J. Chase.

Turbine Water Wheel.

No. 93,175. Patented Aug. 3, 1869.

Fig. 1.

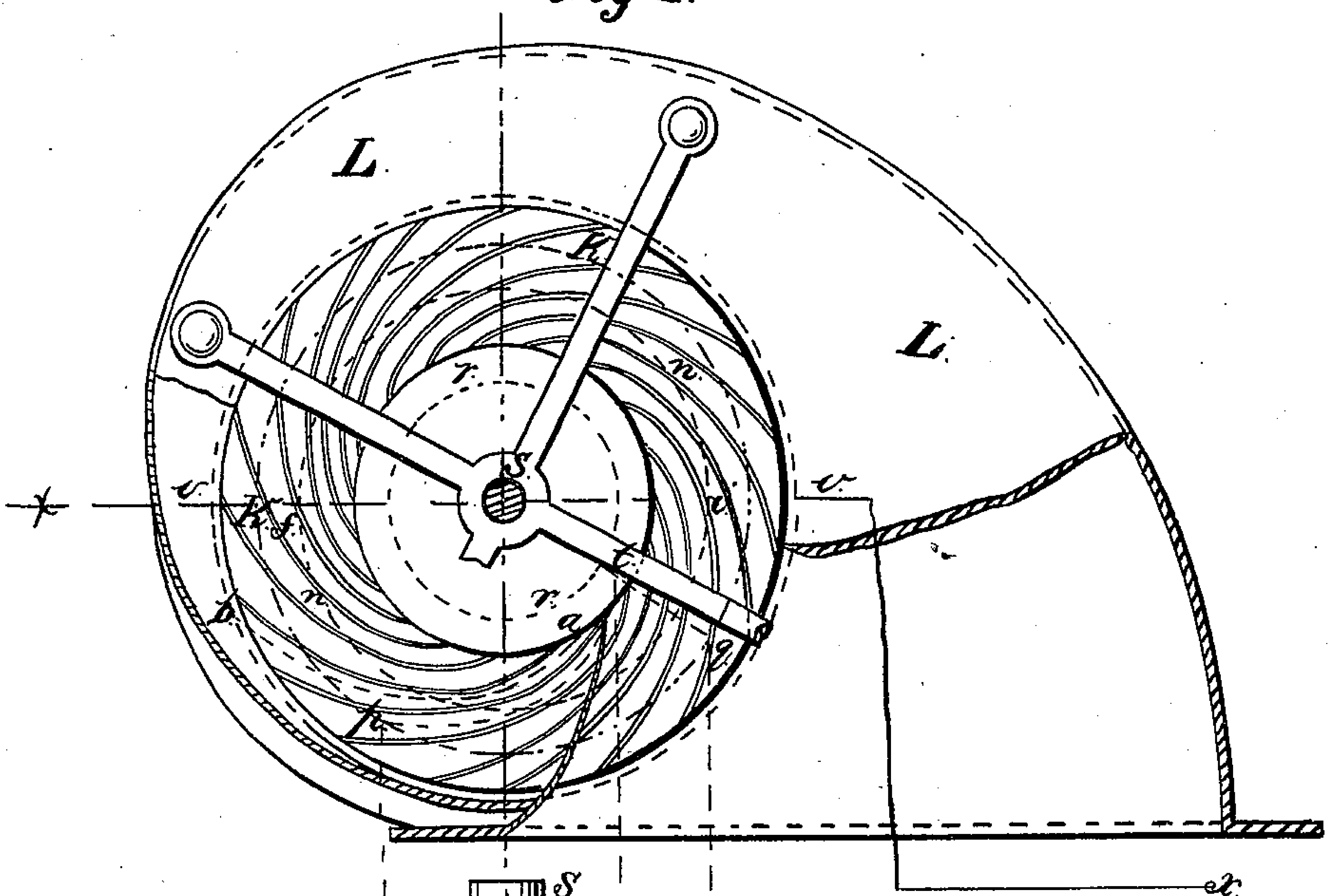
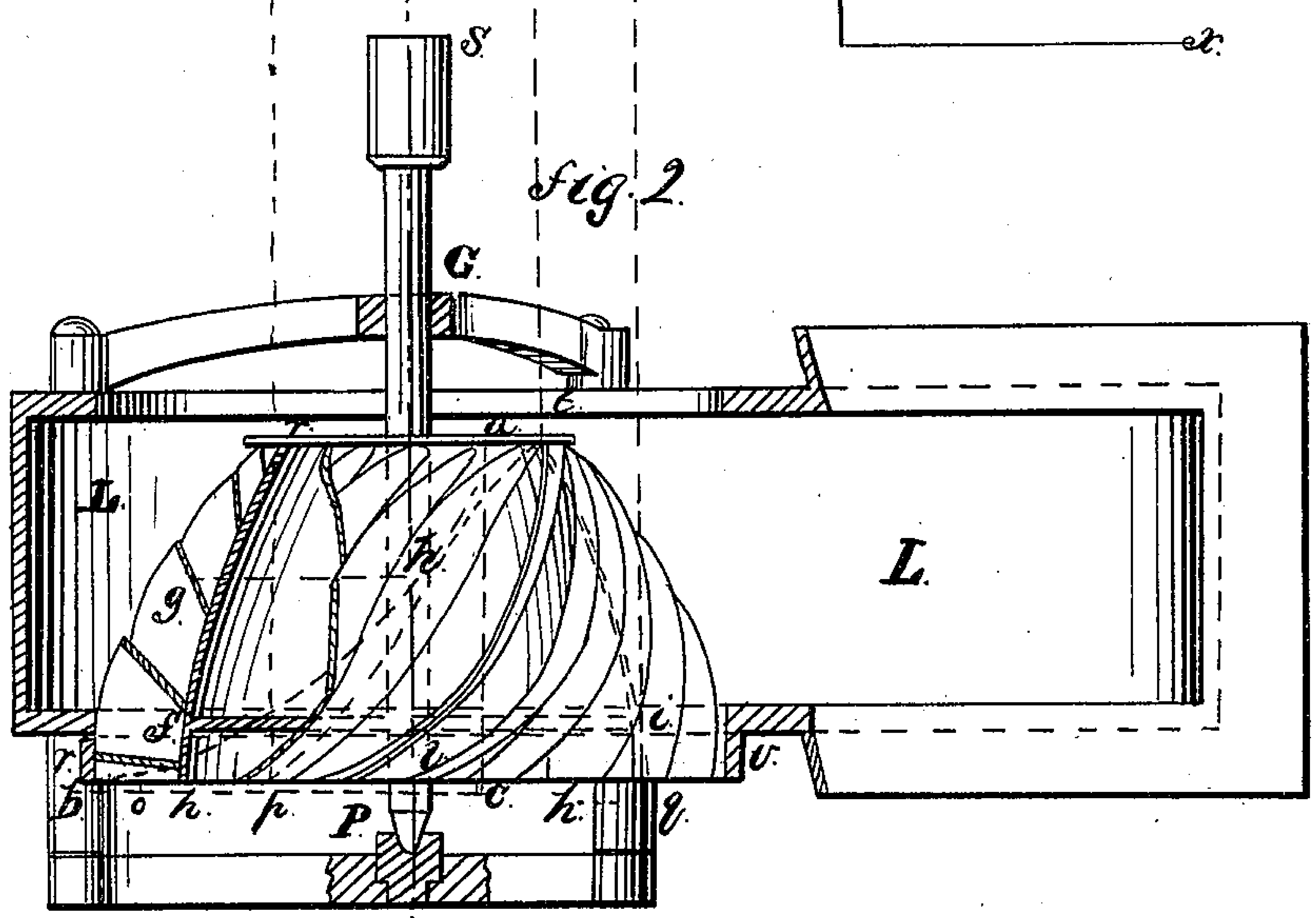


Fig. 2.



Witnesses.

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Letters Patent No. 93,175, *dated August* 3, 1869.

IMPROVEMENT IN TURBINE WATER-WHEELS.

The Schedule referred to in these Letters Patent and making part of the same.

Be it known that I, JOHN CHASE, of the city of Paterson, in the county of Passaic, and State of New Jersey, have invented an Improvement in Turbine Water-Wheels, by the use of which a saving and economizing of water-power can be accomplished; and I do hereby declare that the following is a full, exact, and clear description of the construction and operation of the same, reference being had to the annexed drawings, making part of this specification.

Description of Drawings.

Figure 1 is a plan of the wheel, with part of the chamber broken away.

Figure 2 is an elevation of the wheel, partly in section.

Like letters refer to like points.

L L is the chamber.

S, the shaft.

G, the guide.

P, the pivot and step for the same.

r v v t, the wheel, of which *r f i t* is the upper drum, and *v v* the lower or annular drum.

t p is an average or mean spiral element of the vane *h*.

t q, a line in a vertical radial plane.

r r, upper circumference of upper drum.

v v, circumference of lower drum, (external.)

n n, circumference of lower drum, (internal.)

k k, intermediate between these, or mean radius of annular drum.

Nature of the Invention.

It is evident, that in an ordinary turbine water-wheel, the upper particles of water have less velocity than the lower particles, and that in order to prevent the former from being uselessly and detrimentally dragged around between the vanes or buckets by the greater force or velocity of the latter, thus producing a loss of water-power, the former must be made to act upon portions of the vanes or buckets having less circumferential velocity than have the portions against which the latter act.

Now the object of my invention is to avoid this loss of water-power, which occurs in turbine water-wheels of the ordinary form; and

Its nature consists, first, in constructing the wheel with a varying diameter, diminishing from bottom to top; and second, in combining such a wheel with a cylindrical annular wheel of the ordinary form and construction.

In order to enable those skilled in the art to make and use my invention, I will proceed to describe its construction and operation.

Description of Wheel.

Upon the shaft S, I fix the annular drum, *v v*, corresponding to the annular drum or bucket-chamber of an ordinary turbine water-wheel with downward discharge, and containing the vanes or buckets, *g*, &c., placed at proper angles or inclinations for the securing of an economical action of the water.

Above this annular drum *v v*, I place a closed drum, *r f i t*, of variable diameter or circumference, starting it with a diameter or circumference at the base *f i* equal to that of the inner wall or rim of the annular drum *v v*, and thence diminishing it in diameter or circumference up to the head *r t;* and around this upper drum I continue, on the outside, the vanes or buckets of the annular drum in continuous spirals to the head *r t*, but slightly decreasing the width of the said vanes or buckets as they approach the head *r t*, because of a greater flow of water at the bottom than at the top. It is evident, then, that when the wheel is working, the points on the smaller or upper parts of the drum, being nearer the axis of rotation, will have less actual circumferential velocity than the points on the lower parts of said drum, which are further from the axis of rotation. The said upper drum is therefore made of such form or shape, that when the wheel is working, the actual circumferential velocity of the centres of pressure of the vanes or buckets, at each level in the height of the same, shall be directly proportional to the velocity of water due to the height of water or hydrostatic head at such level; or, in other words, at each level in the height of the upper drum, the perpendicular distance from the axis of the drum to the centre of pressure of a vane or bucket shall be directly proportional to the velocity of water due to the height of water or hydrostatic head at such level. The shape of the upper drum will be that of a spindle or frustum of a spindle with vertical axis.

In ordinary cases the upper drum may be made in the shape of the frustum of a cone, having the upper and lower diameters of such size as to satisfy the above-mentioned proportion, giving sufficient accuracy when so made.

In the language of descriptive geometry, the surface which will contain the centres of pressure of all the vanes or buckets at all levels of such a wheel, should have the arc of a parabola, with vertical axis for a generatrix, and a horizontal circle for a directrix, the relative dimensions of which must vary with every case.

To show more precisely how to determine the proper diameter of the upper drum at any point, reference is had to fig. 2. The diameters of the inner and outer walls or rims of the annular drum are assumed or computed for the particular case. The height of water above the base *f i* is known from the height of fall of the location of the wheel, and hence the velocity of water due to that height may be computed.

Then the radial distance *g h*, from the axis to the centre of pressure of the vane or bucket at the level of the required diameter, as at $g\ h$, is made to hold the same ratio to the velocity due to the height of water due to the hydrostatic head at the level of the said diameter at $g\ h$, that the radial distance $l\ o$ from the axis to the centre of pressure of the vane or bucket at the level of the said radial distance $l\ o$, holds to the velocity of water due to the height of water or hydrostatic head at such level.

The drum $r\ f\ i\ t$ is then made to conform to this proportion, being governed by the width of the vanes or buckets. The wheel constructed in this shape will provide that the actual circumferential velocity at each point on the average or mean spiral (*locus* of centres of pressures of all levels) shall be directly proportional to the velocity of water due to the height of water or hydrostatic head at such point, as above required. The particles of water will then always act upon portions of the vanes or buckets, the relative velocity of which, as the wheel turns under the influence of the same, will be constant, compared with the velocity of said particles, thus preventing the dragging around of the upper particles between the vanes or buckets by the superior force of the lower particles, and a waste of water-power.

I do not intend to confine my invention strictly to the above proportion, but, however, aim in all cases to so diminish the diameter of the upper drum as to secure the advantage, or a portion thereof, above named. The shape of wheel to secure the best results, must be made to vary with the height of fall available.

This shape of wheel I deem especially applicable to low falls, for which I make the height of the wheel equal to that of the fall, thus putting the head $r\ t$ level with the surface of the supply-stream.

Algebraic Expression for Diameter of Drum.

$$d=\sqrt{\frac{h}{H}}.D$$

Where h = hydrostatic head at level of d.
Where H = hydrostatic head at level of D at base $f\ i$.
Where d = radial distance required = $g\ h$.
Where D = radial distance at base = $l\ o$.

Knowing d, the diameter of the drum will be twice (2)d minus twice the radial width of the vane or bucket at the level d, or $2d$—2 (radial width of vane.)

The vanes or buckets are placed at such an angle or inclination with the horizontal plane, that, as nearly as possible, a drop of water will fall down along the line $t\ q$, in the same time that the point p will, by the revolution of the wheel, travel along the arc $p\ q$ to the point q. Therefore compute the average velocity of a drop of water falling down along the line $t\ q$, and also the actual circumferential velocity of the point p. The former, divided by the line $t\ q$, should equal the latter divided by the arc $p\ q$, from which relation the angle or inclination of the vanes or buckets can be determined.

Algebraic Expression for the Arc $p\ q$.

$$\frac{p\ q}{V_c}=\frac{t\ q}{V_h}\quad\therefore\quad p\ q=\frac{V_c}{V_h}.\ t\ q.$$

Where V_c = actual circumferential velocity of the point p.
Where V_h = average velocity of descent along the line $t\ q$ of a drop of water.

In this way an approximation may be made to the best position for the vanes. The most economical angle for the vanes may be computed by the well-known principles of applied mechanics, as applied to turbine water-wheels.

Thus constructed, the wheel is stepped into the chamber or case L L. This case is either open or closed at the top, as the fall is low or high, and open at the bottom. The diameter of the lower opening is slightly smaller than that of the outer wall or rim of the annular drum, so that when the wheel is stepped, the outer wall or rim of the said annular drum sits up against the floor or bottom of the chamber, thus preventing an escape of water save through the passages between the vanes or buckets. The chamber is provided with one or more horizontal spiral flumes or water-leads of such shape as to lead the water economically upon the wheel in accordance with well-established principles of turbine water-wheels. There is a pivot at P, and a guide at G, for the reception of the shaft.

Claims.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. A turbine water-wheel with varying diameter, diminishing from bottom to top, of form and construction substantially as above described and for the purposes set forth.

2. The combination of the upper drum with diminishing diameter from bottom to top, marked $r\ f\ i\ t$ in the drawings, with the lower or annular drum, marked $v\ v$ in the drawings, and with the continuous vanes winding spirally from the lower around the upper drum, substantially as above described and for the purposes set forth.

JOHN CHASE.

Witnesses:
H. C. HUDSON,
JOHN J. SCOTT.