representing a single line scanning, including screening members whose degree of opacity varies according to a sinusoidal law, in respect to distances measurable upon said screening members, cooperating with the balance of the transmitting system to cause the said synchronizing signals to be of a sinusoidal form.

32. A television transmitter including optical reactive means effective between the scanning of each line and that of the line next scanned, said means optically producing synchronizing signals of a predetermined rate of amplitude change and of a predetermined range of amplitude values, an image to be scanned having a range of light values at least as great as has said optical reactive means, portions of said image which have said light values being so positioned relative to one another as to produce image signals at least some of which have a rate of amplitude change greater than that of said synchronizing signals and the amplitude range of which is never greater than the amplitude range of said synchronizing signals, and means for alternately transmitting said image signals and said synchronizing signals whereby said synchronizing signals may be effectively separated and selected from said image signals and from extraneous signals at a television receiver.

33. Means for transmitting television and synchronizing signals effectively separable from one another including optical means for scanning in turn each line of an image, means optically discrete from said scanning means for modifying the light falling upon said optical scanning means after the scanning of each line, said modifying means being provided with a substantially contin-

uous gradation from substantially maximum light reactive value to substantially minimum light reactive value, and means for alternately transmitting said image signals and said synchronizing signals whereby said synchronizing signals may be effectively tuned and distinguished from extraneous signals at a television receiver.

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