

No. 672,710.

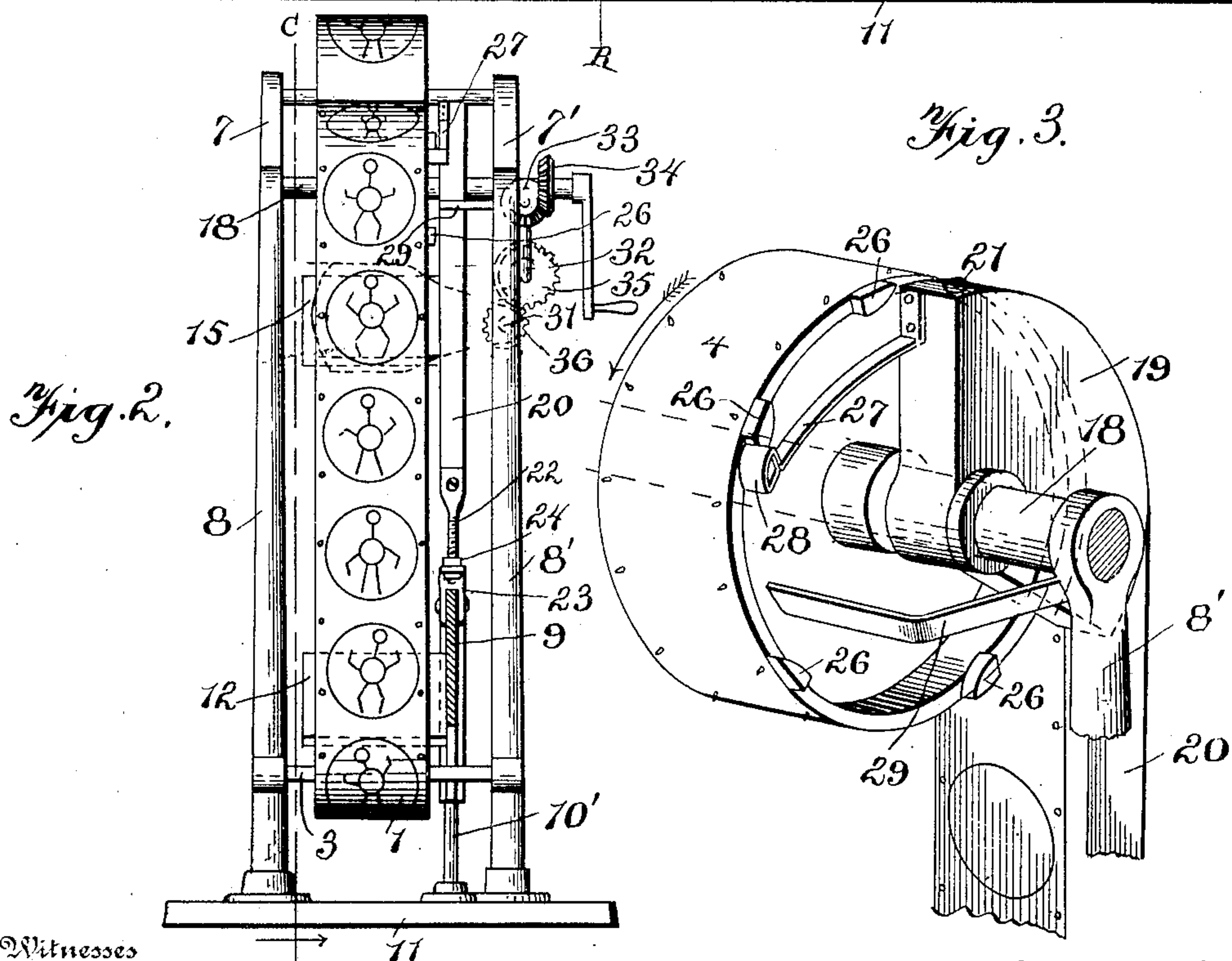
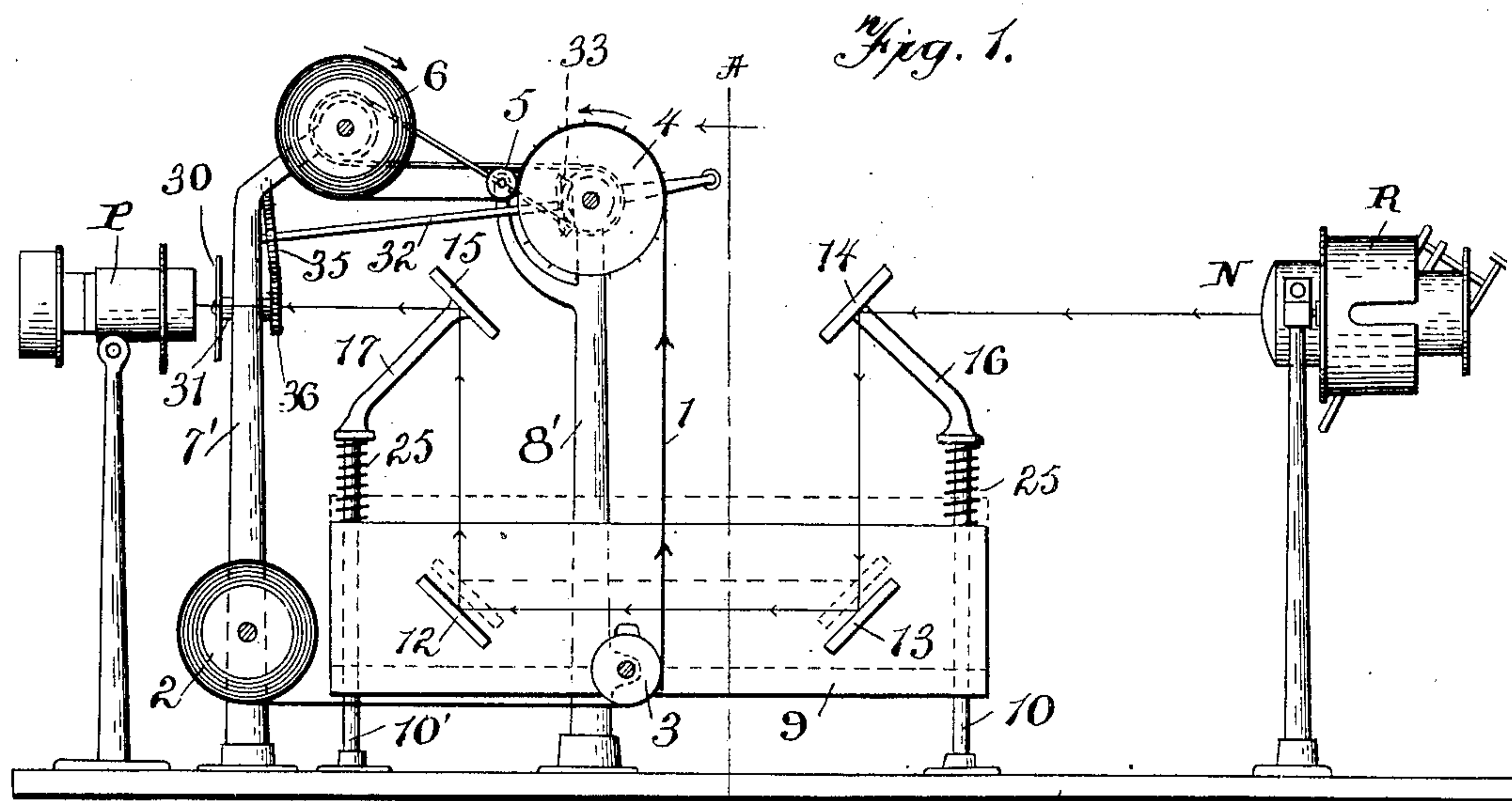
W. H. REID.  
KINETOGRAPHIC APPARATUS.

Patented Apr. 23, 1901.

(Application filed Oct. 1, 1900.)

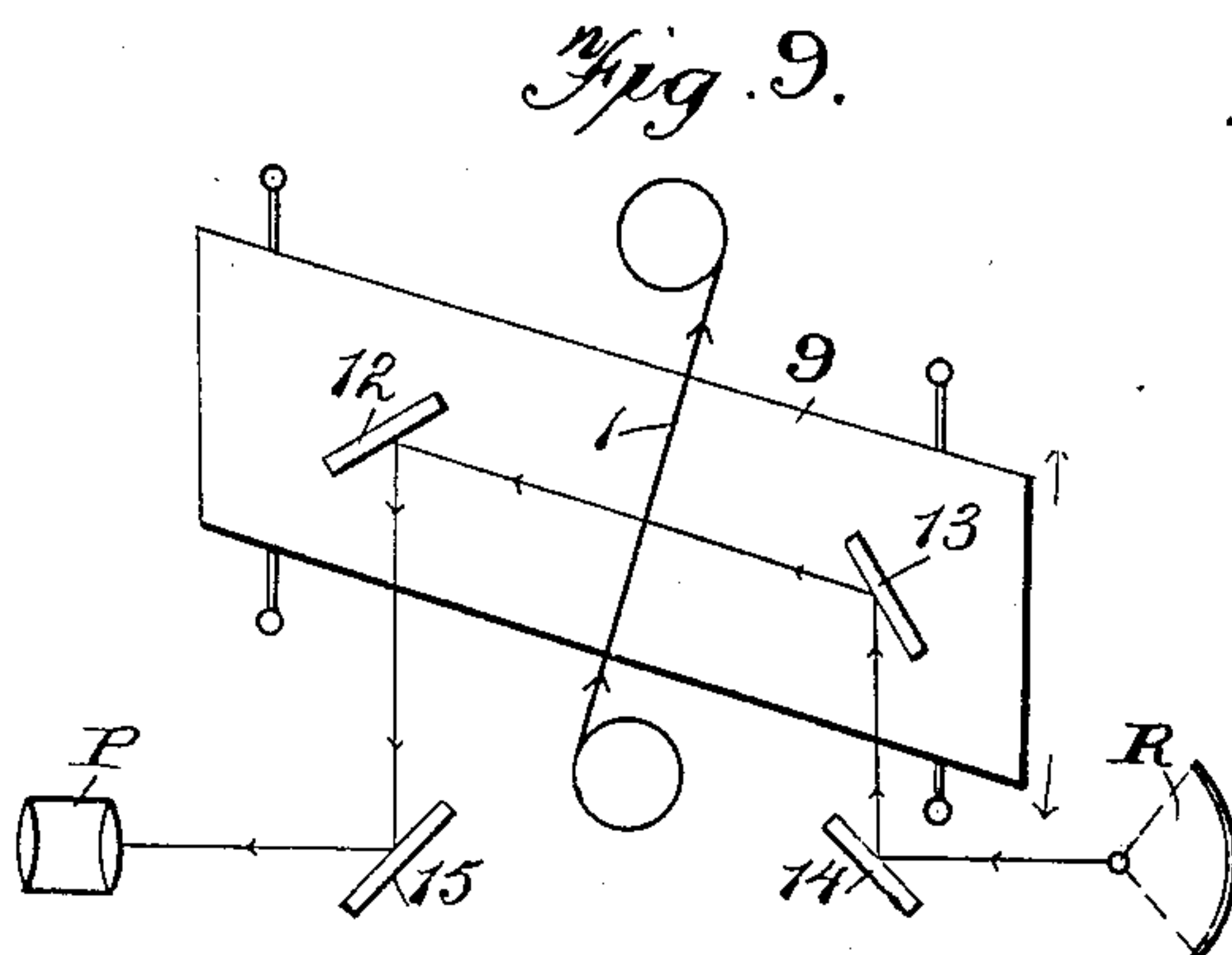
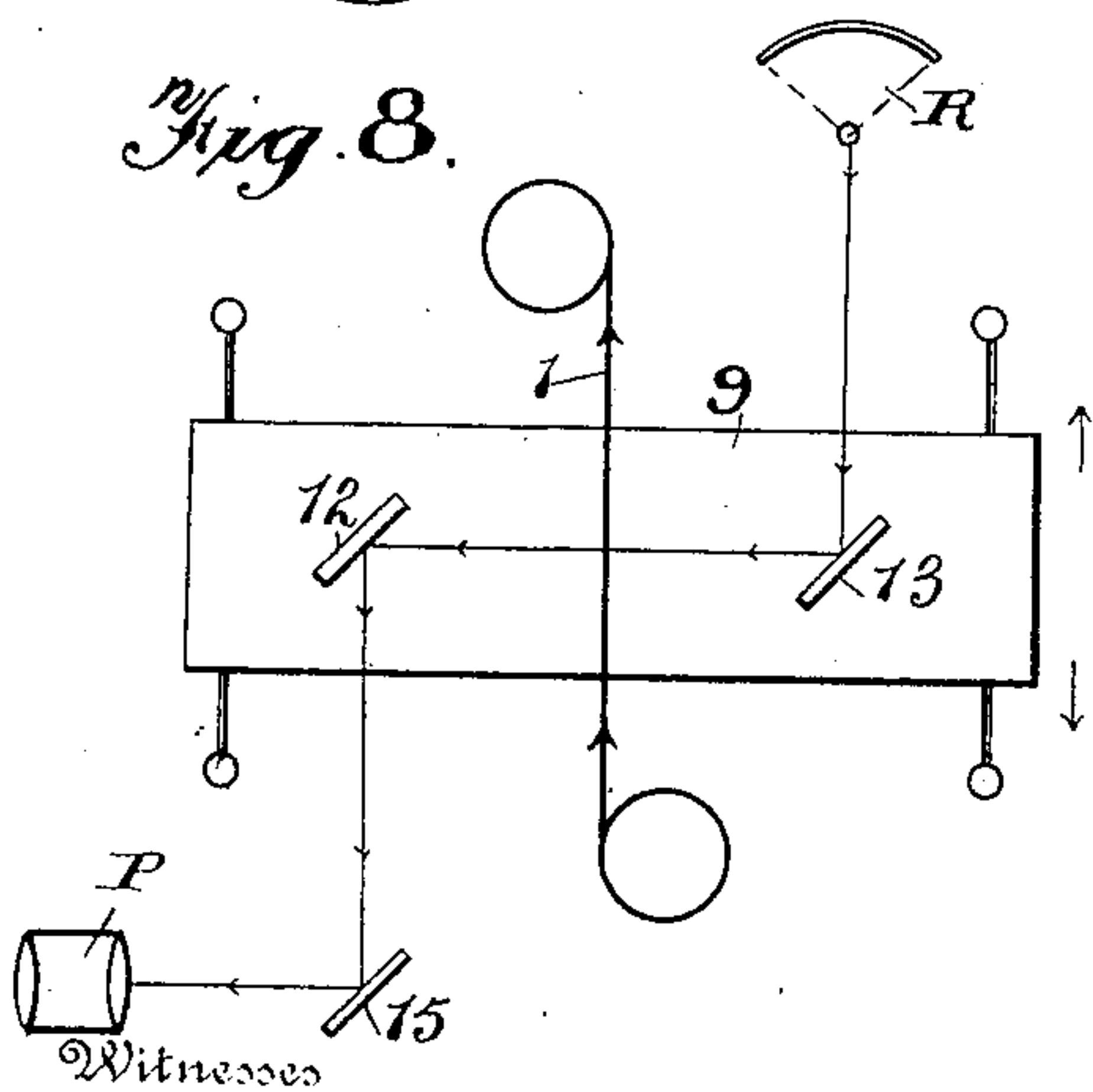
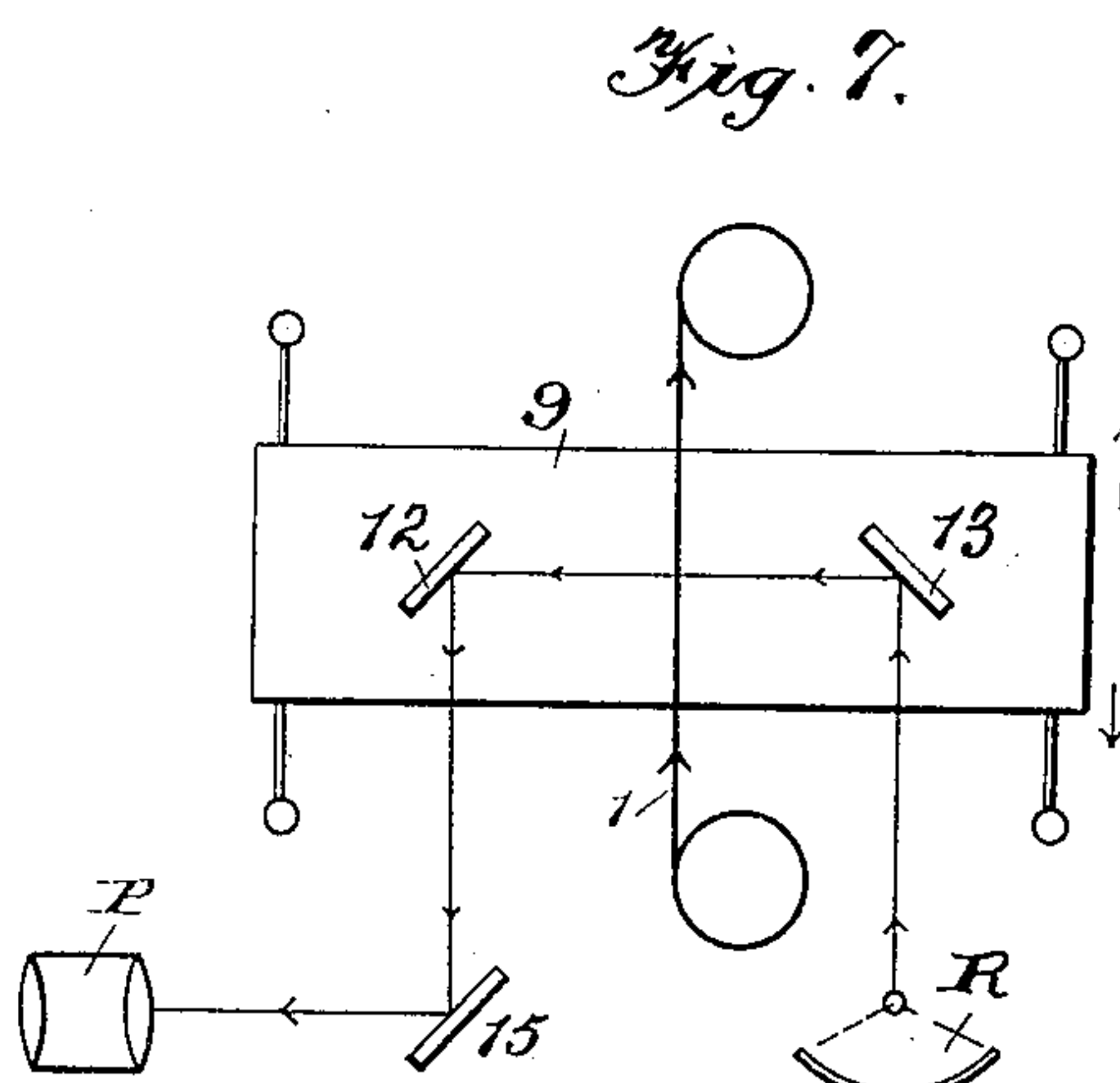
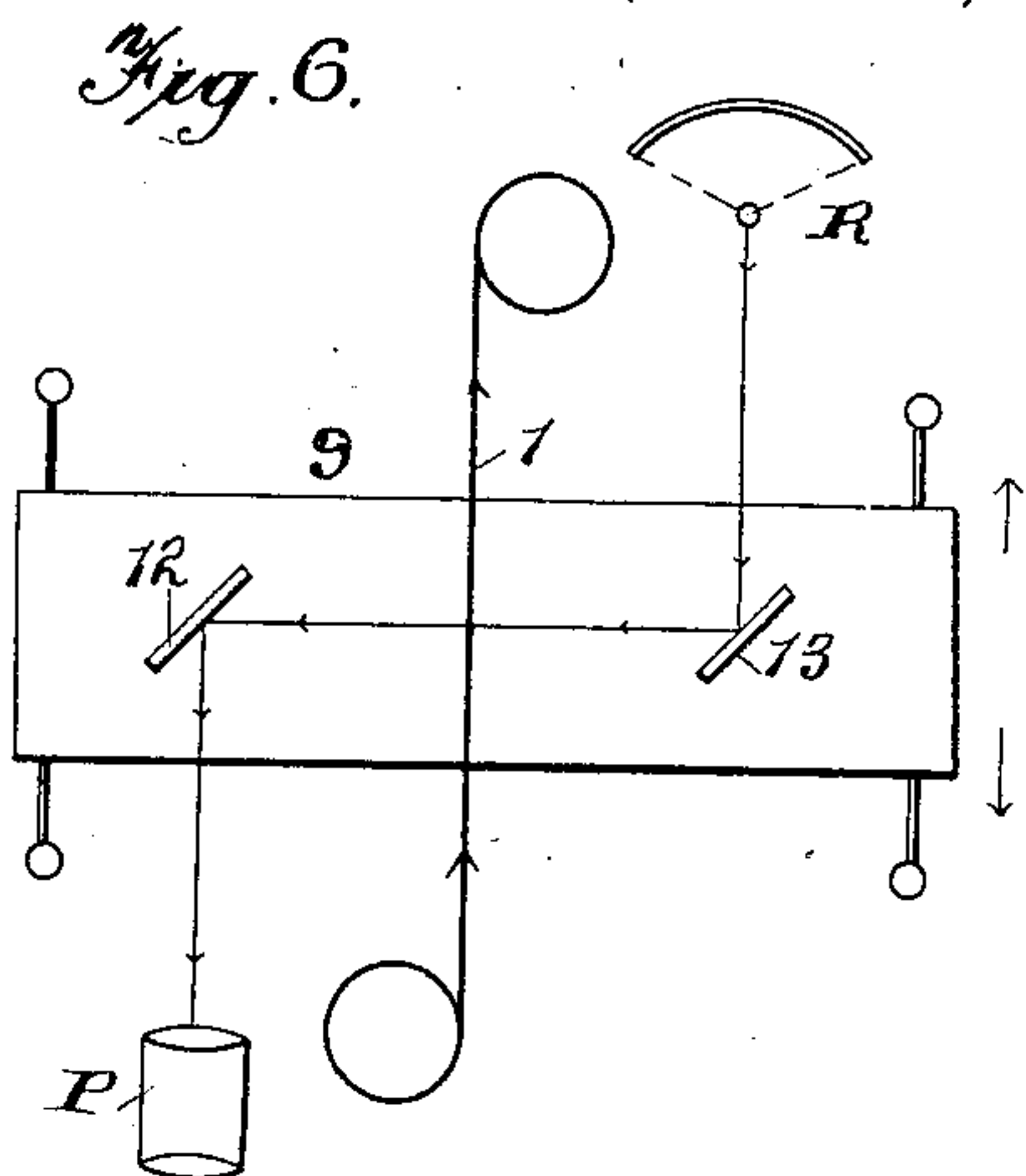
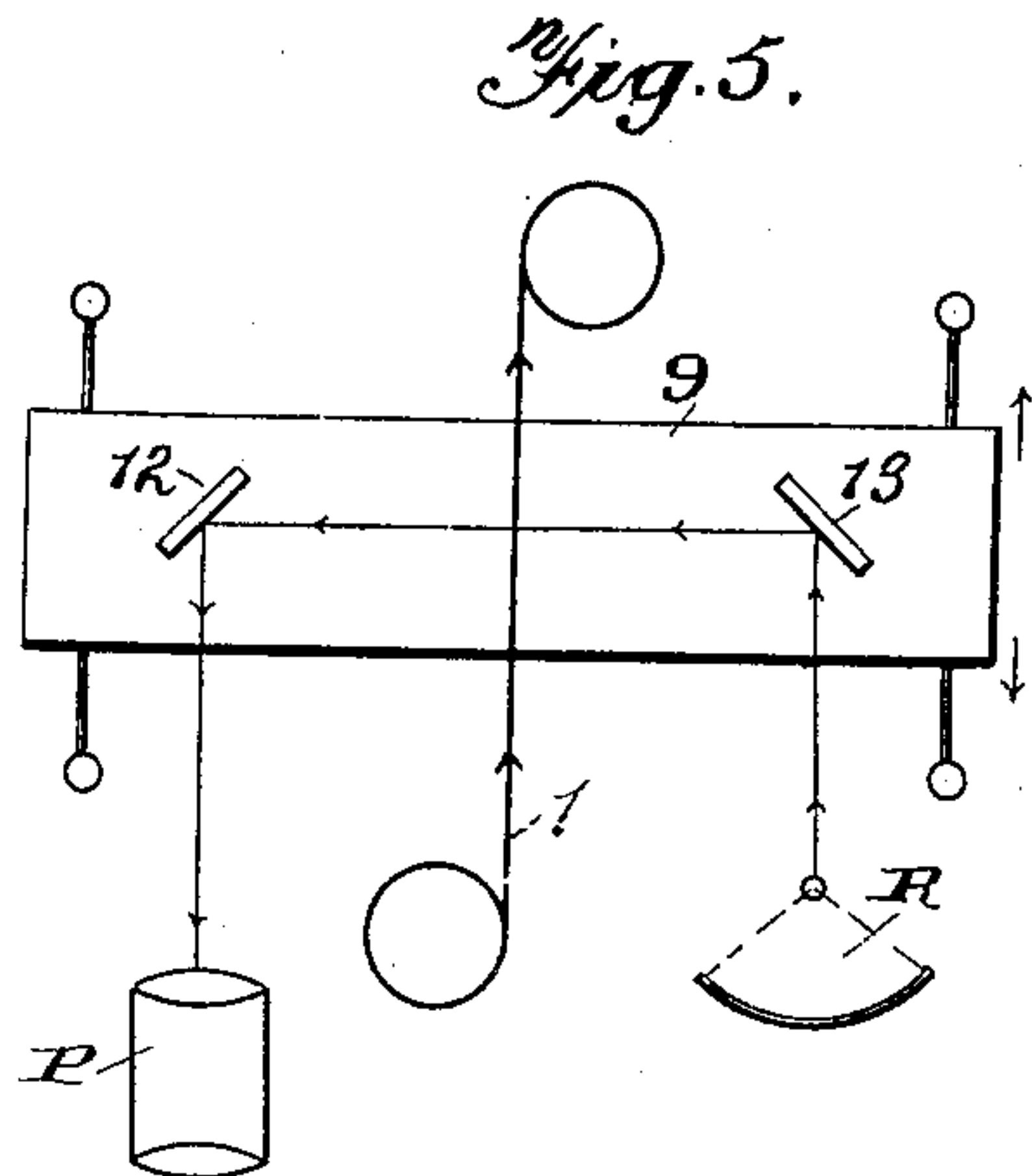
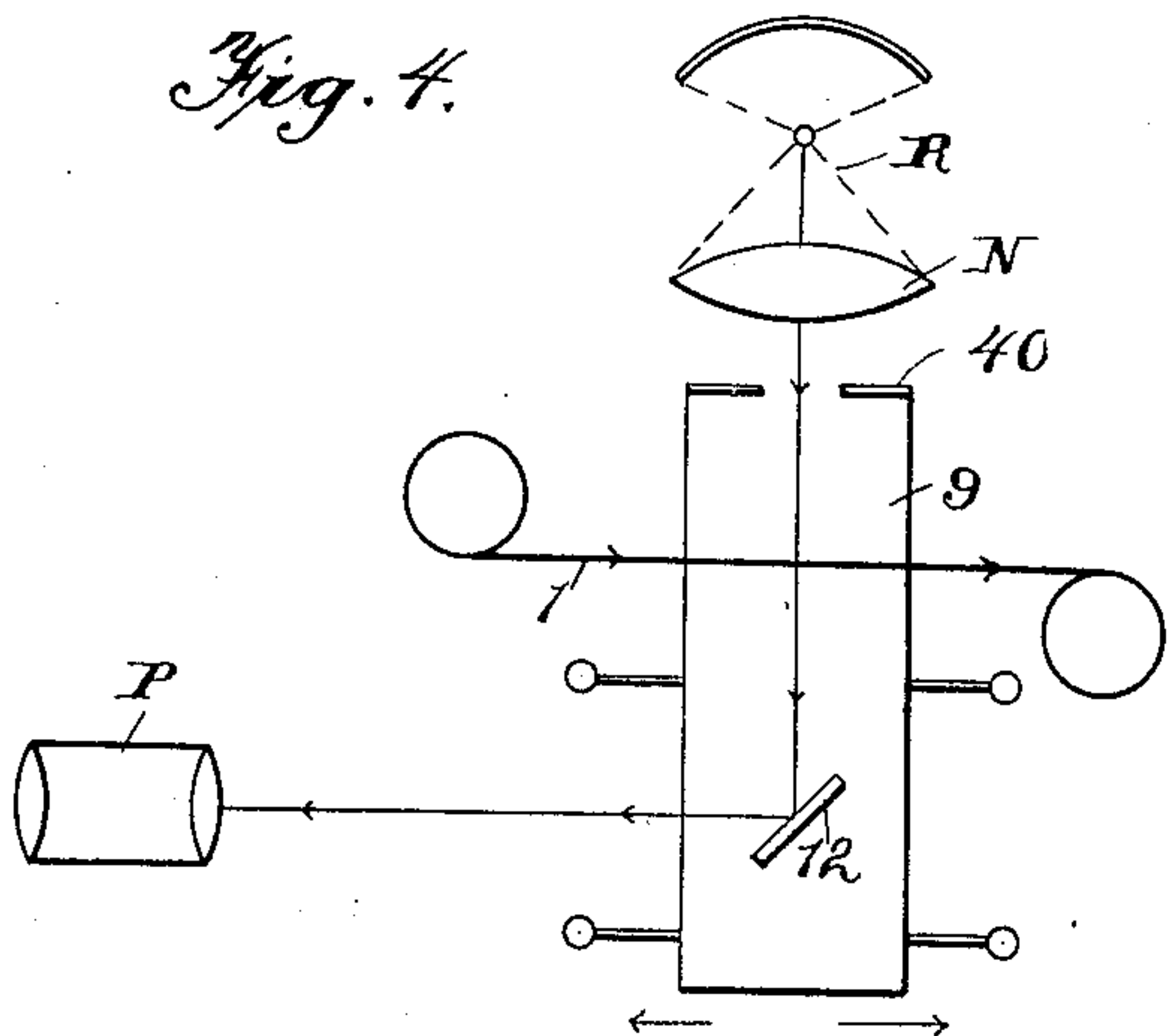
(No Model.)

2 Sheets—Sheet 1.



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# UNITED STATES PATENT OFFICE.

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## KINETOGRAPHIC APPARATUS.

SPECIFICATION forming part of Letters Patent No. 672,710, dated April 23, 1901.

Application filed October 1, 1900. Serial No. 31,727. (No model.)

*To all whom it may concern:*

Be it known that I, WILLIAM H. REID, a citizen of the United States, residing at Washington, in the District of Columbia, have invented a new and useful improvement in Kinetographic Apparatus, and I do hereby declare that the following is a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to apparatus that operates kinetographically, that is, that writes or portrays successive phases of motion of objects. This may be accomplished in three ways. The rays of light reflected from a moving object may be projected onto a sensitized photographic tape-film that is moved intermittently across the axis of lenses. And the apparatus may be used conversely; these successive images of the phases of motion permanently secured on the tape-film may be interposed in rapid succession between a light and the projecting lenses, and be thus portrayed or exhibited on a suitable screen. Or these photographic images may have light directed upon them and reflected by suitable means to a certain place, at which the eye is placed. In the first instance, the phases of motion are written on a sensitized tape-film, and there permanently recorded. In the other cases, the phases of motion are temporarily projected on a screen, or into the eyes.

Heretofore, in apparatus of this character, the tape-film, or other form of image surface is caused to move intermittently across the axis of the lens. And this irregular movement must be so effected, to produce good results, that each image or picture in succession, must remain in the focus of the lens for a certain interval of time; and the image surface moved at an exceedingly rapid speed between the intervals of pause of each image. But, unless every image is brought to rest in exactly the same position relative to the axis of the lens, the projection on the screen or other place, will vibrate or dance. Furthermore, this intermittent motion has been found so destructive on the tape-films that special means must be employed to provide a certain amount of slack in feeding the film.

The purpose of the present invention is to provide a means in the nature of a movable

reflecting arrangement, whereby a continuously moving tape-film or other image surface, may be used, and which will result in causing the rays from every image, picture, or moving object, to enter the lens, or fall upon the film, in exactly the same line of direction; and, what is still more important, each succeeding image will be in absolutely the same position relative to the lens, or the moving film, as the previous one.

My invention consists broadly in using a continuously moving image surface, and a bodily movable reflecting means, that will cause an image to be reflected from the image surface onto the screen, or vice versa, in exactly the same path of direction during the movement of the image surface for a distance equal to the distance apart of the images on the film, and then the reflecting means returns and reflects the next image on the film in precisely the same path as the former image, onto the screen, and so on in alternation.

And my invention comprises such further details of construction and arrangement, either separately or in combination as will be hereinafter described with reference to the accompanying drawings, and particularly pointed out in the claims.

In the accompanying drawings representing an apparatus embodying my invention:—

Figure 1 is an elevation on the line C—D of figure 2.

Figure 2 is an elevation on the line A—B of figure 1.

Figure 3 shows the means for moving the slide.

Figures 4 to 9 inclusive show diagrammatically modified arrangements of the mirrors.

The tape-film, or other image surface, represented on the drawing by the reference numeral 1, is caused to travel preferably by a continuous movement, from a drum 2, over a guide roll 3, onto an actuating drum 4, around which it passes for about half of its perimeter, then over a guide roll 5, to a drum 6, on which it is wound up as used. The actuating drum 4, may be rotated by hand, or other preferred means, and may have pins on its convex surface, near its edges, that engage apertures in the film, to prevent any slip of the film. The winding drum 6 may be driven from the shaft of the film-actuating drum 4,



by a belt, if desired. The shafts of the drums 2, and 6, are supported by the standards 7, and 7', and the drums 3, 4, and 5, have their shafts supported by standards 8, and 8'.

5 A block or slide 9, is arranged to be reciprocated on two or more parallel posts 10, 10', that are secured to the base 11, of the apparatus, and preferably perpendicular thereto.

The tape-film is also preferably arranged  
10 to travel in a vertical direction, and upwardly from drum 3, to drum 4; and a portion of it passing from one of these drums to the other moves in proximity to an intermediate part of the slide, with the image surface trans-  
15 verse to the adjacent face of the slide. The slide is reciprocated preferably by means directly connected with the film-actuating drum 4, which will be fully described hereinafter.

On the slide 9, are rigidly secured the reflect-  
20 ing means, preferably plane mirrors 12, and 13, that are arranged perpendicular to the vertical face of the slide, and each is set at an angle of  $45^\circ$  with the direction of reciprocation of the slide. They are so positioned  
25 on the slide that the reflecting faces make an angle of  $90^\circ$ , with each other.

A mirror 14, is supported by an arm 16, from the post 10, and is arranged vertically above the mirror 13 with the reflecting face  
30 on the lower side, and parallel with the reflecting face of the mirror 13. Another mirror 15, is similarly arranged with respect to the mirror 12; being supported by an arm 17 from the post 10', and arranged vertically  
35 above the mirror 12, with the reflecting face on the lower side, and parallel with the same face of the mirror 12.

The source of light R, may be an arc light, or any other preferred kind, and may have a  
40 double convex lens N, to direct the rays parallel in a horizontal direction onto the mirror 14.

Now as the mirror 14 is parallel with the mirror 13, and hence each is at an angle of  $45^\circ$   
45 with the vertical line, the parallel rays from the lens N, will be reflected by the mirror 14, vertically downwardly, and fall upon the mirror 13; which latter will also deflect the rays  $90^\circ$ , and will direct them in a horizontal path  
50 again. The mirror 12, is so positioned on the slide that the rays reflected horizontally from the mirror 13, will be intercepted by it, and being also set at angle of  $45^\circ$  with the vertical line, will reflect the rays vertically up-  
55 wardly, and upon the mirror 15: which latter mirror, being parallel with the mirror 12, will reflect them again in a horizontal direction. In the latter path is arranged the projecting lens P, that receives the rays and pro-  
60 jects them onto a suitable screen.

Were the slide stationary, the film passing upwardly between the mirrors 13 and 12, would cause the images successively to intercept the light rays passing from 13, to 12, and  
65 be thus projected, by mirror 15, and lens P onto the screen; yet not stationary, but moving across the screen as rapidly as the image

is moving. But if the slide is moved upwardly at the same speed as that at which the film is moving, the mirrors 13, and 12, will  
70 also travel upwardly, yet the mirrors 13, and 14, will still be parallel with each other, and also the mirrors 12, and 15; and any ray coming from the mirror 14, to the mirror 13, will  
75 fall upon the same point on the mirror 13, in the position of the mirror indicated by dotted lines, as in the former position; and obviously the rays will fall upon the mirror 13 at the same angle as before. Consequently, the  
80 rays will still be reflected by the mirror 13 in a horizontal direction, which will be the case for any position of the slide. But the mirror 12, remaining immovable relative to the mirror 13, the rays from the mirror 14 will be re-  
85 flected upon the mirror 13 at the same angle as before, and will impinge upon it at the same points: (for any position of the slide); which will result in the rays being still re-  
90 flected from mirror 13, vertically upwardly and in the same path as heretofore, whatever be the position of the slide. And the mirror 15, receiving the rays in the same path of di-  
95 rection, will reflect them into the lens in the same path.

From these facts it will be readily apparent  
95 that if an image on the film be interposed between the mirrors 13, and 12, so as to be entirely intercepted by rays passing from mirror 13, to mirror 12, and then the slide be  
100 caused to travel upwardly at the same speed at which the film is moving, then, instead of the projected image moving across the screen, the projection will be held stationary on the  
105 screen, because the simultaneous movement of the film and mirrors will cause the rays intersecting the image on the film to remain immovable relative to the image.

As previously mentioned, the best results are obtained when each image is projected  
110 onto the screen for an interval of time, and it is very quickly replaced by the succeeding image. Therefore if the slide and film are moved together for a distance equal to the  
115 distance apart of the images on the film, center to center, and then the slide returned to the former position, the succeeding image on the film will be in exactly the same position relative to the intersecting rays as the previous one, and will be projected onto the screen  
120 at the same place as was the preceding picture. And now the slide must be again moved upwardly simultaneously with the film, so that this image will be held stationary of the screen for a certain interval of time. And the slide  
125 must be moved upwardly the same distance as before, and then returned for the next image, and so on in alternation.

My preferred means for effecting such a reciprocation of the slide, is to have loosely  
130 mounted on the shaft 18, that carries the film-actuating drum, a sector 19, whose radius is equal to the drum 4. There is a flexible connector between the periphery of the sector and the slide, such as a metal band or strap



20, secured to the sector by a screw 21, and adjustably attached to the slide by having a threaded rod 22, secured to the end of the band and passing through a bracket 23, secured to the slide, and being secured to the bracket by jam nuts 24, that allow of a fine adjustment of the slide on the band.

If, while the drum is moving the film upwardly, the sector is coupled to the drum, or its shaft, the sector will wind up the band 20, and thus draw the slide upwardly at the same velocity that the drum 4 is winding or drawing the film upwardly, because of the equal radius of the drum and sector. But, when the slide has traveled upwardly the required distance, the sector is uncoupled from the drum, when the weight of the slide, aided by helical springs 25, on the posts 10, will force the slide downwardly by a rapid movement. And when the slide has descended the required distance, the sector and drum must be again coupled together.

One arrangement of coupling means to produce the described result, is to have the circumference of the drum 4, an exact multiple of the distance apart of the images on the film, center to center, and to have the same number of lugs 26, as this multiple, on the rim of the drum 4. On a radial face of the sector 19, is secured a spring arm 27, having a beveled extremity 28, that engages one of the lugs 26, and thus causing the drum rotating in the direction indicated, to carry the sector with it. But when the end 28 of the arm comes into contact with an arm 29, secured on the standard 8', the arm is forced inwardly towards the shaft, and disengaged from the lug; when the sector will be rotated in the opposite direction by the band 20, and the slide. The elasticity of the arm 27, assisted by centrifugal force, will carry the end 28, outwardly from the shaft, and it and the sector will be arrested by the next lug 26, which will again couple the sector and drum: and when the drum has carried it forward the same distance, they will be again uncoupled by the arm 29.

If desired, a shutter may be provided to intercept the rays, while the reflecting means is moving from one image to the next one. It may consist of a wing or arm 30, of sheet metal, gauze or the like, mounted on a pinion 31, on the standard 7'. A shaft 32, extends from the latter standard over to the standard 8, and has a bevel gear 33, meshing with a gear 34, on the shaft 18, by which the shaft 32 is operated. The other end of the shaft 32, has a gear 35, that engages a gear 36, on the pinion 31, thus driving the shutter. These several gears are so proportioned that the shutter makes one revolution for each reciprocation of the slide, the light being cut off while the slide is making the return movement.

In Figure 4, is shown a modification in which I accomplish the same result as in Figure 1, with the use of one mirror only. Here the

slide 9, moves in a horizontal plane, instead of in a vertical plane, and has but the one mirror, or other reflecting means 12. The parallel rays from the lens N, fall upon the mirror 12, and are by it reflected directly into the lens P. The slide reciprocates in a direction parallel with the path of the rays from the mirror 12 to the lens. A shutter 40, is fixed on the slide 9, and has an aperture just large enough to admit sufficient rays to intersect an entire image on the film. This shutter travels back and forth across the axis of the lens N, hence different parallel rays will be admitted by the shutter, and fall upon the mirror 12; but as only parallel rays in the same path relative to the moving slide, will fall on the mirror 12, they will be directed always in the same path onto the lens P.

Figure 5, shows another horizontally moving slide in which the mirrors 12, and 15, of Figure 1, have been omitted, the light R, sending parallel rays directly upon the mirror 13, while the mirror 12, directs the image into the lens, as in Figure 4.

In Figure 6 the mirrors 12, and 13, on the slide are arranged parallel, with the reflecting faces in apposition. The rays from R, are reflected by the mirror 13, onto the mirror 12, and the latter reflects them into the lens P. In this instance, the aggregate distance from the light R, to the lens P, does not vary, because as the distance from the mirror 13, to R, decreases, the distance from the mirror 12 to the lens P, increases and vice versa.

In Figure 7 three mirrors are used, the mirror 15, serving to reflect the rays from mirror 12 at a right angle.

Figure 8 shows the form shown in Figure 6, with the mirror 15 added, and another reflection of 90° given to the rays.

In each of the above modifications it will be observed that the slide reciprocates in a direction parallel with the path into which the rays are reflected by the reflecting means, the mirror 12. But in each of these cases the mirrors 12, and 13, were set at an angle of 45° with the path of reflection. However, this angle is not necessary, but may be varied, it being only essential that the mirror 12, travel in the path of the reflected rays.

In Figure 9 the mirror 12, is set at an angle of 60° with the said path of reflection; and the mirror 13, is set at an angle of 30° with this path of reflection. But the slide must still be reciprocated in a direction parallel with the path of reflection of the rays from the mirror 12.

It is not necessary that the film, or image surface travel in a path parallel with the movement of the slide. Nor is it necessary that the film move in a path at right angles with the intersecting rays; but any considerable deviation would result in the projection being elongated on the screen somewhat.

I have described my preferred form of arrangement and modification as used for the



projection of images contained on a transparent film. But if a sensitized film were used, and the light and the mirrors 13, and 14, were omitted, the lens P, focused on a moving object, would cause a series of images of phases of motion to be thrown on the film, which could be made permanent by proper photographic treatment. The apparatus would have to be enclosed, and a properly proportioned shutter used instead of the shutter 30.

Or my apparatus may be used to project the views directly into the eyes, instead of onto a screen, by placing the eyes in the path from the mirror 12, or the mirror 15. And instead of a transparent film, an opaque picture surface could be used, that would reflect the pictures onto the mirror 12, by reflected instead of transmitted light.

While I have shown and described plane mirrors as my preferred form of reflecting means, other forms could be used, such as prisms, to produce the same results. By the term "image surface" herein used, I mean either a sensitized surface for receiving and recording an image, or a surface on which an image has been recorded, the latter image being either translucent or opaque. Where the expression "bodily movable" is herein employed with reference to the reflecting means, I refer to a movement of the same in which every point is given a movement of translation, that is to say, a movement during which the distance of every point in the reflecting means from every fixed point varies; in contradistinction to a movement of rotation, or of oscillation, about a fixed axis, during which latter movement every point in the reflecting means remains at a constant distance from said axis.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent of the United States is:

1. In an apparatus of the character described, the combination of means for projecting rays of light in a certain path, movable reflecting means arranged to receive said rays and cause them to travel in another path, a movable image surface arranged to intersect said rays, and means for moving said reflecting means bodily in such a manner that the angle which the reflecting means makes with the deflected rays remains constant during the periods of illumination.

2. In an apparatus of the character described, the combination of means for projecting rays of light in a certain path, movable reflecting means arranged to receive said rays and cause them to travel in another path, a movable image surface arranged to intersect said rays traveling in one of said paths, and means for moving said reflecting means bodily in the other of said paths during the periods of illumination.

3. In an apparatus of the character described, the combination of means for projecting rays of light in a certain path, movable reflecting means arranged to receive said

rays and cause them to travel in a path at right angles to said path, a movable image surface arranged to intersect said rays, and means for moving said reflecting means bodily in such a manner that the angle which the reflecting means makes with the reflected rays remains constant during the periods of illumination.

4. In an apparatus of the character described, the combination of means for projecting rays of light in a certain path, movable reflecting means arranged to receive said rays and cause them to travel in another path, a movable image surface arranged to intersect said rays, and means for causing a rectilinear reciprocation of said reflecting means.

5. In an apparatus of the character described, the combination of means for projecting rays of light in a certain path, movable reflecting means arranged to receive said rays and cause them to travel in another path, an image surface arranged to intersect said rays traveling in one of said paths, said surface being arranged to move in a path at right angles to the path of rays it intersects, and means for moving said reflecting means bodily in such a manner that the angle which the said reflecting means makes with the reflected rays remains constant during the periods of illumination.

6. In an apparatus of the character described, the combination of means for projecting rays of light in a certain path, movable reflecting means arranged to receive said rays and cause them to travel in another path, a movable image surface arranged to intersect said rays, means for moving said surface in a certain direction, and means for moving said reflecting means bodily in substantially the same direction as said moving surface during the periods of illumination.

7. In an apparatus of the character described, the combination of means for projecting rays of light in a certain path, movable reflecting means arranged to receive said rays and cause them to travel in another path, a movable image surface arranged to intersect said rays, and means for causing a rectilinear reciprocation of said reflecting means in which the movement is of greater velocity in one direction than the other.

8. In an apparatus of the character described, the combination of means for projecting rays of light in a certain path, movable reflecting means arranged to receive said rays and cause them to travel in another path, a movable image surface arranged to intersect said rays, and means for causing a rectilinear reciprocation of said reflecting means in which the movement is practically instantaneous in one direction and comparatively prolonged in the other direction.

9. In an apparatus of the character described, the combination of means for projecting rays of light in a certain path, movable reflecting means arranged to receive said rays



and cause them to travel in another path, a movable image surface arranged to intersect said rays, means for moving said image surface, and means for moving said reflecting means in such a manner that it remains immovable relative to said moving image surface during the periods of illumination.

10. In an apparatus of the character described, the combination of means for projecting rays of light in a certain path, movable reflecting means arranged to receive said rays and cause them to travel in another path, a movable image surface arranged to intersect said rays, means for moving said image surface, and means for moving said reflecting means bodily, the movement of the image surface relative to the movement of the reflecting means being so arranged that the points of said intersection of the rays with the image surface remain unchanged during the periods of illumination.

11. In an apparatus of the character described, the combination of means for projecting rays of light in a certain path, a movable image surface arranged to intersect said rays, bodily movable reflecting means arranged to receive said rays and cause them to travel in another path, means for moving said reflecting means in a rectilinear path, and means for moving said image surface in a path parallel with the path of movement of said reflecting means.

12. In an apparatus of the character described, the combination of means for projecting rays of light in a certain path, movable reflecting means arranged to receive said rays and cause them to travel in another path, an image surface arranged to intersect said rays, means for moving said image surface continuously, and means for bodily moving said reflecting means in such a manner that the angle which the reflecting means makes with the reflected rays remains constant during the periods of illumination.

13. In an apparatus of the character described, the combination of means for projecting rays of light in a certain path, movable reflecting means arranged to receive said rays and cause them to travel in another path, means for moving said reflecting means bodily, an image surface arranged to intersect the rays traveling in one of said paths, and means for moving said image surface in such a manner that the angle of said intersection of the image surface with the path of rays remains constant during the periods of illumination.

14. In an apparatus of the character described, the combination of a movable image surface, means for causing rays of light to intersect an image contained on said surface and thereby project said image, movable reflecting means arranged in the path of said projection, and means for moving said reflecting means bodily in such a manner that the angle that the said reflecting means

makes with said path remains constant during the periods of illumination.

15. In an apparatus of the character described, the combination of a movable image surface, means for causing rays of light to intersect an image contained on said surface and thereby project said image, movable reflecting means arranged in the path of said projection, and means for moving said reflecting means bodily in the path of the reflected rays during the periods of illumination.

16. In an apparatus of the character described, the combination of a movable image surface, means for causing rays of light to intersect an image contained on said surface and thereby project said image, movable reflecting means arranged in the path of said projection for causing a deflection of  $90^\circ$ , and means for moving said reflecting means bodily in such a manner that the angle which the said reflecting means makes with the said path of rays remains constant during the periods of illumination.

17. In an apparatus of the character described, the combination of a movable image surface, means for causing rays of light to intersect an image contained on said surface and thereby project said image, movable reflecting means arranged in the path of said projection, and means for causing a rectilinear reciprocation of said reflecting means.

18. In an apparatus of the character described, the combination of a movable image surface, means for causing rays of light to intersect an image contained on said surface and thereby project said image, movable reflecting means arranged in the path of said projection, and means for causing a rectilinear reciprocation of said reflecting means in a vertical path.

19. In an apparatus of the character described, the combination of a movable image surface, means for causing rays of light to intersect an image contained on said surface and thereby project said image, means for moving said image surface continuously, movable reflecting means arranged in the path of said projection, and means for moving said reflecting means bodily in such a manner that the angle which said reflecting means makes with said path remains constant during the periods of illumination.

20. In an apparatus of the character described, the combination of a movable image surface, means for causing rays of light to intersect an image contained on said surface at right angles and thereby project said image, movable reflecting means arranged in the path of said projection, and means for moving said reflecting means bodily in such a manner that the angle that said reflecting means makes with said path remains constant during the periods of illumination.

21. In an apparatus of the character described, the combination of a movable image



surface, means for moving said surface in a certain direction, means for causing rays of light to intersect an image contained on said surface and thereby project said image, movable reflecting means arranged in the path of said projection, and means for moving said reflecting means bodily in substantially the same direction as said moving surface during the periods of illumination.

22. In an apparatus of the character described, the combination of a movable image surface, means for causing rays of light to intersect an image contained on said surface and thereby project said image, movable reflecting means arranged in the path of said projection, and means for causing a rectilinear reciprocation of said reflecting means in which the movement is of greater velocity in one direction than in the other.

23. In an apparatus of the character described, the combination of a movable image surface, means for causing rays of light to intersect an image contained on said surface and thereby project said image, movable reflecting means arranged in the path of said projection, and means for causing a rectilinear reciprocation of said reflecting means in which the movement is practically instantaneous in one direction and comparatively prolonged in the other direction.

24. In an apparatus of the character described, the combination of a movable image surface, means for causing rays of light to intersect an image contained on said surface and thereby project said image, movable reflecting means arranged in the path of said projection, means for moving said image surface, and means for moving said reflecting means in such a manner that it remains immovable relative to said moving surface during the periods of illumination.

25. In an apparatus of the character described, the combination of a movable image surface, means for causing rays of light to intersect an image contained on said surface and thereby project said image, movable reflecting means arranged in the path of said projection, means for moving said image surface, and means for moving said reflecting means bodily, the movement of the image surface relative to the movement of the reflecting means being so arranged that the angle made by the intersecting rays with the said surface remains constant during the periods of illumination.

26. In an apparatus of the character described, the combination of a movable image surface, means for causing rays of light to intersect an image contained on said surface and thereby project said image, movable reflecting means arranged in the path of said projection, means for moving said image surface, and means for moving said reflecting means bodily, the movement of said image surface relative to the movement of the said reflecting means being so arranged that the

points of said intersection remain unchanged during the periods of illumination.

27. In an apparatus of the character described, the combination of a movable image surface, means for causing rays of light to intersect an image contained on said surface and thereby project said image in a certain path, bodily movable reflecting means arranged to intercept said projection and thereby cause it to be projected in another path, means for moving said reflecting means in a rectilinear path, and means for moving said image surface in a path parallel with the path of the said deflected rays.

28. In an apparatus of the character described, the combination of a movable image surface, a movable slide, a pair of reflectors rigidly secured on said slide, a source of light, one of said reflectors being arranged to receive rays from said light and reflect them toward said other reflector, said other reflector being arranged to receive said reflected rays and reflect them in a direction parallel with said rays passing from the said light to the first reflector, means for moving said slide in such a manner that the reflectors maintain a constant angle with said parallel paths of rays during the periods of illumination, and means for moving said image surface during the periods of illumination in a path intersecting said rays passing between said reflectors on the slide.

29. In an apparatus of the character described, the combination of a movable image surface, a movable slide, a pair of reflectors rigidly secured on said slide, a source of light, means for causing rays from said light to impinge on one of said reflectors, said latter reflector being arranged to reflect said impinging rays  $90^\circ$ , said other reflector on the slide being arranged to receive said latter reflected rays and reflect them  $90^\circ$ , means for moving said slide in such a manner that the reflectors maintain a constant angle with said latter reflected rays during the periods of illumination, and means for moving said image surface during the periods of illumination in a path intersecting said rays passing between said reflectors on the slide.

30. In an apparatus of the character described, the combination of a movable image surface, a movable slide, a pair of reflectors rigidly secured on said slide, a source of light, one of said reflectors being arranged to receive rays from said light and reflect them toward said other reflector, said other reflector being arranged to receive said reflected rays and reflect them in a direction parallel with said rays passing from said light to the first reflector, means for reciprocating said slide in a direction parallel with said parallel path of rays, and means for moving said image surface in a path intersecting said rays passing between said reflectors on the slide.

31. In an apparatus of the character described, the combination of a movable image



surface, a rotatable shaft, means secured on said shaft for moving said surface, movable reflecting means, means mounted loosely on said shaft for moving said reflecting means  
5 bodily, and means for causing said loosely mounted means to be driven from said shaft at certain intervals.

32. In an apparatus of the character described, the combination of a movable image  
10 surface, a rotatable shaft, means secured on said shaft for moving said surface continuously, movable reflecting means, means mounted loosely on said shaft for moving said reflecting means bodily, and means for caus-  
15 ing said loosely mounted means to be driven from said shaft at certain intervals.

33. In an apparatus of the character described, the combination of a movable image surface, a rotatable shaft, means secured on  
20 said shaft for moving said surface, movable reflecting means, means mounted loosely on said shaft for moving said reflecting means bodily in one direction, means for causing said latter means to be driven from said shaft  
25 at certain intervals, and means for moving said reflecting means in the opposite direction.

34. In an apparatus of the character described, the combination of a movable image  
30 surface, a rotatable shaft, means secured on said shaft for moving said image surface, reciprocable reflecting means, means mounted loosely on said shaft for reciprocating said reflecting means in a rectilinear path, and  
35 means for causing said loosely mounted means to be driven from said shaft at certain intervals.

35. In an apparatus of the character described, the combination of a movable image  
40 surface, a rotatable shaft, means secured on said shaft for moving said surface, movable reflecting means, means mounted loosely on said shaft for moving said reflecting means bodily, and means for causing said loosely  
45 mounted means to be driven from said shaft at certain intervals and thereby move said reflecting means at the same speed as that of the image surface.

36. In an apparatus of the character de-  
50 scribed, the combination of a movable image surface, a rotatable shaft, means secured on said shaft for moving said surface, vertically reciprocable reflecting means, means mounted loosely on said shaft for moving  
55 said reflecting means upwardly, and means

for causing said loosely mounted means to be driven from said shaft at certain intervals.

37. In an apparatus of the character de-  
scribed, the combination of an image surface,  
winding means for moving said surface, mov- 60  
able reflecting means, a second winding means, a flexible connector between said second winding means and said reflecting means for causing the said second winding means to  
move the reflecting means in one direction, 65  
and means for causing said former winding means at certain parts of its movement to actuate said second winding means.

38. In an apparatus of the character de-  
scribed, the combination of an image surface, 70  
winding means for moving said surface, movable reflecting means, a second winding means concentric with said winding means, a flexible connector between said second wind-  
ing means and said reflecting means for caus- 75  
ing the second winding means to move the reflecting means in one direction, and means for coupling said former winding means at certain parts of its movement to said second  
winding means. 80

39. In an apparatus of the character de-  
scribed, the combination of an image surface,  
a rotatable drum for moving said surface,  
movable reflecting means, a winding means,  
a flexible connector between said winding 85  
means and said reflecting means for causing the winding means to move the reflecting means in one direction, and means for coupling said drum at certain parts of its move-  
ment with said winding means. 90

40. In an apparatus of the character de-  
scribed, the combination of an image surface,  
a drum for moving said surface, a shaft on  
which said drum is mounted, a sector mount-  
ed loosely on said shaft, movable reflecting 95  
means, a flexible connector between said reflecting means and said sector for causing said sector to move said reflecting means in one direction, a series of lugs on said drum,  
an arm on said sector arranged to engage said 100  
lugs successively and thereby couple said sector with said drum, and a trip device for releasing said arm from said lugs at certain in-  
tervals.

In testimony whereof I affix my signature 105  
in the presence of two witnesses.

WILLIAM H. REID.

Witnesses:

MITFORD C. MASSIE,

ANTON A. GLOETZNER, Jr.