

1,351,508.

APPLICATION FILED NOV. 27, 1917.

Patented Aug. 31, 1920.

3 SHEETS—SHEET 1.

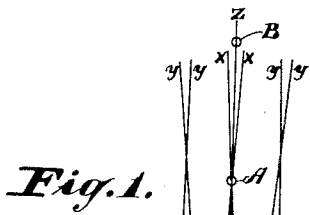


Fig. 4.

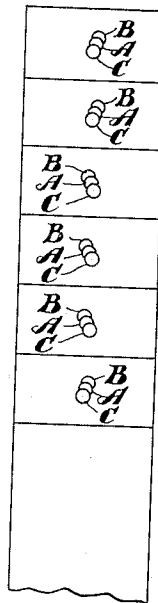


Fig. 2.

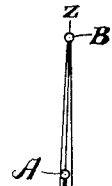


Fig. 3.

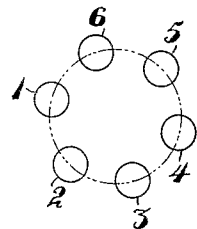


Fig. 1^b

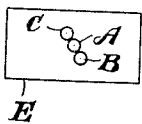
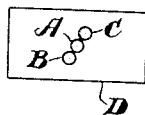


Fig. 1^a



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3 SHEETS—SHEET 2.

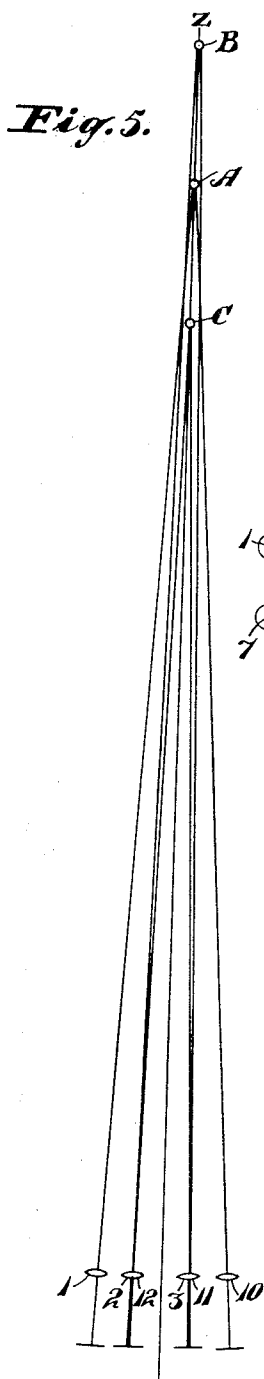
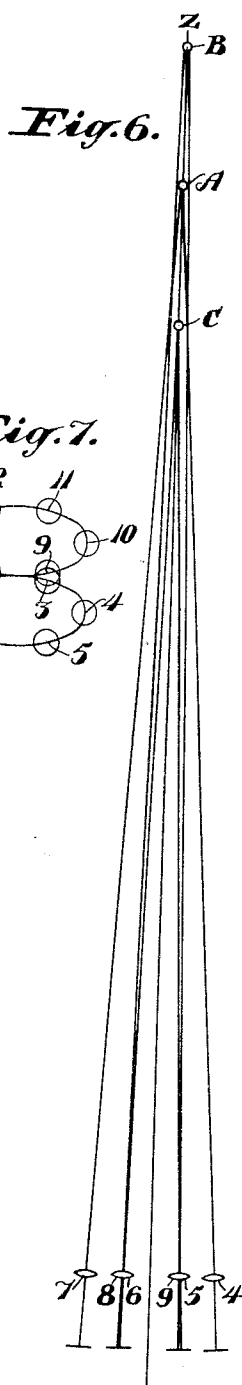
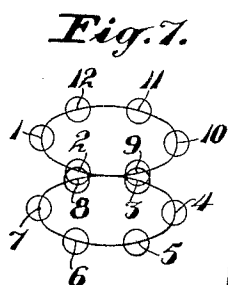


Fig. 8.

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WITNESS:

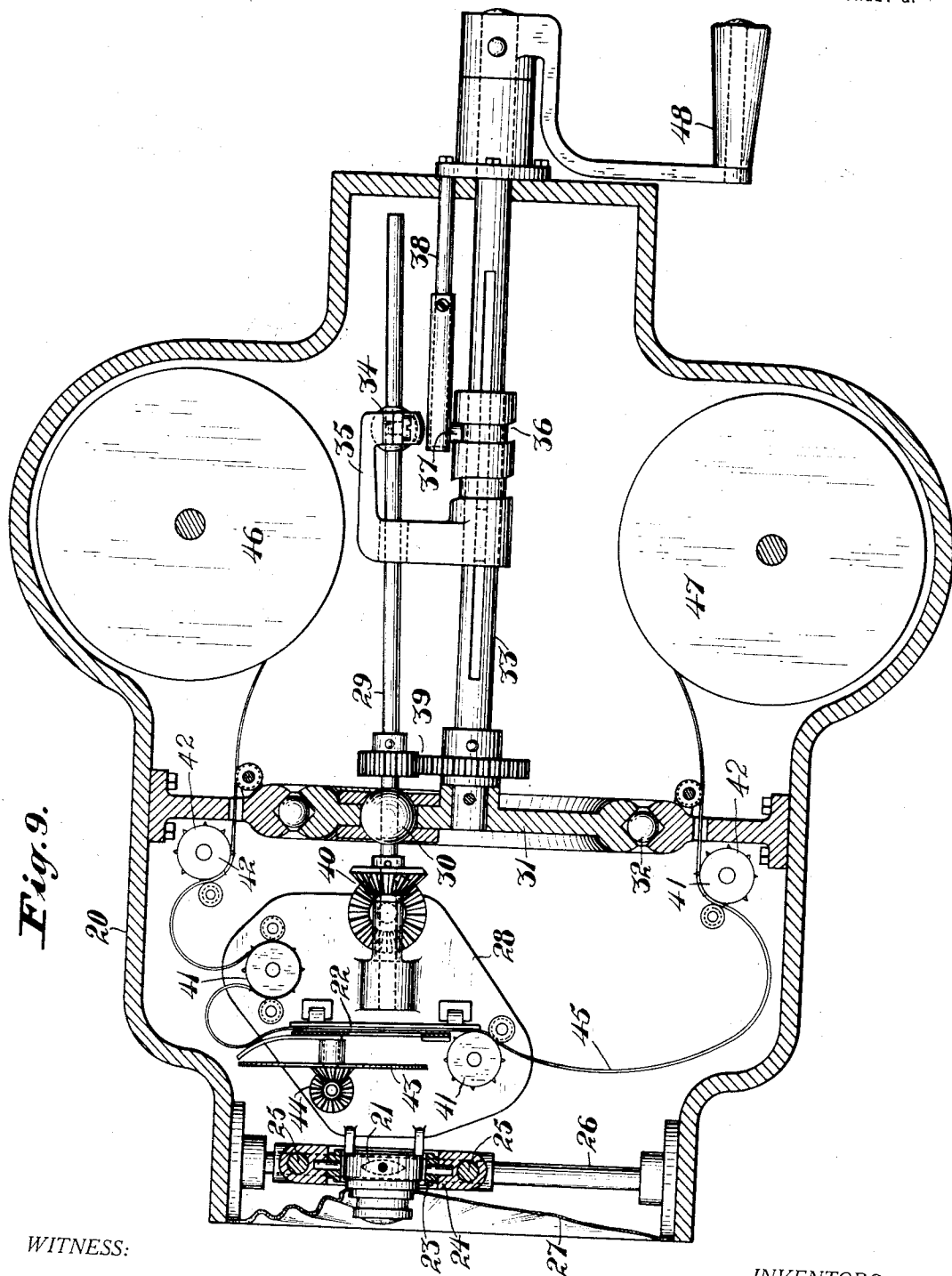
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R. A. DUHEM AND J. D. GRANT,
METHOD OF PRODUCING STEREOSCOPIC EFFECTS IN MOTION PICTURES.
APPLICATION FILED NOV. 27, 1917.

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3 SHEETS—SHEET 3.



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UNITED STATES PATENT OFFICE.

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METHOD OF PRODUCING STEREOSCOPIC EFFECTS IN MOTION-PICTURES.

1,351,508.

Specification of Letters Patent. Patented Aug. 31, 1920.

Application filed November 27, 1917. Serial No. 204,272.

To all whom it may concern:

Be it known that we, RAYMOND A. DUHEM and JOHN D. GRANT, citizens of the United States, residing at the city and county of San Francisco and State of California, have invented new and useful Improvements in Methods of Producing Stereoscopic Effects in Motion-Pictures, of which the following is a specification.

15 This invention relates to the production of stereoscopic effects in motion pictures, on the principle shown and described in the co-pending application of Raymond A. Duhem, filed August 22, 1916, Ser. No. 116,245:

20 According to the disclosure in said prior application, stereoscopic effects in motion pictures are produced by causing a single lens motion picture camera to be shifted from side to side with its principal optical axis directed toward the center of the object or scene being photographed, in order that successive exposures of the same object may be taken from different positions in such a way as to form images on adjacent pictures of a dissimilarity equivalent to that existing between right and left eye pictures in natural vision, and combining these dissimilar images by persistence of vision when they are rapidly projected upon a screen.

30 We find, however, that it is in this respect the chief novelty of the present invention lies, that a centering of the principal optical axis of the camera on a fixed point in all positions of the camera, while producing stereoscopic effects has the disadvantage that only objects in the immediate vicinity of the fixed point will remain stationary on the screen, other objects, either in front of or behind the fixed point, having a limited movement on the screen. This is due to the fact that the principal optical axis of the lens, when the camera is at one end of its path of movement, strikes to one side of the distant or close-up objects, whereas when the camera is at the other end of its movement the principal optical axis will strike toward the opposite side of such objects, thereby recording these objects in different positions on the film.

40 This situation is akin to that existing in natural vision where only objects in the limited space called the horopter blend or coalesce, those behind showing homonymously double and those in front showing heter-

onymously double. Nature corrects these double images by reason of the fact that the eyes unconsciously travel back and forth from one extreme to the other of the object or scene, thereby changing their angle of convergence and successively blending the homonymous and heteronymous images.

In the present invention we eliminate or so minimize the apparent movement of the images or objects either in the background or foreground by so rocking or skewing the camera that the point of intersection of its principal optical axis with a median line will alternately shift back and forth instead of remaining centered upon a fixed point in all positions. It is thus possible to obtain stereoscopic effects in motion pictures in which no appreciable shifting of the objects in the fore or background is present.

Several different forms which our invention may assume are exemplified in the following description and illustrated in the accompanying drawings, in which—

Figure 1 shows a diagram of a simple back and forth shifting of the camera, wherein the principal optical axis of the lens is kept centered upon a fixed point, as in the case of the prior application referred to, and illustrating the manner in which the images of the objects either in front of or behind the fixed point shift from side to side on the film.

Figs. 1^a and 1^b show the position of the images upon the film, when taken in accordance with Fig. 1.

Fig. 2 represents, by diagram in plan, the different positions assumed by the camera or lens in the course of an orbital movement in accordance with our invention.

Fig. 3 shows a diagram of the same in elevation.

Fig. 4 shows a strip of film representing the positions of the images when taken in accordance with the method diagrammed in Figs. 2 and 3.

Fig. 5 shows a diagram in plan of the upper half of a figure 8 movement of the lens and film holder.

Fig. 6 shows a diagram of the lower half of the same.

Fig. 7 shows a diagram in elevation of the path of movement of the lens and film holder according to the modified arrangement of Figs. 5 and 6.

Fig. 8 shows a diagram of a film exposed in accordance with the arrangement and operation shown in Figs. 5 to 7.

Fig. 9 shows a sectional view of one form of apparatus for practising our method.

By way of arriving at a better understanding of the problem we have solved, the case of a simple back and forth shifting movement of the lens or camera, in which the principal optical axis in all positions is directed upon a fixed point will be considered. Such a plan of operation is diagrammed in Fig. 1, wherein the point A represents an object on which the lens and film are centered in both positions 1 and 2, the lines $x-x$ representing the principal optical axes and $y-y$ the secondary axes or rays of the lens. B represents an object considerably behind A, and C one considerably to the front of A on the median line $z-z$. It will be obvious that we have greatly exaggerated the conditions prevailing in practice in this diagram, but the same will serve to illustrate the cause of the shifting movement of the images upon the film.

In position 1, point B is imaged at the left and C at the right, as shown by the negative film D, Fig. 1^a. In position 2 the point B is imaged upon the film negative E at the right and the point C at the left, Fig. 1^b. Therefore in adjacent pictures both B and C will be considerably offset and when projected will have the appearance of shifting from side to side on the screen. This is similar to the heteronymous and homonymous images in nature not generally recognized but invariably present and which are coalesced or combined by running the line of vision from one extreme to the other in the scene and thereby varying the angle of convergence of the lines of sight.

In order that a more faithful representation of the objects may be made, this shifting movement must be overcome and in the present invention we have applied natural laws to the solution of this problem.

Figs. 2, 3 and 4 represent by diagram one method of practising our invention, which, briefly, consists in moving the camera or at least the lens and the film in an orbital path, during each cycle of which six or any other suitable number of exposures are taken, the orbit being of a size to permit each position of the camera at the time of exposure to be spaced about $2\frac{1}{2}$ inches from its previous position, or more accurately $2\frac{5}{8}$ inches. This spacing should be uniform as between successive pictures, and may vary somewhat, depending upon the distance which separates the objects from the lens. A practical rule to insure good results under any and all conditions can be laid down as follows: With a normal speed of photography, *i. e.* sixteen pictures per second, a travel of from thirty to fifty

inches should be imparted to the camera per second, the result of which is to move the picture making parts, *i. e.*, the lens and film, from two to three inches, approximately, between successive exposures.

Fig. 2 shows the positions occupied by the camera or lens in plan; Fig. 3 shows the positions of the same in elevation; and Fig. 4 shows the arrangement of the images upon the film when so taken. Objects A, B and C are indicated here in the same position as in Fig. 1. $x-x$ and $y-y$ are respectively the principal optical axes and the secondary axes of the lens. The median line is represented by $z-z$.

In position 1 the lens and film are positioned so that the principal optical axis is directed upon the point or object A in the center of the scene. In moving to the succeeding position, designated by the numeral 2, the lens and film have been rocked so that the principal optical axis falls on the point or object C in the foreground of the scene. In position 3 the principal optical axis falls also on object C, and in position 4 it is directed again upon A. In positions 5 and 6 this line strikes the object B in the background, thus shifting back and forth on the median line $z-z$ during each revolution or movement of the camera about its orbit.

The result is as shown in the film (Fig. 4) where it will be seen that instead of the distant and close-up objects B and C jumping from side to side in adjacent pictures they will have but comparatively little off-set in adjacent pictures, and, therefore, the shifting movement will be so slow and gradual, when the pictures are projected, as to be scarcely noticeable, but at the same time an appearance of solidity or relief will be given to the objects, since they are viewed in adjacent pictures from different positions and the dissimilar views combine on the screen by reason of persistence of vision.

In the operation of this form of our invention certain extreme points in the scene or object space which it is desired to hold more or less stationary should first be determined and then the apparatus set up so that the camera or lens, during its shifting movement, can be rocked or turned to cause its principal optical axis to play back and forth between the two extreme points, which preferably should be done so gradually as to eliminate any apparent jumping or shifting of the images upon the film. The shifting movement which the camera or lens undergoes need not necessarily be circular or elliptical. It may be in the shape of a figure 8, triangle, straight line or any other figure of a cyclic nature.

Figs. 5, 6, 7 and 8 illustrate by diagram a different form of orbital path, wherein exposures are taken from twelve different po-

sitions in the course of one cycle of movement. The positions are numbered consecutively and the same letters are used to designate the objects, principal optical axes and median lines as in the case of the previous figures. In position 1 the principal optical axis of the camera is directed upon the intermediate object A; in positions 2 and 3 upon the close-up object C; in position 4 upon the intermediate object A; in positions 5 and 6 upon the distant object B; in position 7 upon the intermediate object A; in positions 8 and 9 again upon the close-up object C; in position 10 upon the intermediate object A; and in positions 11 and 12 upon the distant object B.

The result is as shown in the film of Fig. 8, from which it will be seen that the different objects A, B and C progressively appear successively in the center of the picture, there being comparatively little off-set in the positions of the images of the different objects in adjacent pictures.

Merely to illustrate one way of carrying out our method, we show an apparatus in Fig. 9 suitable for moving the lens, film holder and intermittent feeding mechanism for the film through the positions shown in Figs. 2 and 3. In this form we employ a camera having a casing 20, a lens 21 and a film holder 22. The lens is pivoted horizontally in a gimbal ring 23, which in turn is pivoted vertically on a frame 24, the latter being slidable horizontally on rods 25, which rods are capable of vertical movement on posts 26. These connections permit the lens to be rocked about vertical and horizontal pivots and also to be moved bodily in a vertical or horizontal direction or any direction combining these two movements. Light is excluded from the interior of the casing by a flexible front 27 surrounding the lens.

The film holder 22 is mounted upon a frame 28, rigidly connected to the lens and the two are carried as a unit upon a shaft 29 supported by a ball and socket joint 30 in a disk 31, which latter is rotatable on ball bearings 32. By means of a driving shaft 33 upon which the disk 31 is fixed, the said shaft 29 is revolved. The shaft 29 extends rearwardly and has a ball and socket connection 34 with an arm 35 keyed on the driving shaft. The lens and film holder will thus describe a circular path, the diameter of which can be varied by manually sliding the arm 35 back and forth on the driving shaft. The rocking of the lens, whereby to cause its axis to shift in the manner shown in Figs. 2 and 3, is accomplished automatically by a cam groove 36 on the bearing of the arm 35, into which a pin 37 on an arm 38 fits, said arm and pin being stationarily mounted on the casing.

The film should be fed in timed relation with the movement of the picture making

parts and this is done mechanically by rotating the shaft 29 through a spur gear connection 39 with the driving shaft and by means of bevel gearing 40 operating an intermittent feed 41 carried on the frame 28. This intermittent feed may be of any suitable form. Pin toothed wheels for feeding the film to and from the intermittent mechanism and maintaining sufficient slack therein to permit shifting of the frame 28 are shown at 42, being journaled within the camera housing one adjacent to each reel. A shutter 43 is shown as being carried by the frame 28 and having actuating mechanism 44 connected to the film feeding mechanism. The film is indicated at 45 and is wound upon reels 46 and 47 carried within the casing. We show a hand crank 48 at the exterior of the casing for operating the drive shaft 33.

Having thus described our invention, what we claim and desire to secure by Letters Patent is—

1. A method of producing stereoscopic effects in motion pictures, which consists in taking a series of exposures with a single lens picture camera, and shifting the camera in a manner to cause the principal optical axis thereof to cross a median line at points receding from and approaching the camera.

2. The method of producing stereoscopic effects in motion pictures, which consists in taking a succession of exposures of the same object or scene with a single lens motion picture camera while shifting the camera from side to side, and turning said camera during the course of its shifting movement so that its principal optical axis plays back and forth between the distant and close-up points in an object space which it is desired to hold more or less in the same position on the film.

3. A method of producing stereoscopic effects in motion pictures, which consists in taking a series of exposures with a single lens motion picture camera while shifting the camera from side to side and skewing the camera, so that its principal optical axis crosses a median line at varying points during each cycle of movement.

4. A method of producing stereoscopic effects in motion pictures, which consists in taking a series of exposures with a single lens motion picture camera while shifting the camera from side to side and skewing the camera, so that its principal optical axis crosses a median line at points gradually receding from and approaching the camera.

5. The method of producing stereoscopic effects in motion pictures, which consists in taking a series of exposures with a single lens motion picture camera while shifting the latter, keeping the principal optical axis of the camera directed toward the center of the object space during a portion of its

shifting movement and during the remainder of its shifting movement skewing it about so that its principal optical axis crosses a median line at points gradually receding from said point.

6. The method of producing stereoscopic effects in motion pictures, which consists in taking a succession of exposures of the same object or scene with a single lens motion picture camera while moving the camera through an orbital path and turning the camera to cause its principal optical axis to cross a median line at points gradually shifting back and forth in the successive positions of exposure.

7. A method of producing stereoscopic effects in motion pictures, which consists in moving a single lens motion picture camera through an orbital path and taking, during each cycle of movement, a series of exposures of the same object or scene, and skewing the camera so that its principal optical axis alternately passes through the distant and close-

up points on a median line in the object space.

8. A method of producing stereoscopic effects in motion pictures, which consists in moving a single lens motion picture camera through an orbital path and taking, during each cycle of movement, a series of exposures of the same object or scene, and skewing the camera so that its principal optical axis alternately passes through the distant and close-up points on a median line in the object space, the shifting of the principal optical axis from one point to the other being gradual and varying in adjacent exposures.

In testimony whereof we have hereunto set our hands in the presence of two subscribing witnesses.

RAYMOND A. DUHEM.
JOHN D. GRANT.

Witnesses:

W. W. HEALLY,
J. C. BENESCH.