

Oct. 5, 1926.

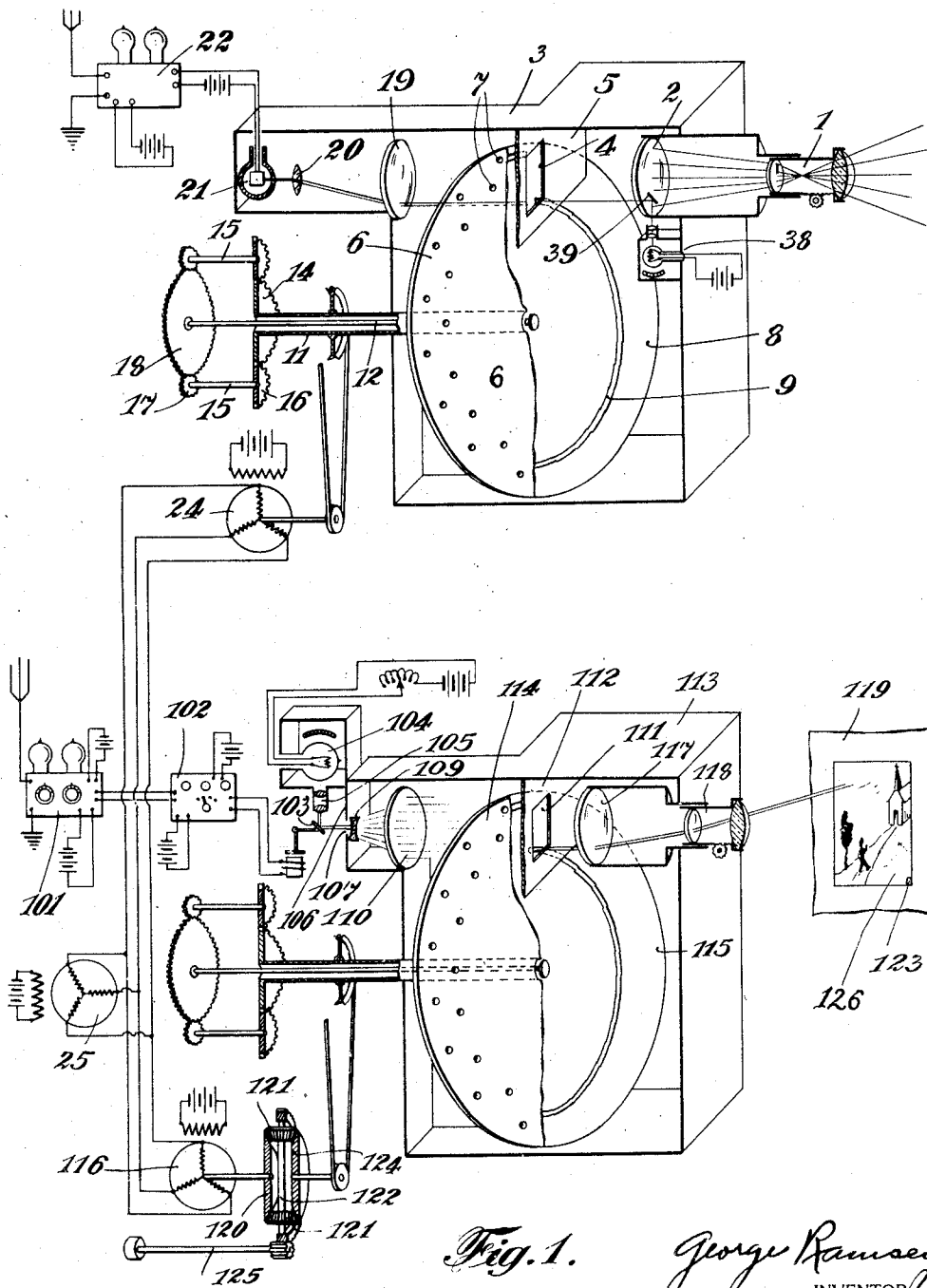
1,602,121

G. RAMSEY

TELEVISION

Filed Dec. 5, 1923

3 Sheets-Sheet 1



Oct. 5, 1926.

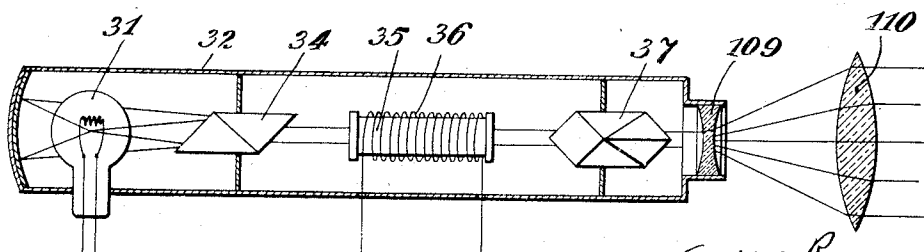
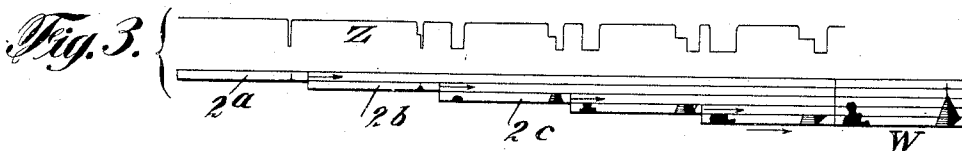
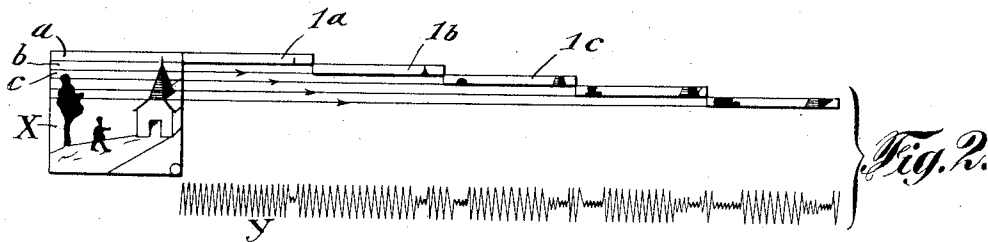
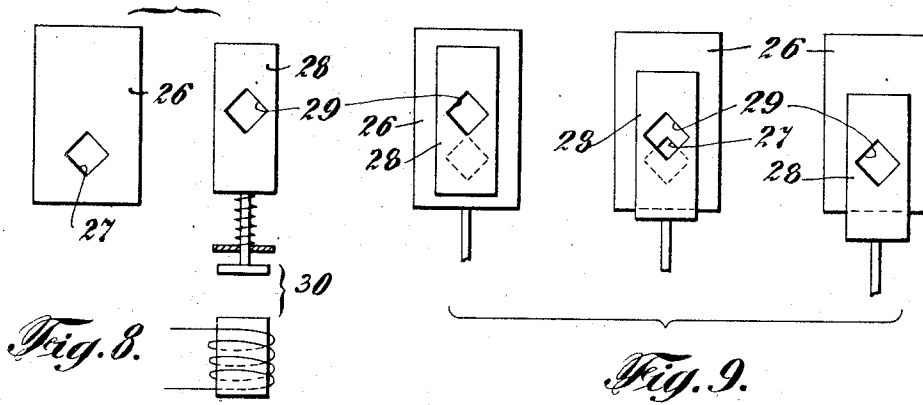
G. RAMSEY

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TELEVISION

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3 Sheets-Sheet 2



George Ramsey  
INVENTOR

Oct. 5, 1926.

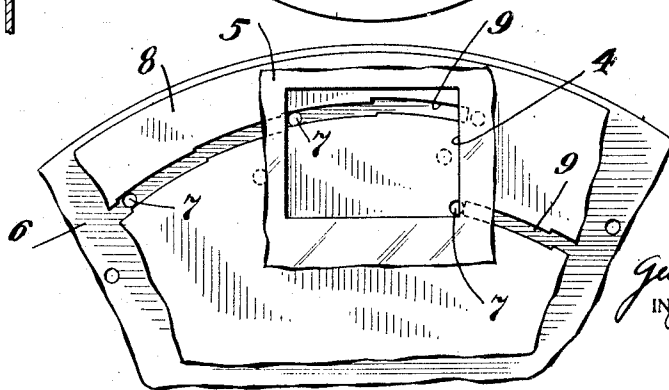
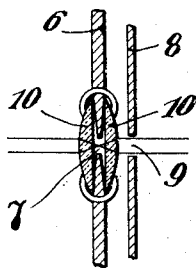
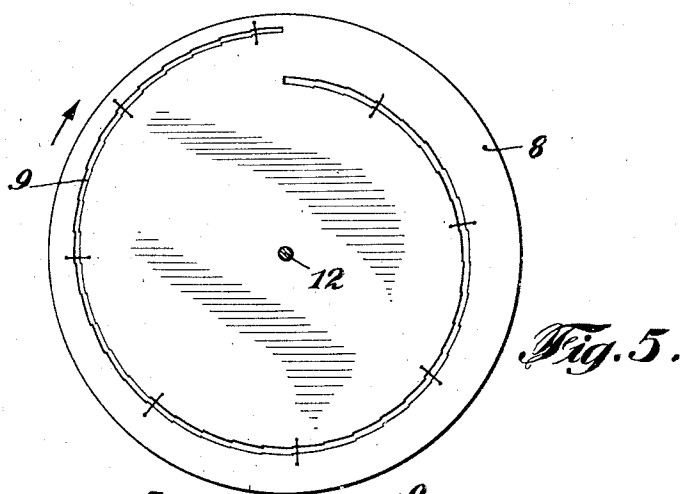
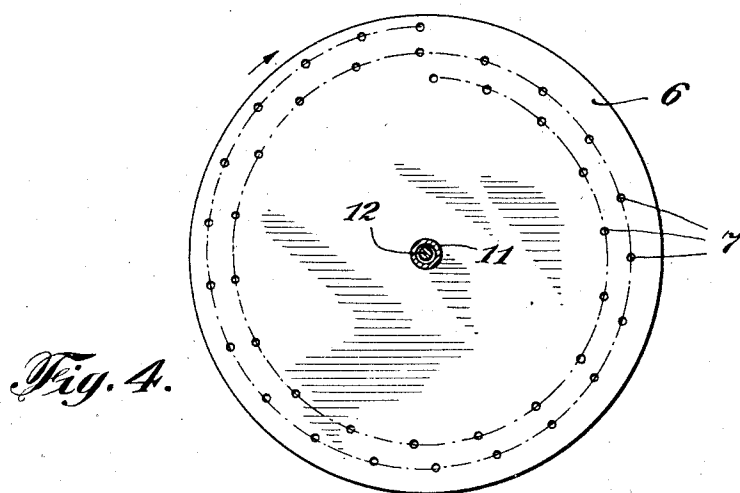
1,602,121

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TELEVISION

Filed Dec. 5, 1923

3 Sheets-Sheet 3



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## UNITED STATES PATENT OFFICE.

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## TELEVISION.

Application filed December 5, 1923. Serial No. 678,715.

This invention relates to television, and more specially to an apparatus for reproducing distant images by the use of electric apparatus.

5 The present invention, comprising a method and apparatus for television, is carried out by analyzing a visual image at a sending station as to light values, then composing a visual image at the receiving station to correspond to the light values in the image which is analyzed at the sending station. This composition is brought about by transmitting energy in wave form from the sending to the receiving stations whereby light 15 values at the receiving station are controlled by and simultaneously with the analysis of the light values of the optical image at the sending station.

A general description of one form of 20 apparatus for carrying out this invention comprises a mechanism whereby portions of an optical image are caused to be projected as a spot of light of variable intensity upon a light sensitive electric cell in such manner 25 that the variations of the light intensity produced by the light and dark portions of the image cause the electric current flowing through the cell to vary as the intensity of the light varies. Mechanism is provided for 30 transmitting energy as corresponding electrical or magnetic waves to a receiving station provided with means for receiving said variable waves or transmitted energy. This energy received at the receiving station controls a beam of light so that the intensity of the beam corresponds to the variations in the energy received. This undulating light at the receiving station is translated over an optical plane at the same rate of speed of 40 movement which analyzed the original image at the sending station, and where the transmitted image is to be viewed directly the rate of speed is beyond the persistency of the retina so that a visual replica of the original image is reproduced at the receiving station. 45

More specifically stated, the present invention may be embodied in or carried out as to one form, by mechanism and apparatus comprising a focusing lens to project and focus 50 a scene through a framing screen on a moving member, such as a disk, a cylinder, a shutter, or moving endless belt, which is provided with a plurality of analyzing open-

ings spaced apart a distance equal to the 55 width of the image through a framing screen. The rows of openings are arranged in a spiral when on a disk, or the openings may be in a line and a linear movement be given to the moving member. The purpose 60 being to carry one opening at a time across the field and with the paths of succeeding openings being slightly different so that the whole field is covered at a rate of speed 65 faster than the reluctance of the eye. In order to avoid loss of light through interference produced by the side walls of the openings it may be desirable to cover these openings with small lenses which will carry the light through the openings without in- 70 terference.

It is desirable to divide up the image into a number of small parts, and this may be accomplished by using a large number of analyzing openings in the analyzing member. 75 Where a large number of analyzing openings are used on a disk a double spiral may be resorted to, and in such case it is necessary to provide a shutter which also carries a continuous spiral opening which is rotated at the proper speed to expose but a single analyzing opening at a time. Where 80 two convolutions of analyzing openings are used on the disk then the speed of the shutter shall be one half the speed of the analyzing disk. It will now appear that as an analyzing opening in the analyzing disk sweeps over the image projected thereon by the projecting lens a thin section of the image may be said to be cut by the path of 85 the analyzing opening. As this analyzing opening cuts across the projected image, light passing through the opening will vary in accordance with the intensity of the light in the cross-section of the image at this 90 point. This light is collected by a condenser lens which is of sufficient size to cover the entire field exposed through the framing opening, and this condenser lens when assisted by a second or super-condenser, brings 100 the rays of light, passing any place through the framing opening, down to a point of light which falls upon a photo-electric cell or light sensitive cell, which is well known in the electrical art. 105

As the point or beam of light falls upon the photo-electric cell, which is connected with a suitable electrical circuit, the cell

acts as a valve so that greater or less electricity will pass through the cell, dependent upon the intensity of the light falling on the cell. The variable electric current thus  
 5 produced may be sent out to receiving station, over a transmission wire, or may be superimposed upon transmission wires in the form of transmission known as "wired-wireless", or the undulating waves may be  
 10 transmitted to a common form wireless broad-casting apparatus which will send out undulating magnetic and electric waves broadcast.

The receiving station comprises an apparatus of similar character to the sending station and comprises a composing disk or belt with composing openings therein of the same character as the analyzing disk in the sending station. This disk may also be accompanied by a shutter disk where the composing openings are arranged in a plurality of convolutions. Where a single convolution is used, then a shutter is not needed in either the sending or the receiving apparatus.  
 25 ratus.

The undulating wave energy sent out by the sending station is received through the wire or by wired wireless, or by wireless apparatus well known in the art of wireless telephony, at the receiving station, where the energy is operative to control an intense beam of light in such manner that when the received wave is at zero the light from the beam will be zero, and when the wave is at  
 30 its peak or most intense part, then full light beam will be transmitted.

This may be accomplished in various ways, one of which is the use of a strong electric light which, by means of reflectors and lens, is concentrated upon a mirror mounted for oscillation in such manner that the rays of light normally are projected against a screen, but when energy is received at the receiving station the mirror is oscillated by electro-magnetic means in such manner as  
 40 to throw a corresponding amount of light through an opening in the screen, this undulating light is received by a dispersion system of lenses which spread the light out over a field equal in size to the opening in the framing screen within which the image is to be composed. The composing member, either disk or belt and its respective shutter, (where a shutter is used) is now rotated at  
 45 such a speed as to cause the composing openings to pass across the framing screen at the same rate of speed and at the same instant of time that the analyzing openings are passing across the framing screen opening at the sending station. Since the beam of light at the receiving station is controlled in exact accordance with the light which is passing through the analyzing openings at the sending station, it will be observed that  
 50 the light conditions at the receiving sta-

tion are a replica of the light conditions at the sending station. Preferably the composed image at the receiving station is received upon a condensing lens which cooperates with projecting lenses to throw the  
 70 composed image upon a suitable screen.

It will be observed that it is desirable that the motive power for driving the analyzing disk shall be synchronized with the motive power for driving the composing  
 75 disk. This synchronization may be accomplished by any of the methods well known in the electrical art for synchronizing the motors, and where the sending and receiving stations are substantially near to each other, synchronous motors operated from the same power line may be used to attain the desired synchronism. In order to properly tune the receiving instrument with the sending instrument, the sending instrument  
 80 is provided with a source of light, such as an electric lamp, which at all times produces a bright spot in a definite part of the space through the framing screen; for example, in the lower right-hand corner of the screen. This fact is known to the receiver, who adjusts his apparatus in such manner as to locate the bright spot in the lower right-hand corner of the field of his screen. When this is done, (assuming the motors to be synchronized) then all other portions of the image will be in their proper relation relative to the sending station. This framing operation may be accomplished in various ways one of which is the provision of mechanism whereby the rotative relation between the driving motor and the analyzing disk is under control of the operator through planetary gears or other suitable mechanism. There are several alternate  
 85 apparatus which may be utilized in carrying out my invention; for example, a sliding plate provided with suitable analyzing and composing openings, may be substituted for the disks or belts; and the control mechanism for the light beam at the receiving station may comprise a suitably operated shutter like an iris diaphragm or a pair of sliding plates. Another convenient way of controlling the light beam at the receiving station may be by utilizing the principle that polarized light is rotated by a magnetic field, and by arranging the polarizing means on one side of the magnetic field relative to an analyzing prism or means on the other side of the field so that under normal conditions no light will pass through the system, but when the field is magnetized the polarized beam will be rotated into relation to the analyzing crystal or means so that the final beam will be proportionate to the intensity of the magnetic field.  
 90 95 100 105 110 115 120 125

The principle of the present invention is the analysis of an optical scene which may be either a stationary picture or one of mov-  
 130

ing objects. The image of the picture or moving objects is analyzed into sections at a great rapidity and then the same scene is re-composed by the receiving station with the same rapidity, which is beyond the reluctance of the retina of the eye of the observer, so that the scene is recomposed so rapidly that the retina retains the vision of all parts thereof while the composition is taking place. Various sized openings and numbers of openings in the analyzing and composing members may be used as the conditions may determine, but by way of illustration, assuming the framing opening at both sending and receiving stations to be one inch square. The analyzing and composing lenses or openings in the rotating disks shall be substantially one inch apart. Assuming the double spirals to contain substantially one hundred and twenty analyzing and composing openings in each disk, and that the entire field of the framing opening is to be covered twenty times per second, it will be necessary to rotate the disks at a speed of two thousand four hundred revolutions per minute, or forty revolutions per second. Where a single spiral is used and no shutter, then the analyzing and composing disk need to be rotated only twenty times per second, one thousand two hundred times per minute, and this is sufficient for the majority of cases. When this takes place, it will be observed that the image at the sending station is cut or sliced, figuratively speaking, into a number of thin sections, and the complete slicing operating of one image takes place in the twentieth of a second so that twenty sliced up images are represented to the retina of the observer within the period of a second, so therefore the observer will not perceive the slicing operation, but will see the complete image as a whole.

It is realized that the present invention may be carried out and embodied in methods and apparatus other than those herein specifically disclosed without departing from the invention; and, therefore, it is desired that the disclosures herewith shall be considered as illustrative and not in the limiting sense. Throughout the several figures of the drawings like characters are used to represent like parts.

Figure 1 is a diagrammatic illustration of a sending station and a receiving station with the motors of the two stations connected in a common power circuit.

Figure 2 illustrates the method of linear analysis of an optical image formed in the framing screen at the sending station.

Figure 3 illustrates the method of re-composed image projected on the screen at the receiving station.

Figure 4 illustrates one form of analyzing disk.

Figure 5 illustrates one form of shutter

to be used where a plurality of convolutions of analyzing openings are used in the analyzing or composing disk.

Figure 6 illustrates the use of lens over the openings in either or both the analyzing or composing disk in order to transmit light rays through the openings without substantial loss.

Figure 7 is an enlarged detail fragment view through the framing screen, the shutter, and the analyzing or composing disk to illustrate the operations thereof.

Figures 8 and 9 illustrate a sliding shutter form of light control at the receiving station.

Figure 10 illustrates a polarized light magnetic control for the beam at the receiving station.

Referring to the drawings and more especially to Figures 2 and 3 which illustrate the present method of television, the image X is optically cut into strips or slices  $a-b-c$  etc. These slices are illustrated as being of substantial thickness, while in practice the strips or slices are very narrow. The analysis is that of a progressive series, that is, the instant slice  $a$  is finished slice  $b$  is begun etc., and considered from the standpoint of time, the slices may be understood to be extended end to end as illustrated beside the image X, as slices  $1^a-1^b-1^c$  etc. The light values of these linear slices may be considered to be projected at right angles to the line of the slices and to control an electric carrier wave Y according to the light values in the adjacent slice. This operation has translated the image into linear optical values, which in turn are translated into linear electrical values. The carrier wave when received at a receiving station is translated into a resultant linear wave Z, that controls the light values in strips or slices  $2^a-2^b-2^c$  etc., which are used to compose an image W which is a replica of the original image X.

It is to be understood that the image W at the receiving station may be recorded photographically or it may be viewed directly or projected upon a screen. Where the image W is to be viewed directly, the speed of analysis of the whole image X and the composition of the replica image W must be repeated at a speed which exceeds the normal reluctance of the eye. Where the image is to be recorded at the receiving station photographically, the speed limits are not so narrow, and the speed of analysis and composition may be as slow or fast as desired.

Referring now to the mechanism illustrated in the drawings, in which one embodiment of the invention is disclosed diagrammatically, and more especially to Figure 1, which illustrates both the sending and receiving stations, the sending station is pro-

vided with an adjustable lens 1, which is similar to the lens of an ordinary camera, and the lenses are adapted to be focused by adjustment in such manner, that an image is formed and the rays thereof are projected in substantially parallel lines by means of a suitable condenser lens 2, with all these optical members mounted within a suitable light tight casing 3.

This condenser lens is of a sufficient size to cover the opening 4 in a framing screen 5, which may be of various sizes, but for the purpose of the present invention, may be approximately one inch square. An analyzing disk 6 is mounted to rotate back of the opening 4 in the frame screen 5, and in the form illustrated, comprises substantially two convolutions of analyzing openings 7; therefore, in order to prevent more than one opening being exposed at a time, a shutter disk 8 is provided in which is arranged a narrow spiral opening. This shutter (see Fig. 5), is composed of arc-shaped sections 9, each of which is shown as one half the width of the opening 4 in the framing screen 5, and each of these arc-shaped sections 9 correspond in radius to the radius of the arc of travel of a definite opening in the analyzing disk. The openings 7 in the analyzing disk are preferably covered with small lenses 10 (Fig. 6), which carry the light rays through the small openings 7 without undue loss of light. The lenses 10 are not absolutely essential, but in some cases may be desirable. The analyzing disk 6 is mounted upon a suitable shaft, and the shutter 8 is likewise mounted upon a suitable shaft, and, in the form illustrated, the hollow shaft 11 carries the analyzing disk, while the shaft 12 extends through the hollow shaft 11 and carries the shutter 8. In the form of shutter and disk illustrated it is desirable that the speed of the shutter shall be one half the rotative speed of the disk, and shall be in the same rotative direction as that of the disk. Furthermore, the spirals on the disk and on the shutter also run in the same direction. This speed reduction may be accomplished by means of suitable gearing, comprising a gear 14 on the hollow shaft 11 and connected by stub shafts 15 and pinions 16 and 17 thereon, with a suitable gear 18 on the shaft 12 whereby the shaft 12 will rotate at one half the speed of shaft 11 and in the same rotative direction.

While the invention has been illustrated as applied to an analyzing unit in which the apertures are arranged in two convolutions and the arcuate slots of the shutter disc are arranged in one convolution, various numbers of convolutions of apertures and shutter slots may be employed with the same principles of construction and operation. It is necessary that the aperture disc and the shutter disc be rotated at such speeds

that the complete spiral of apertures and the complete spiral of shutter slots are both swept over the exposure space in the same time. Therefore, in order that there may be relative movement between the aperture disc and the shutter disc, it is necessary that the shutter disc have a smaller number of convolutions than the aperture disc.

When an aperture starts to sweep over the exposure space, it is aligned with the rear end of a slot sector in the shutter disc and as it leaves the exposure space, it is aligned with the front edge of the same slot sector. It is accordingly necessary that the length of the shutter slot shall be so related to the width of the exposure space (which is the same as the aperture spacing) as to make up for the difference in the distance travelled by the shutter slot and the distance travelled by the aperture while the latter is crossing the exposure space. In the general case, the apertures are spaced apart by an angle equal to  $d$  and arranged in  $n$  convolutions, which gives the spiral of apertures a total angular length of  $360n$  degrees; and the shutter disc is provided with  $(n-a)$  convolutions of slot sectors, where  $a$  is a number less than  $n$ . The total angular length of the shutter spiral is therefore,  $360(n-a)$  degrees. In order that the two spirals may be completely swept over the exposure space in the same time, the speeds must be directly proportioned to their total lengths. In other words,

$$\frac{\text{Speed of shutter disc}}{\text{Speed of aperture disc}} = \frac{360(n-a)}{360n} = \frac{n-a}{n}$$

Accordingly, the shutter disc is rotated at

$$\frac{n-a}{n}$$

times the speed of the aperture disc, and the length of each slot sector of the shutter disc is equal to

$$d - \frac{d(n-a)}{n} = \frac{da}{n}$$

A second condenser lens 19 is mounted adjacent the disk 6 and in line with the opening 4 in the framing screen. This lens tends to bring the light rays passing through the opening 4 in the framing screen substantially to a focus. A third condenser lens 20 may be utilized to more sharply focus the rays of light coming through the second condenser 19. A photo-electric cell 21 of a sensitive nature, as is well known in the art, is arranged to receive the condensed rays through the third condenser lens 20. Preferably all of the lenses in the entire system are constructed of materials which will absorb the least amount of rays of the character which are most effective on the photo-electric cell. This photo-electric cell

is illustrated diagrammatically as being connected with an amplifying broad-casting wireless system 22 of the character well known in the art for broad-casting music or other undulating forms of wave energy. The shaft 11 is illustrated as being connected to be driven by a synchronous motor 24, which is arranged in an electric power circuit supplied by a suitable dynamo 25.

10 The wave energy sent out by the broad-casting station 22 is received at the receiving station 101, which is of any well known form of receiving apparatus used for wireless telephony, these waves are then trans-  
15 mitted to an electro-magnetic mechanism 102 similar to that used in a loud speaker for wireless telephony, and the incoming waves which have been amplified, by mechanisms well known in the wireless art, operate to  
20 oscillate a suitable mirror 103. This mirror receives the concentrated rays from an adjustable electric lamp 104, which rays may be concentrated by means of adjustable lens 105, so that the rays normally will be thrown  
25 upon a screen 106. This screen is provided with an opening 107 adjacent which is arranged a dispersion lens 109 and a condensing lens 110 to make the rays through lens 109 parallel one with another. When electrical energy is received in the receiving station the mirror 103 is oscillated to throw a proportionate beam of light through the opening 107, that is, for a weak undulation only a small amount of light will be thrown  
35 through the opening, and for a strong undulation a full beam will pass through the opening. The light passing through the opening 107 is spread out by the system of lens over an area very slightly greater than  
40 the opening 111 in the framing screen 112. A composing disk 114 is provided exactly like the analyzing disk 6 in the sending station, and a shutter disk 115 is also provided like the shutter disk 8 in the sending station.  
45 The composing disk and shutter are mounted on the same type of system of gearing and shafts as used at the sending station and are driven by a synchronous motor 116, which is illustrated as being in the same power circuit as the synchronous motor 24, therefore the motor 24 and the motor 116 will be synchronized.

It is also to be understood that the optical apparatus at the receiving station are  
55 mounted in a suitable light-tight casing 113.

From the foregoing it will be observed that as an analyzing opening 7 in the analyzing disk sweeps over the framing opening 4 in the framing screen 5 any light passing through the opening 7 will be proportionate to the light transmitted through the projected image and will be alternately greater or less as the image varies in density at the point where the particular opening 7 is cut-

ting across. This light falling on the photo-  
electric cell will produce an undulating wave which is sent out from the sending station. This undulating wave is picked up by the receiving station and transformed into an undulating beam of light which is turned  
70 upon the composing disk that is rotating in synchronism with the analyzing disk so that the variation in light through the composing openings will be exactly in accordance with the variation in light which originally passed  
75 through the analyzing openings. Since the speed of the analyzing disk and composing disk is such that the entire space of the framing opening is steadily covered at a speed higher than the normal reluctance of  
80 the eye, for example, from sixteen to twenty times per second, the light rays coming through the analyzing disk will compose an image similar to that which was received and analyzed at the sending station. This  
85 composed image at the receiving station may be projected through a second condenser lens 117 and then through projecting lenses 118 and received upon a screen 119 as a projected image.

Assuming that the two motors 24 and 116 are rotating in synchronism, it may be possible that the motor at the receiving station may be started at such time that the position of the spirals in the sending and receiving disks do not exactly coincide and, therefore, the projected image will not be properly framed. In order to assist in framing, a source of light such as a small electric light 38 and a mirror 39 may be  
100 provided at the sending station to maintain a brilliant spot in a definite portion of the opening 4, for example, in the lower right hand corner and the operator at the receiving station merely needs to adjust his instrument until this brilliant spot 123 assumes its proper position in the lower right  
105 hand corner when the received image 126 will be properly framed. It may be desirable at the receiving station to arrange an absorption screen to absorb the brilliant spot so that it will not unpleasantly affect the projected picture. The receiving instrument, therefore, preferably is provided with an adjustment mechanism for adjusting the  
110 rotative relation of the analyzing disk and shutter to the rotation of the motor shaft. This may be accomplished by providing a bevel gear 120 on the motor shaft which drives through bevel pinions 121 on an adjustable rotative member 122, and which  
120 mesh with a second bevel gear 124, that is connected to drive the composing disk shaft. By rotating the support 122 of the bevel pinions 121, by means of a hand adjustment member 125 the rotative relation between the motor drive shaft and the analyzing disk and shutter is within the con-

trol of the operator while the device is in operation. This method of adjustment is merely illustrative and any other mechanical device for this purpose may be utilized.

5 For sending pictures or projected images of scenes which are simple in character, the reflecting mirror is in most cases most satisfactory. In other cases where different orders of variation in speed of reception 10 is required different characters of receiving mechanism may be utilized. In Figures 8 and 9 there is illustrated a different form of light beam control comprising a stationary member 26 provided with a diamond-shape opening 27. A sliding shutter 15 28 is mounted adjacent the stationary member 26 and the shutter is likewise provided with a diamond shape opening 29. This shutter is suitably connected with the electromagnetic apparatus 30 so that normally the openings 27 and 29 do not coincide, but as the electromagnetic device oscillates under an undulating current the openings 20 will be brought into greater or less coincidence, from zero to full opening, thereby acting as a light valve to control the amount of light passing through the system.

Another and convenient method of controlling the light beam at the receiving station is based upon Faraday's experiment with the effect of magnetism upon polarized light and this form of receiving device comprises a brilliant source of light such as 25 a brilliant electric light 31 mounted in a suitable light-tight tube 32 so that the rays of light from the source will be concentrated upon a suitable polarizing medium 34 which may be a suitable prism or other polarizer, 40 and arranged so that the rays of light will pass through a tube of carbon-bisulphide 35, or other suitable medium, around which is arranged suitable conductors 36 so that the tube of liquid will be within a magnetic field when the conductors are suitably energized from the receiving station. Next in the path of the rays of light is an analyzing member, or crystal, which is so set normally on the rays passing through the system and striking the second crystal 37 the other analyzer or polarized light will normally be stopped, but when a magnetic field is produced around the tube of liquid the rotating effect of the magnetic field on 45 the polarized light passing through the tube will proportionately permit light to pass the second analyzing member 37. The rays passing this system are focused upon the dispersion lens 109 to be spread out over 50 the area of the composing opening 111 in the framing screen 112. By this last mentioned system it will be observed that since the rotation of the polarized light passing through the liquid is proportional to the

strength of the magnetic field, (which is 65 produced by the undulating current which has been properly amplified by the receiving apparatus) the amount of light passing through the system will be dependent upon the strength of the impulses being 70 received at the particular moment. A light valve is thus produced in which there are no mechanical moving parts.

The rotating disk, or other analyzing or composing member may be used both to analyze and to compose. A sending station may be arranged on one side of the disk and a receiving station may be arranged on the other side, both using a common disk and shutter. Under these conditions the same station may be sending and receiving at the same time and in this way the operator may determine how the broad-casting from his station is progressing or he may be receiving images projected and broadcast 75 from distant stations providing the wave lengths are sufficiently different from those being sent out from his own station. While this double use of the disk is herein disclosed such use introduces difficulties and 80 is not the preferred form.

Having described my invention, what I claim is:—

1. A device of the class described comprising optical means to form an image of 85 a distant scene, a rotating disk provided with analyzing openings arranged in a spiral having a plurality of convolutions, a shutter constructed to expose a single opening at a time in such manner that the rays of light from said image will pass through said openings one at a time as a substantially continuous beam of light, and light sensitive electrically controlled means adapted to vary an electrical current in proportion to the successive light values in said beam. 100

2. In an apparatus of the class described an optical analyzing unit comprising, a rotating disc provided with a plurality of convolutions of openings arranged to sweep over an image, and means to prevent exposure of the image to more than one opening at any one time. 110

3. In an apparatus of the class described an optical analyzing unit comprising, a rotating disc provided with a series of apertures arranged in more than one convolution to sweep over an image, and means to cause the apertures to sweep over the image, one after another from the beginning to the end of the series. 115 120

4. In an apparatus of the class described an optical analyzing unit comprising, a disc provided with a series of apertures arranged in two convolutions and spaced apart by a distance equal to the width of the image to be analyzed, a shutter disc provided with a series of arcuate slots each of length equal 125

to half the distance between adjacent apertures, and means to rotate the shutter disc at one speed and the apertured disc at twice that speed.

5 5. In a device of the class described, a moving member provided with an opening adapted to sweep over an image, and a pair of lenses attached to said moving member, one of said lenses being positioned on  
10 each side of said opening.

6. In an apparatus of the class described, an optical analyzing unit comprising a disc provided with a series of apertures spaced apart by angle  $d$  and arranged in  $n$  convolutions, a shutter disc provided with  
15  $(n-a)$  convolutions of arcuate slots, each slot subtending an angle of

$$\frac{da}{n},$$

20

$$\frac{n-a}{n}$$

25

times that speed.

7. In an apparatus of the class described, an optical analyzing unit comprising, a perforated disc provided with a series of openings spaced apart by an angular distance  
30 equal to the angular width of the image to be analyzed, a shutter disc provided with a series of arcuate slots, and means to rotate the shutter disc at one speed and the perforated disc at a different speed and in the  
35 same direction as the shutter disc, whereby the image is scanned in a series of arcuate paths one following another.

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