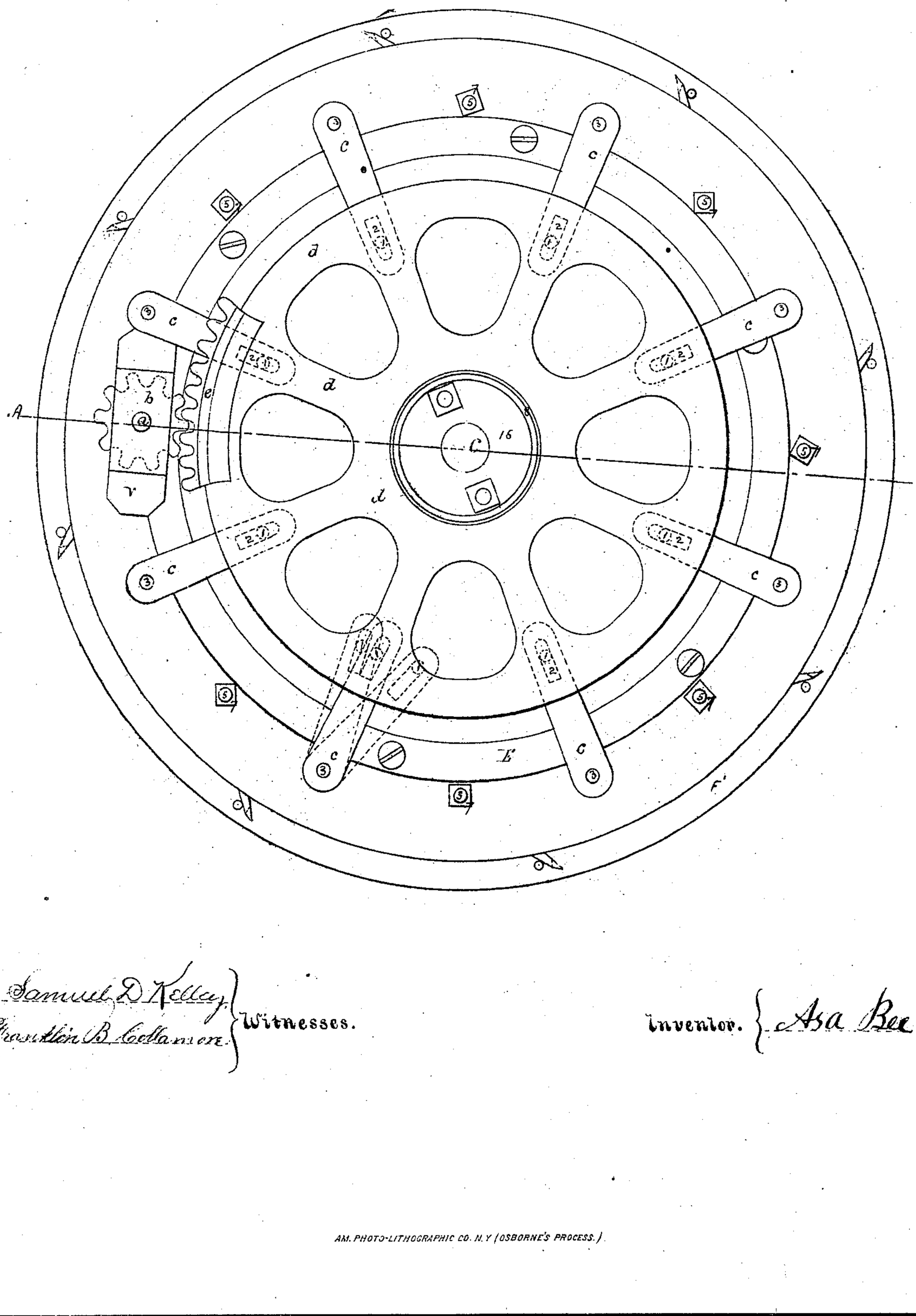
5 Sheets--Sheet 1.

Asa Bee's Improved Turbine Water Wheel.

No. 119,558. Patented Oct. 3, 1871.

Fig 1



Witnesses.

Samuel D Kelley

Franklin B Coltamore

Inventor.

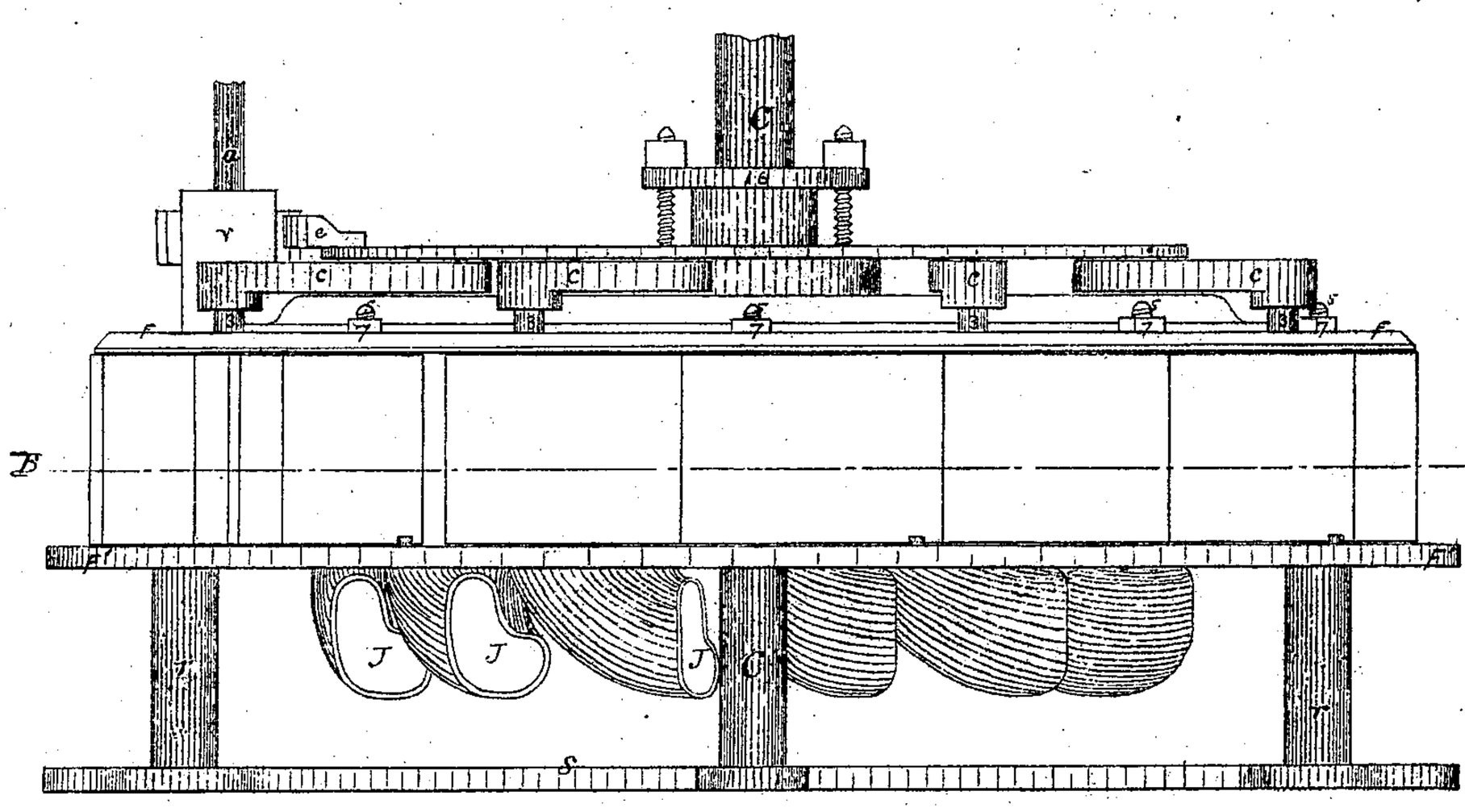
Asa Bee

5 Sheets--Sheet 2.

Asa Bee's Improved Turbine Water Wheel.

No. 119,558. Patented Oct. 3, 1871.

Fig 2



Witnesses.
Samuel D. Kelley
Franklin B. Callamore

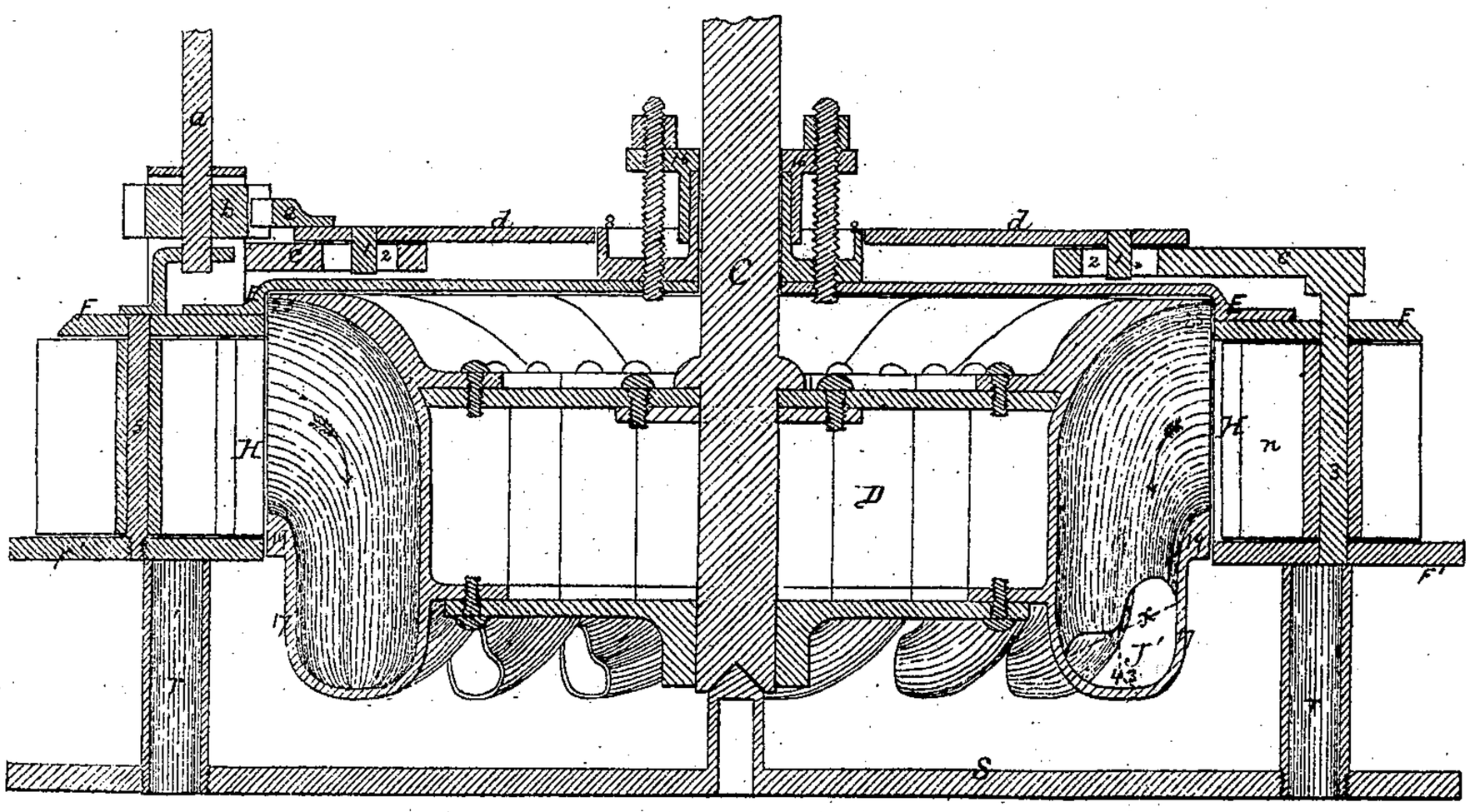
Inventor.
Asa Bee

5 Sheets--Sheet 3.

Asa Bee's Improved Turbine Water Wheel.

No. 119,558. Patented Oct. 3, 1871.

Fig. 3



Witnesses.
Samuel D Kelley
Franklin B Coffamore

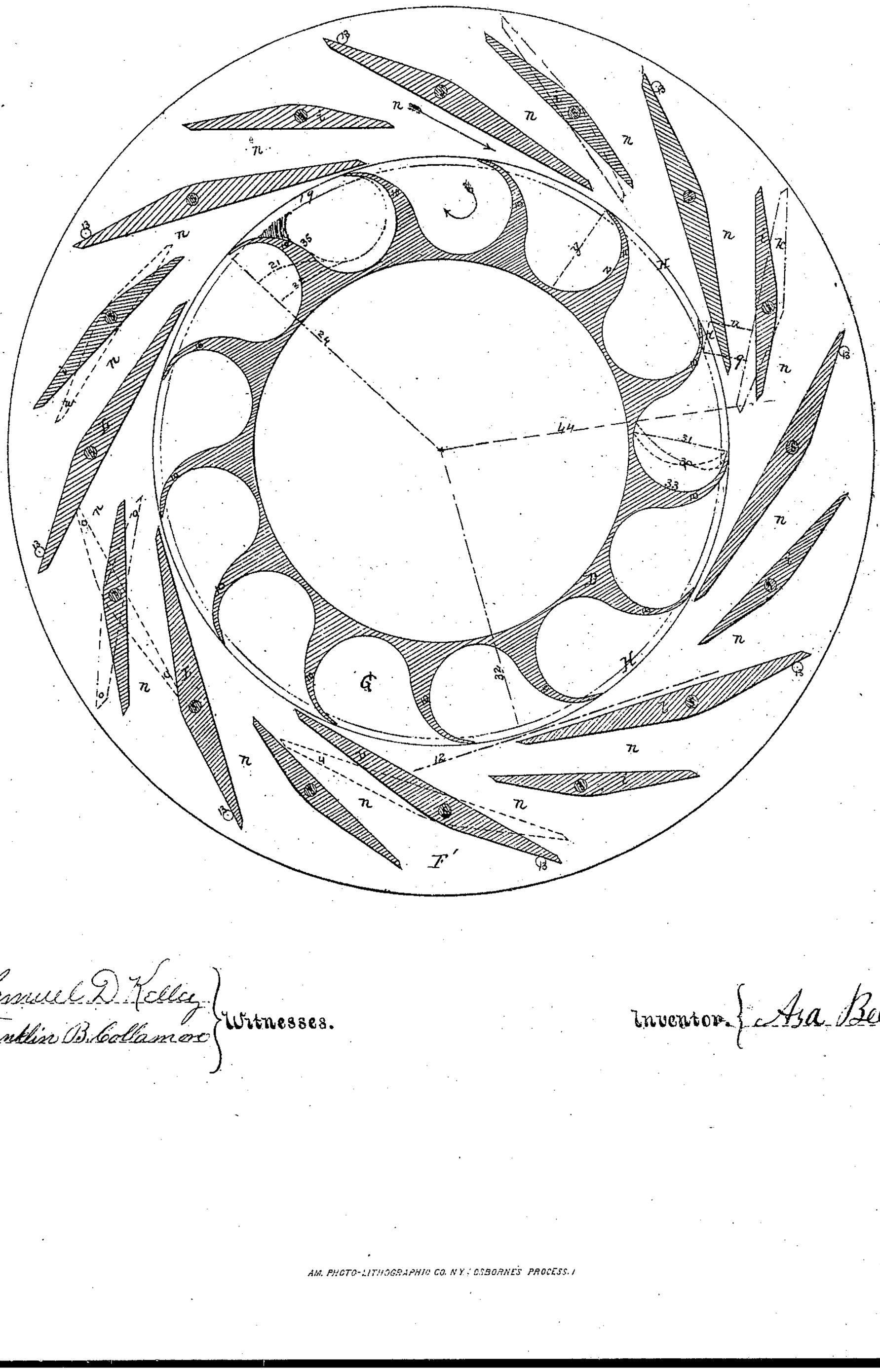
Inventor.
Asa Bee

5 Sheets--Sheet 4.

Asa Bee's Improved Turbine Water Wheel.

Fig 4

No. 119,558. Patented Oct. 3, 1871.



Witnesses.
Samuel D. Kelley
Franklin B. Callamore

Inventor.
Asa Bee

5 Sheets--Sheet 5.

Asa Bee's Improved Turbine Water Wheel.

No. 119,558. Patented Oct. 3, 1871.

Fig 6

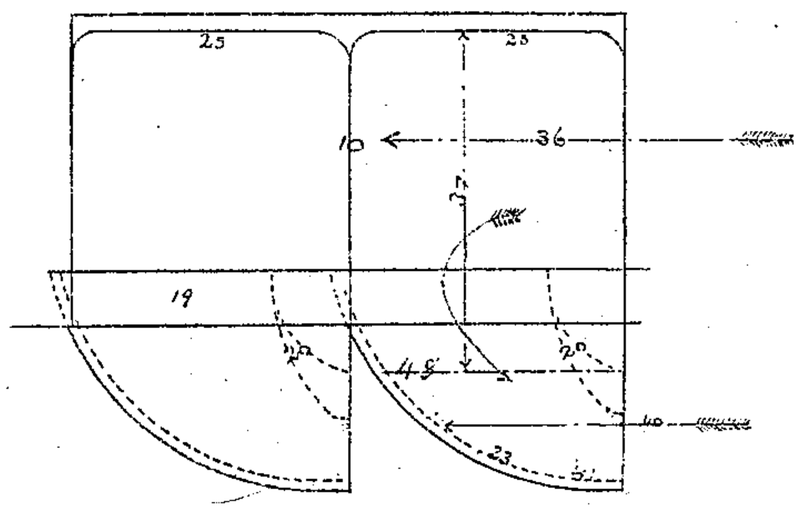


Fig 5

Witnesses
Samuel D Kelley.
Franklin B. Coltamore.

Inventor
Asa Bee

UNITED STATES PATENT OFFICE.

ASA BEE, OF LANCASTER, MASSACHUSETTS.

IMPROVEMENT IN TURBINE WATER-WHEELS.

Specification forming part of Letters Patent No. 119,558, dated October 3, 1871.

To all whom it may concern:

Be it known that I, ASA BEE, of Lancaster, in the county of Worcester, and State of Massachusetts, have invented a new and useful Improvement in Turbine Water-Wheels, of which the following is a specification:

Fig. 1 is a top view, showing the wheel-shaft, wheel-case, and the device for opening and closing the gates. Fig. 2 is a side elevation. Fig. 3 is a transverse section drawn on line A of Fig. 1. Fig. 4 is a horizontal section drawn on line B of Fig. 2, showing the guides, gates, plate F′ on which they rest, and wheel in section. Fig. 5 is a stud-bolt which passes through the guide pieces L vertically, and is fastened at each end to plates F and F′, which form the upper and lower sides of the chutes *n*; Fig. 6, a side view of two buckets; C, Fig 1, wheel-shaft; E, the cap over the wheel; D, the wheel; G, the bucket; H, the opening where the water enters the buckets; S, the cross on which the wheel is supported when the case-plate F′ rests on the flume-floor; *r*, the studs which connect the cross S to the plate F′. The arrow 36, Fig. 6, shows the direction of the water as it enters the bucket and impinges against the float 10. The vertical pointed line 37 shows the upward and downward pressure of the water which, acting as a brace, holds the pressure due to the reaction of the water on the inclined curve 23, so that it presses in the direction indicated by the arrow 40 the same as if it were pressing against a vertical plane. All other arrows indicate the course of the water.

Similar characters of reference indicate corresponding parts in the various figures.

The nature and object of my invention consist: First, in the manner of constructing and arranging the device for opening and closing the gates. Second, in so constructing and arranging the gates and guides, and so constructing the wheel D, that all the available power of the water which enters the wheel shall be transmitted to the wheel in the exact direction of the wheel's motion with as little frictional surface as possible.

In order that others skilled in the art to which my invention appertains may be enabled to fully understand and use the same, I will now proceed to describe it in detail.

For the purpose of opening and closing the gates, I secure a pinion, *b*, Fig. 1, to the cap E of the wheel-case, by means of the yoke *v* and shaft *a*, which passes through the yoke *v* and pinion *b* and enters the cap E of the wheel-case. By turning the shaft *a*, which is tight in the pinion *b*, but loose in the yoke *v* and wheel-cap E, we give motion either with or against the sun to the skeleton *d* by means of the rack *e*. The skeleton *d* rests upon the arms *c* and gives motion to them by means of pins 1, which are firmly fastened to the skeleton *d*, but pass through and move freely in the slot 2. These arms give motion to the gates *i*, Fig. 4, by means of their shafts 3, (seen plainest in Fig. 3,) for the purpose of increasing or diminishing the thickness of the streams of water which pass to the wheel through the chutes *n*, or for closing them entirely, as shown by gates *o o* in dotted lines, Fig. 4. The skeleton *d* is held in position and revolves round a vertical ring, 8, Fig 3, which is made fast to the top of the wheel-cap. The arms in Fig. 1, represented in dotted lines, show their position when the gates *i* are either fully open or entirely closed, as seen in gate *o o*, Fig. 4. The position which the arms are now in would hold the gates as represented by dotted lines *w*. What I claim for this arrangement for opening and closing the gates, over the common form of controlling them by connecting-rods is, cheapness, simplicity, and durability. 16 is the stuffing-box around the shaft of the wheel, clearly shown in drawing in Fig. 3. The gates are held in position by their shafts passing through the plates F F′, which act as bearings in which they turn. These plates are held firmly in position, F above and F′ below the gates *i* and guides L, by means of the stud-bolts, Fig. 5, which are screwed into the lower plate, but pass through the upper plate and are provided with nut 7, Fig. 1. The plates F and F′, the cap E, the guides L, and gates *i*, when secured by stud-bolts 5 and shafts 3, as described, form the wheel-case. The guides L and gates *i* form the vertical sides of the chutes *n*, and the plates F and F′, when secured as described, form their upper and lower sides. By fitting these plates closely to the wheel they become stop-waters, and prevent leakage around the wheel. That part of the wheel D, Fig. 3, above the rim 19, Fig. 6, contains the upper part of the buckets G, which I construct by making the vertical part of the floats 10, as seen in Figs. 4 and 6, and the outward edge of the top 25, nearly horizontal, as seen in Fig. 6; but as the top

of the bucket passes backward and downward it gradually assumes a concave form. (See the downward inclination of the inner portion of the bucket as seen in Fig. 3, beginning at 25.) This concave shape of the upper and back part of this upper portion of the bucket is new, so far as I am aware, as is also the combination of the concave shape of the upper part of the bucket with float 10 when curved so as to retain all the centrifugal throw of the water which enters the wheel. I construct the lower part of my buckets by continuing the curve of floats 10, cut off by line *y*, downward and backward on the sweep of line 23, gradually narrowing with the outward inclination of the inner wall 22, Fig. 4, to its terminus at the issue J, as may be seen by comparing the width at line *y*, Fig. 4, at the top of the rim 19, Fig. 4, with the width at the issue J′, Fig. 3. The outer wall 17, Fig. 3, is vertical, and on the same circle of the wheel. I round the inner corner of rim 19, Fig. 4. The outward inclination of the inner wall of the vertical portion of the issue is explained by dotted line 21, Fig. 4. For the shape of the upper portion of the wall of the bucket which passes under the float 10, compare the back of the float of the bucket G, marked 35, with lines 20, Fig. 6, the upper one of which shows the curve of the top of the vertical portion of the issue, and the lower one the curve of the top to the horizontal portion, and then compare these three last described with the shape of that portion of the issue J′, Fig. 3, which is above the inclined line *x*, and the shape of that portion of the bucket will be understood. The end of the bucket thus formed, I cut off vertically on a line to the center of the wheel. All that I claim for this form of the lower part of a bucket is combining it with the upper part in the shape already described; but when it is not desired to use more water through a wheel of a given diameter than can be discharged ovally on the outside, I dispense with all the horizontal portion of the bucket which forms the elbow cut off by dotted lines 43, thus making the bucket one complete tapering oval, changing from the shape seen in full lines in bucket 35, Fig. 4, to the vertically-oval shape at issue J′, Fig. 3. When thus made I claim the entire lower portion of the bucket as new. The common practice of setting the guide-pieces L about as far from the float 10, Fig. 4, as the spaces in the strainers at the head of the flume are wide, has long been known to be objectionable, because the water which passes between them, instead of spending all its impinging force against the float 10, spends a portion of its power by striking against the water issuing from the next chute, pressing it against the next guide in an oblique direction, as shown by dotted line 12, Fig. 4. To set stationary guides close to the floats would not only subject the guides to the danger of being broken by foreign bodies that might pass into the wheel, but also the floats themselves, as often happens when the strainers get broken so as to let in large foreign bodies. To avoid this danger, and at the same time overcome the loss of power last referred to, wheel-builders have fallen into another mistake almost as injurious in its effects—that of setting the guides and gates so that the water instead of impinging against the floats at right angles with the diameter of the wheel, as it should, strikes obliquely toward the center. This leads to another mistake equally injurious—that of turning the floats so that the water shall impinge squarely against them, or perhaps, a little obliquely outward, as if supposing that the loss due to the inward direction could be compensated for by crossing the line of the wheel's motion in an opposite direction, (see floats 30 in dotted lines,) which admits of still another loss of power, which may be better understood by measuring the depth of the curve 30, shown by line 31, and comparing it with the thickness of the stream of water impinging against it, by which it will be seen that the curve is too shallow to hold all the centrifugal throw of the water due to the wheel's motion. This difference is more than one-third, which will cause an oblique outward pressure upon the guides equal to the centrifugal throw of that amount of water. This is an entire loss, as well as all the indirect pressure already described.

Having thus far endeavored to give a concise description of some of the principal defects in the best turbine-wheels heretofore invented, that the advantages of my construction and combination may be better understood, I will now proceed to describe how I construct these same parts so as to overcome these objections.

It will be remembered that the first of these was that of setting the guides at a distance from the floats, which was objectionable because a portion of the water, by passing between the guides and floats, does not press against the floats, but on the next guide, as shown by the dotted line 12, Fig. 4. This I overcome by setting the guides close to the wheel. The faces of these guides should in all cases be at right angles with the diameter of the wheel, as shown by guide *l* and dotted line 32. The second objection was that of their liability to be broken by foreign bodies passing into the wheel. This I overcome by hanging the guide loosely on the stud-bolt 5, so that when any foreign body passes between the float 10 and the inner end of the guide L the guide will yield readily till it assumes the position shown by guide 4 in dotted lines, and as soon as relieved will return to its proper position and be held there by pin 13 or its equivalent, at the outer end, and the pressure of the water at the inner end, it being greater on the side from than on the side next to the float 10. The arrangement of guides and gates herein described also affords a constant and permanent provision against leakage when the gates are closed, as the pressure of the water on the outer ends of the guides L tends to keep them closely against the gates *i*, no matter how much these parts may become worn in use. The third objection was that of setting the guide *k*, or its equivalent, so as to cause the water to strike obliquely toward the center of the wheel, as shown by line 44. This I fully overcome by my mode of setting the guides, already described, by which

the water is made to impinge against the float at right angles with the diameter of the wheel, because the faces of the guides are set at right angles with said diameter, thus applying its impinging force in the exact direction of the wheel's motion. The fourth objection was that of making the curves 30 too shallow to retain the centrifugal throw of the water, allowing it to be thrown obliquely against the guide L, whence it is aided by the oblique outward pressure already described. (See the relation of line 31 to the diameter of the wheel.) This I overcome by making the combined depth of the buckets equal to the combined thickness of the streams of water passing through the chutes *n*. (For depth of curve of floats 10 measure from line *y* to curve *z*, Fig. 4.) The combined depth of all the curves of the floats 10 equaling the combined thickness of the chutes *n*, it is evident that they will retain the centrifugal throw of all the water thus passed into them, and neither adds to nor takes from the power of the wheel, except what it adds in steadiness of motion, acting as so many weights placed in so many cavities in the rim of a common fly-wheel; which, while it adds in weight, adds nothing in atmospheric friction, thus fully overcoming all the objections thus far explained. It should also be observed that this form of a float cannot be used to advantage when the guides point obliquely toward the center of the wheel, as in guide or gate *k*, Fig. 4, because the water would act on the back of the float like a wedge, as shown by lines *t u* and 9. My form of a guide may also be used to advantage in the common scroll, either with or without the gates, and the device for opening them; which device, when used, may be set inside of the scroll and operated by letting the pinion-shaft *a* pass up through the cap of the scroll; or the pinion, rack, skeleton, and arms may be placed on top of the scroll, and the gate-shafts 3 pass down through the top of the scroll for the purpose of operating the gates; or the whole gate-opening arrangement may be placed below the wheel in the water and operated from above by shafts and bevel-gears, in which case the opening arrangement will be inverted.

Having thus fully explained how I obtain all the impinging force of the water on the upper portion of my wheel in the exact direction of the wheel's motion, I will now proceed to describe how I obtain all the remaining pressure due to the action of the water in its passage through the lower portion of the wheel in the exact direction of the wheel's motion.

Now, if the issues J were closed and water let into the buckets through the chutes *n* till they were full, it is evident the wheel would stand still, because water presses equally in opposite directions; now, open any part of a bucket, and the pressure will be released on the part opened, but retained on that part which is opposite at right angles with the square of the opening. Then, is it not equally evident that my plan of discharging the water horizontally at right angles with the diameter of the wheel on the side of each bucket opposite the forward motion of the wheel is the only one by which the final pressure of the water can be made to bear on the wheel in the exact direction of the wheel's motion. By opening the buckets at issue J both the water and the wheel are set in motion by the inequality of pressure thus produced, a part of which pressure is on that part of the buckets exactly opposite to the square of the opening in the chutes *n*, and the remainder exactly opposite to the square of the opening called the issue. All other parts of the buckets, having an opposite and consequently an equal pressure, neither add to nor take from the power of the wheel, except in friction, because the water is carried onward with the wheel while passing through these parts, offering little or no resistance to the wheel's motion, because power is consumed by friction produced by forcing the water over the surface of all parts of the buckets except that part over which it passes in the direction of the wheel's motion. I construct all parts of my buckets as nearly round as the space they occupy will admit. I believe constructing and combining all the parts of a wheel in the manner which I propose, to be new and an improvement—nearer to perfection than has ever before been attained—not only for the reasons above assigned, but also from the fact that, in practice, it is very desirable that the quantity of water used should vary as nearly as possible with the amount of power required, without opening and closing the gates. My form of a wheel accomplishes this more nearly than it is possible to do it with any form of a bucket which discharges the water before it has attained to a complete reverse action, because, when the wheel is not laboring, it moves more nearly with the natural flow of the water, offering less resistance to force the water on to its final discharge, which, having more nearly to find its own way than it would if pressed, will evidently find it easier through a bucket whose curve only forms a fourth of a circle than through one which makes a complete half circle, as mine does.

I am aware that some of the shapes which I employ in constructing my buckets have been used before; but I do not know or believe that such as I claim to be new have been ever before used, nor combined in the manner which I propose. I am also aware that scroll-shaped gates, and also scroll-shaped stationary guides, have been used, and do not wish to be understood as claiming anything in that shape, or operated with rods and joints.

It will be seen, by referring to the drawing, Fig. 3, that so much of the wheel D as relates to making the buckets separately and securing them as shown is not described nor referred to, because it is a separate invention, made by myself and Benjamin F. Rice, now deceased, as an improvement to be connected with this or any other wheel, and is designed to be the subject of another patent.

Having thus described my invention, what I claim as new and useful, and desire to obtain Letters Patent for, is—

1. A bucket or float G, having its lower or discharge end of tubular and tapering form, terminating in an orifice of oval or reniform shape in cross-section, substantially as herein represented and described.

2. The combination of the gates *i* hung and operated as described, the guides L arranged as described, and the buckets G constructed as above specified, for the purposes set forth.

ASA BEE.

Witnesses:
SAMUEL D. KELLEY.
FRANKLIN B. COLLAMORE.

(118)