No. 738,022. PATENTED SEPT. 1, 1903.

A. E. W. FRAZER.

AMUSEMENT RAILWAY.

APPLICATION FILED MAY 8, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

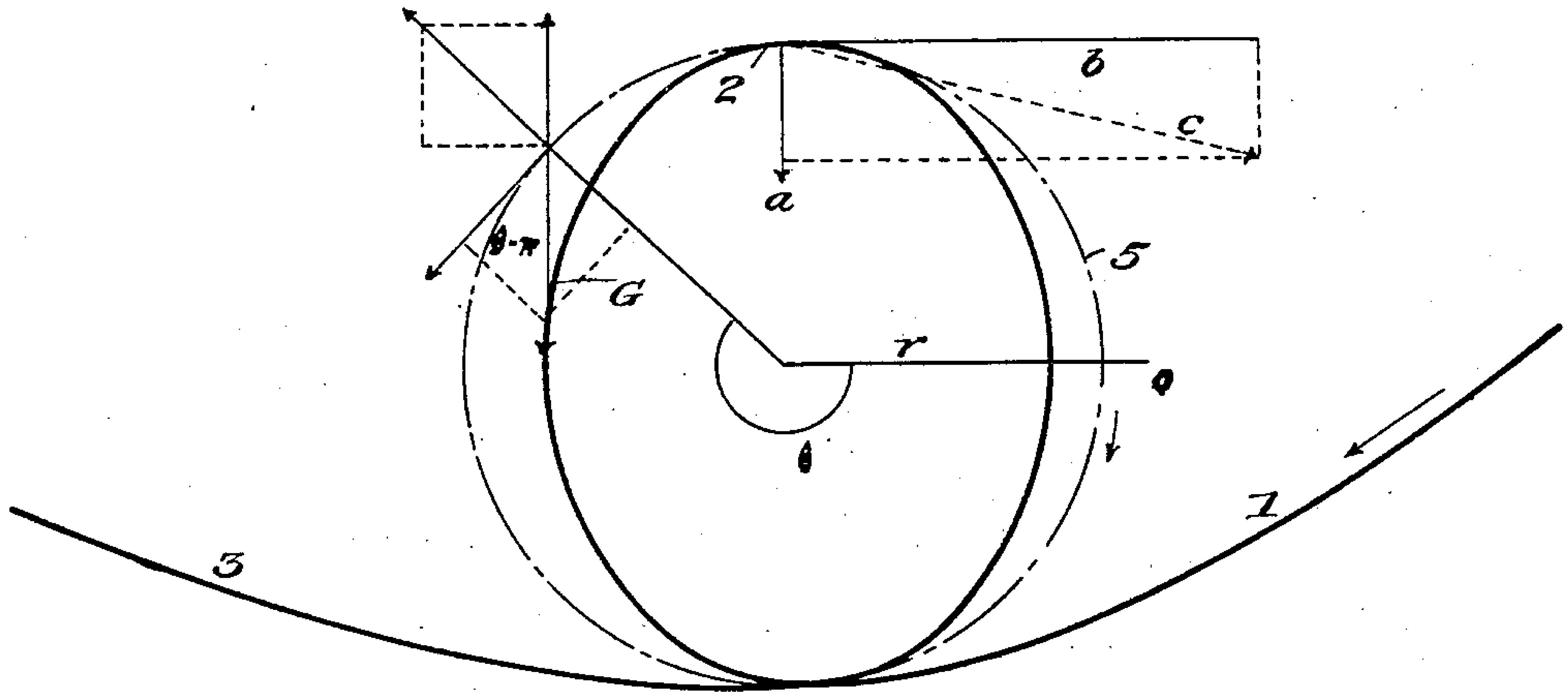

Fig. 1.

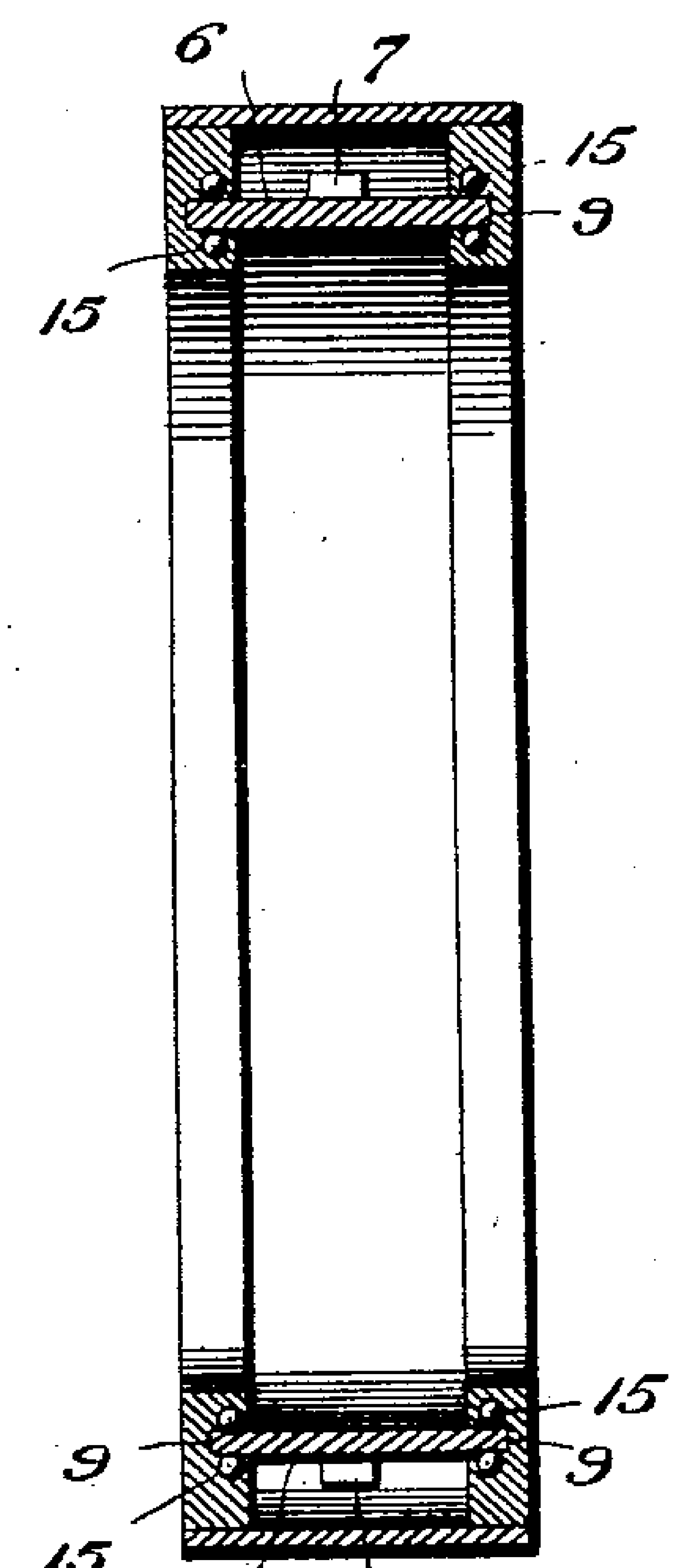

Fig. 3.

Witnesses

Wm. ... (signature)

Grace P. Brereton

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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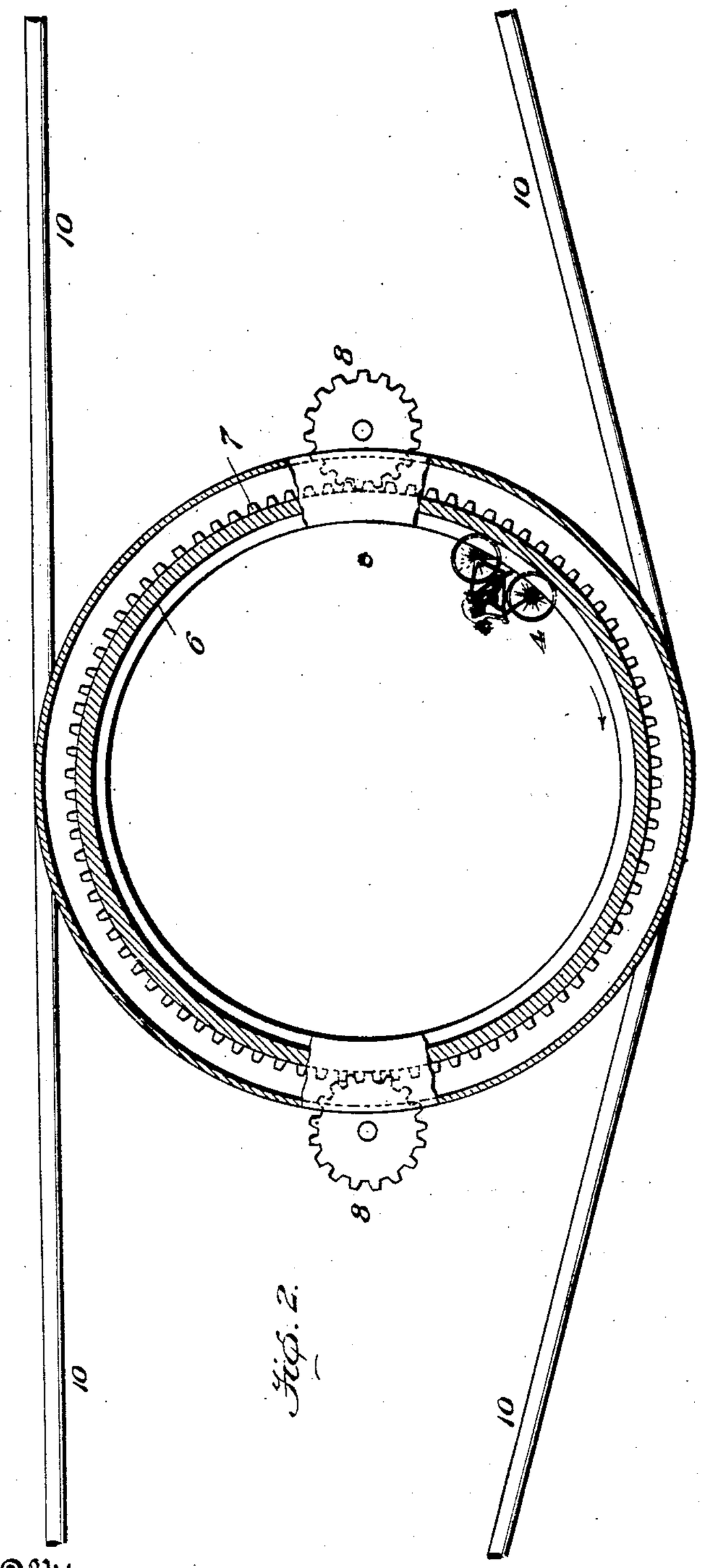

Fig. 2.

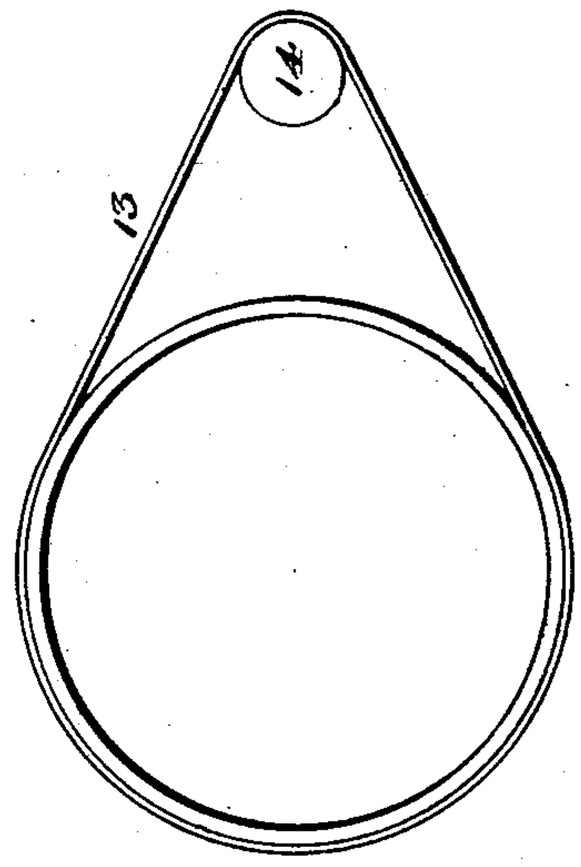

Fig. 4.

Witnesses

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No. 738,022. Patented September 1, 1903.

UNITED STATES PATENT OFFICE.

ANNE E. W. FRAZER, OF WASHINGTON, DISTRICT OF COLUMBIA.

AMUSEMENT-RAILWAY.

SPECIFICATION forming part of Letters Patent No. 738,022, dated September 1, 1903.

Application filed May 8, 1903. Serial No. 156,262. (No model.)

To all whom it may concern:

Be it known that I, ANNE E. W. FRAZER, a citizen of the United States, residing at Washington, in the District of Columbia, have invented certain new and useful Improvements in Amusement-Railways, of which the following is a description, reference being had to the accompanying drawings and to the letters of reference marked thereon.

My invention relates to amusement-railways; and it consists in the construction hereinafter set forth by which a propelled vehicle is caused to traverse a circular vertically-arranged path without direct support.

It is well known that a propelled vehicle carrying a rider may be caused to traverse a vertical loop, provided that sufficient momentum is acquired by the vehicle by first traversing an inclined track of sufficient length and provided that the loop which forms a continuation of the inclined track is of the proper non-circular or elliptical form. In devices for effecting this result, commonly known as "loop-the-loop" devices, the momentum attained by the vehicle by its descent of the incline prior to entering the loop must be sufficient to carry the car, with its burden, over and past the first or upward half of the loop, after which the force of gravity operates to carry the vehicle over and down the second half of the loop. As the vehicle passes the highest point of the loop it tends to fall directly downward, the direction of fall being, however, modified by the momentum of the vehicle, so that the modified direction of fall being such, provided the initial momentum acquired is sufficient, that the wheels of the vehicle will remain in contact with the track, provided the track is elliptical. It has not been found possible to traverse a track having a loop of circular form by means of momentum acquired by descent of an incline, whatever the length or degree of inclination of the preliminary incline. Attempts to do so have resulted in the vehicle, with its rider, falling usually immediately after passing the highest point of the loop. It necessarily follows and has been found by experiment that it is impossible to traverse the inner periphery of a closed loop or wheel, both by reason of the impossibility of acquiring sufficient momentum without the long inclined path and also by reason of the impossibility of keeping the wheels of the vehicle in contact with a circular path after it has passed the highest point of the loop.

I have found that by giving to the vehicle at the point at which it tends to fall an increased velocity its tangential or centrifugal force may be made to overcome its gravitational tendency, and thus its wheels may be caused to remain in contact with the track until the falling-point is passed. My present invention consists in means for giving the vehicle this added velocity, so as to enable a circular loop to be traversed without danger of falling.

In the drawings, Figure 1 is a diagrammatic view showing in full lines the loop-the-loop track as ordinarily constructed and showing in dotted lines the circular path, also indicating the forces which have to be considered. Fig. 2 is a front elevation, partly in section, showing my invention. Fig. 3 is a horizontal section through the center of the circular track, and Fig. 4 illustrates a modified form of the driving means.

Referring to the drawings, 1 indicates the preliminary incline, 2 the loop, and 3 the terminal portion of the loop-the-loop track as ordinarily constructed.

4 indicates the vehicle.

5 indicates a circular path.

Arrow *a* indicates the direction of the gravitational force, arrow *b* the direction of the tangential or centrifugal force, and arrow *c* the resultant of these forces at the highest point of the loop. It will be apparent that the direction of the resultant of the forces indicated by *a* and *b*—that is, the direction of the arrow *c*—must not fall materially within the line of the loop 1 at this point, as otherwise the wheels of the vehicle will fail to remain in contact with the track. It has heretofore been found impossible to give the vehicle such momentum that the force indicated by *b* shall so far exceed the force indicated by *a* that the resultant *c* would not fall materially within the circle indicated by 5, especially when the vehicle consisted of a bicycle propelled by a rider. In my invention I provide for giving the increased velocity by moving the track, or such portion of it as may be necessary, in order that the force indicated

by b may so far exceed the force indicated by a that the resultant c shall not fall materially within the circle.

My invention comprises a circular track 6, preferably of sheet metal, of sufficient stiffness to maintain its shape, preferably provided on its interior with means, such as teeth 7, by which the driving means 8 may engage it. The track 6 is preferably guided by its edges moving in guides 9, which are rigidly supported by any convenient means, as by brace-rods 10, from a base 11.

The driving means 8 preferably consist of gear-wheels driven by electric motors 12. Two or more of the driving-gears 8 may be used. Other means for driving the track 6 may be used—such, for instance, as a belt 13, driven by an electric or other motor 14. The guides 9 should preferably be provided with suitable antifriction devices 15. The means for driving the track 6 should preferably be so arranged or inclosed as not to be visible from the front, so as to avoid making it apparent that the track is moved.

While it will be found more convenient to move the entire track, the device may, if preferred, be so arranged that only the portions of the track necessary to give the added velocity required shall be moved. The direction of movement of the track will of course be the same as the direction of movement of the vehicle. It will be understood that the velocity necessary to be given the track will depend upon the velocity of movement of the vehicle and may be readily computed for any given speed of the vehicle. The outward pressure due to velocity equals $\frac{v^2}{r}$, where v equals velocity in feet per second, r the radius of the circle in feet, and M the mass of the moving body—*i. e.*, its weight G divided by $g = 32.2$. Referring to the diagram Fig. 1, the outward pressure due to gravity equals $-\text{G sin. } (\theta - n) = \text{G sin. } \theta$. If these two pressures are equal and opposite, we have

$$\text{G sin. } \theta = -\frac{v^2}{r}\frac{\text{G}}{g}$$

or

$$\text{sin. } \theta = -\frac{v^2}{rg}$$

If the outward pressure due to velocity exceeds the inward force of gravity, the vehicle will not leave the circle. This will be the case if $\frac{v^2}{rg}$ is greater than one or v is less than $\frac{v^2}{g}$ or r^2 is greater than rg. For a circular track having a radius of nine feet the velocity should be greater than 17.02 feet per second. For a circular track having a radius of eighteen feet the velocity should be greater than 24.07 feet per second. The velocity will in the operation of my invention be the sum of the velocity of movement of the track and the velocity at which the vehicle is propelled relative to the track. Taking v' as the velocity of the track and v'' as the velocity of the vehicle relative to the track, the total absolute velocity of the vehicle will be $v' + v'' = v$. As above stated, v^2 must be greater than rg. Consequently $(v' + v'')^2$ must be greater than rg, $v' + v''$ must be greater than $\sqrt{rg}$, and v' must be greater than $\sqrt{rg} - v''$. Taking h as the height of the vehicle and V the velocity acquired in falling this height or the velocity required to reach this height, then

$$\text{V}^2 = 2gh$$

or

$$h = \frac{\text{V}^2}{2g} = \frac{\text{V}^2}{64.4}$$

If the vehicle starts at the point o, its height above the lowest point of the track will be equal to r. Consequently the velocity acquired in falling this height or the velocity lost in ascending the opposite side of the track to the same height will be $\text{V} = \sqrt{2gr}$. Before ascending the track above the line of the horizontal diameter the velocity of the vehicle must be greater than the velocity at which the outward pressure exceeds the inward force of gravity plus the velocity lost in ascending to the line of the horizontal diameter. In other words, $v + v' = v''$ must be greater than $\sqrt{rg} + \sqrt{2rg}$ or $13.69\sqrt{r}$ and v' must be greater than 13.69. At the bottom of the circle the absolute velocity $v + v' = v''$ must be greater than $3\sqrt{rg}$ $17.02\sqrt{r}$ and v' must be greater than $17.02\sqrt{r} - v''$. From this it will be clear that for a circular track having a radius of nine feet, the vehicle being propelled at a velocity of ten miles per hour, or 14.66 feet per second, it will be sufficient if the track is moved at a velocity slightly greater than eighteen miles per hour, or 26.46 feet per second.

In the operation of my invention the vehicle 4, preferably a bicycle carrying a rider, and in any case a vehicle provided with means for propelling it, is held by any convenient means at a point as near as practical to the point o at one end of the horizontal diameter. The track being caused to move as above described, the bicycle is started and propelled by its rider so as to attain as high a velocity as possible at the lowest point of the track. As above pointed out, the velocity given to the bicycle by the efforts of the rider is additional to the velocity acquired by the fall from point o to the lowest point, and the absolute velocity is equal to the acquired velocity of the bicycle relative to the track plus the velocity of the track. From the computations above given it will be apparent that in a track such as above described, having a diameter of nine feet, it will be entirely practicable to attain a combined velocity of bicycle and track sufficient to overcome the gravitational force which tends to cause the bicycle to fall at the highest point of the loop.

Instead of a bicycle propelled by its rider

a mechanically-propelled vehicle may be used, and the track and vehicle may be made of any size desired. For instance, the vehicle may be a spring-driven toy vehicle, such as are found on the market, and the track may be constructed of a size adapted for such toy vehicle and may be driven by a spring-motor or other form of motor, as may be found convenient.

By my invention it is made possible for the vehicle, whether a bicycle or other vehicle, as above described, to make the circuit as many times as may be desired.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In an amusement-railway, the combination with a circular track and means for rotating it about its center, of a vehicle adapted to travel on the track and provided with means for propelling it independently of the track; substantially as described.

2. In an amusement-railway, the combination with a circular track, means for rotating it in one direction about its center, of a vehicle adapted to travel on the track and means for propelling the vehicle in the same direction in which the track is moved; substantially as described.

3. In an amusement-railway, the combination of a circular track, guides for said track, means for causing the track to rotate in said guides about its center, a vehicle adapted to travel on said track and means for propelling the vehicle independently of the track; substantially as described.

4. In an amusement-railway, the combination of a circular track, guides for said track, means exterior to said track for causing the track to rotate in said guides about its center, a vehicle adapted to travel the interior of said track and means for propelling the vehicle independently of the track; substantially as described.

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

ANNE E. W. FRAZER.

Witnesses:

A. L. HOUGH,

A. P. GREELEY.