

Jan. 29, 1935.

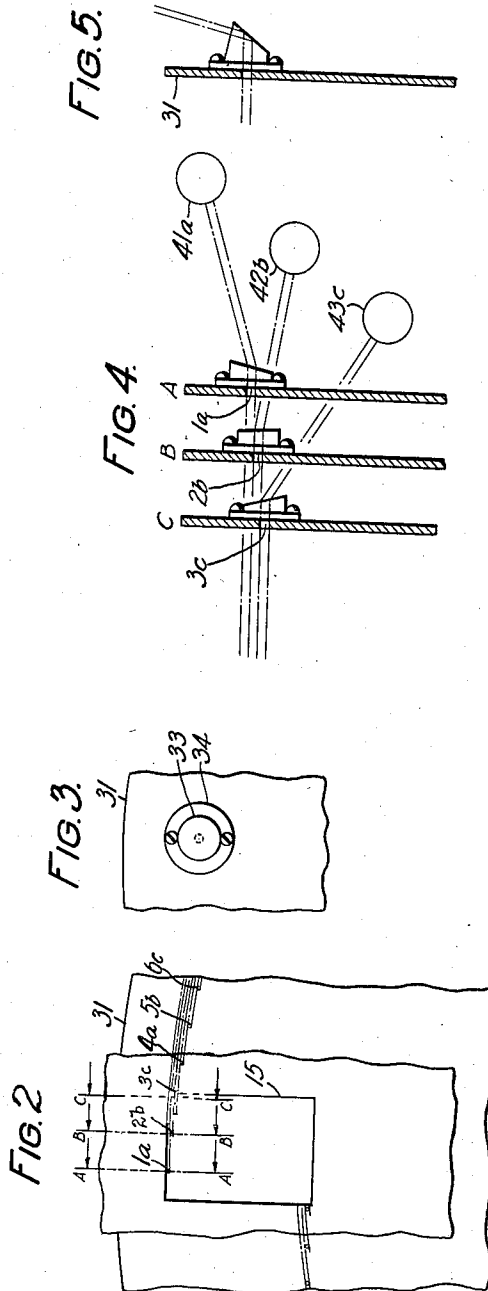
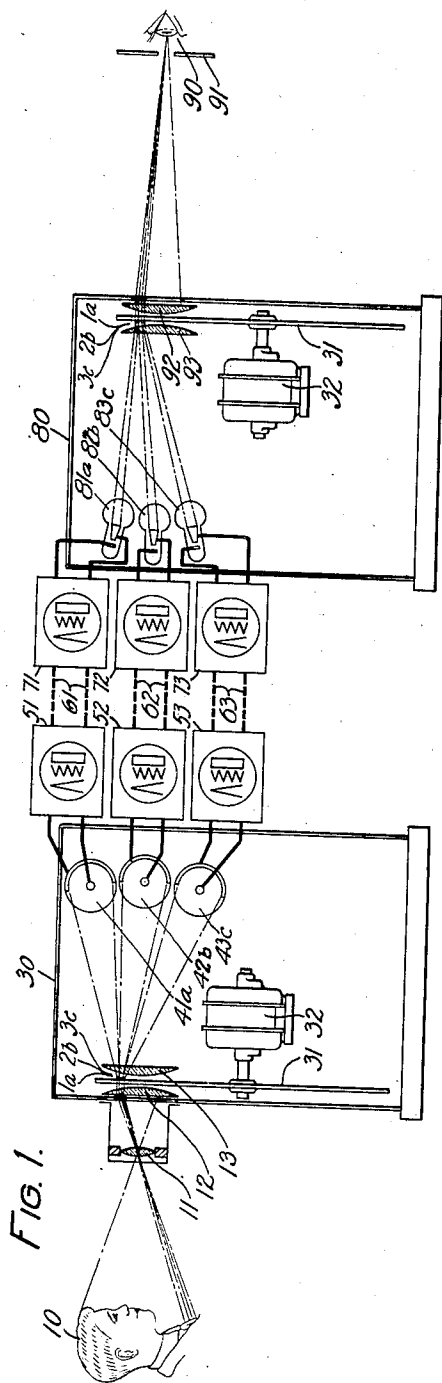
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1,989,618

ELECTROOPTICAL TRANSMISSION

Filed July 11, 1928

3 Sheets-Sheet 1



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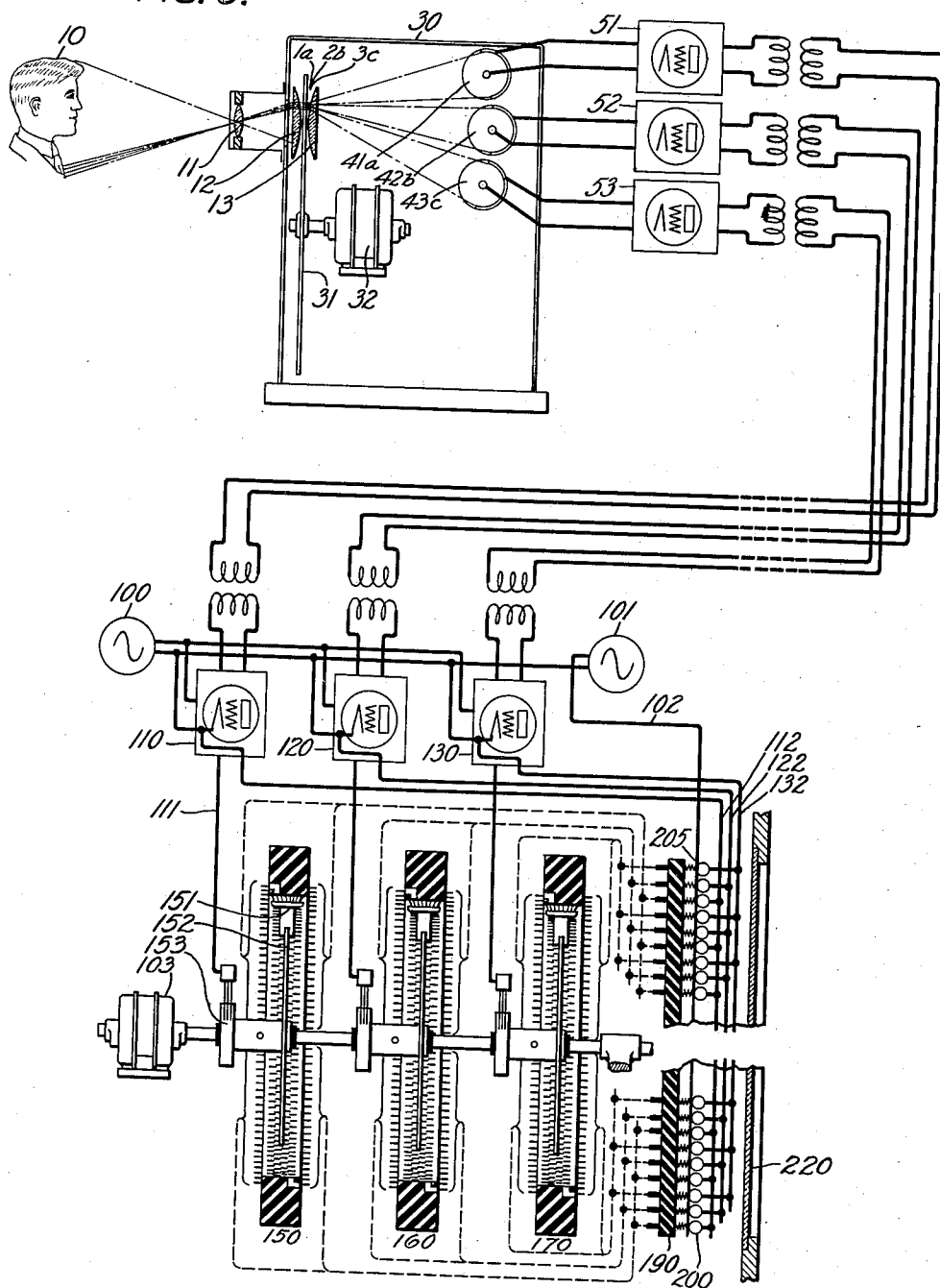
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ELECTROOPTICAL TRANSMISSION

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FIG. 6.



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ELECTROOPTICAL TRANSMISSION

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FIG. 7.

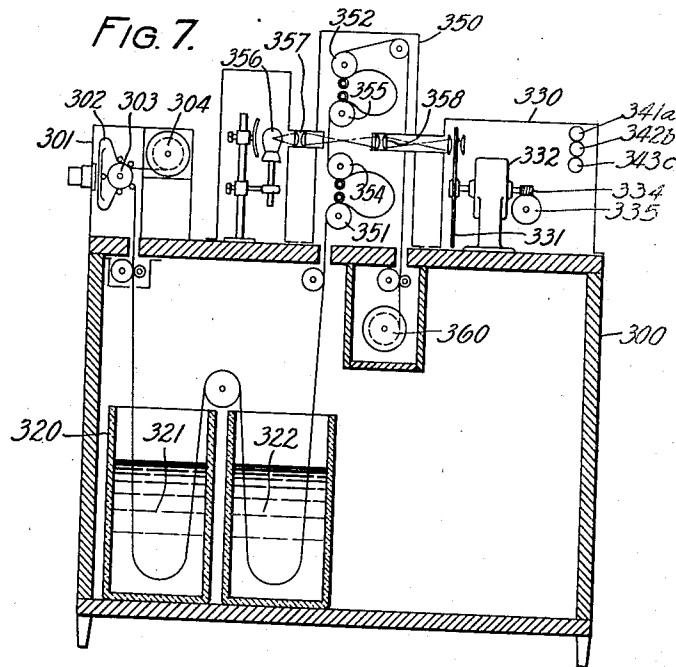


FIG. 8.

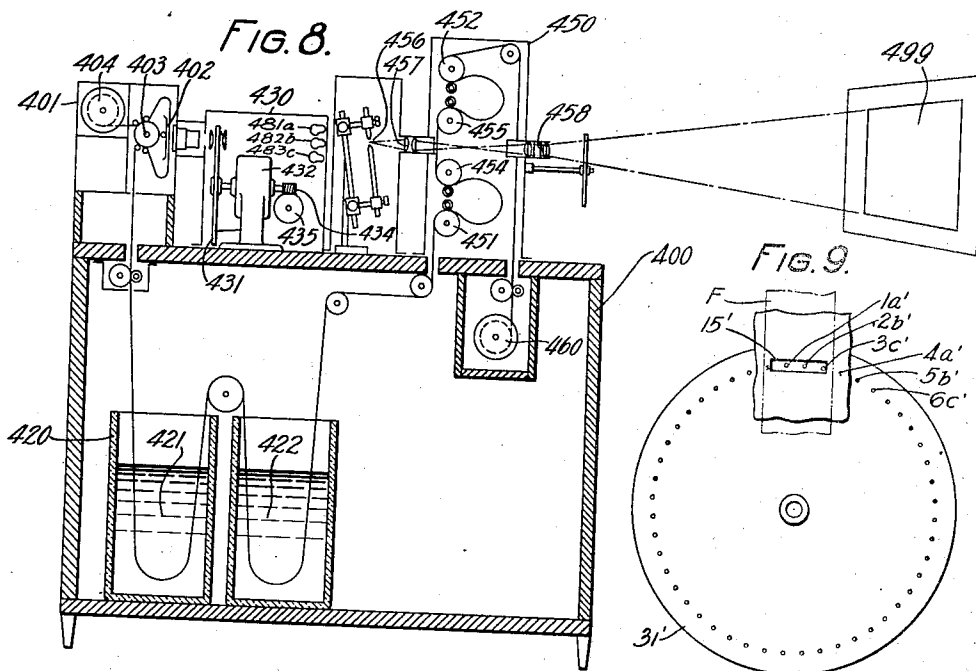


FIG. 9.

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ELECTROOPTICAL TRANSMISSION

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Application July 11, 1928, Serial No. 291,744

6 Claims. (Cl. 178—6)

This invention relates to electro-optical systems, and more particularly to means for multiple channel transmission of images of still or moving objects or of pictures.

5 An object of this invention is to provide an improved scanning system for multiple channel operation. In its preferred form it is suitable for generating image currents adapted to be transmitted over commercial telephone lines or other transmission channels which are per se incapable of transmitting a sufficiently wide band of frequencies without considerable distortion. However, either wire or radio channels of any width of frequency bands may be used. The preferred form of the invention, moreover, is intended for use with the type of system in which a plurality of separate transmission channels are utilized simultaneously to transmit the image currents, the current over each channel corresponding to the tone values of lines of elemental areas of the object field, which lines are interspersed with other lines, the image currents of which are transmitted over other channels. This type of system has the advantage that the effect of differences in transmission characteristics of the various channels upon the receiving field is much less than would be the case if each channel were to transmit a large section of the field as has heretofore been proposed. This effect might be even less objectionable if, as has also been heretofore proposed, a separate channel were assigned to each line of the object field, but this method is not commercially practicable because of the large number of channels required.

15 In accordance with this invention, simple and reliable means are provided for carrying out the necessary scanning processes at both the transmitter and the receiver. In a preferred embodiment of the invention channel terminating means are employed which include scanning means comprising a spirally apertured scanning disc at both the transmitting and the receiving stations the apertures being covered with light deviating means, preferably prisms, for directing light between each line of elemental areas of the field and the translating apparatus associated with the corresponding telephone line or other transmission channel. The total number of apertures in the scanning disc is equally divided among the several channels. The scanning discs used at the transmitting and at the receiving stations are similar.

55 The invention also contemplates combining the described multiple channel method with light amplification, effected by taking a moving pic-

ture of the object field and immediately developing and scanning the developed picture, whereby a very great additional gain in effective available light is obtained. Such amplification is particularly useful with multiple channel operation, since with ordinary flood lighting sufficient illumination for good results may not be obtainable, and illumination with a moving beam of light cannot readily be used because of the difficulty of preventing interference between different light channels.

A more detailed description of the invention follows and is illustrated in the accompanying drawings.

Fig. 1 is a schematic representation of a multiple channel television system arranged for directly viewing the produced image.

Fig. 2 is a front side view of a fragmentary portion of the scanning disc showing particularly the arrangement of the scanning apertures and their position with reference to the scanning or viewing area at a given instant.

Fig. 3 is a rear side view of a portion of the scanning disc showing an end of a prism associated with an aperture.

Fig. 4 is a schematic drawing showing sections of the scanning disc, the direction of the light beam entering and leaving each of three adjoining apertures each associated with different channels and the arrangement of the refracting prisms in a preferred arrangement.

Fig. 5 is a section view of a portion of the scanning disc through an aperture and a side view of an associated prism of the reflecting type.

Fig. 6 is a schematic representation of a multiple channel television system employing the transmitting apparatus shown in Fig. 1 and receiving apparatus arranged for producing the image on a large multiple element grid type receiving lamp.

Fig. 7 is a schematic representation of the transmitting apparatus of a multiple channel television system arranged for rapidly photographing an object on a moving film and for translating with the aid of light amplification the light effects recorded on the film into electric currents for transmission over a plurality of transmission channels.

Fig. 8 is a schematic representation of the receiving apparatus of a multiple channel television system arranged for rapidly photographically receiving the image on a moving picture film and for projecting with the aid of light amplification the image after quick development of the film on a large viewing screen.

Fig. 9 is a side view of a scanning disc showing a modified arrangement of the scanning apertures for use with a continuously moving photographic film.

Referring to Fig. 1, the object 10 is scanned by the multiple channel scanning apparatus 30. An image of an illuminated object or field of view is formed by means of a suitable objective lens system 11 on the scanning area of the scanning disc 31 in substantially the same manner as an image of an object to be photographed is formed upon a photographic film. The lens system 12—13 concentrates the light rays from the lens 11 into an image of restricted area in the plane of the photoelectric cell or cells. Each aperture 1a, 2b, 3c, etc., of the scanning disc is equipped with a light deflecting element, such as a prism, the function of the prisms being to divide the light and direct the beams in a predetermined direction upon a plurality of light sensitive cells 41a, 42b, 43c, etc., originating a corresponding number of separate electrical transmission channels. Three channels have been shown for illustrating the invention but obviously a different number may be used. The angle of refraction of each of the separate prisms associated with the apertures 1a, 2b, and 3c is such that the light passing through the prisms is always directed to one of the points of origin of the several electrical transmission channels, the light sensitive cells 41a, 42b, and 43c, respectively; and succeeding apertures of the scanning disc such as 4a, 5b, and 6c, shown in Fig. 2, when they pass before the viewing field similarly direct the light from the object in different directions to the corresponding light sensitive cells 41a, 42b, and 43c, respectively. Succeeding apertures as the scanning disc rotates repeat the process. In the case shown every third aperture directs its light rays to the same light sensitive cell or transmission channel. The condensing or projection lens system 12—13 is arranged to form an image of the objective lens 11 on the light sensitive cells while the prisms on the scanning disc determine which cell or channel is to be activated by a given scanning light beam. The proper relationship between the size and focal length of the objective lens 11 and the projection lens system 12—13 and the angles of the prisms should be observed in order that the spread of the light channel to each of the light sensitive cells 41a, 42b, and 43c for the several respective channels is so limited that the light channels do not overlap and cause interference between the different channels. In the preferred arrangement elemental areas of juxtapositioned lines of the object whose image is transmitted are simultaneously scanned and elemental areas of each series of juxtapositioned lines are simultaneously transmitted by a plurality of transmission channels as is obvious from the arrangement shown in the drawings. Other positioning of the lines of elemental areas in scanning may be arranged. The scanning disc 31 is driven in synchronism, by any suitable means such as the motor 32, with a similar scanning disc at the receiving station. The photoelectric current generated in the light sensitive cells originating each transmission channel is amplified for transmission by suitable amplifiers 51, 52, and 53.

The receiving apparatus 80 is connected with the transmitting apparatus 30 by means of suitable transmission channels 61, 62, and 63, such as wire or radio channels, though only the former is shown in the drawings. The received photo-

electric currents are amplified at the receiving station by suitable amplifiers 71, 72, and 73 and impressed upon glow discharge lamps 81a, 82b, and 83c terminating the several electrical transmission channels. These amplifiers as well as those at the transmitting station are adjustable so that each channel may be adjusted to operate in uniformity with the associated channels. The light emitted by each of these light sources varies in accordance with the current variations received over the transmission channel with which each is connected. The lens system 93—92 images the light sources 81a, 82b, and 83c in the eye of the observer 90 through the aperture in the observer positioning plate 91. A scanning disc 31 having apertures 1a, 2b, 3c, etc. carrying prisms associated with each aperture similar to that at the transmitting station directs the scanning light beams into the eye of the observer so as to scan the produced image in synchronism with the scanning operation at the transmitting station. The receiving sources of light may be of any suitable type producing a small size intense light which varies in accordance with the exciting current. A glow discharge lamp suitable for this is shown in the patent to Frank Gray, No. 1,830,163, dated November 3, 1931.

The arrangement of the scanning disc apertures in relation to the viewing area at a given instant is especially shown in Fig. 2. The viewing area or field 15 has a length equal to the radial depth of the spiral of apertures and a width equal to the pitch distance between adjoining apertures of a given channel and such that the number of apertures exposed at any instant equals the number of channels in operation. As hereinbefore mentioned three channels have been shown for illustrating the invention and the apertures 1a, 2b, and 3c or any other three adjacent apertures may at any instant appear in and scan the viewing field. While these apertures are shown uniformly spaced they might have any other suitable arrangement which permits only one aperture representing a given channel being exposed at the same time provided the same arrangement of apertures or equivalent elements is provided at the receiving station.

Fig. 3 is a side view of a portion of the scanning disc showing an end view of a prism such as is associated with each aperture of the disc. The prism proper 33 is fastened to the scanning disc 31 by any suitable arrangement such as a clamping ring 34 in which the prism is fixed and which is bolted to the disc. The angles between front and rear faces of the various prisms are different, as is shown in Fig. 4.

Fig. 4 is a schematic drawing especially showing the direction of a light beam entering and leaving three adjoining scanning apertures and their associated refracting prisms, each directing a scanning light beam between a different transmission channel and a different elemental area of the field of view. Three views, A, B, and C, in this figure are sections of the scanning disc along the lines A—A, B—B, and C—C of Fig. 2. The relative positions of the three light sensitive cells 41a, 42b, and 43c with respect to the scanning disc are shown in Fig. 4 and by means of dash-dot lines the path of the scanning beam from them to and beyond the prisms and apertures of the scanning disc is also shown. In each case the scanning beam passes through the aperture in the disc substantially parallel to its axis and upon passing out of the associated prism the beam is deflected in the direction necessary to

place it in its proper transmission channel. The prism associated with aperture 1a deflects the light to the position of the light sensitive cell 41a. The prism associated with aperture 2b deflects the light to the position of the light sensitive cell 42b and the prism associated with aperture 3c to the position of the light sensitive cell 43c. This arrangement represents the direction of scanning light beams simultaneously acting in a three channel system. As the scanning disc rotates the apertures 4a, 5b, and 6c cross the viewing field and the light passing through these apertures is directed to the positions of the light sensitive cells 41a, 42b, and 43c, respectively, and the incoming beams passing through different apertures scan different lines of elemental areas across the object as each new scanning aperture passed across the scanning field. It is desirable to have a lens system 12-13, as shown in Fig. 1, back of the prisms in order that the light beams in addition to being diverted into the respective channels by the prisms on the disc are also directed as the prisms move across the scanning field towards the center of the respective light sensitive cells.

In the foregoing, Fig. 4 has been described with reference to the scanning operation at the transmitter. It is obvious, however, that a similar optical arrangement including prisms associated with the apertures of the scanning disc may be used at the receiving station, as shown in Fig. 1, in which case variable light sources are positioned back of the scanning disc in relatively the same position as the light sensitive cells are in the transmitting apparatus.

Fig. 5 shows a section of the scanning disc 31 and a light reflecting prism rather than a refracting prism. Either reflection or refraction may be used by positioning the light sensitive cells or the light sources accordingly. It is also obvious that other light deflecting devices such as mirrors or the like may be associated with each of the apertures on the scanning disc.

Fig. 6 is a schematic representation of a multiple channel television system using the transmitting apparatus shown in Fig. 1 and receiving apparatus which produces the image on a large multiple element grid type receiving lamp. Reference characters similar to those applied to the transmitting apparatus shown in Fig. 1 have been applied to similar apparatus in Fig. 6 and the description heretofore made of Fig. 1 also applies to the transmitting apparatus shown here. The photoelectric currents generated by the transmitter are sent to the receiver over any suitable transmission channels. The incoming photoelectric or signal current received over each of the several channels is impressed upon separate receiving amplifier and control networks for each channel. In the arrangement shown the transmitted current is an alternating current of varying amplitude representative of light variations above and below the average tone value of the object being scanned. The receiving apparatus is similar to that shown in the patent to Herbert E. Ives, No. 1,796,931, dated March 17, 1931. The incoming alternating signal current received from each transmission channel is impressed upon its respective amplifier and control circuit 110, 120, and 130 and is caused to modulate a high frequency oscillating current generated by the oscillator 100. The modulated high frequency current controlled by each channel is next passed through commutator distributors 150, 160, and 170 for each of the respec-

tive channels and from these distributors to the multiple electrode glow discharge receiving lamp 200. The receiving amplifier and control network 110, 120, and 130 and the several commutator distributors are similar to those shown for a single channel system in the patent to Frank Gray, No. 1,759,504, dated May 20, 1930. The viewing field at the receiving station is illuminated by a large grid-type multiple electrode glow discharge lamp, one electrode being employed for each elemental area of the field. The commutator distributors contain one contact for each element or individual electrode of the glow discharge lamp and connection is made between them by individual wires. Each commutator distributor at any instant connects with only one electrode on the glow discharge lamp and thereby limits the illumination of the elemental area defined by the connected electrode. In this system the several channels are simultaneously operated and a corresponding number of elemental areas of the receiving lamp are simultaneously illuminated. Each commutator distributor has a rotating brush and the brushes of all distributors are mounted upon a single shaft which is driven in synchronism and in phase with the scanning apparatus by means of the driving motor 103.

The electrical circuits for the picture producing current flowing through the glow discharge lamp is between an individual electrode on the lamp, each of which is connected with an individual contact in the commutator distributor to the common electrode of the lamp. The multiple electrode glow discharge lamp is divided in accordance with the several channels by grouping the sections of each channel with its respective commutator distributor and connecting the common electrode of the different sections to a common electrode connected with the proper channel. The common conductors 112, 122, and 132 may group the various tube sections according to channels and in turn connect with the receiving circuit networks 110, 120, and 130, respectively of the various channels. The arrangement of the connections between the commutator distributors and the sections of the glow discharge lamp and of the common electrode of each section of the glow discharge lamp so as to uniformly distribute the sections associated with each channel, preferably juxtapositioning the sections of the lamp representing different channels, provides for connecting every third tube section, since three channels are shown, to their same respective channels.

The current for the modulated high frequency picture current may be traced for one channel from the receiving circuit network 110, conductor 111, slip ring 153, brush arm 152, distributor brush 151, one of the contacts in the commutator distributor 150, one of the individual lead wires from such contact to an individual connection through the multiple contact panel 190 to an individual electrode on the glow discharge lamp 200 and common return lead 112, back to the receiving circuit network 110. A similar circuit may be traced in connection with each of the other channels. As many individual wires connect between the commutator distributors contacts and the glow discharge lamp as there are individual electrodes on the lamp, though in the drawing this plurality of wires is shown by a few single lines for simplicity.

The glow discharge lamp in the arrangement shown is operated by a modulated high frequency

current and in order to prevent lag in the action of the picture current applied to the individual electrodes of the lamp the gas in the tubes is excited by means of an auxiliary high frequency current continuously applied at a point in the various tube sections outside of the field of view. This second high frequency current may be supplied from a high frequency oscillator 101. One terminal of this oscillator connects by means of the conductor 102 to the auxiliary electrode 205 on each tube section of the glow discharge lamp 200, while the other terminal of the oscillator connects through the receiving circuit networks of the several channels with the common electrodes in the glow discharge lamp through the several lamps common return conductors 112, 122, and 132. The response of a glow discharge lamp is much more sensitive to starting and to small current variations if the lamp is already under excitation when the signal current is impressed thereon and this fact is taken advantage of by continuously exciting the lamp through a special set of electrodes so arranged as to avoid interfering with the luminosity of the viewing screen. A large panel of ground glass 220 positioned closely in front of the glow discharge lamp 200 may be added to form a picture receiving or viewing surface. This may, however, be omitted when the audience is a considerable distance from the glow discharge lamp.

A multiple channel system of three channels has been shown and described, but this number, as heretofore stated, may be increased or decreased. The operation of each channel is substantially the same as any other channel and the apparatus used in each channel may be in most respects substantially the same as that disclosed in the patent to Frank Gray, No. 1,759,504, dated May 20, 1930, *supra*. Further details of this receiving apparatus, particularly the glow discharge lamp 200, may be found in the patent to H. E. Ives, No. 1,796,931, dated March 17, 1931, *supra*.

A further embodiment of this invention comprising light amplification provides for making a photographic film record of the object, developing and fixing the film, and then passing the developed film through beams of light directed upon light sensitive cells thereby causing the light sensitive cells to generate electric currents varying in accordance with the light tone values of elemental areas of the film. Several elemental areas are simultaneously scanned, the number equaling the number of channels simultaneously in operation for transmission.

A general view of the transmitting apparatus comprising a moving picture recording camera, film, photographic developing and fixing apparatus, moving picture projecting apparatus for projecting the picture record into television transmitting scanning apparatus for converting the record into varying electric currents for transmission, and synchronizing apparatus, is shown in Fig. 7. The various component elements of the transmitting apparatus are mounted within and upon the framework 300. The moving picture camera 301 may be any suitable standard moving picture camera. It is so associated with the other transmitting apparatus that the moving picture film 302 after being exposed for the picture record passes through the photographic developing and fixing apparatus 320. Any suitable developing and fixing process may be used, though in the drawings only two steps are indicated by tanks 321 and 322 for the developing and fixing operations, respectively. Such other steps as

provision for washing and drying may be incorporated in the apparatus. The film after being fixed is passed without drying through the picture projecting apparatus 350. An image of the picture is projected into the television scanning apparatus 330 which for each channel successively impresses the light from each elemental area simultaneously being scanned onto the light sensitive cells 341a, 342b, and 343c, one for each channel. The light sensitive cells connect through suitable amplifying networks to individual transmission channels as heretofore explained. Synchronizing apparatus is arranged to transmit synchronizing current over a suitable transmission channel. After the film has been passed through the transmitting apparatus, it may be wound upon a reel 360 or otherwise disposed of.

The transmitting apparatus is positioned so that the moving picture camera 301 is directed upon the object or field whose image is to be transmitted. Unexposed moving picture film 302 is placed in the magazine 304 of the moving picture camera 301 and then threaded through the various apparatus units, as shown in the drawings and finally to the storing reel 360. Suitable guides and driving gearing control the movement of the film at various positions. The film in passing through the moving picture camera 301 and the picture projecting apparatus 350 is intermittently driven. The movement of the film at the different points is maintained in proper synchronism with the different apparatus elements by means of gearing, not shown in the drawing, interconnecting the various driving gears, and all connected with the synchronous driving motor 332 which is of usual construction but preferably of good size to overcome any tendency to change of speed with changing reactions from the apparatus driven thereby. Connection of this gearing with the motor may be made through any suitable arrangement such as the worm and gear connection 334 and 335. The movement of the film through the camera 301 is obtained by any well known standard gearing arrangement 303 associated with the camera. In the projecting apparatus 330 the film is fed in and out at a uniform rate by means of the sprocket gearing 351 and 352, while it is driven intermittently by the sprocket gearing 354 and 355, all of which are connected by well known means to the driving gearing from the motor element 322. The sprocket gearing 351 also moves the film through the developing and fixing tank 321 and 322, respectively.

The exposed film after being developed and fixed is passed through the projector 350, where it passes through an intense beam of light from the projector lamp 356 and a lens system 357 and 358, which projects in accordance with standard practice an image of the picture upon the scanning disc 331 of the television scanning apparatus 330. The scanning apparatus is the same as shown in Fig. 1, with the exception that a section of the scanning disc is blank during the movement of the film from one frame to the next, and the description heretofore given is otherwise applicable here. During this film shift photoelectric transmission ceases and the transmission channels are accordingly less effectively used than would be the case with continuous scanning as subsequently described in a modified arrangement. A plurality of elemental areas, one for each channel, of the image projected from the photographic film record upon

the scanning disc, are simultaneously scanned and photoelectric currents for the different elemental areas are generated in each of the different light sensitive cells originating different electrical transmission channels.

A general view of the receiving apparatus comprising television receiving scanning apparatus, a moving picture recording camera, film photographic developing and fixing apparatus, moving picture projecting apparatus, and synchronizing apparatus, is shown in Fig. 8. The various component elements of the receiving apparatus, many of which are similar to corresponding elements in the transmitting apparatus, are mounted within and upon the framework 400. The moving picture camera 401 may be any suitable standard moving picture camera. This receiving camera is positioned in front of the television receiving apparatus 430 in such relation thereto that the image produced by the television apparatus is focused upon the moving picture film 402. The television apparatus contains a plurality of light sources 481a, 482b, and 483c, each terminating a separate incoming electrical transmission channel. The light intensity of these various lamps varies in accordance with the incoming image signals. The arrangement of the television receiving apparatus here is similar, with the exception that a section of the scanning disc is blank during the movement of the film from one frame to the next, to that shown in Fig. 1. The scanning disc 431 is similar to the scanning disc in the transmitting apparatus and it is operated by a synchronous driving motor element 432, which may be of any well known form and preferably of good size, in synchronism and in phase with the transmitting apparatus. The transmitting scanning disc scans the photographic image of the picture to be transmitted in a series of parallel lines, groups of juxtapositioned lines representing the different channels, thereby setting up varying picture currents whose strength at any instant corresponds with the light intensities of the various elemental areas of the image on the transmitting film. These currents cause corresponding variations in the light intensity of the several light sources 481a, 482b and 483c, which in turn are caused to successively illuminate the corresponding elemental areas of the receiving film at each instant with a light intensity similar to that of the image on the film at the transmitting station. A positive picture is thus recorded on the receiving film 402 which corresponds to the negative picture on the transmitting film 302. The moving picture recording film 402 after being exposed for the picture record passes through the photographic developing and fixing apparatus 420 containing the two tanks 421 and 422, respectively. However, as explained in connection with the transmitting apparatus any suitable process may be used and such steps as washing and drying the film may be incorporated. The film after being fixed is passed without drying through picture projecting apparatus 450. An image of the picture is projected in accordance with standard moving picture practice upon a suitable screen for viewing. After the film has passed through the projecting apparatus it may be wound upon a reel 460 or otherwise disposed of. The receiving apparatus is positioned so that the moving picture projecting apparatus projects the picture on a large screen 499 in front of the audience.

Unexposed moving picture film 402 is placed in

the magazine 404 of the moving picture camera 401 and then threaded through the various apparatus units, as shown in the drawings and finally to the storing reel 460, substantially the same as in the transmitting apparatus. Suitable guides and driving gearing control the movement of the film at the various positions. The film in passing through the moving picture camera 401 and the moving picture projecting apparatus 450 is intermittently driven, while the movement of the film at the different points is maintained in proper synchronism with the different apparatus elements by means of gearing, not shown in the drawings, interconnecting the various driving gears and all connected with the synchronizing driving motor 432. Connection of this gearing with the motor may be made through the worm and gearing connections 434 and 435. The movement of the film through the camera 401 is obtained by any well known standard gearing arrangement 403 associated with the camera.

In the projecting apparatus 450 the film is fed in and out at a uniform rate by means of a sprocket gearing 451 and 452 while it is driven intermittently by the sprocket gearing 454 and 455, all of which are connected by well known means to the driving gearing of the motor element 432. The sprocket gearing 451 also moves the film through the developing and fixing tanks 421 and 422.

The exposed film after being developed and fixed is passed to the picture projector 450, where it is passed through an intense beam of light from the projector lamp 456 and a lens system 457 and 458, which projects in accordance with standard practice an image of the picture upon a large viewing screen 499.

In the foregoing description relating to Figs. 7 and 8 the movement of the film through most of the various apparatus elements has been described as being intermittent, that is stopped during the taking, scanning, and projecting of each picture. This invention is applicable to any other suitable arrangement for making the pictures upon the film and for translating them into photoelectric energy and vice versa. For example, in the transmitting apparatus, the film might be moved intermittently in the camera 301 in taking the moving pictures in accordance with standard practice and moved continuously in the projecting apparatus 350 from which an image of the picture is projected into the television scanning and transmitting apparatus 330 where it is translated into photoelectric current. With the film moving continuously at the proper rate before the television scanning apparatus the scanning apertures and associated prisms of the scanning disc may be positioned in a circle on the scanning disc, as shown in Fig. 9, and the continuous movement at the proper rate of the film normal to the movement of the scanning apertures causes each aperture to scan a different line across the film, thus producing the same result as having the film move the proper amount intermittently in front of a scanning disc having its apertures spirally arranged. In this arrangement the viewing field has a length substantially equal to the product of the width of a scanning line and the number of apertures in the scanning disc, and a width substantially equal to the pitched distance between adjoining apertures of a given channel and such that the number of apertures exposed at any instant equals the number of channels in operation. The lengthwise distribution of the scanning lines across the picture is

governed by the movement of the sensitized film or plate. Fig. 9 shows a scanning disc 31' having apertures 1a', 2b', 3c', 4a', 5b', and 6c', etc., circularly arranged. Any adjacent three apertures, such as 1a', 2b', and 3c' each of different channels may at any instant appear in and move across the scanning zone or belt as shown by the opening 15' in the plate in front of the scanning disc. The position of the moving film is shown by the dot-dash lines F. Successive lines of elemental areas across the picture are transmitted irrespective of whether the system is a single or a multiple channel system. The positioning of the apertures in circular arrangement and continually moving an associated film is old in a single channel but dividing the scanning into a plurality of channels for multiple channel operation as here disclosed is novel. A similar modification may be made in the television receiving element 430 and the film in the receiving camera 401 moved at a uniform rate. In projecting the finished film on the screen for viewing any standard picture projector 450 may be used. Moving the film at a uniform rate for electro-optical transmission has the decided advantage of permitting the television transmitting and receiving apparatus to operate continuously and not cease photoelectric transmitting and receiving operations between pictures as is required when the film is intermittently advanced in the usual way from picture to picture. This advantage is important in effecting economies and efficiencies in the use of the transmission system and apparatus. The loss in time due to intermittently advancing the film may be fifteen to twenty per cent of the total time which is the equivalent of one channel in a five or six channel system.

It is also obvious that different types of transmitting apparatus can be used with a given type of receiving apparatus or vice versa. For example, the transmitting apparatus employing light amplification by means of a film as shown in Fig. 7 might be used with the grid type glow discharge lamp receiver shown in Fig. 6 or the transmitting apparatus shown in Fig. 1 might be used with the light amplification arrangement employing a film as shown in Fig. 8. However, when only one photographic process is employed since the photographic process reproduces in general in a reciprocal manner, means must be provided for so warping the characteristics of the picture transmission that the non-linear characteristic inherent in the photographic process when carried through only one of the two operations is compensated for. Either optical or electrical distortion may be employed for effecting this compensation. Also the proper electrical polarity must be made in the circuit connection

in order that received photoelectric current may produce a positive picture at the receiver irrespective of the combination of apparatus units used. Other combinations of transmitting and receiving apparatus are obvious.

What is claimed is:

1. In a multiple channel electro-optical system, a rotatable scanning disc comprising a plurality of light beam directing optical prisms arranged in a single line upon said disc within 360°, and means for causing light beams to pass simultaneously from a number of said prisms equal in number to the transmission channels and to cross a viewing field in juxtapositioned scanning lines.
2. In a multiple channel electric-optical system, a rotatable disc comprising a plurality of light directing optical prisms spirally arranged upon said disc in a single spiral, and means for causing light to pass simultaneously through a number of said prisms equal in number to the transmission channels.
3. In a multiple channel electro-optical system, a rotatable disc comprising a plurality of apertures in a single row within 360°, and means for causing light to pass simultaneously through a number of said apertures equal to the number of transmission channels.
4. The method of multi-channel television which comprises scanning a series of parallel strips of a field of view in succession for each channel, each strip comprising a series of elemental areas, the strips for each channel being interspersed with strips for the other channel or channels, the scanings for all channels being concurrent and the time of beginning of scanning of each strip being different from that for an adjacent strip by the same amount.
5. A multi-channel television system comprising means for scanning a series of parallel strips of a field of view in succession and in the order of their occurrence across the field, each strip comprising a series of elemental areas, the time of beginning of scanning of each strip being different from that for an adjacent strip by the same amount, and which is less than a line scanning period, and means for causing different portions of the field to be transmitted over different channels concurrently.
6. A multi-channel television system comprising means for scanning parallel strips of elemental areas of a field of view and for causing the period of scanning of each strip to substantially overlap that of each strip adjacent thereto, and means for causing different portions of the field to be transmitted over different channels concurrently.

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