(No Model.) 2 Sheets—Sheet 1.

C. ANGSTRÖM.

Turbine Water Wheel.

No. 239,636. **Patented April 5, 1881.**

Fig. 1.

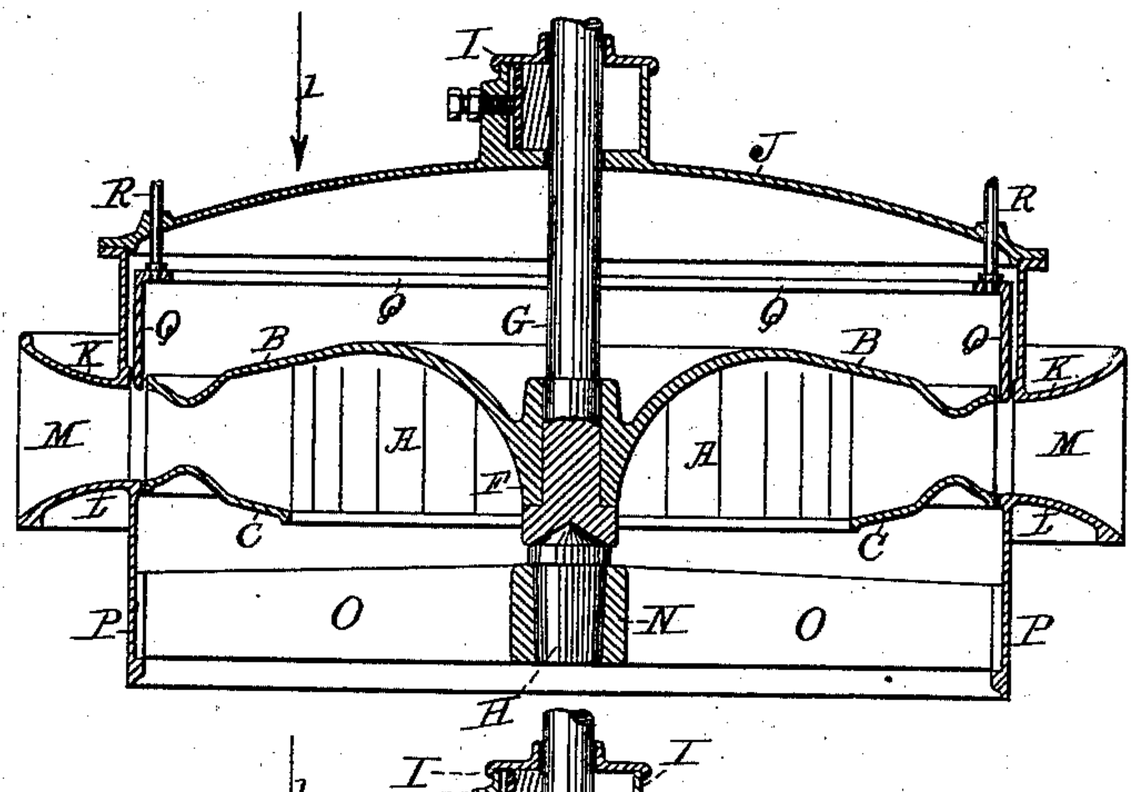


Fig. 2.

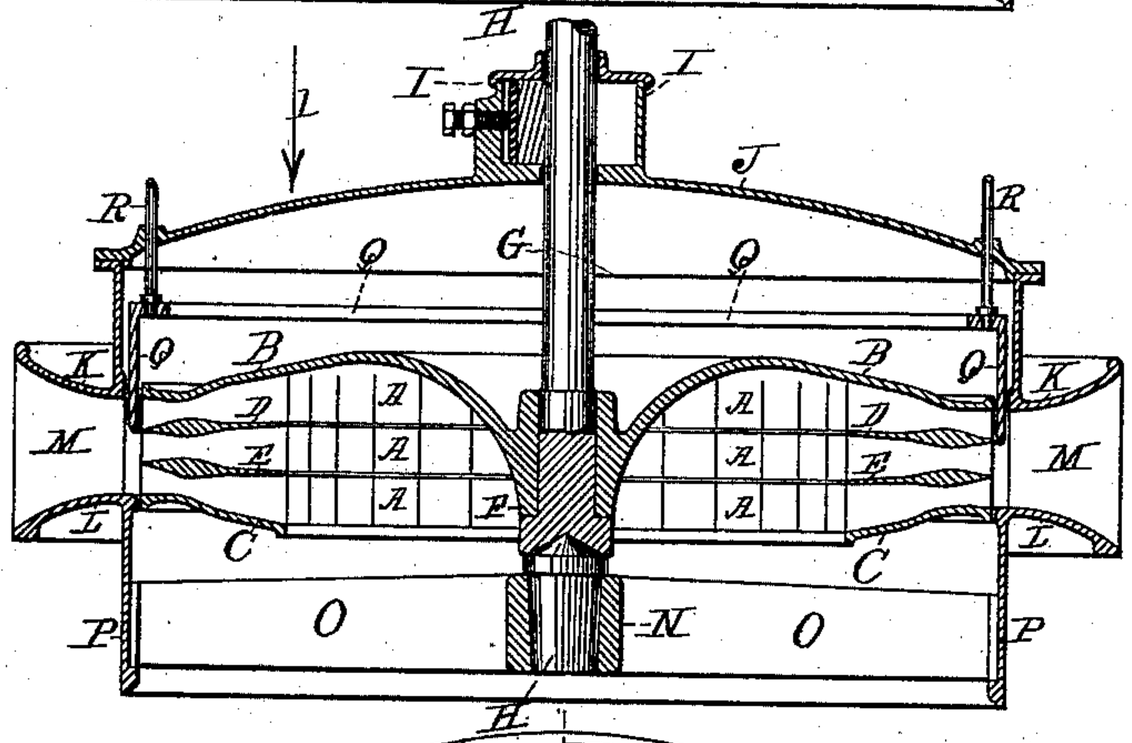
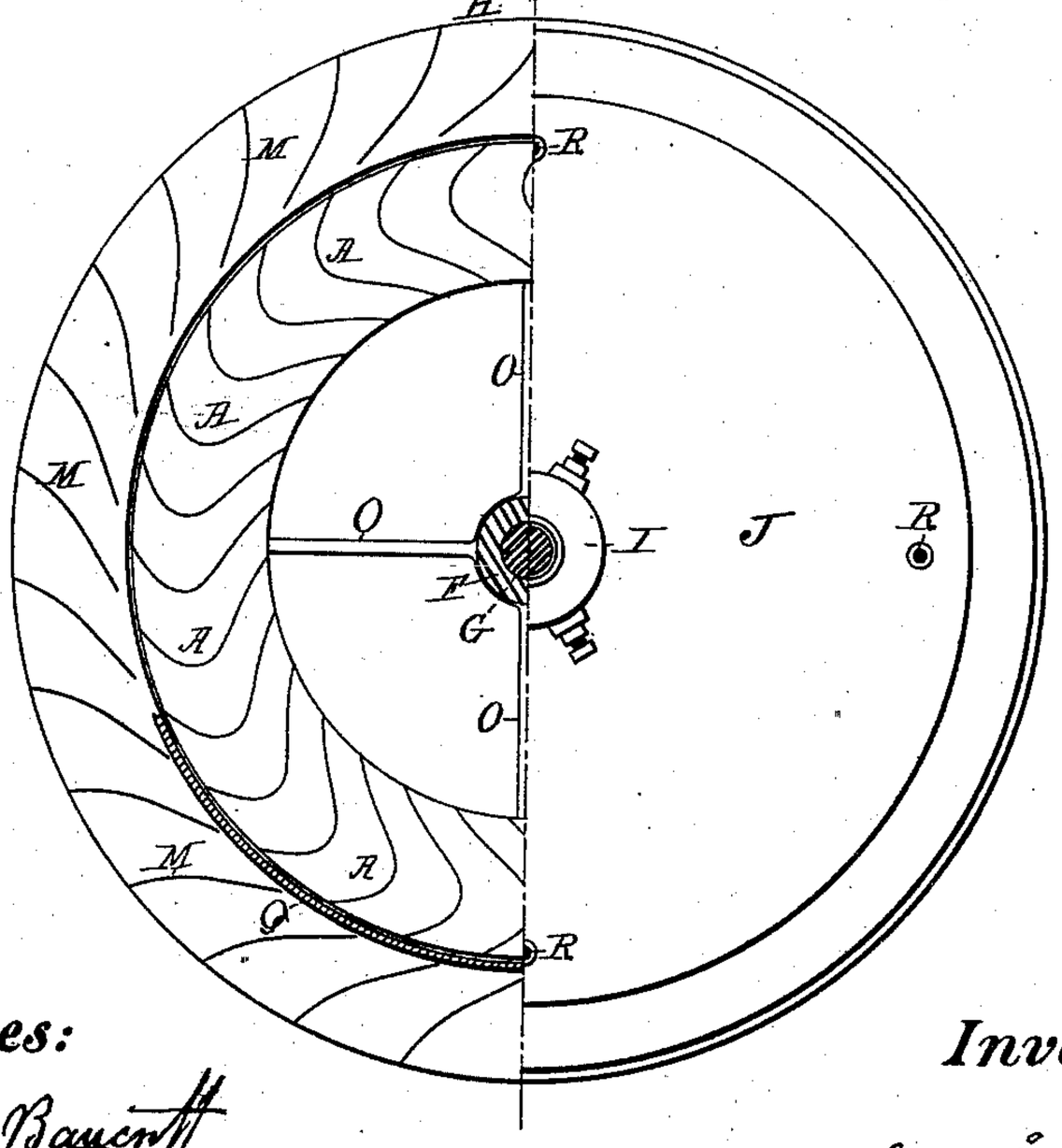


Fig. 3.



Witnesses:

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(No Model.) 2 Sheets—Sheet 2.

C. ANGSTRÖM.

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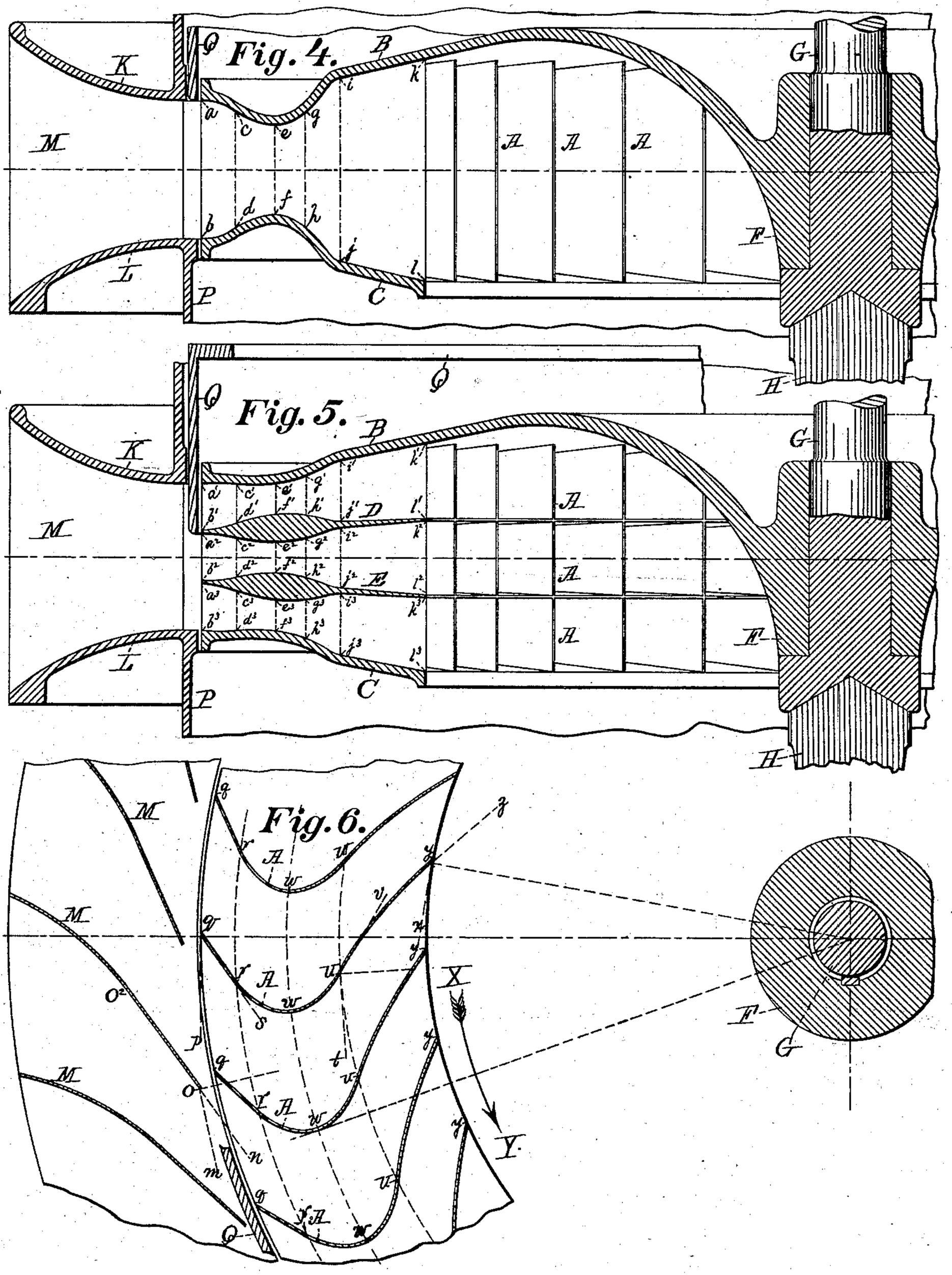

UNITED STATES PATENT OFFICE.

CARL ANGSTRÖM, OF WORCESTER, MASSACHUSETTS.

TURBINE WATER-WHEEL.

SPECIFICATION forming part of Letters Patent No. 239,636, dated April 5, 1881.

Application filed June 18, 1880. (No model.)

To all whom it may concern:

Be it known that I, CARL ANGSTRÖM, of the city and county of Worcester, and State of Massachusetts, have invented certain new and useful Improvements in Turbine Water-Wheels; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, and in which—

Figures 1 and 2 represent central sections through my aforesaid improved turbine water-wheel, taken longitudinally through the axis of said wheel. Fig. 3 represents a half-plan view and half-section of one of my aforesaid wheels, the half upon the right-hand side being a view looking in the direction indicated by arrows 1 1, Figs. 1 and 2, while the left-hand half is a section through the buckets, &c., of the wheel, taken upon a plane at right angles to the axis of said wheel; and Figs. 4, 5, and 6 represent, upon an enlarged scale, portions of the wheel which will be hereinafter more fully described.

My invention relates to that class of turbine water-wheels in which the water is diverted inwardly or toward the axis of the wheel by fixed guide-blades, said guide-blades giving to the water a tangential whirl as it enters the wheel.

The object of my invention is to utilize the power produced by water passing through a turbine water-wheel to the fullest extent possible, this being done by forming and arranging the guide-blades and buckets and the rims that inclose said buckets in such a manner that the water enters the wheel and is guided forward without violent shocks or impact, the water being allowed to expend its power at first at a gradually-increasing rate toward a maximum point inside of the buckets, and then at a diminishing rate until it reaches the inside edge of the buckets, when all the power in the water is then expended on the wheel, except just enough to give the water sufficient velocity to move through the discharging draft-tube. Thus it will be seen that all the power contained in water is utilized to its fullest extent. I have found it necessary, in order to accomplish this, that the wheel-buckets and inclosing-rims must have a form entirely different from those now in use. Furthermore, there exists certain distinct relations between different parts of the buckets, and corresponding distances between the rims that inclose said buckets, the distances between rims being measured on lines parallel with the axis of the wheel.

My invention consists in the particular form of the guide-blades and buckets; also in the particular distances between the rims that inclose said buckets, and of the particular arrangement and combination of the aforesaid elements in forming a turbine water-wheel.

To enable those skilled in the art to which my invention belongs to make and use the same, I will proceed to describe it more in detail.

In the drawings, the parts marked A represent the buckets of my turbine water-wheel, which are inclosed between the rims B and C, Figs. 1 and 4, or between the rims B, D, E, and C, Figs 2 and 5. The upper rim, B, is extended toward the centre to a hub, F, said hub being fastened to shaft G, which rests upon pivot H, and is guided and retained in position by bearing I, which is formed or secured upon crown-plate J. The wheel is surrounded by the stationary casings K and L, containing the guide blades M. The pivot H is inserted in a sleeve, N, which is provided with arms O, and is secured to the draft-tube P.

In the annular space between the guide-blades M and buckets A is inserted a ring, Q, said ring being operated, by means of rods R and suitable gearing, to raise and lower the same, so as to regulate the admission of water. When ring Q is in its lowest position it rests upon guide-blade casing L, thereby entirely shutting off the water-supply from the wheel.

The guiding arrangement for directing the water to the wheel consists of a suitable number of guide-blades inclosed between the casings K and L. The terminal parts o^2 o (see Fig. 6) are plane surfaces parallel with the axis of the wheel, and said planes, if extended beyond the terminal point o in the same direction, should form an acute angle, $n\,o\,m$, with a line, $o\,m$, drawn through the point o, and in the same direction as the wheel revolves, (shown

by arrow X Y,) said line being a tangent to a circle concentric with the wheel, and laid through the terminal point *o*.

The wheel-buckets A consist of a suitable number of curved vanes, which are parallel with each other in the direction of the axis of the wheel. For convenience of description, the buckets may be considered as being formed of the following three distinct elements or parts, viz: The first part, *q r*, (see Fig. 6,) is a straight line forming an acute angle, *p q s*, with a line, *p q*, drawn in the direction of the motion of the wheel, said line *p q* being a tangent to a circle concentric to the wheel, and laid through the point *q*. The second element or part consists of a continuous curve, *r w u*, without any points of inflection, and to which the first part described is a common tangent. If said curve is continued in the same direction from the terminal point *u*, it will form an obtuse angle with a line, *t u*, drawn from the point *u*, and in the same direction (X Y) as the wheel rotates, said line being a tangent to a circle concentric with the wheel, and laid through the point *u*. The third and last element or part is a continuation of the second, the line *u v* being a common tangent to both of said second and third elements. The point *u* is a point of inflection, or where the curvature of the bucket changes from the inward concave part, *r w u*, to the outward concave part, *u y*. A tangent, *y z*, drawn from the terminal point *y*, in continuation of the part *u y*, will form an obtuse angle, *x y z*, with a line, *y x*, drawn from the terminal point *y*, in the same direction (X Y) as the wheel revolves, said line being a tangent to a circle concentric to the wheel, and laid through the terminal point *y*.

The rims between which the buckets A are inclosed consist of rings curved in such a manner that the distances between them, if measured in directions parallel with the axis of the wheel, will at first diminish (the distance *c d*, Fig. 4, being less than *a b*, and *e f* less than *c d*) and then increase toward the center of the wheel, the distance *g h* being more than *e f*, and *i j* more than *g h*. The parts from *i j* to *k l* consist of straight lines slightly divergent toward the center of the wheel. The points *a c e g i k* on one side, and *b d f h j l* upon the other, are so united that continuous curves are obtained without any sharp corners or projections between the points *a k* and *b l*. The line *i j*, when the straight lines *i k* and *j l* unite with the curved lines *g i* and *h j*, is the same distance from the center line of the wheel as the point of inflection of buckets A at *u*, Fig. 6. The minimum distance *e f*, Fig. 4, and the point *w*, Fig. 6, are upon the same, or nearly the same, distance from the center of the wheel.

The turbine wheel shown in Figs. 2 and 5 is a slight modification of my invention as shown in Fig. 4, the only difference being that the distances *a b*, *c d*, &c., are divided into three equal or proportional parts, *a' b'*, *a² b²*, *a³ b³*, *c' d'*, *c² d²*, *c³ d³*, &c., each of said parts being arranged as separate turbines, the lines *a' b'*, *c' d'*, &c., being the distances in the upper one, *a² b²*, *c² d²*, &c., in the middle one, and *a³ b³*, *c³ d³*, &c., in the lower one, all of which are secured to the rim B and hub F together. It will therefore be seen that the wheel shown in Fig. 4 may be divided into any number of smaller wheels desired, the distances in each being in proportion to those in the large one, the division into three parts, as aforesaid, being taken only as an illustration, and not to govern or imply that that is the only number of parts into which the same may be divided.

In practice I prefer to subdivide the distance between rims B and C, as above described and shown in Fig. 5 of the drawings, for the reason that the curvatures *a'*, *c'*, *e'*, &c., of the rims of the subdivided wheel shown in said Fig. 5 are less abrupt than the corresponding curvatures *a*, *c*, *e*, &c., of the rims of the wheel shown in Fig. 4, thereby causing less loss of power through impact and irregular motion of the water as it passes through the wheel. The aforesaid results are obtained, as will be seen, by the addition of partitions D E, and a slight modification of the curvature of the rims to conform therewith, the principle remaining the same.

It will be understood that the purpose of subdividing a turbine water-wheel is to obtain better effect at partial gate—for instance, supposing the gate Q to be lowered so as to shut off the water from the upper apartment, as shown in Fig. 5, said water passing through the lower ones will still produce the same proportional effect, because each apartment acts as a complete and independent turbine water-wheel.

Having described my improvements in turbine water-wheels, what I wish to claim therein as new and of my invention, and desire to secure by Letters Patent, is—

1. In a turbine water-wheel having one or more apartments or divisions, one or more buckets, A, consisting of the three parts *q r*, *r w u*, and *u y*, substantially as and for the purposes set forth.

2. In a turbine water-wheel, the rims B and C, curved so that the distances between said rims will at first diminish from *a b* to the minimum distance *e f*, and then increase rapidly from *e f* to *i j*, then from *i j*, increasing at a less rapid and constant, or nearly constant, rate toward *k l*, substantially as and for the purposes set forth.

3. In a turbine water-wheel, one or more buckets A, consisting of the three parts *q r*, *r w u*, and *u y*, in combination with rims B and C, curved so that the distances between said rims will at first diminish from *a b* to the minimum distance *e f*, and then increase rapidly from *e f* to *i j*, then from *i j*, increasing at a less rapid and constant, or nearly constant,

rate toward *k l*, substantially as and for the purposes set forth.

4. A turbine water-wheel consisting of two or more apartments or divisions, each having rims D E, curved so that the distances between said rims will at first diminish from a^2 b^2 to the minimum distance e^2 f^2, and then increase rapidly from e^2 f^2 to i^2 j^2, then from i^2 j^2, increasing at a less rapid and constant, or nearly constant, rate toward k^2 l^2, substantially as and for the purposes set forth.

5. A turbine water-wheel consisting of two or more apartments or divisions, each having one or more buckets, A, consisting of the three parts *q r*, *r w u*, and *u y*, in combination with rims D E, curved so that the distances between said rims will at first diminish from a^2 b^2 to the minimum distance e^2 f^2, and then increase rapidly from e^2 f^2 to i^2 j^2, then from i^2 j^2, increasing at a less rapid and constant, or nearly constant, rate toward k^2 l^2, substantially as and for the purposes set forth.

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