(Model.)

2 Sheets—Sheet 1.

W. O. CROCKER.

TURBINE WATER WHEEL.

No. 250,889. Patented Dec. 13, 1881.

Fig. 1.

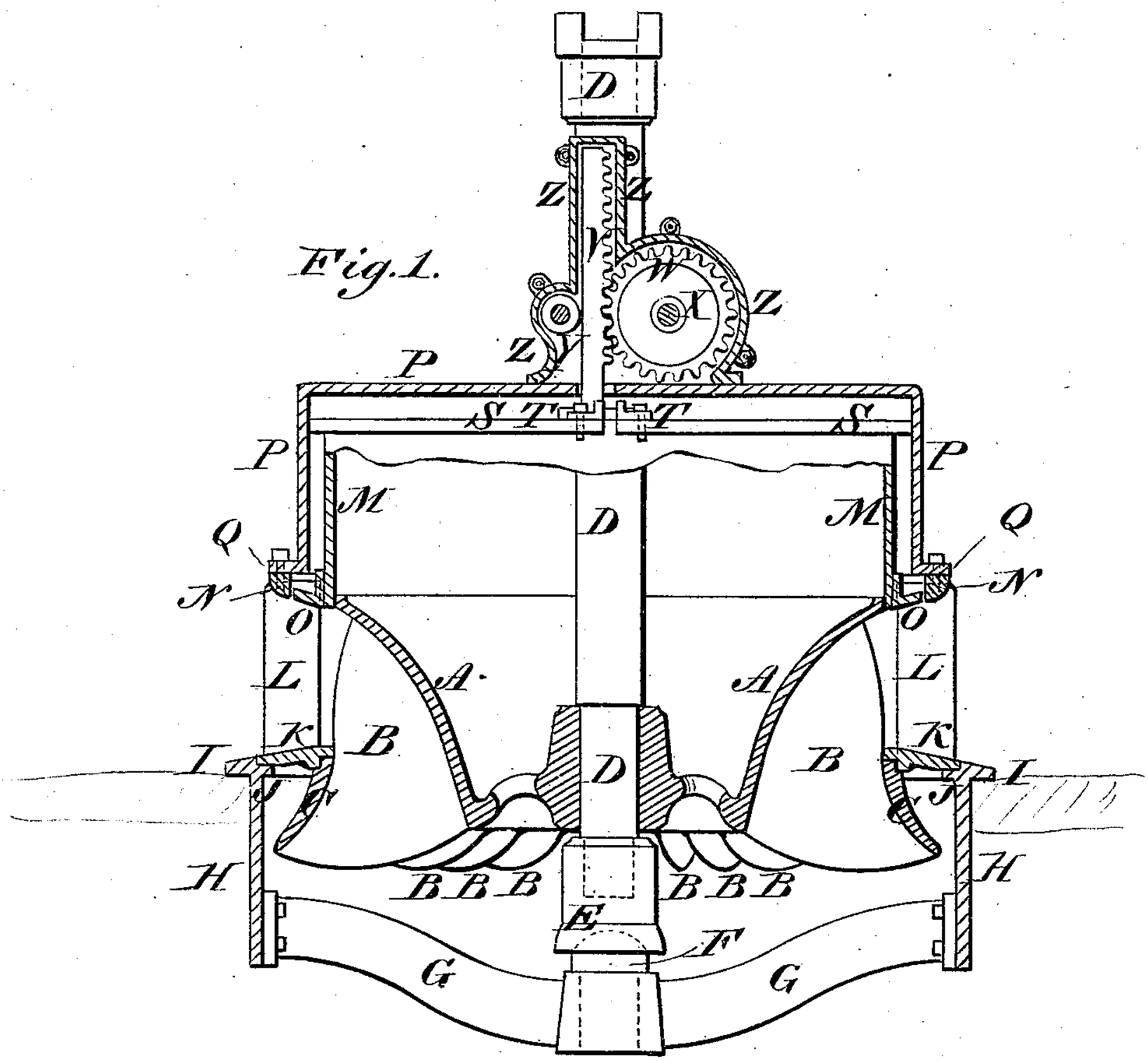
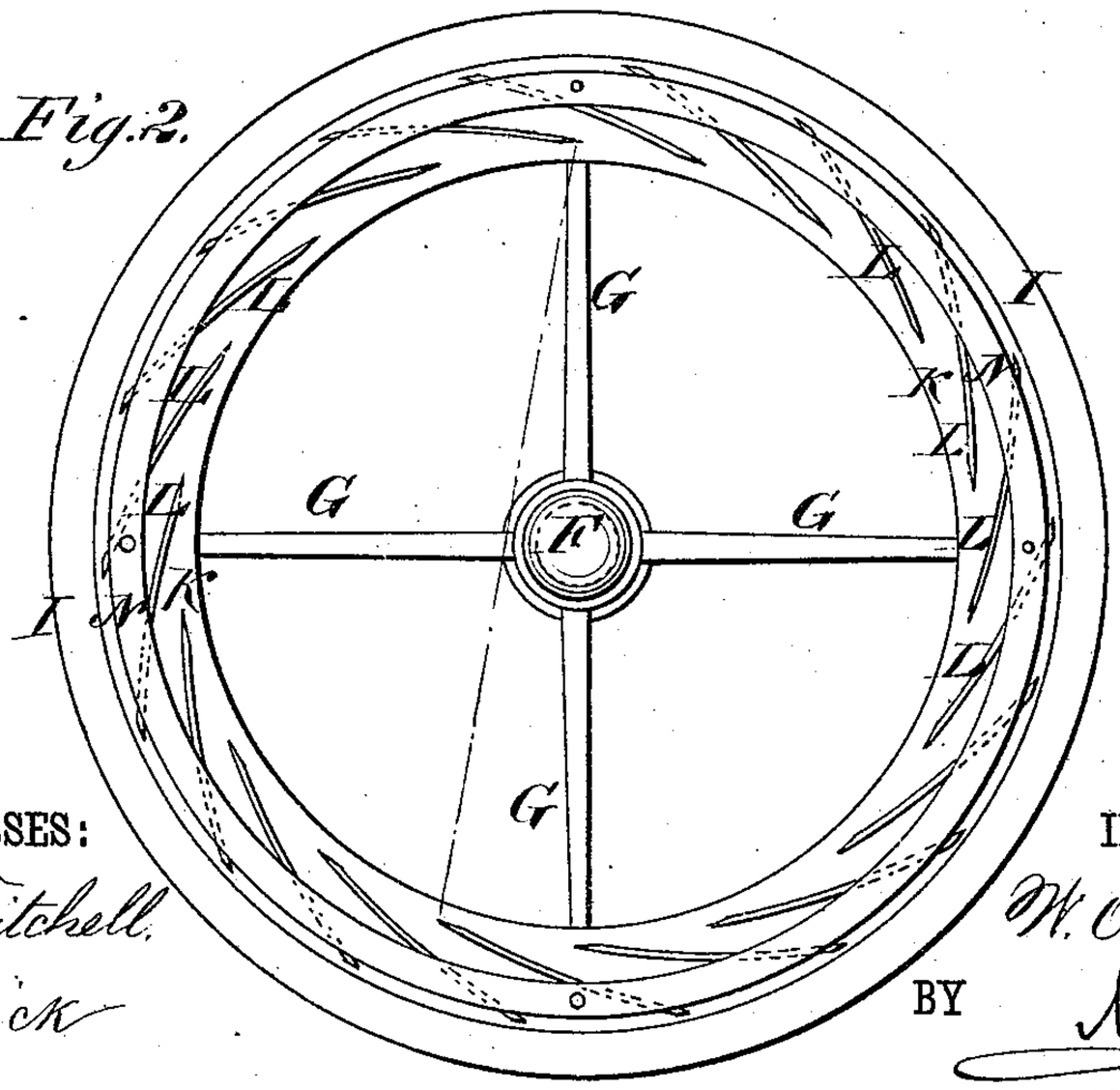


Fig. 2.



WITNESSES:

Donn Twitchell.

C. Sedgwick

INVENTOR:

W. O. Crocker

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(Model.)

2 Sheets—Sheet 2.

W. O. CROCKER.

TURBINE WATER WHEEL.

No. 250,889. Patented Dec. 13, 1881

Fig. 3.

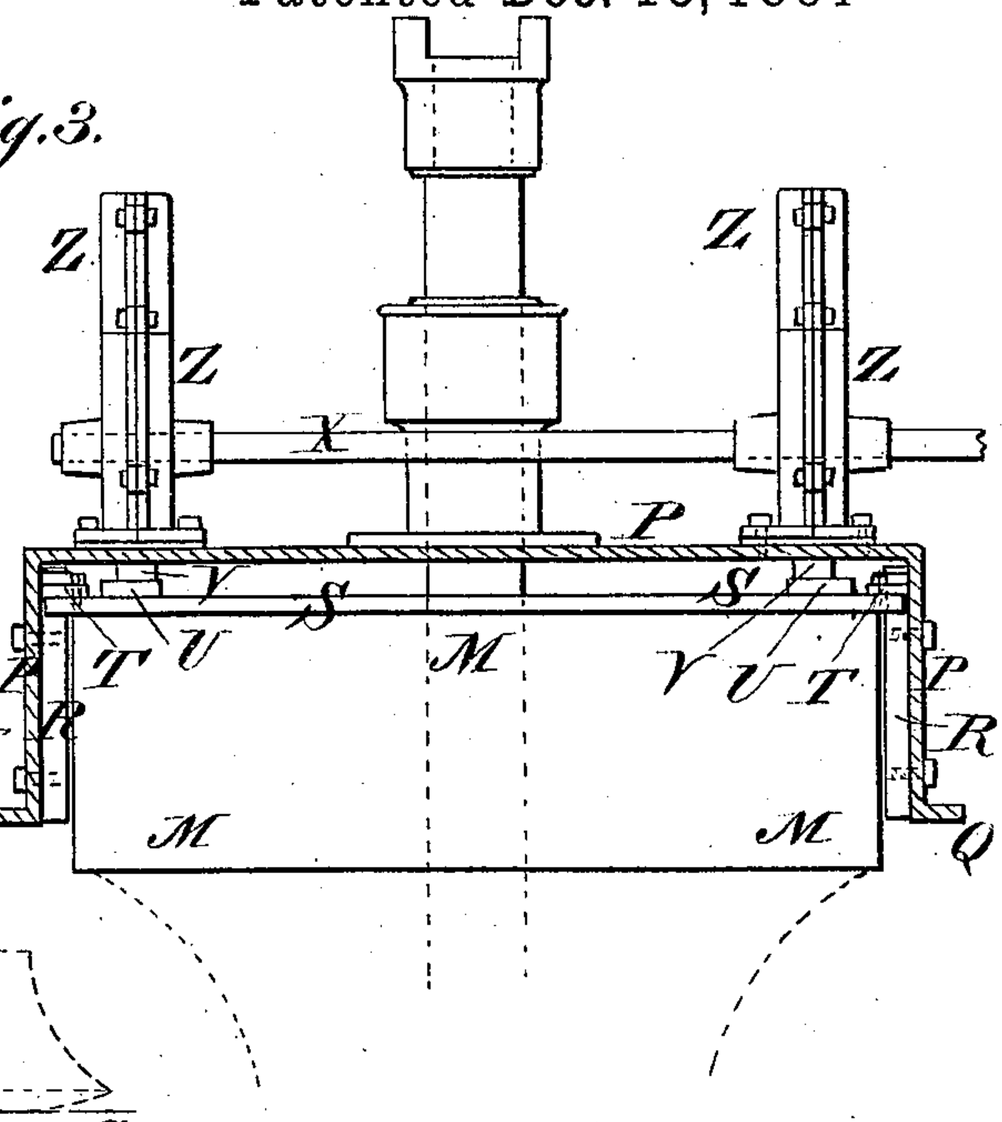


Fig. 6.

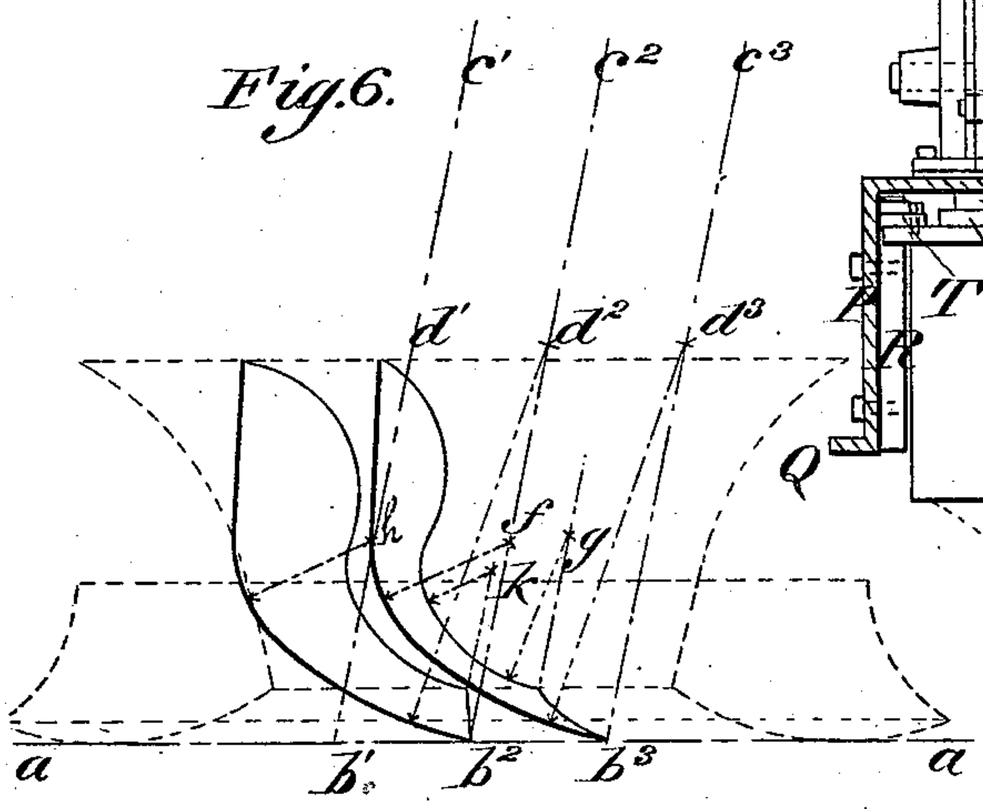


Fig. 4.

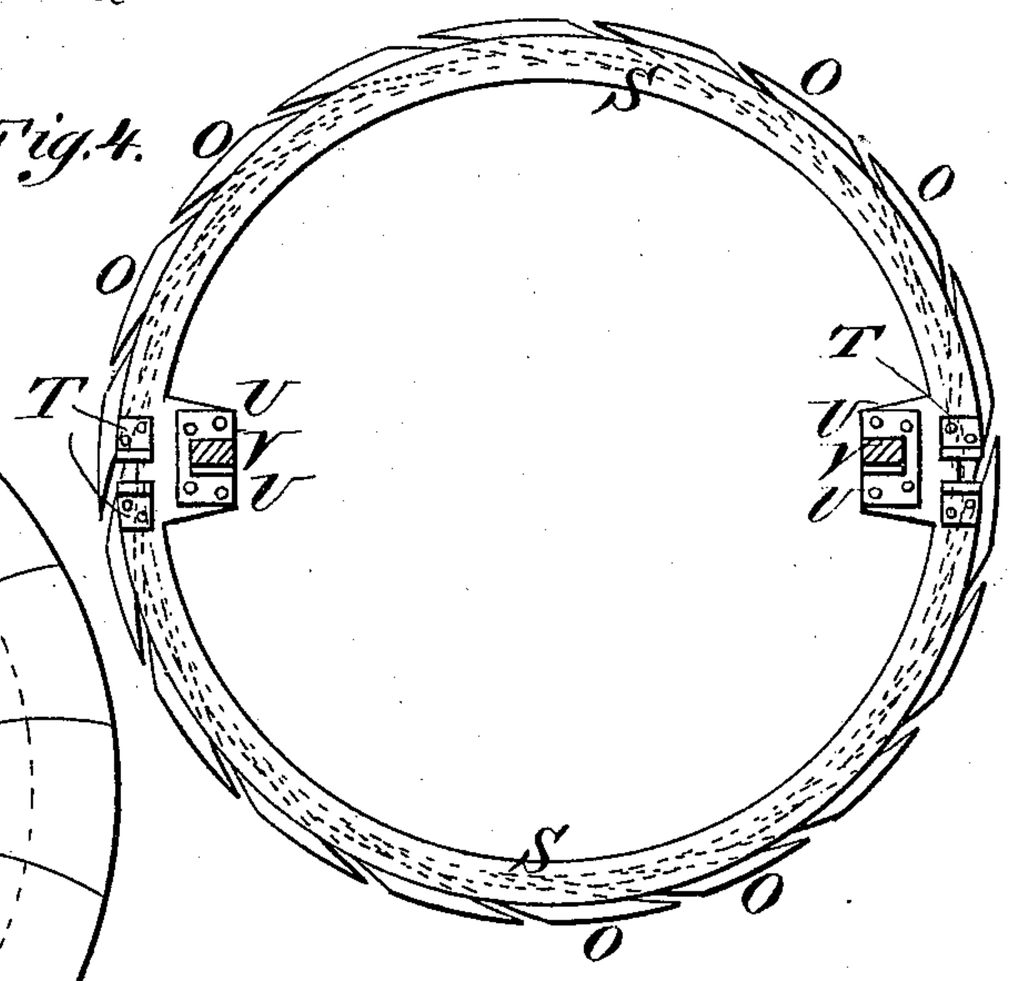
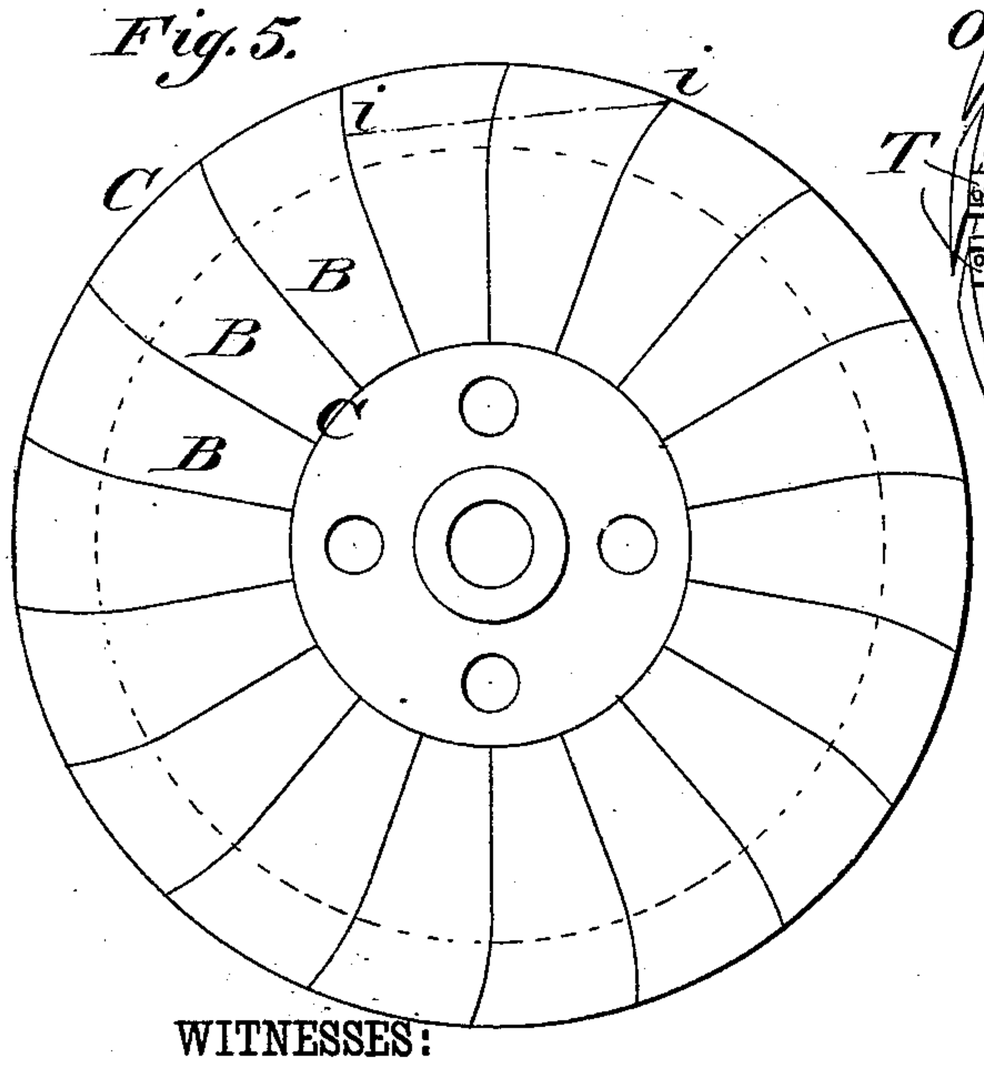


Fig. 5.



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UNITED STATES PATENT OFFICE.

WILLIAM O. CROCKER, OF TURNER'S FALLS, MASSACHUSETTS.

TURBINE WATER-WHEEL.

SPECIFICATION forming part of Letters Patent No. 250,889, dated December 13, 1881.

Application filed June 13, 1881. (Model.)

To all whom it may concern:

Be it known that I, WILLIAM ORMAN CROCKER, of Turner's Falls, of the county of Franklin and State of Massachusetts, have invented a new and useful Improvement in Turbine Water-Wheels, of which the following is a full, clear, and exact description.

Figure 1, Sheet 1, is a sectional elevation of my improvement. Fig. 2, Sheet 1, is a plan view of the chutes, draft-tube, and spider or bridge-tree. Fig. 3, Sheet 2, is a side elevation of the gate and its operating mechanism, the dome being shown in section. Fig. 4, Sheet 2, is a plan view of the gate, the racks being shown in section. Fig. 5, Sheet 2, is a bottom view of the wheel. Fig. 6, Sheet 2, illustrates the laying out of the buckets.

The object of this invention is to increase the capacity, speed, and efficiency of turbine water-wheels of the kind that receive the water on the outer side through perpendicular chutes and discharge the water in a downward direction below the chutes.

The invention consists in the turbine water-wheel constructed with a bell-shaped body having its largest diameter upward and its concaved surface outward, the buckets, and the bell-shaped band having its smaller diameter upward and its convexed surface inward, and having its smallest diameter equal to or a little greater than the largest diameter of the wheel-body; also, in the combination, with the wheel and the vertical chutes connected at the outer parts of their upper ends by a ring, of the cylindrical gate having outwardly-projecting blades or a slotted flange upon its lower edge, whereby the gate can be readily removed; also, in the combination, with the dome and the cylindrical gate, of the guide-bars, the slotted flange, and the lugs or slides to keep the said gate in position; and, also, in the combination, with the dome, the racks, the gear-wheels, the shaft, and the rollers, of the casing to support and protect the gearing, as set forth.

The wheel consists of the body A, the buckets B, and the band C. The body or crown A is made bell-shaped, and its hub is attached to the shaft D with its largest diameter upward, and its concaved surface outward or toward the buckets B. The band C, which incloses the lower or reacting parts of the buckets B, is also made bell-shaped, and is placed with its smallest diameter upward, and its convexed surface inward or toward the buckets. The band C is made of such a size that its smallest diameter will be equal to or a little greater than the largest diameter of the body A.

I will now give what I consider the best proportion, forms, and arrangement of the parts A B C, but do not limit myself to such construction.

The depth of the wheel-body A should be two-fifths of the largest diameter of the said body, and the smallest or bottom diameter should be one-half the largest or top diameter. The outer or concaved surface of the body A should be formed to a cissoid curve generated from the outer edge of the top of the said body. The upper edge of the band C should be at a distance below the upper edge of the body A, equal to one-fourth the largest diameter of the said body A plus the thickness of the lower chute-flange. The depth of the band C (including the thickness of the lower chute-flange) should be equal to one-fifth the largest diameter of the body A. The largest or bottom diameter of the band C should be one-fifth greater than the largest or top diameter of the body A. The inner surface of the band C, should also be formed to a cissoid curve.

The buckets B are formed as follows: On a line, $a\ a$, Fig. 6, are set off points of division b' b^2 b^3, found by dividing the circumference of the body A at its upper edge by the number of buckets to be used, (usually eighteen.) At the points b' b^2 b^3 are drawn lines b' c' b^2 c^2 b^3 c^3, inclined at an angle of twelve degrees (12°) in the opposite direction from the required direction of motion of the wheel. Taking the first line, b^3 c^3, at the right, a point, d^3, is found upon the said line, which, used as a center for an arc beginning at the point b^3 and drawn toward the left, will pass above the point b^2, and leave a distance between it and the said point b^2 equal to the sum found by adding the thickness of the bucket to the quotient found by dividing the largest diameter of the body A by the number of buckets to be used.

Upon the line b^2 c^2 is found a point, f, which

is used as a center for drawing an arc, having a radius equal to the distance between the points b^2 b^3, and meeting the arc drawn from the point d^3 as a center. The compound curve produced by these two arcs forms the working curve of the buckets upon a diameter equal to the longest diameter of the body A. From the arc last drawn the bucket-line continues nearly vertical to the top of the body A.

The part of the bucket that joins the body A is formed in a similar manner, except that the arc generated from the center *g* should have a radius equal to about two-fifths of that generated from the point d^3, and the arc generated from the point *h* should have a radius equal to one-half of the radius of the arc drawn from the point *f* as a center. From this last arc the curve or bucket line inclines back as it approaches the top of the wheel-body, and forms upon the surface of the said body, in connection with the working curve of the bucket, an ogee. With this construction the inner part of the buckets opposite the entrance-place of the water inclines back considerably, whereby better results are obtained when the gate is partly open.

By reference to Fig. 5, it will be seen that the base-lines of the buckets B are radii, or nearly radii, from the lower end of the hub of the body A to the circumference of a circle having a diameter equal to the inner diameter of the top of the band C; but from this circumference to the points of intersection of the said base-lines with the said band C the base-lines of the buckets are drawn back upon a curve struck with a radius equal to the sum of the spaces between two base-lines from the point of intersection of the second base-line in front with the said band C, as indicated by the line *i i*, Fig. 5. As the lower edge of the body A is at a higher level than the lower edge of the band C, the lines of the buckets B drop until they approach the said band, and then curve upward until they intersect the said band C. The form thus given to the parts of the buckets B beneath the band C corrects the angle of discharge formed at this point by the intersection of the buckets with the expanding surface of the said band C, and also absorbs any centrifugal force generated when the gate is partly raised, the water being consequently carried somewhat by the wheel.

To the lower end of the wheel-shaft D is attached a foot, E, having its lower end concaved to receive and revolve upon a step, F, secured in the usual manner to the center of the bridge-tree or spider G, which is bolted to the lower part of the short draft-tube H.

Upon the upper edge of the draft-tube H are formed an outwardly-projecting flange, I, and an inwardly-projecting flange, J. The outer flange, I, is designed to rest upon the bottom of the flume around the aperture in which the wheel is placed. The inner flange, J, is rabbeted upon the upper side to receive the outer edge of the lower chute-ring, K, so that the upper surface of the said chute-ring K may be flush with the upper surface of the flange I, so as to form a smooth surface for the water to pass over when passing through the chutes. The lower side of the inner edge of the chute-ring K is rabbeted, or has a shoulder, flange, or rib formed upon it, to form a seat for the upper edge of the band C, which band C is thus entirely beneath the said chute-ring K.

Upon the upper side of the chute-ring K are arranged the vertical chutes L at a proper distance from the body A of the wheel to allow the cylindrical gate M to be lowered and raised within the said chutes L. The upper ends of the chutes L are held in place by a ring, N, secured to the outer parts of the said upper ends, and which has its lower side rounded, as shown in Fig. 1, to lessen the resistance to the entering water when the gate M is fully raised.

Upon the outer side of the lower edge of the gate M are formed flanges or blades O, which are so shaped as to fit between the chutes L, so that the gate M and blades O can be removed from within the said chutes L without detaching any of the parts of the wheel. With this construction, when the gate is fully raised the lower sides of the blades O will be flush with the lower surface of the chute-supporting ring N, as shown in Fig. 1, to form a smooth surface for the top of the water-passages.

P is the dome, which receives the gate M when raised and protects the crown of the wheel from water-pressure. The dome P has a flange, Q, upon the outer side of its lower edge, to receive the bolts by which the said dome is secured to the upper chute-ring, N. The interior diameter of the dome P is a little greater than the exterior diameter of the gate M, and to the inner surface of the opposite sides of the said dome P are attached upright bars R. The bars R fit into notches or slots in the outwardly-projecting flange S, formed around the top of the gate M, and which is made of such a width as to fit against the inner surface of the side walls of the dome P.

To the upper side of the flange S, upon the opposite side of each slot, are attached lugs T, to rest against the opposite sides of each guide-bar R, and thus increase the surface bearing against the said bars R. With this construction the gate M will be held from twisting and vibrating when the wheel is at work, and will be kept in a central position within the dome, so that the blades O will move freely between the chutes L.

To the opposite sides of the top of the gate M are attached lugs or brackets U, to which are secured the lower ends of the racks V. The racks V pass up through apertures in the top of the dome P, and into their teeth mesh the teeth of the gear-wheels W, attached to the shaft X. The racks V are held forward against the gear-wheels W by rollers Y, which rest against the rear edges of the said racks and are journaled to the casing Z. The casing Z is made in two parts bolted together, is securely attached to

the top of the dome P, and covers and protects the racks V, the gear-wheels W, and the rollers Y from any rubbish that may be in the water. Upon the opposite sides of the casings Z are formed perforated bosses to serve as bearings for the shaft X. The shaft X can be turned to raise and lower the gate M by any suitable gearing.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. A turbine water-wheel consisting of the inverted-bell-shaped body A, having its concave surface outward and the upright frustum of a bell-shaped band, C, having its lower edge extending below the lower edge of the body, and joined thereto by the buckets B, having their lower edges curved.

2. In a turbine water-wheel, the combination, with the wheel A B C and vertical chutes L, connected at the outer parts of their upper ends by a ring, N, of the cylindrical gate M, having outwardly-projecting blades O, substantially as herein shown and described, whereby the gate can be readily removed, as set forth.

3. In a turbine water-wheel, the combination, with the dome P and the cylindrical gate M, of the guide-bars R, the slotted flange S, and the lugs T, substantially as herein shown and described, whereby the said gate is kept in position, as set forth.

WILLIAM O. CROCKER.

Witnesses:

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NATHAN D. ALLEN.