

Dec. 7, 1943.

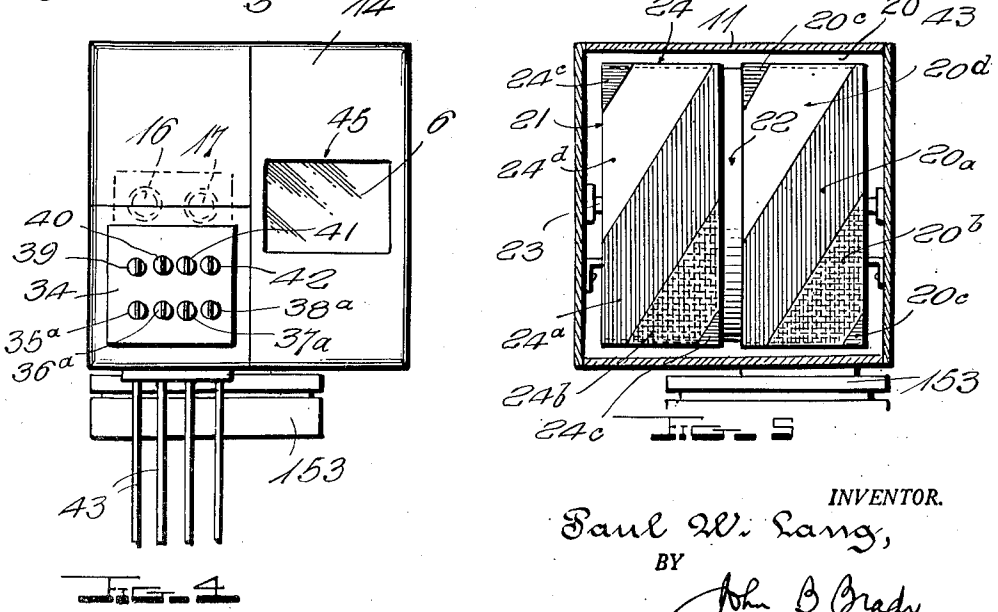
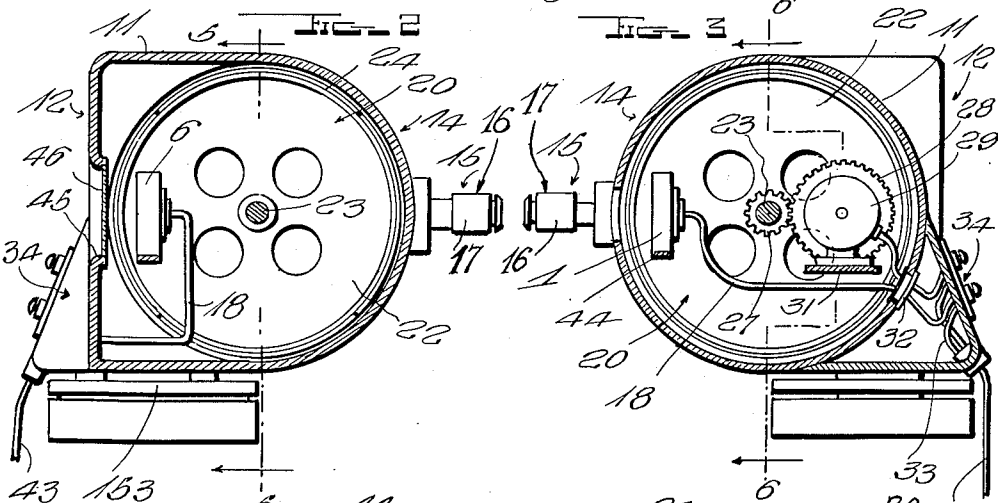
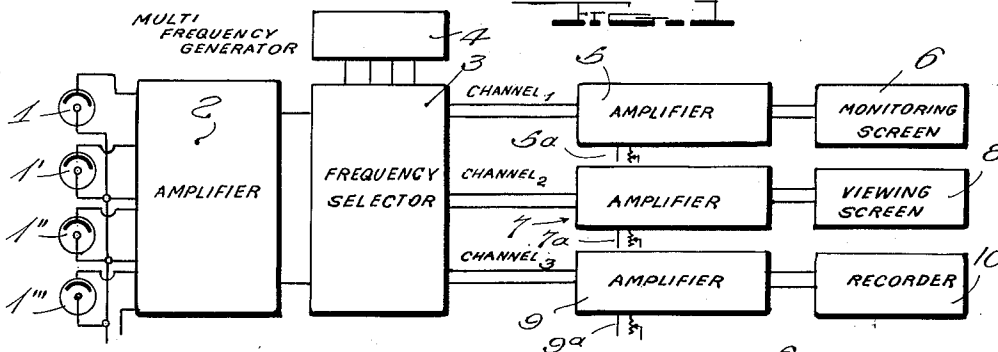
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2,335,864

PHONOVISION SYSTEM

Filed Oct. 17, 1941

4 Sheets-Sheet 1



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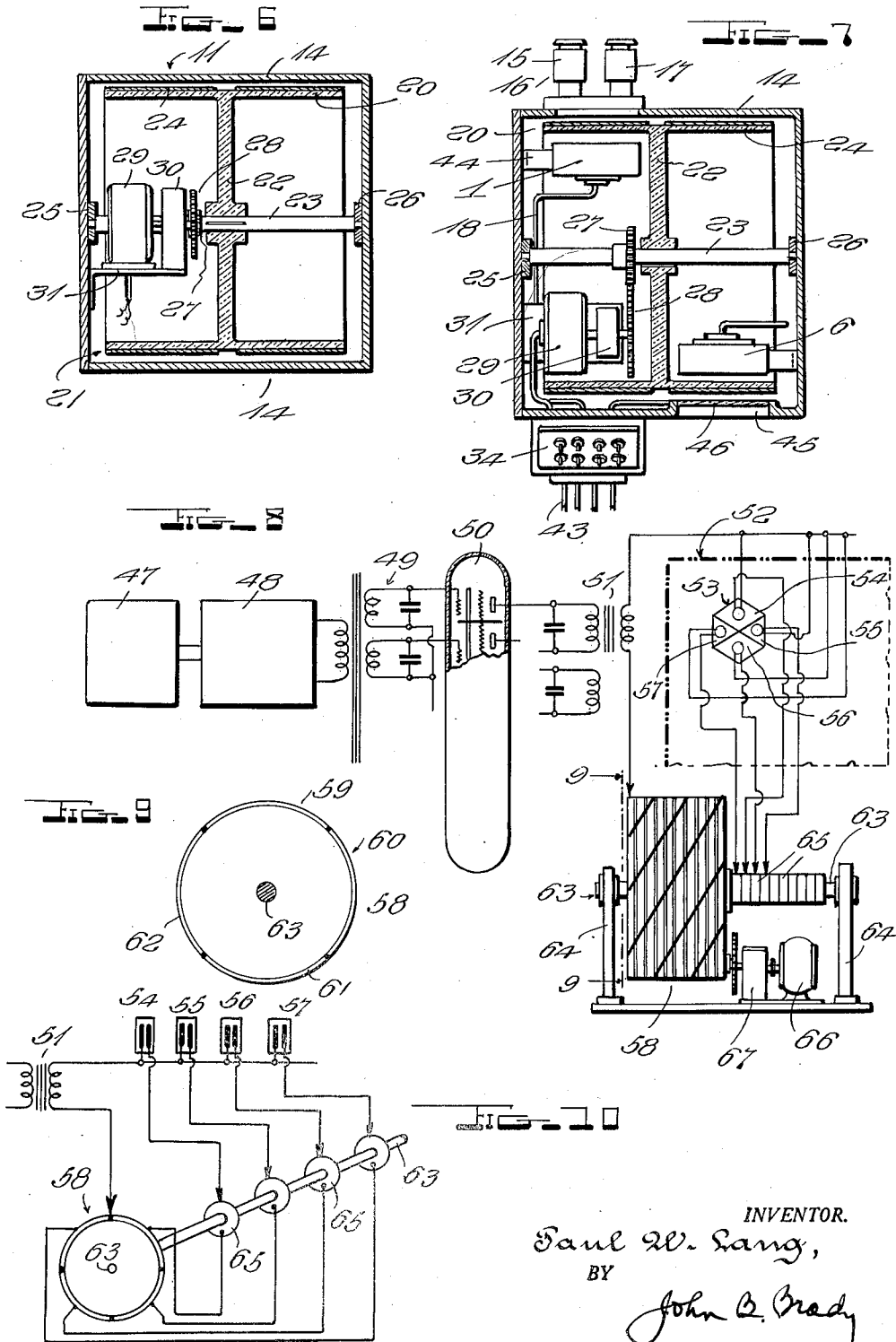
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PHONOVISION SYSTEM

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4 Sheets-Sheet 2

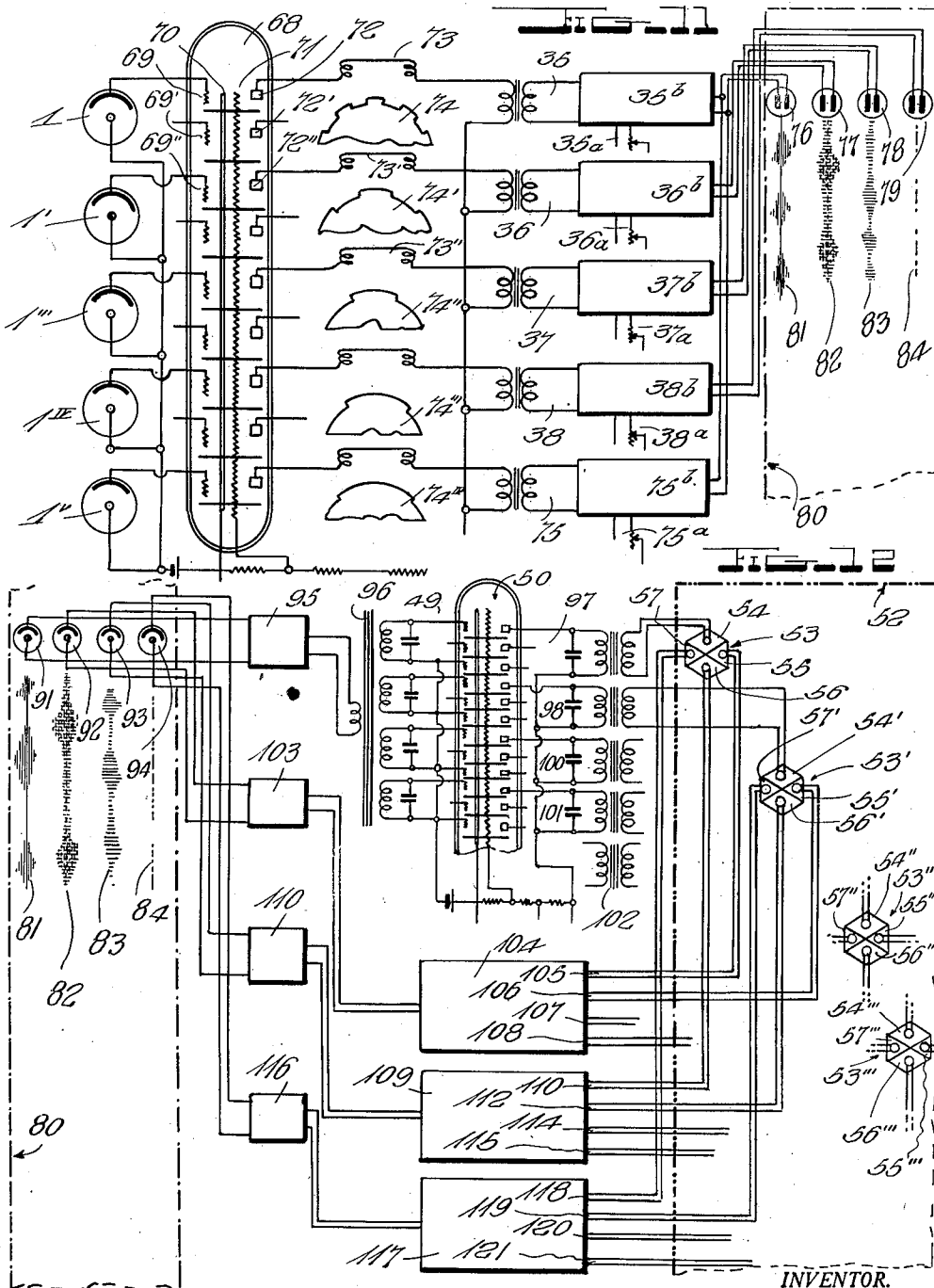


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4 Sheets-Sheet 3



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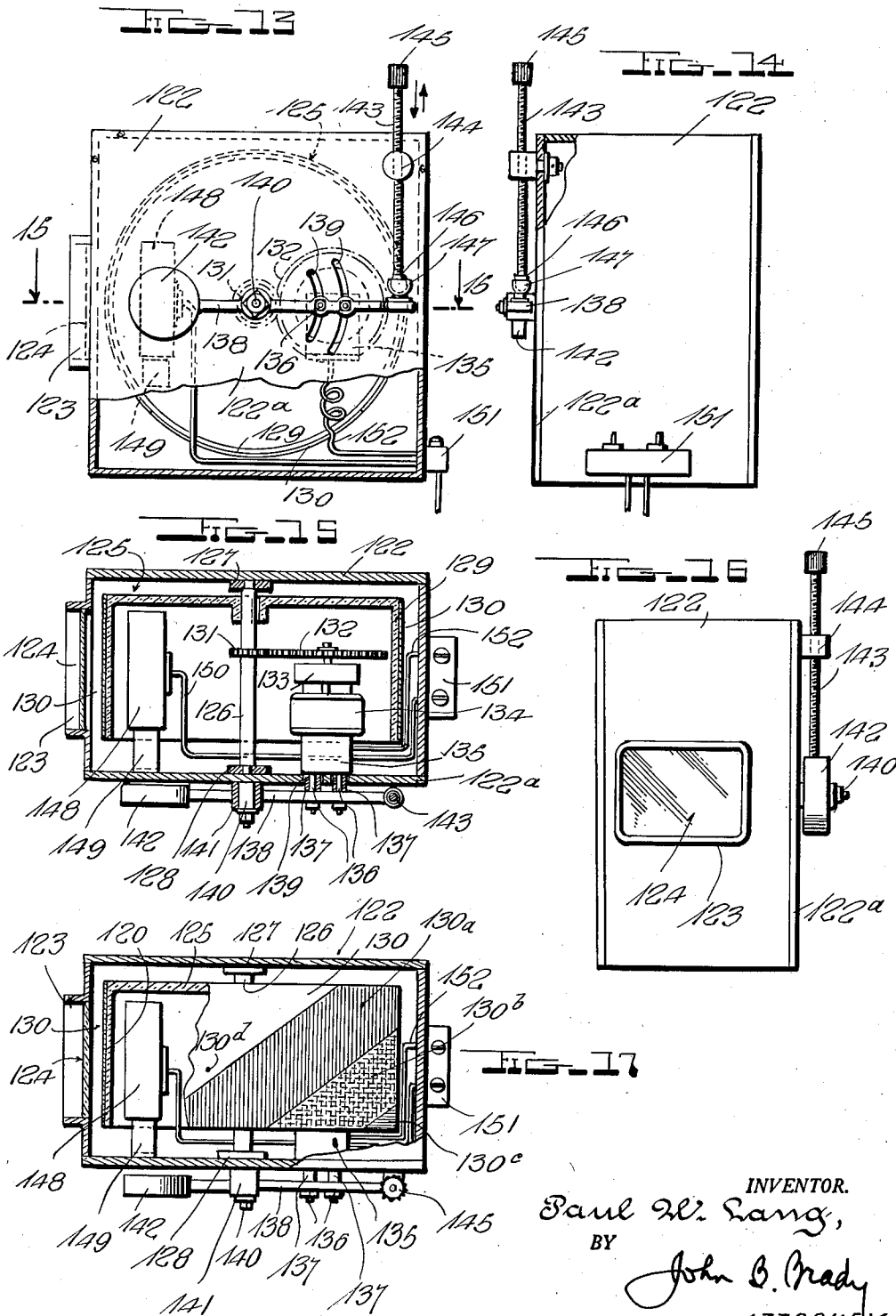
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PHONOVISION SYSTEM

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4 Sheets-Sheet 4



UNITED STATES PATENT OFFICE

2,335,864

PHONOVISION SYSTEM

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Application October 17, 1941, Serial No. 415,464

5 Claims. (Cl. 178—5.2)

My invention relates broadly to electrical recording and reproduction of images and more particularly to an improved apparatus for recording and reproducing images.

This application is a continuation-in-part of my application, Serial No. 357,999, for Phonovision system, filed September 23, 1940.

One of the objects of my invention is to provide an improved construction of camera for electrically recording images and reproducing such images at a distance.

Another object of my invention is to provide a construction of camera having means for electrically recording images and monitoring such images immediately adjacent the operator's position while simultaneously reproducing and/or recording the images thus monitored at a distance.

A further object of my invention is to provide a system for electrically reproducing images in natural color simultaneously in a monitoring position adjacent the operator and in a distant position.

A still further object of my invention is to provide a construction of image reproducing apparatus for electrically reproducing images according to the natural color of the original object having means for orienting a scanning color filter adjacent the observing apparatus for synchronizing the color screen with the movement of a color filter at the camera position for rendering images visible with substantial clarity in natural colors.

Another object of my invention is to provide a circuit arrangement for electrically recording impulses representative of optical images including means for electrically controlling the intensity of the color components of the electrically produced images.

Still another object of my invention is to provide a system and apparatus for recording electrical impulses representative of optical values in which similar color components of the image are integrally recorded in channels selective to a particular color component with means for controlling the effective intensity of such components whereby a plurality of color components may be recorded simultaneously.

A still further object of my invention is to provide a system for optically reproducing images from electrically recorded impulses in which similar color values of the image are integrally transmitted over separate channels selective to impulses representative of predetermined color

values and combined for simultaneously reproducing color values of the original object as an optical image in natural colors.

Other and further objects of my invention reside in the construction of camera and optical reproducing unit as set forth more fully in the specification hereinafter following by reference to the accompanying drawings, in which:

Figure 1 diagrammatically illustrates the one arrangement of electrical system for the camera of my invention including a screen for optically reproducing pictures according to the object upon which the camera is focused while simultaneously reproducing in a remote location or locations similar pictures and/or electrically recording the impulses electrically produced by the camera; Fig. 2 is a vertical sectional view taken through the image monitoring portion of the camera; Fig. 3 is a vertical sectional view taken through the image focusing portion of the camera; Fig. 4 is a rear view of the camera; Fig. 5 is a vertical sectional view through the casing of the camera on line 5—5 of Fig. 2 with the cylindrical color filter and color screen elements shown in elevation; Fig. 6 is a vertical sectional view taken substantially on line 6—6 of Fig. 3; Fig. 7 is a transverse sectional view through the camera showing the optical system and light recording equipment and illustrating the arrangement of the mechanism; Fig. 8 schematically illustrates my invention as applied to reproduction of images on relatively large size screens; Fig. 9 is an end view of the commutating mechanism employed for selectively energizing portions of the glow discharge devices which are distributed over the area of reproducing screen for the reproduction of an optical image; Fig. 10 is a fragmentary perspective schematic view showing the arrangement of the selector for coordinating elementary portions of the reproducing screen with the circuits which transmit electrical impulses thereto for selectively energizing the areas of the screen; Fig. 11 is a diagrammatic view of an optical recording system embodying my invention and in which color values throughout a picture or scene are integrated and recorded in a channel selective to impulses which represent similar color values; Fig. 12 schematically illustrates a system of reproducing impulses according to my invention from a multiple film record having separate channels for similar color values and showing means for optically reproducing such color values through separate channels for integrally reproducing on

the large size screen the image of the original object; Fig. 13 is a side elevational view of the optical reproducing apparatus of my invention; Fig. 14 is an end elevation of the apparatus shown in Fig. 13; Fig. 15 is a horizontal sectional view taken on line 15—15 of Fig. 13; Fig. 16 is an end view of the reproducing apparatus showing the viewing screen in elevation; and Fig. 17 is a top plan view of the apparatus of my invention with parts broken away and illustrated in section.

My invention is directed to an improved construction of optical pick-up or camera device for converting optical scenes into electrical impulses with means for monitoring the apparatus directly at the camera at the same time transmitting the electrical impulses and reproducing the same optically at a distance. That is to say, the operator at the camera is able to view the electrical reproduction of the scene as it is being electrically reproduced at a distance under control of the camera. The improved camera construction of my invention also permits the recording of electrical impulses corresponding to the views upon which the camera is focused. The recorded impulses may be subsequently reproduced from time to time. My invention contemplates both the reproduction of scenes in a relatively small screen area as well as screen areas comparable in size with standard motion picture screens. The scenes may be reproduced in the monitoring position at the camera in natural color and in the remote position the scenes may be reproduced in natural color on a viewing screen of either relatively small size or upon screens of large area.

In order to monitor the scenes in color directly at the camera I provide a simplified arrangement of parts which insures the synchronization of both the optical recording means as well as the monitoring reproducing means. I provide a housing for the camera having a substantially cylindrical portion within which a shaft is journaled. The shaft carries a disc-like support having an internal drive means associated therewith with gears interposed between the drive means and the disc-like support for obtaining high rotative speeds necessary in mechanical scanning systems. The disc-like support carries a pair of cylindrical members which are supported from the disc-like member with the aid of such supplemental bracing from the rotative shaft as may be desirable. Each of the cylindrical members are transparent and may be formed from Lucite, glass or other transparent plastic. One of the cylindrical members is provided with spirally or diagonally arranged bands of different colors constituting color filters. These colors may be molded directly into the material of the cylindrical member or may be superimposed upon the surface thereof, the character of the color being such that light rays freely pass through the cylindrical member in the course of its passage through the lens system. I have shown my invention applied to a camera of the stereoscopic type in which a double objective lens system is employed for directing superimposed images upon the bank of light-sensitive cells disposed interiorly of the cylindrical member. The bank of light-sensitive cells are arranged to receive the image focused thereon from the stereoscopic lens system with the cylindrical member carrying the color filter interposed for movement by the lens system and the bank of light-sensitive cells. The color filter accordingly continuously scans the bank of light-sensitive cells with the effect of the

optical image focused thereon whereby the cells may be variously controlled according to the natural color of the object upon which the camera is focused. The complementary cylindrical member supported by the disc-like member comprises a cylinder carrying translucent strips of color spirally or diagonally arranged on the surface of the cylindrical member and driven directly in synchronism with the operation of the color filter of the apparatus for converting light into electrical impulses as heretofore explained.

The position of the color strips on the second mentioned cylindrical member is displaced 180° with respect to the corresponding positions of the color filter bands on the first mentioned cylindrical member whereby the viewing screen of the monitoring device may be located at the rear of the camera to enable the operator to observe the electrical character of the pick-up while photographing the object to be reproduced. The monitoring screen comprises a bank of gaseous discharge tubes individually arranged in similitude with respect to the positions of the light-sensitive cells upon which the image is focused. A translucent screen extends across the bank of electric discharge tubes upon which the reproduced picture may be viewed. This same type of translucent screen may be employed in association with auxiliary remotely disposed banks of electric discharge tubes for reproduction of similar pictures in remote positions. In the monitoring device there is a gaseous discharge tube for each of the light-sensitive cells in the bank of light-sensitive cells upon which the image is focused. Luminous discharge is effected at the camera of selected gaseous discharge tubes according to the excitation of particular light sensitive cells and in positions comparable with the positions of the cells. The effect of the discharge is controlled as to color simultaneously with the effect of the color scenes upon the correspondingly positioned light-sensitive cells. The fact that the color scene is rotating at precisely the same speed as the color filter insures synchronism between the pick-up and the monitoring device. The fact that a color screen is employed permits the use of gaseous discharge tubes of uniform characteristics not segregated especially as to color. The gaseous discharge tubes at the monitoring screen are operated simultaneously with the operation of gaseous discharge tubes in the remotely located screen. I control the operation of both the monitoring screen and the remotely located screen according to the principles set forth in my copending application, Serial No. 357,999, filed September 23, 1940, for Phonovision system of which this application is a continuation-in-part. That is to say, the impulses from the camera after suitable amplification control a frequency generator which is connected with the frequency selector, the output of which may lead to any number of channels with necessary amplification interposed in each channel. The viewing screen constituting the monitoring device is connected in the output circuit of the amplifier in one channel while the remote viewing device is controlled by the output of an amplifier connected in another channel. Any number of such channels may be employed for operating a corresponding number of viewing screens and the amount of amplification employed in such channels may be increased according to the transmission problem encountered by the impedance of such channel.

If, instead of directly reproducing the colored

pictures, it is desired to record the impulses for subsequent reproduction, I may directly record the impulses representing the optical effects directly upon a wax phonograph record, a magnetic telegraphophone record, and/or a film record. When using a film record I may record all of those impulses representing infinitesimal elements of the picture insofar as one color is concerned in one channel while recording all of those elemental impulses corresponding to a different color in another channel or light wave trace, while the elemental impulses representing still a different color are recorded in still another light channel, thus simplifying the reproducing process where the film is used to reproduce colored pictures.

In employing the system of my invention for the reproduction of pictures in color on screens comparable in size with the area of a standard motion picture film, I provide each elemental area of the screen with a composite cluster of gaseous discharge tubes the sections of which are individually capable of reproducing a light impulse corresponding to the primary colors of red, blue and yellow, and/or white light. The channels of selected frequencies extending from the output of the amplification system are each provided with selectors capable of rendering the luminous discharge tubes of different color characteristics alternately effective in the output channel. Receipt of an impulse according to the particular color characteristic of the corresponding discharge tubes operates to trigger-off that tube which renders the elemental area of the screen luminous according to that particular color characteristic. Inasmuch as the elemental area of the reproducing screen are each arranged in similitude with respect to corresponding areas of the light-sensitive cells employed in the original image focusing process, the location of one luminous discharge with respect to the location of another luminous discharge may be correlated to form an integral reproduced picture of the original image in its natural color. Because of persistence of vision, the effect of the gaseous discharge tubes of different color characteristic will blend to produce the integral effect of the original object in colors even though the individual gaseous discharge tubes may actually be excited at infinitesimally spaced time intervals.

In controlling the reproduction of color in each of the elemental areas of the large size screen, I provide a commutator device in which a segmental member is employed to control the electrical connection of the individual color sections of the discharge tubes constituting a cluster in each elemental area of the screen with the output circuit of the amplifier. The members are so displaced relative to each other that the effect of scanning by the original color screen is obtained. The segments of the several ring members are actually displaced relative to each other in substantially diagonal or spiral paths forming elements of the cylindrical drum which is built up by the related ring members forming the circuit controller for the integral operation of all of the elemental areas of the screen.

To insure constant and related speed of operation of the camera, the recorder if used, and/or the scanner for the relatively small size screen or the selector for the relatively large size screen, I employ synchronous alternating current motors driven from a timed or constant rate power supply system and preferably the same power supply system so that the equipment will re-

main in step and all functions progressed synchronously. In order to properly position the color screen with respect to the bank of discharge lamps at the reproducer, I provide in association with a rotary cylindrical color screen, a mounting for the driving motor whereby the motor may be oriented in position forward or backward to bring the color screen into synchronized position with the corresponding position of the color screen used in taking the original picture. The color screen may thereby be shifted clockwise or counterclockwise to secure the maximum visibility of the picture.

Referring to the drawings in detail, Fig. 1 schematically represents a camera pick-up system embodying my invention including a monitoring screen located adjacent the camera to enable the operator to directly observe the scenes upon which the camera is focused, at the same time operating a viewing screen remotely located at a distance and at the same time recording the electrical impulses representative of the scenes upon which the camera is focused. Such recorded impulses may be subsequently reproduced for reproduction of the scene at a desired time. Reference characters 1, 1', 1'', 1''' represent the individual light-sensitive or photoelectric cells constituting the bank of light-sensitive cells employed in the camera and represented structurally at 1 in Figs. 3, 4, 7, etc., connected to the input circuit of an audio frequency amplifier system represented at 2 in Fig. 1. The output of the amplifier 2 controls the multiple frequency selector 3 which is connected with the multiple frequency generator 4 of the type explained more fully in my copending application 357,999, supra. The output of the multiple frequency selector by which audio frequency tones over the entire frequency spectrum may be supplied to the visual picture reproducing screens and/or the recorder is shown connected to three separate channels designated "channel 1," "channel 2" and "channel 3." Each channel includes suitable audio frequency amplification for amplifying the impulses supplied from the bank of light-sensitive cells. The amplifier in channel No. 1 which connects to the monitoring screen is indicated at 5, the output circuit of the amplifier being electrically connected to the monitoring screen in the rear of the camera which I have designated at 6. Inasmuch as the monitoring screen is located immediately adjacent the position of the light-sensitive cells there is negligible drop in the channel circuit so that a relatively small amount of amplification is required. The intensity of the light reproduced on the monitoring screen is controlled by the adjustable cathode circuit which I have designated at 5a leading to amplifier 5.

Channel No. 2 connects to the remotely located viewing screen and because of the substantial drop in the cable circuit contains a larger amplifier which I have represented at 7 adjustably controlled by cathode rheostat 7a, the output of the amplifier being connected to the remotely located viewing screen which I have indicated at 8.

In order that the views upon which the camera is focused may be perpetrated, I connect channel No. 3 to the recorder through amplifier 9. Amplifier 9 is controllable as to amplitude of the transferred energy under control of adjustable rheostat 9a. The output of amplifier 9 connects to the recorder designated at 10. Any desired type of recorder may be employed such

as a disc or cylindrical deformable record type; a magnetic telegraphone type; or a film record type. That is to say, any type of recorder capable of receiving and recording a multiplicity of audio frequencies constituting the elements of the transmitted picture may be employed.

The camera employed in the phonovision system of my invention includes a casing 11 having a relatively flat rear surface 12 and a curved front surface 14 from which the objective lens system 15 of the camera extends. I employ a stereoscopic lens system represented generally by the objective lenses 16 and 17 which are capable of being trained upon the object and which focus images of the object through a system of optical prisms upon the bank of light-sensitive cells represented at 1. The bank of light-sensitive cells 1 are connected through a multiple cable 18 with the input circuit of the amplifier schematically shown in Fig. 1.

Intermediate the bank of light-sensitive cells 1 and the optical prism system I provide a rotatable color filter carried by the rotatable scanning drum shown generally at 20 in Figs. 2, 3, 6 and 7. The color filter 20 is formed by a plurality of diagonally or spirally extending bands arranged on the surface of the scanning cylinder as shown generally at 21 and constituting the primary colors, that is, red, yellow and blue shown at 20a, 20b and 20c, respectively, arranged with respect to a similarly disposed white band 20d. These filter bands are formed directly in the material of the scanning cylinder 21 or may be applied to the surface thereof. The scanning cylinder may be formed from Lucite, glass or other transparent material. The scanning cylinder 21 is supported transversely by means of a disc-like member 22 which is disposed midway between the ends of the cylinder and is carried by the axially extending shaft 23. The scanning cylinder 21 extends on each side of the transverse disc 22 and as heretofore explained comprises the color filter portion 20 on one side. On the other side of the transversely extending disc member 22 the scanning cylinder comprises a color screen which I have indicated generally at 24. The color screen consists of diagonally or spirally disposed bands of primary colors which I have shown at 24a, 24b, 24c, etc., that is, red, yellow and blue, respectively, associated with a white band 24d disposed in a similar arrangement.

The shaft 23 which carries the disc 22 is journaled in bearings 25 and 26 mounted in the ends of casing 14 so that the scanning cylinder is free to rotate at a high rate of speed. I employ precision type ball bearings or roller bearings of anti-friction type for insuring high speed operation of the scanning cylinder. Shaft 23 carries a gear 27 thereon with which the drive gear 28 meshes. Motor 29 drives the drive gear 28 through a speed multiplying gear box 30 whereby high speed operation of the scanning cylinder is obtained. A shelf member 31 extending from the inner end wall of casing 14 forms a support for the motor 29. A similar shelf 44 extends from the opposite end wall of the camera into the space within scanning cylinder 21 for the purpose of supporting the bank of light-sensitive cells 1. Casing 14 is apertured and provided with an insulated bushing 32 through which the cables extending from and entering the casing are adapted to pass.

For the purpose of controlling the camera, I arrange a control panel 34 adjacent the rear of the casing 14 and extending in a convenient plane

for rendering the controls readily accessible to the operator. The panel 34 carries a multiplicity of control attenuators for regulating the degree of amplification in the channels connected with the light-sensitive cells and leading to the channels which are arranged to amplify electrical impulses representative of the same color values. The electrical circuits for this camera have been shown in Fig. 11 from which it will be seen that a separate amplifying system is provided for control of electrical impulses of similar color values, that is, all impulses representing red pass through one channel 35 and are controlled by attenuator 35a; electrical impulses representing yellow color values pass through channel 36 and the intensity thereof is controlled by attenuator 36a; electrical impulses representing blue color values pass through channel 37 and pass through attenuator 37a, while electrical impulses representing white pass through channel 38 and are controlled by attenuator 38a. I have represented each of these attenuators on control panel 34. Switch 39 is provided for starting and stopping driving motor 29 at the camera. Switch 40 is provided for cutting on or off the monitoring screen 6; switch 41 is provided for cutting on and off the remote viewing screen 8 while switch 42 is provided for cutting on and off the recording apparatus 10. I contemplate the provision of local control switches for either the viewing screen and/or the recording apparatus at the remote end of the system. The electrical conductors entering and passing out of the casing 14 connect with the control switches on panel 34 as represented generally at 33, while the flexible cables 43 also connect with the switching mechanism on panel 34 and extend externally of the camera to the associated apparatus diagrammatically illustrated in Figs. 1 and 11.

The monitoring screen comprising the multiplicity of gaseous discharge tubes located in positions similar to the positions of the light-sensitive cells in the bank of cells 1 are disposed within the cylindrical color screen 24 in alignment with the aperture 45 in casing 14 across which there extends the translucent glass plate 46. The optical images of the object upon which the camera is focused appear on this translucent screen so that the operator is advised as to the quality of the picture being transmitted by the camera to the remote position.

The viewing screen in the remote position may be of relatively small size as shown, for example, in the arrangement in Figs. 13-17, or the viewing screen may be of large size as represented in Figs. 8 and 12. In the arrangement illustrated in Fig. 8 I have schematically shown the method of exhibiting pictures on a relatively large size screen from impulses stored upon a recorder. The method of recording the impulses has been indicated generally in Figs. 1 and 11 and also explained in my copending application 357,999, supra. The multiple frequency recorder is shown diagrammatically at 47 connected through amplifier 48 to the frequency selection circuit represented generally at 49 containing the multi-unit electron tube 50 by which a selected tone frequency may be passed to the output circuit 51 for transfer to the gaseous discharge tube associated with the relatively large size screen represented at 52. The screen 52 includes a multiplicity of gaseous discharge devices shown at 53 which are sectionalized to provide distinctively colored luminous discharges, that is to say, there are four sections which I have represented at 54

including a gas for producing, for example, a red discharge; a section 55 including a gas producing a yellow discharge; a section 56 enclosing a gas producing a blue discharge and a section 57 enclosing a gas producing a white discharge. These sections of the discharge tube 53 are arranged to operate sequentially by means of a mechanically driven distributor 58 consisting of ring members each including four segments insulated one from the other represented at 59, 60, 61 and 62 supported upon rotatably driven shaft 63. The ring members are arranged in stacked relation on shaft 63 which is journaled in suitable bearing support 64. Collector or slip rings 65 are provided on shaft 63 for the purpose of establishing connection with the segments of each of the ring members. Four collector rings 65 are provided for each of the ring members, that is, a collector ring for each segment and electrically connected with the segments and to each of the sections of the gaseous discharge tube 53. A brush contact member completes the circuit to the output circuit of the amplifier at 51 so that sections of the gaseous discharge tube are sequentially connected with the output circuit of the amplifier at 51. It will be observed that the several ring members are displaced step-by-step with respect to each other on the distributor drum. This permits the several gaseous discharge tubes and the sections thereof to be electrically connected in similitude in the order which corresponds with the rotation of the scanning filter 20 of the camera. That is to say, the position of the sections of the gaseous discharge tubes is selected to correspond with the positions on scanning of the object by the color filter at the camera. To insure high speed operation of the distributor 58 I provide a driving motor 66 which operates through a speed multiplying gear box 67 for driving the distributor 58.

One of the elemental sections of the distributor and collector rings and sections of the gaseous discharge tube has been illustrated in Fig. 10 for the purpose of explaining my invention. It will be seen that a sequential connection of the sections of the gaseous discharge tube is timed to enable the sections of the gaseous discharge tube to respond to corresponding color values of the object at the transmitter or according to recording impulses representing such color values.

In Fig. 11 I have illustrated a method of recording electrical impulses representative of an optical image where the color values of the object are segregated into separate channels which may be independently controlled and employed to effect a record on the same film. The camera including the bank of photo cells has been represented as before as comprising light sensitive cells 1', 1'', 1''', 1'', 1'', connected to the independent grid electrodes of the multi-grid tube represented at 68. The multi-grid tube 68 is more fully explained in my copending application, Serial No. 357,999 supra, and includes generally the multiplicity of grid electrodes 69', 69'', etc., arranged adjacent the cathode 70 and the screen grid 71 and coacting with the anode electrodes 72', 72'', etc. The plate circuit for the multiple tube each include windings 73, 73', 73'', etc., connected to the separate anode electrodes. The windings are each subjected to the action of the variously shaped magnetic inductors shown at 74, 74', 74'', 74''', 74'', etc., which are rotatably driven for producing in the individual output circuits different and discriminating audio frequencies. The frequency of the current which is permitted to pass at any other of the output cir-

cuits is representative of the color values in the object which is focused upon the coacting light sensitive cell. The position of the cells in the bank of cells is such that the frequency of the currents which are permitted to flow in the several output circuits can be recorded and/or directly reproduced for producing a picture in similitude with respect to the original object. The output circuits are shown connected to the channels 35, 36, 37, 38, and 75, etc., leading to the input circuits of amplifiers designated at 35b, 36b, 37b, 38b, and 75b, respectively. The amplitude of the energy transferred by each of the amplifiers is indirectly controlled by suitable rheostats in the control circuits 35a, 36a, 37a, 38a, and 75a, respectively. By virtue of such control circuits the amplitude of the current of selected frequency and accordingly the color values represented by such current may be controlled. The output circuits of the separate amplifiers lead to the recording lamps 76, 77, 78, and 79 in the recording head of the light sensitive film record 80. The photo cells in the different sections of the bank of cells which are sensitive to the same range of color values have the output circuits of the amplifier terminating in the same recording lamp. Thus recording lamp 76, responsive to values of red connects not only to the output of amplifier system 35b but also to the output of amplifier system 75b. The wave trace 81 which is recorded on film record 80 thus contains a multiplicity of different frequencies representing the red values throughout the object. The recording lamp 77 connects to the output of amplifier 36b and to the output of all of the other of the amplifiers in the several channels which are responsive to the yellow color values in different parts of the object for thus recording on the screen the wave trace 82 including various frequencies representing yellow color values throughout the picture. Recording lamp 78 connects to the output of amplifier 37b and to the output circuits of all of the other amplifier channels representative of blue color values throughout the object so that the recorded wave trace 83 includes frequencies representative of all of the blue color values throughout the original object. The output circuit of amplifier 38b connects to recording lamp 79 selectively responsive to the white color values of the original object and this same recording lamp 79 connects to the output circuit of each amplifier in the channels over which the white color values are transmitted. Thus the wave trace 84 includes various frequencies representative of white color values in various parts of the object.

In Fig. 12 I have shown one method of reproducing colored pictures on a screen under control of the film record 80 already prepared in accordance with the method shown in Fig. 11. A plurality of light sensitive cells are arranged in the pick-up head individual to each of the recorded wave traces 81, 82, 83, 84, from the film record 80. These cells are represented at 91, 92, 93, and 94, each aligned with the multiple frequency wave trace which includes the several frequencies representative of predetermined ranges of color values. The light sensitive cell 91 which is selectively responsive to frequencies of red color values connects to the input circuit of amplifier 95 which in turn connects to the input circuit 96 of the multiple frequency tube system 50. The multiple frequency selector tube system 50 is similar in principle to the tube 50 illustrated in Fig. 8. The different sections of the tube 50 are screened

one from another and the input circuits 49, each selectively adjusted to transfer a selected tone frequency which is representative of a particular color value. It will be understood that the input circuit and the output circuit of amplifier system 50 are selectively tuned to pass a particular frequency representative of the same range of color values but in different positions in the screen 52 precisely similar to the location of such color values in the original object. That is to say, the output circuit 97 and amplifier 50 connects to section 54 of discharge tube 53 for reproducing the color red while output circuit 98 connects to discharge section 54' in discharge tube 53' for reproducing the color red corresponding to the frequency to which input circuit 99 and output circuit 98 of amplifier 50 are selective, which frequency is also indicative of position of the said color values in the original object. The output circuit 100 connects to the red discharge section of a red discharge section 54'' of another discharge section 53'' in a different location of the screen disposed in a location similar to the location of the light sensitive devices in the original camera. Similarly the frequency selective circuit 101 connects to the red discharge section such as 54''' or discharge tube 53''' located in position in the screen corresponding to the position of light sensitive recording elements in the original camera. Additional sections of the selector tube connect to additional output circuits which I have represented generally at 102 for connection to the red section of discharge tubes in certain elemental areas of the screen located according to position of the original light responsive elements in the camera.

The yellow, blue and white color values are reproduced from the film record through separate channels in a manner corresponding to the method described in connection with the reproduction of the red color values. That is to say, photo electric tube 92 responsive to the frequencies designating yellow color values recorded in wave trace 82 on film record 80 connects to the input circuit of amplifier 103 which connects to selector system 104 similar to the multi-unit tube 50, the circuits of which discriminate as to frequencies designating the color values in the yellow color range throughout the different elemental areas of the object. The output of selector system 104 connects to the yellow discharge sections of the several discharge tubes throughout the screen 52. That is to say, the output circuit 105 connects to the section 55 of gaseous discharge tube 53 producing a yellow discharge. The circuit 106 connects to the other discharge section 55' of gaseous discharge tube 53' for producing a yellow discharge representing the particular frequency and location of the corresponding light sensitive element in the camera with respect to the object. Similarly, circuit 107 connects with the yellow discharge section of another gaseous discharge tube such as a section 55'' in gaseous discharge tube 53''. Similarly, the output channel 108 connects to the yellow discharge section of another gaseous discharge tube such as section 55''' of gaseous discharge tube 53'''. Thus all of the yellow color values of the original object are reproduced according to their locations on the screen.

Similarly, the blue color values are reproduced through channel 109 wherein frequency discriminating circuits are provided in the input circuits which connect through amplifier 110 with the light sensitive cell 93 that is aligned with wave

trace 83 containing frequencies corresponding to the blue color values in the object. The output channel 111 connects to the blue discharge section 56 of discharge tube 53. Similarly, the frequency discriminating output channel 112 connects to the blue discharge section 56' of discharge tube 53'. Output channel 114 containing impulses representative of blue color connects to the blue discharge section of a discharge tube in another location of the screen such as section 56'' of discharge tube 53''. Channel 115 connects to the blue discharge section such as section 56''' of another gaseous discharge tube such as tube 53'''. Additional output circuits connect to the blue discharge section of other discharge tubes throughout the elemental areas of the screen.

The channel which reproduces the white color values throughout the elemental areas of the object connect to light sensitive cell 94 disposed in the input circuit of amplifier 116. The output circuit of amplifier 116 connects to the frequency selector circuit 117 having a multiplicity of frequency discriminatory output circuits represented at 118, 119, 120, 121. Output circuit 118 connects to the white discharge section 57 of gaseous discharge tube 53. Output circuit 119 connects to the white discharge section 57' of gaseous discharge tube 53'. The output circuit 120 connects to the white discharge section of another discharge tube such as the section 57'' of gaseous discharge tube 53''. The output circuit 121 connects to the white discharge section of another gaseous discharge tube such as the white discharge section 57''' of gaseous tube 53'''. Another frequency discriminating circuit corresponding to the white color values of the object leading to the white discharge sections of other gaseous discharge tubes throughout the elemental areas of the screen 52. The foregoing description relates to the reproduction of pictures on screens of relatively large size comparable to standard motion picture screens.

In Figs. 13-17 I have represented one form of relatively small size viewing screen practical for home reproduction of pictures from disc or film records or direct operation over a line wire channel from the camera at the transmitting station or by space radio. The apparatus is shown enclosed in a casing 122 containing at one side thereof an aperture 123 which contains a translucent viewing screen 124. A cylindrical member 125 having a cylindrical surface portion formed from transparent material is supported by an end plate on shaft 126 which is journaled at 127 and 128 with respect to the walls of casing 122. The cylindrical transparent surface 129 of cylindrical member 125 carries color screen 130 thereon formed by a multiplicity of spirally or diagonally arranged bands of transparent zones of color which I have represented as red at 130a, yellow at 130b, blue at 130c, and white at 130d. The angular disposition of these bands corresponds with the angular arrangement of the bands of the color filters at the camera shown at 24a, 24b, 24c and 24d in Fig. 5. The cylindrical member 130 is rotatably driven by means of gear 131 on shaft 126 which is meshed with gear 132 driven from gear box 133 at relatively high speed by motor 134. The motor 134 is carried by a support 135 from which projects securing bolt members 136 having suitable spacing sleeves thereon represented at 137 to effect connection between the bolt members 136 and the lever 138 in predetermined spaced relation. The side wall 122a

of casing 122 is provided with arcuate slots 139 through which the bolt members 136 with sleeves 137 thereon project so that angular movement of lever 138 about stud 140 as a center enables the motor driven mechanism to be oriented with respect to the cylindrical member 125. The lever member 138 is provided with an enlarged central portion 141 which is journaled upon stud 140. Lever member 138 is counterbalanced by means of weight 142 so that the motor mechanism is substantially floating within the cabinet structure capable of being angularly shifted clockwise or counterclockwise by means of the adjustable screw 143 which passes through the screw threaded angularly rockable project support 144 on cabinet structure 122. The screw 143 has an adjusting knob 145 on the extremity thereof and terminates in a substantially spiral head 146 which fits into a similarly shaped socket member 147 carried by the end of the lever 138. Thus angular movement of lever 138 may be controlled allowing for lost motion and small angular shifts in position of screw 143 for adjusting with precision the position of the driving gear 132 with respect to driven gear 131 in which the bank of discharge tubes constituting the viewing screen of the apparatus is represented at 148 supported on bracket 149 from the interior of cabinet 122 in alignment with the translucent screen 124 in aperture 123. The bank of discharge tubes is connected through cable 150 which passes through the wall of cabinet 122 and through the cable entrance 151 for connection with circuits from a recording system or from a camera as represented for example, in Fig. 1. The cable entrance 151 also provides passage for cable 152 leading to the driving motor 134. High speed operation of the motor is assured by the step-up gearing contained in gear box 133. Suitable supports are provided for equipment of both the camera and the reproducer. I have represented, for example, in Figs. 2-5 inclusive a supporting head 153 which may be mounted upon a tripod for operation of the camera in the field. As heretofore mentioned I provide synchronous motor drives for both the camera and reproducer thereby assuring synchronized operation of the apparatus. The adjustment 145 at the receiver of Figs. 13-17 insures the proper alignment of the color screen with the similarly arranged color filter at the camera for insuring reproduction of pictures with maximum clarity.

I have described my invention in certain of its preferred embodiments but I realize that modifications may be made. For example, I have illustrated the use of banks of discharge tubes constituting the reproducing screens. I may employ other forms of electronic devices in these parts and it is my intention that my invention shall cover all such modifications and I intend no limitations upon my invention other than may be imposed by the scope of the appended claims.

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

1. In a system for recording electrical impulses representing in similitude and color the elemental areas of an object comprising light-sensitive discriminatory means focused upon the object, said means being discriminatory as to position and color of the elemental area of the object, separate channels for said means, a multi-frequency generator for producing individual currents of different frequencies representative of the position and color values of elemental areas of the object, individual luminous discharge

tubes corresponding in color value to the color sensitiveness of the discriminatory means, individual connections between all of the channels transmitting currents representative of the same color value and the luminous discharge tube corresponding to said color value, a film record exposed to each of said luminous discharge tubes for recording currents representing the same color values in individual light traces on the film, and means individual to each of said channels for controlling the amplitude of the record trace on the film for determining the intensity of the color values represented by the light traces.

2. In a system for reproducing pictures in color in combination with a screen containing a plurality of luminous discharge devices distributed over the area thereof, each of said devices containing luminous discharge sections of different color characteristics, connections extending from each of said luminous discharge sections, a multi-channel selector connected to each of said connections, a record comprising a plurality of individual channels, the individual channels including frequencies representative of the same color values in the picture to be reproduced, a light-sensitive device individual to each channel, and connections between an individual light-sensitive device and one of said selectors for exciting from the said channel the luminous discharge portion of the same color characteristic in each of the luminous discharge devices distributed over the area of the screen for synthetically reproducing a picture in color.

3. In a system for reproducing pictures in color, a screen containing a plurality of luminous discharge devices distributed over the area thereof, each of said devices including individual luminous discharge sections of different color characteristics, a distributor selectively connecting the several sections of said luminous discharge device, a multi-channel frequency selective circuit coupled with said distributor, and a composite multiple frequency record containing frequencies representing various picture components of different color values connected with said selector, said distributor being synthetically operated for selectively rendering effective a luminous discharge section of said luminous discharge device of a color value corresponding to frequency components supplied from said record through said selector.

4. In a system for reproducing pictures in color, a screen containing a plurality of luminous discharge devices distributed over the area thereof, each of said devices including individual luminous discharge sections of different color characteristics, a distributor selectively connecting the several sections of said luminous discharge device, a multi-channel frequency selective circuit coupled with said distributor, and a composite multiple frequency record containing frequencies representing various picture components of different color values connected with said selector, said distributor containing electrical circuit controlling elements displaced in sequential position corresponding to the effective scanning characteristic represented by the electrical impulses contained in said multiple frequency record for rendering effective a particular luminous discharge section of said luminous discharge device of a color value corresponding to the color values represented by impulses delivered by said record through said selector.

5. In a system for reproducing pictures in color, a screen containing a plurality of luminous dis-

charge devices distributed over the area thereof, each of said devices including individual luminous discharge sections of different color characteristics, a distributor selectively connecting the several sections of said luminous discharge device, a multi-channel frequency selective circuit coupled with said distributor, and a composite multiple frequency record containing frequencies representing various picture components of different color values connected with said selector, said 10

distributor containing circuit elements displaced from each other in spiral paths corresponding to the scanning characteristics contained in the recorded impulses of said multiple frequency record for rendering effective selected luminous discharge sections of said luminous discharge devices throughout the area of said screen through said selector and to said record for synthetically reproducing a picture in color.

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