June 21, 1932. E. P. L. LE BARBIER 1,864,445

STEREOSCOPIC CINEMATOGRAPHY

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Fig. 1.

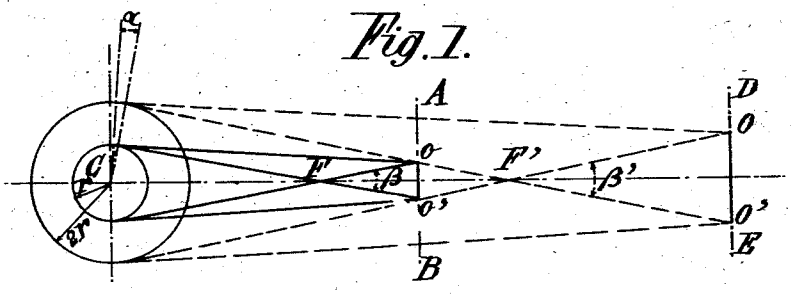


Fig. 2.

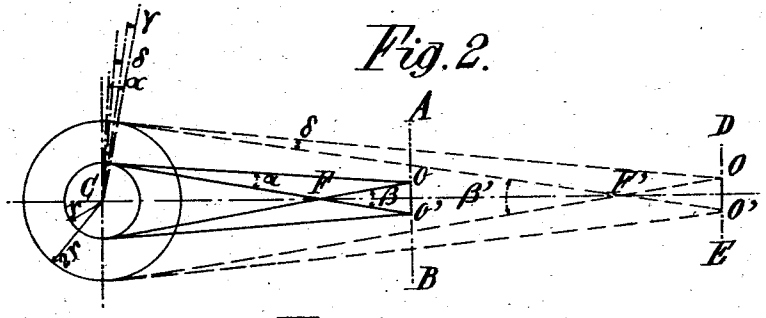


Fig. 3.

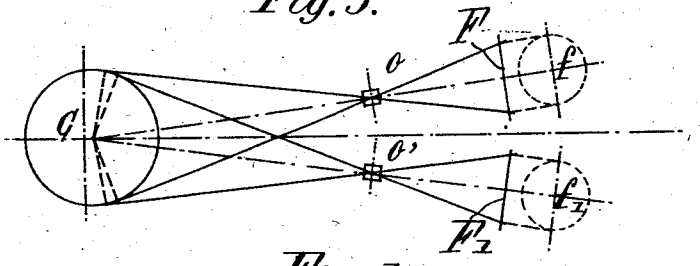
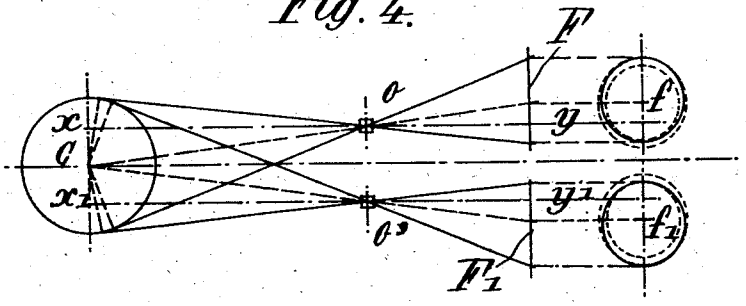


Fig. 4.



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STEREOSCOPIC CINEMATOGRAPHY

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Fig. 5.

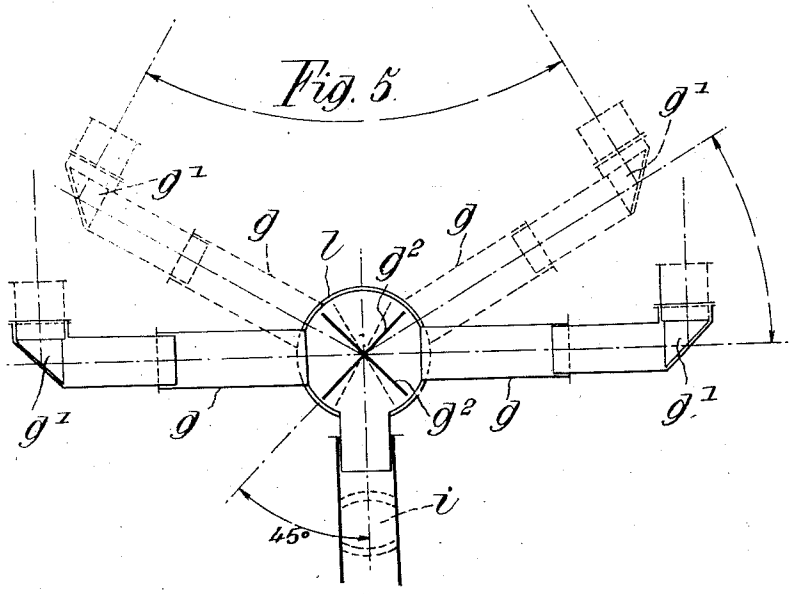

Fig. 6.

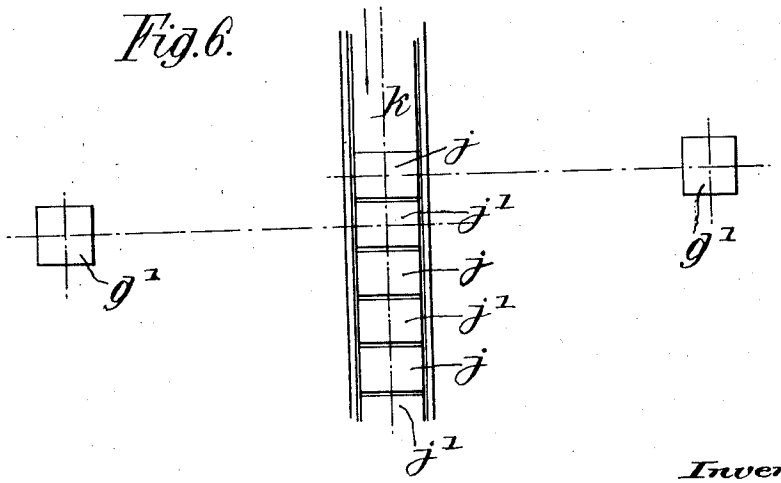

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Fig. 7.

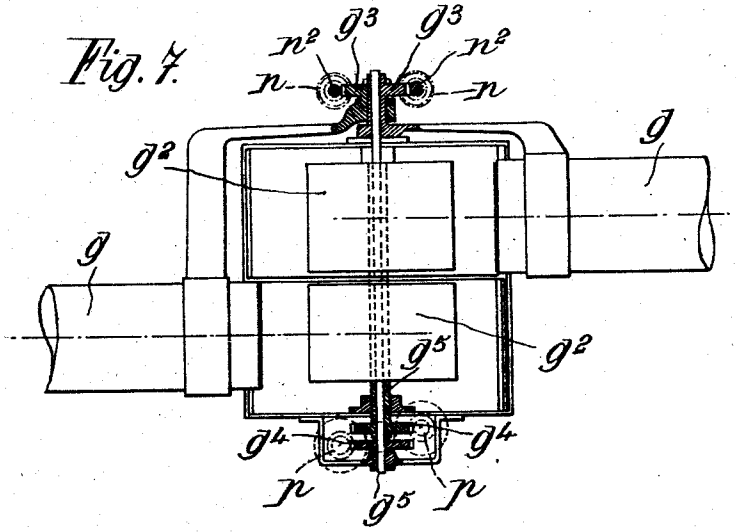
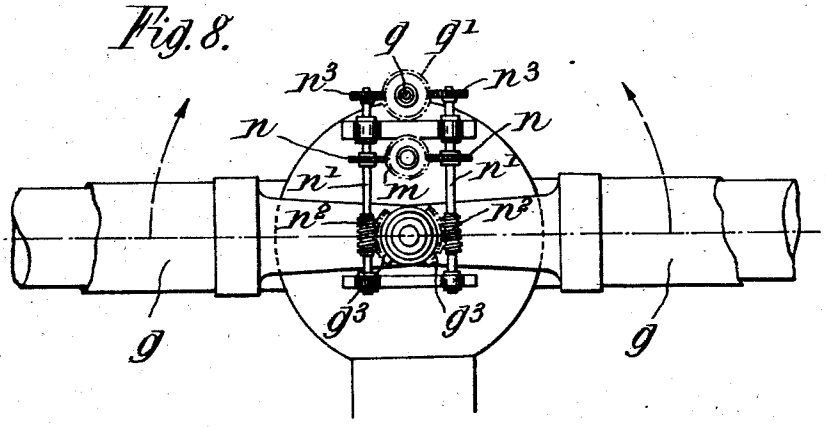


Fig. 8.



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Patented June 21, 1932 1,864,445

UNITED STATES PATENT OFFICE

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STEREOSCOPIC CINEMATOGRAPHY

Application filed February 5, 1929, Serial No. 337,687, and in Belgium March 30, 1928.

The present invention relates to stereoscopic photography and, more particularly, to the application of the stereoscopic principle to the production of moving pictures.

One of the objects of the invention is to provide a method and apparatus for producing enlarged stereoscopic images of objects corresponding substantially to those observed by tho human eye.

Another object is to provide means for registering right and left stereoscopic images on the same strip of film.

Further objects will appear in the course of the detailed description now to be given with reference to the accompanying drawings, in which:—

Fig. 1 is a diagram showing the relative positions of the object and one form of apparatus constructed in accordance with the invention;

Fig. 2 is a similar diagram showing the positions that would be occupied by the same object relatively to the ordinary types of stereo-cinematographic apparatus now in use;

Fig. 3 is a diagram showing the position which the object occupies relatively to a second constructive embodiment of the invention;

Fig. 4 is a diagram showing the position that the object represented in Fig. 3 would occupy relatively to an ordinary stereocinematographic apparatus;

Fig. 5 is a plan of an apparatus embodying the principle of the devices illustrated diagrammatically in Figs. 1 and 3;

Fig. 6 represents, in elevation, the position of the film relatively to the apparatus shown in Fig. 5;

Figs. 7 and 8 are elevations and plans, respectively of the apparatus illustrated in Fig. 5, showing all the essential constructive details thereof.

In the stereoscopic systems employed up to the present time, it has been the custom to maintain the two objectives used for taking the picture and for projecting at a fixed distance corresponding approximately to that of the human eyes i. e. 60–70 millimeters, generally in the vicinity of 63 millimeters. This procedure is perfectly logical when the negatives are viewed in the ordinary stereoscope, but has serious defects where the image being projected is considerably magnified as in stereocinematography. In order that the impression of relief be the same for the spectator in the case of a magnified image as is observed by a pair of normal eyes, it is necessary that the distance between the objectives be increased in proportion to the relative size of the real object and the image as received on the screen. In cinematography, for example, it is common to enlarge the object in the proportion of 1:2 or 1:3. The distance between the objectives should, therefore, be twice or three times 60–70 mm. If the degree of enlargement of the object be represented by n, the distance between objectives may be taken as $n \times 60$–70 mm. The angle of convergence of the eyes may be taken as a measure of the relief obtained. If, therefore, it be desired to conserve the same relief in an enlarged image, it is necessary to maintain the same angle of convergence during projection.

When enlarged projections are made with objectives 60–70 mm. apart, blurring effects are obtained because of the impossibility of superposing the edges of each object in the field. With the objectives in the position above defined this effect is, as will be shown later, done away with.

Figs. 1 and 2 show, diagrammatically, the differences in relief obtained with the type of stereoscopic apparatus now generally in use and with an apparatus of the type hereinafter to be described. In both figures the cylinder is assumed to be viewed laterally by two normal eyes (or objectives) at o and o^1 situated on line AB. When projected at double enlargement, the cylinder axis C will remain the same but its radius will be $2r$ and the distance between axis C and line AB will be doubled i. e. at DE.

In Fig. 1, the objectives, situated at O and O^1 on line DE are spaced at double the distance o, o^1. Angles (only one has been shown) representing the oblique portions of the cylinder i. e. the relief, will be the same whether viewed from o, o^1 or O, O^1. The

cylinder of radius 2 r will, therefore, have the same aspect and present the same relief as the original cylinder and angle β will be equal to angle β'.

In the case represented in Fig. 2, the eyes (or objectives) are at o, o^1 but they are spaced at the same distance at O, O^1. Angle α viewed from O, O^1 will be greatly reduced and the magnified image of the cylinder will lack the relief of the original. Angle β' embraces a larger sector i. e. is increased by twice the angle γ, while the oblique portion whose relief is to be reproduced is reduced to 2 δ.

The increase of distance between the objectives involves certain changes in the medium, and back grounds, the luminous rays, in certain cases, crossing behind, or to the left or right, of those of the foreground. In this connection it is to be noted that:

1° the visual sensation of relief exists readily only for objects in the foreground, and objects in the medium or back ground are "estimated" by comparison with those in the foreground;

2° normal eyes do not perceive accurately horizontal errors in the spacing of objects the maximum angle of displacement of the eyes in their orbits being about 85°, if the spectator is close to a screen, he will see accurately only a limited portion thereof, and errors occurring in distant portions will escape him entirely, while, if placed at a distance from the same screen, he will view the entire image but will not detect errors in projection because of the relatively large space intervening between himself and the screen;

3° normal eyes are much more sensitive to vertical errors in the representation of objects.

From the foregoing it follows that, while the distance between a pair of objectives may be increased safely in horizontal directions up to about 85° in conjugated and convergent types of apparatus, the vertical distance therebetween should not be altered.

Fig. 4 represents, diagrammatically, a stereocinematographic apparatus of the type now in use. o and o^1 are objectives having parallel axes $x\ y$ and $x'\ y'$, and F, F^1 a pair of films positioned perpendicularly to the latter. A cylinder having an axis C is represented as being viewed laterally by the objectives. Each image of the cylinder has the form of a non-symmetrical deformed oval shown in solid lines on the film which is supposed to be turned into view. In reality this image is formed between two circumferences shown in dotted lines. The deformation is difficult to detect in ordinary stereophotography because of the fact that the composite image resulting from the superposition of points f and f^1 is much smaller than the object photographed. In stereocinematography, when the projected image is considerably larger than the original object, this defect becomes at once apparent and requires correction.

Fig. 3 shows how correction is obtained. Here, the axes of objectives o and o^1 are convergent and films F, F^1 are positioned perpendicularly to said axes. The images reproduce exactly the real shape of the object and the deformation noted above is done away with.

The constructive embodiment of the invention shown in Figs. 5 to 8 consists of a pair of horizontal telescoping arms g, g positioned in parallel planes lying a distance of the height of the image above one another and arranged to rotate about a common vertical axis,—a pair of totally reflecting prisms g^1, g^1 positioned on the end of said arms and adapted to reflect rays toward the common vertical axis of g, g,—a pair of mirrors g^2, rotatably mounted about said axis,—a pair of superposed i (or a single bifocal objective) positioned to receive rays from g^2, g^2,—and a film receiving simultaneously a pair of juxtaposed images j, j^1.

Simultaneous control of arms g, g and of mirrors g^2, g^2 is obtained by means, of a milled disc (not shown) capable of being manipulated by hand to rotate a gear m, the latter driving (1) arms g, g simultaneously in opposite directions through the intermediary of pinoins n, n and worms n^2, n^2 mounted on shafts n^1, n^1, and independent sectors g^3, g^3 connected in driving relation to g, g, and (2) mirror g^2, g^2 through the intermediary of pinions n^3, n^3, helicoidal gear q^1 mounted on shaft q, a pair of gears similar to pinions n, n driven from shaft q and driving worms p, p, and concentric gears g^4, g^4 attached to each mirror mounted on concentric shafts g^5, g^5.

The various gear systems should be designed so that (1) arms g, g are displaced simultaneously through the same angle, and (2) mirrors g^2, g^2 through an angle equal to one-half of that of each arm.

In proceeding to effect a photographing operation, (1) the right hand objective may be focussed on the center of the subject, and the left hand image on the edges of the latter or conversely, or (2) a combination of these procedures may be employed so as to accentuate one image or the other. To insure accurate superposition in projection, the first images may consist simply of reference marks i. e. of central vertical or horizontal lines which may be centered in the manner generally employed in polychrome photography.

What I claim is:—

1. In combination, a pair of extensible arms rotatable about a common axis, said arms being rotatable in different planes, reflecting elements supported on said arms, a lens system, and means for reflecting images

projected by the reflecting elements into said lens system.

2. In combination, a pair of extensible arms rotatable about a common axis, said arms being rotatable in different planes, reflecting elements mounted on said arms, a lens system, means for reflecting images projected by said reflecting elements into said lens system, and means for simultaneously displacing said arms through equal angles.

3. In combination, a pair of extensible arms rotatable about a common axis, said arms being rotatable in different planes, reflecting elements supported by said arms, a lens system, reflecting means interposed between said reflecting elements and the lens system and adapted to deflect light rays coming from the former into the latter, and means for simultaneously effecting angular displacement of said reflecting means and of said arms.

4. The method of producing stereoscopic images which comprises the step of increasing the distance between a pair of objectives during photographic registration beyond 70 millimeters by an amount proportional between the size of the object being photographed and the size of the image thereof as projected on a screen.

In testimony whereof I have signed this specification.

EMILE PIERRE LOUIS LE BARBIER.