(No Model.) 3 Sheets—Sheet 1.

N. F. BURNHAM.

TURBINE WATER WHEEL.

No. 438,878. Patented Oct. 21, 1890.

Fig. 1.

ON LINE 1-1

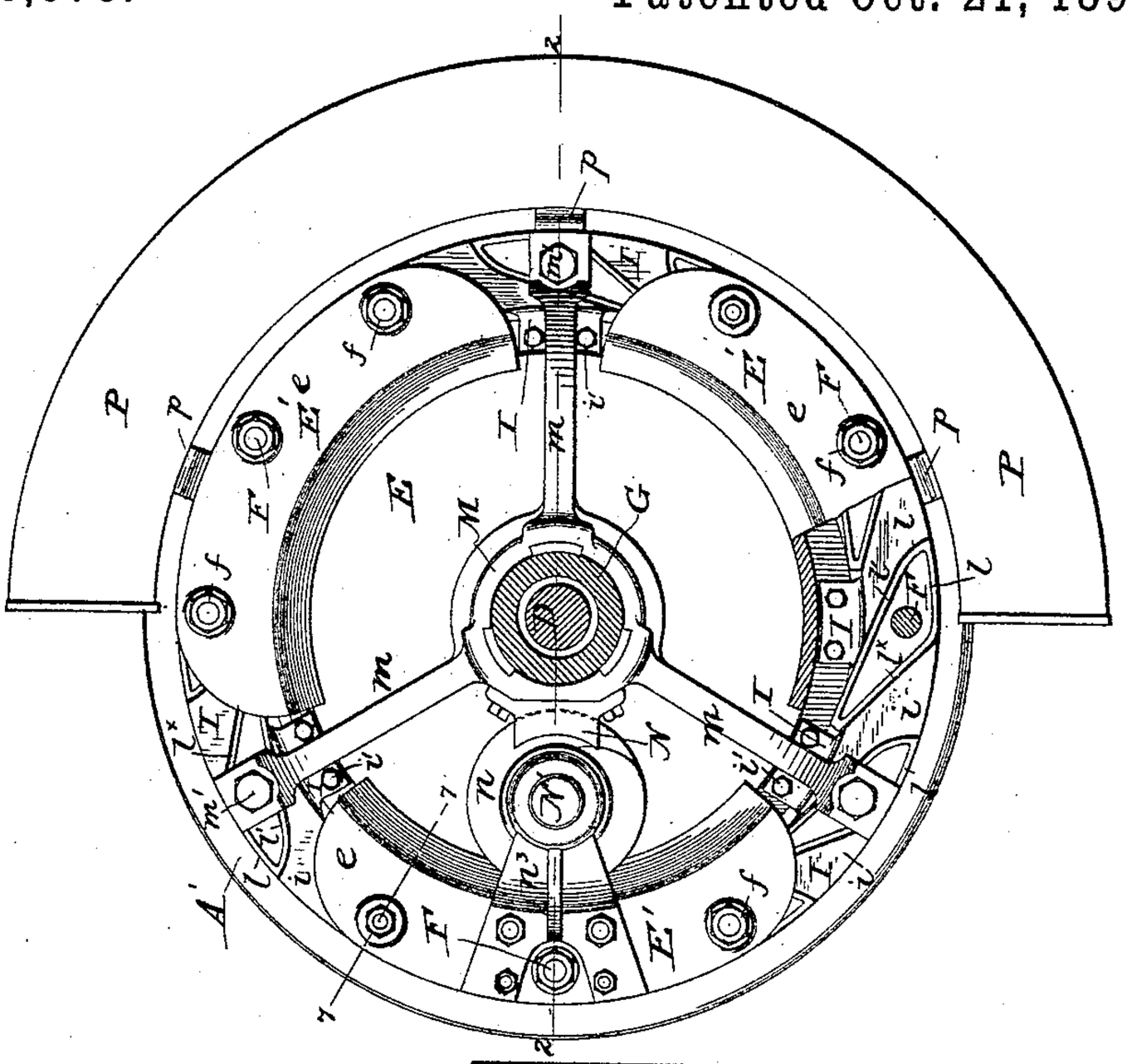


Fig. 2.

ON LINE 2-2

Attest.

Sidney P. Hollingsworth

Baltus D'Long.

Inventor.

Nathan F. Burnham

by his attorneys.

Baldwin Davidson & Wright

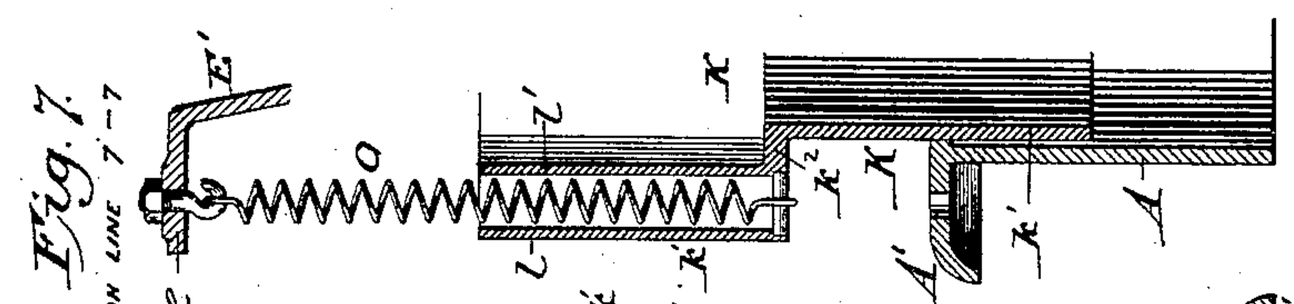
(No Model.) 3 Sheets—Sheet 2.

N. F. BURNHAM.

TURBINE WATER WHEEL.

No. 438,878. Patented Oct. 21, 1890.

Fig. 7.



ON LINE 7—7

Fig. 4.

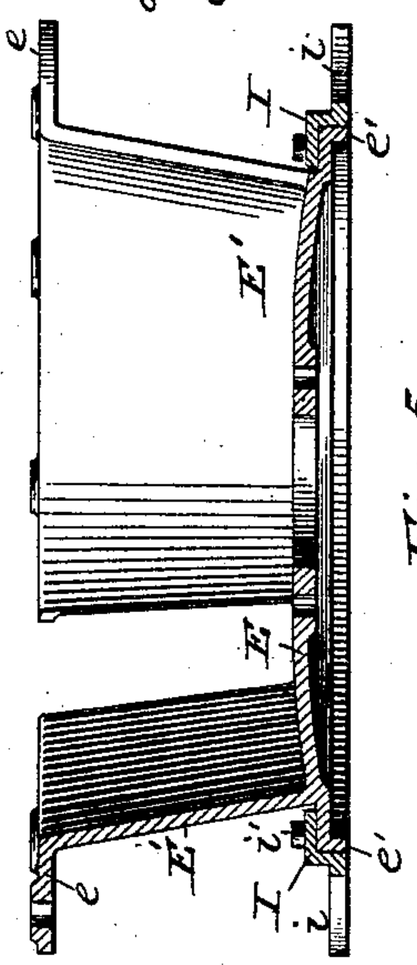


Fig. 5.

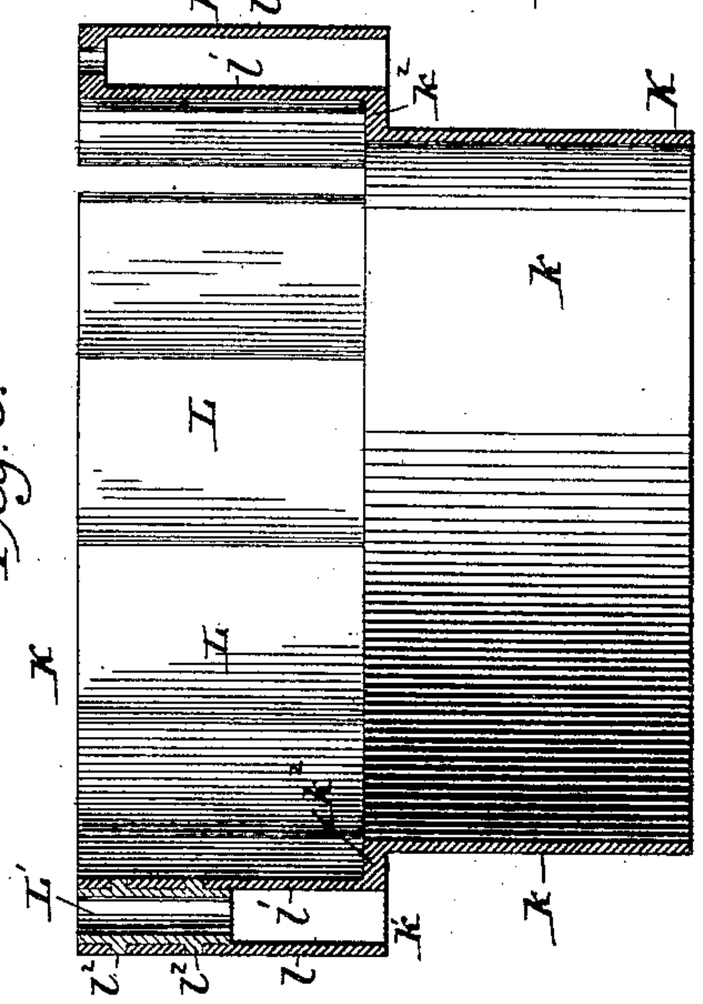


Fig. 6.

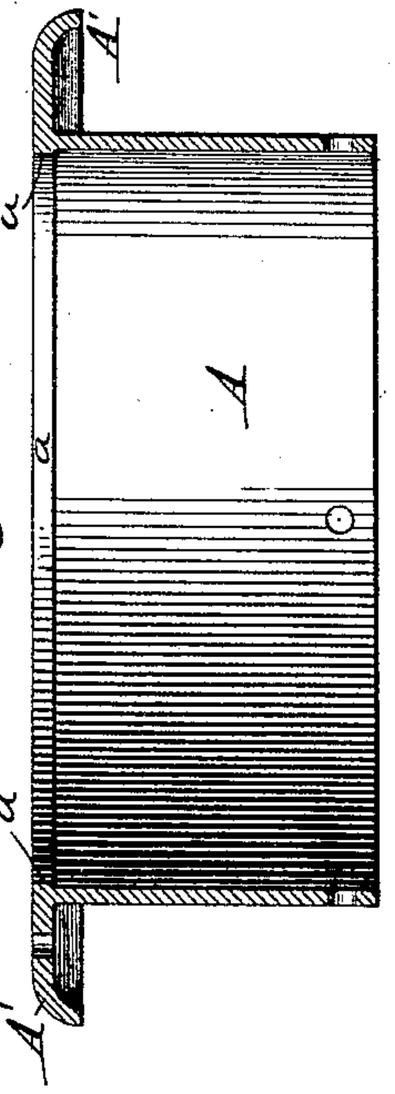


Fig. 8.

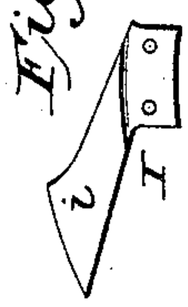
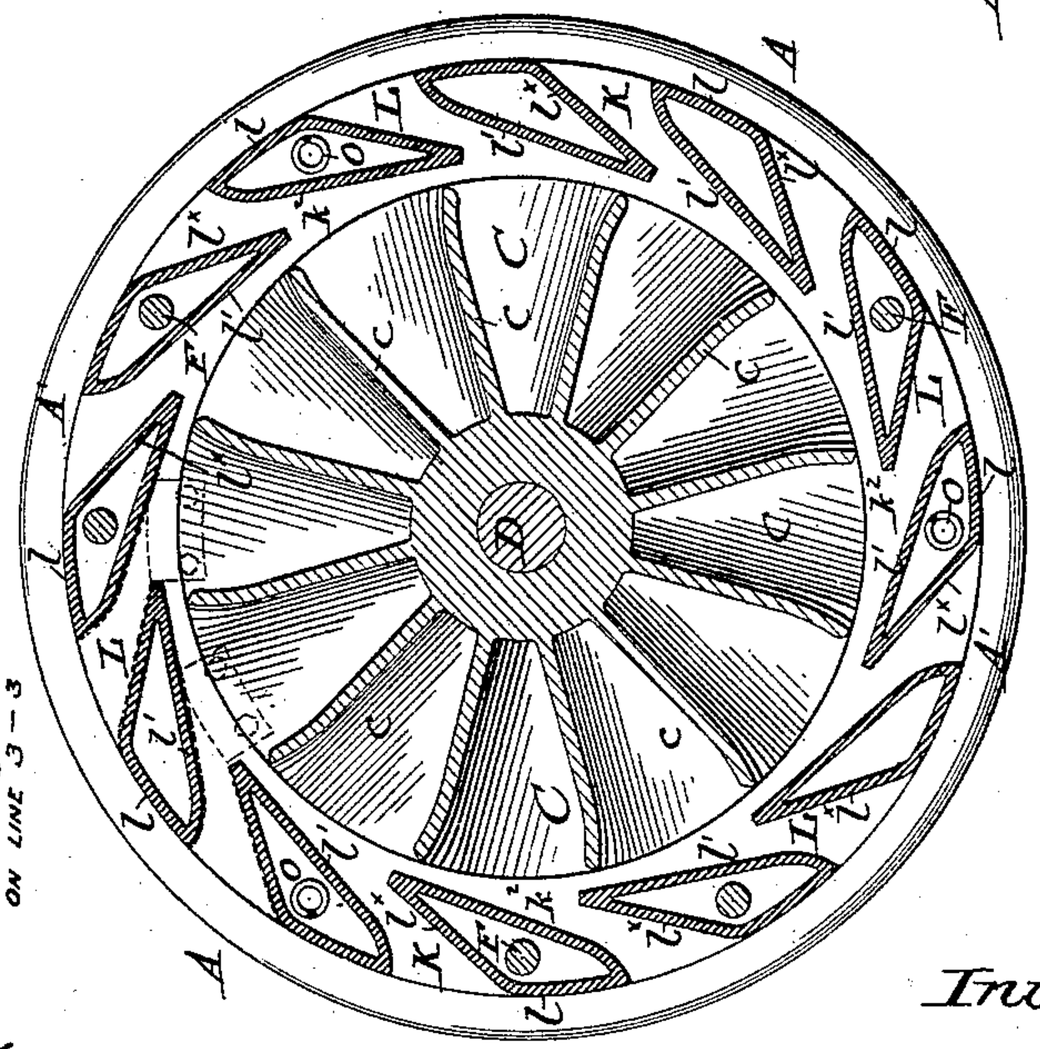


Fig. 3.

ON LINE 3—3



Attest.

Sidney P. Hollingsworth

Baltus D. Long.

Inventor.

Nathan F. Burnham

by his attorneys

Baldwin Davidson & Wright.

(No Model.) 3 Sheets—Sheet 3.

N. F. BURNHAM.

TURBINE WATER WHEEL.

No. 438,878. Patented Oct. 21, 1890.

Fig. 9.

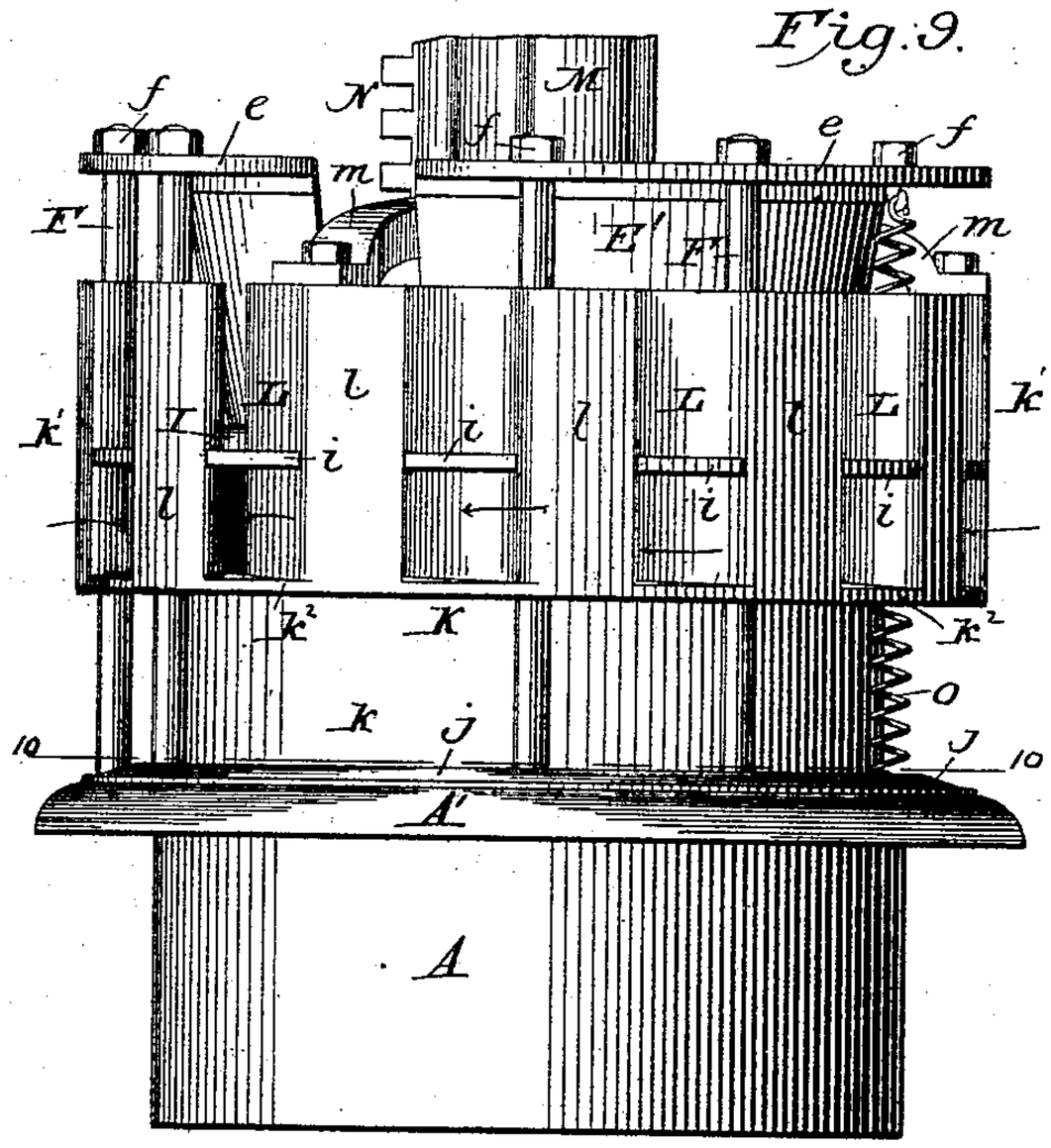


Fig. 11.

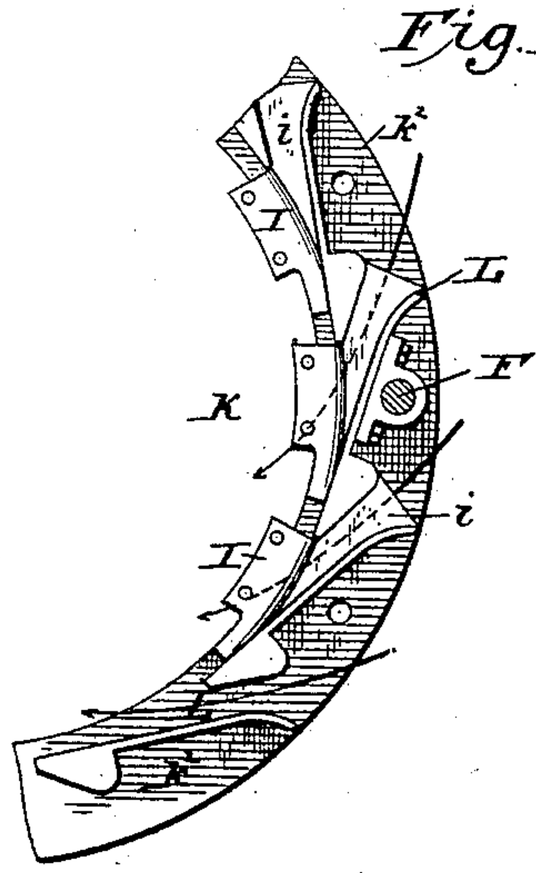


Fig. 12.

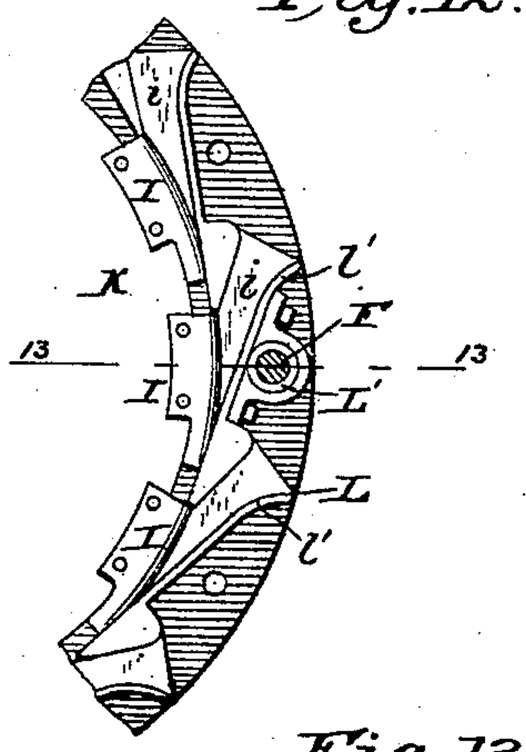


Fig. 10.

ON LINE 10—10

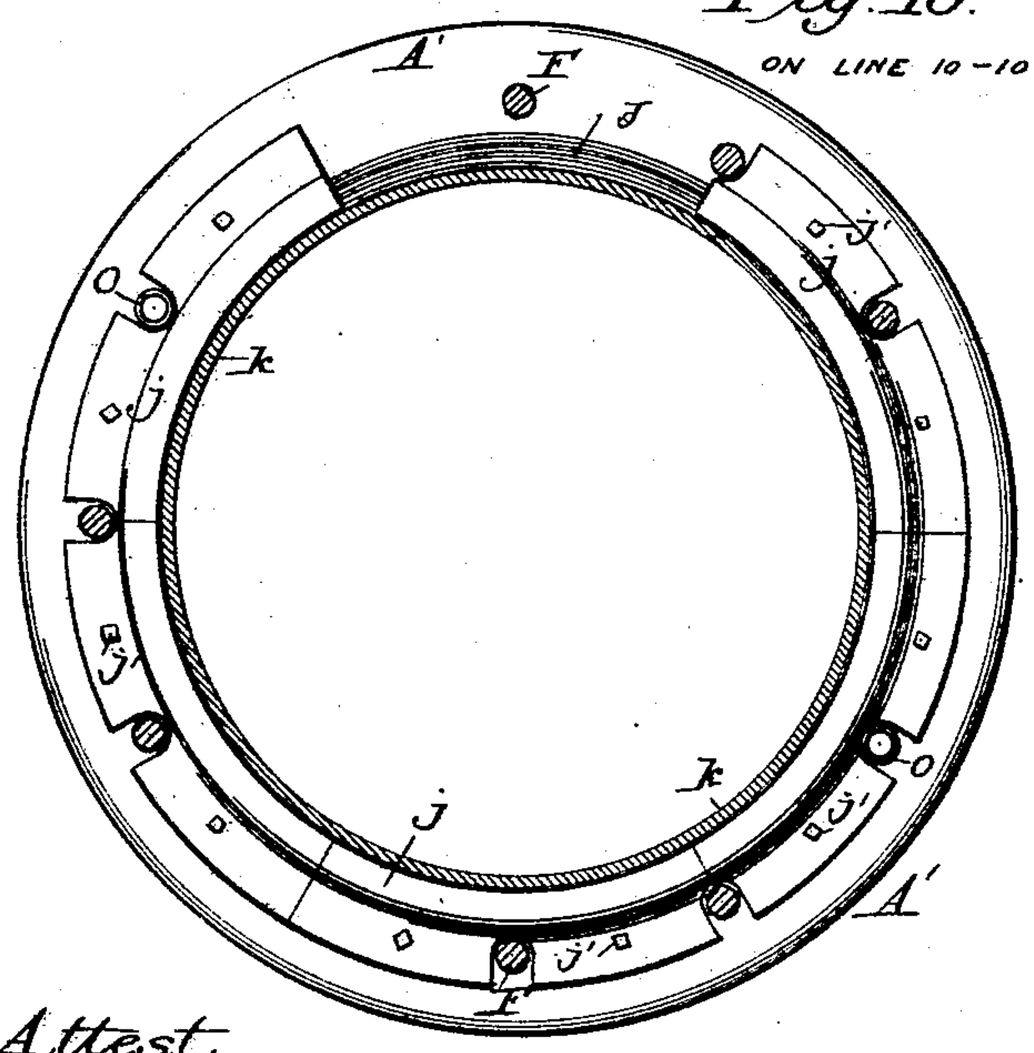
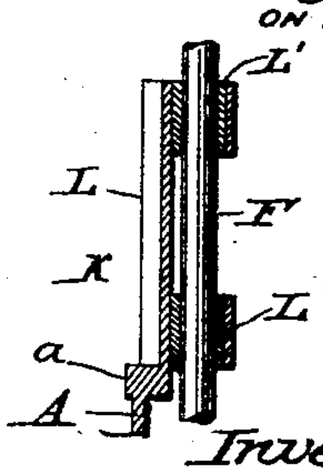


Fig. 13.

ON LINE 13—13



Attest.

Sidney P. Hollingsworth

Baltus DeLong.

Inventor:

Nathan F. Burnham

by his attorneys

Baldwin Davidson & Wright

UNITED STATES PATENT OFFICE.

NATHAN F. BURNHAM, OF YORK, PENNSYLVANIA.

TURBINE WATER-WHEEL.

SPECIFICATION forming part of Letters Patent No. 438,878, dated October 21, 1890.

Application filed June 14, 1890. Serial No. 355,439. (No model.)

To all whom it may concern:

Be it known that I, NATHAN F. BURNHAM, a citizen of the United States, residing in the city and county of York, in the State of Pennsylvania, have invented certain new and useful Improvements in Turbine Water-Wheels, of which the following is a specification.

My invention relates to that class of turbines in which the supply of water to the buckets of the wheel is controlled by a vertically-moving cylinder-gate. Its objects are to guide the gate properly in opening and closing, so as to prevent undue wear or friction of the parts; to pack the joint between the supporting-cylinder or draft-tube and gate, so as to prevent leakage and compensate wear; to direct the water properly upon the buckets, so as to secure the maximum effect at every stage of the opening of the gate; to provide means for readily raising and lowering the gate and holding it in any desired position, and, finally, to render the gate buoyant or self-poising, so as to counteract its weight and facilitate its opening and closing. These ends I attain, first, by causing the gate to traverse in fixed guides, which always maintain it in proper relation to the wheel and cover; second, by interposing a self-adjusting packing-ring between the supporting-cylinder or draft-tube and the cylinder-gate, which ring accommodates itself to variations in the relation of these parts caused by wear or other incidents; third, by combining with the cover fixed water-guides which project into the chuteways and cause the water to be thrown upon the wheel in proper relation thereto to produce the best effect at any stage of adjustment of the gate and chutes; fourth, by raising and lowering the gate by means of a worm-gear mounted upon the cover, which not only adjusts the gate, but holds it in such adjusted position; fifth, by counterpoising the weight of the gate and its connected parts by means of springs interposed between the gate and cover; sixth, by counteracting the weight of the gate and its attachments by means of a buoy or float connected therewith, and, seventh, by certain novel constructions, combinations, and organizations of instrumentalities, hereinafter described.

The subject-matter claimed will be designated in the claims at the close of this specification.

The accompanying drawings show so much of a turbine water-wheel embracing all my improvements in the best manner now known to me as is necessary to illustrate the subject-matter claimed. Some of these improvements, however, may be used without the others and in wheels differing somewhat in their details of construction from those herein shown and described. Unless otherwise specified, the parts are of usual well-known construction.

Figure 1 represents a plan or top view, partly in section on the line 1 1 of Fig. 2, showing one half or section of the buoy which floats the gate and its connected moving parts, and with parts of the cover broken away to show the chutes and stationary water-guides; Fig. 2, a vertical central section on the line 2 2 of Fig. 1; Fig. 3, a horizontal section on the line 3 3 of Fig. 2. Figs. 4, 5, and 6 represent, respectively, vertical central sections through the cover, the chutes and gate, and the supporting-cylinder or draft-tube, illustrating their details of construction; Fig. 7, a similar section on the line 7 7 of Fig. 1, showing one side of the cover, the supporting-cylinder, the interposed vertically-moving cylinder-gate, and one of its sustaining-springs; Fig. 8, a plan view of one of the stationary water-guides detached; Fig. 9, a side elevation of a portion of the apparatus, showing the gate about half open; Fig. 10, a horizontal section on the line 10 10 of Fig. 9. Figs. 11 and 12 are sectional detail plan views showing modifications of the gate, chutes, and guides; and Fig. 13, a vertical transverse section on the line 13 13 of Fig. 12, showing the details of the gate-guides.

A supporting-cylinder or draft-tube A is shown as provided at its upper end with an external annular flange A′, curving outward and downward to facilitate the inward flow of the water. A slight inwardly-projecting annular flange *a* constitutes a part of this flange A′, for a purpose hereinafter described. A bridge or cross B is secured in the lower part of the supporting-cylinder by screws *b* and supports a central wooden step B′.

A wheel C, hereinafter more fully described,

is secured on the lower end of a spindle D, provided at its bottom with a concave bearing turning on the step B′, above mentioned.

The cover is crown-shaped, consisting of a slightly-arched ring E, from which spring a series of curved outwardly-inclined sections E′, having horizontal external flanges *e* at their upper ends. An annular flange *e′* extends first horizontally outward and then vertically downward from the bottom of the cover outside of the lower parts of the inclined sections E′ and surrounds the top of the wheel, which turns freely within it, a small space sufficient for that purpose being left between them.

The supporting-cylinder, cover, and other parts, hereinafter described, are held in proper relation to each other by accurately-turned vertical bolts or guide-rods F, shouldered at their ends and terminating in screws. These rods are interposed at suitable intervals between the flanges A′ and *e* of the supporting-cylinder and cover-sections, respectively, against which their shoulders abut, the screwed ends of these guide-rods passing through these flanges and being secured in place by nuts *f*, thus always maintaining the parts in the proper fixed relation.

A tubular standard G is provided with an external bottom flange *g*, inserted in a central opening in the cover E, and secured thereto by screws *g′*. The upper portion of this standard carries the usual adjustable bearings H, consisting of wood follower-blocks actuated by screws *h*, passing through the casing in which the blocks move. A gland or stuffing-box H′ surrounds the shaft above these adjustable bearings. Stationary water-guides I are secured to the lower cover-flange *e′* by bolts or screws *i′*. These guides are shown as consisting of an inner horizontal portion resting on the top of the flange *e*, a vertical portion extending downward outside of and parallel with the vertical portion of that flange, and a horizontal wing or blade *i*, extending outward between the chutes and operating as hereinafter more fully explained.

The gate K consists of a lower cylinder *k* of a diameter slightly less than that of the supporting-cylinder A, within which it is free to move vertically, and of an upper ring or gate section *k′* of larger diameter, the two sections being connected by a horizontal flange k^2 at the top of the lower section and the bottom of the upper one, so that the two sections in fact constitute a single cylinder-gate.

A loose self-adjusting packing-ring J, of leather, rubber, or other suitable material, rests on the flange A′ and projects slightly over or beyond the inner flange *a*, so as to fit snugly against the gate-cylinder. Flanged segments *j* overlap this packing-ring, and are held in place by bolts *j′*. The packing-ring J is made slightly narrower and thinner than the space between the flange A′ and the clamping-segments *j*, so as to allow the ring to move slightly horizontally to compensate any lateral play of the cylinder of the gate should such there be. The pressure of the water is sufficient to hold the ring at all times properly against the gate-cylinder to pack the joint properly to prevent leakage, which is its only function.

The chutes L are formed integral with or bolted securely to the flat portion or flange k^2 of the gate at suitable intervals and constitute its upper portion. These chutes are shown as having three vertical sides or walls, the outer side *l* constituting in effect the outer wall of that portion of the gate. The front wall $l^{\times}$ and inner or rear wall *l′* extend therefrom inward, converging to a point near the inner rim of the flange k^2, so as to discharge the water properly upon the buckets. The blades or wings *i* of the stationary water-guides I project between these chutes, conforming closely in shape with the chute-openings, but fitting loosely therein, so that the chutes are free to travel vertically between the guides as the gate opens or closes.

Guide boxes or bearings L′, secured to the gate at suitable intervals, constitute bearings or guides through which the connecting-bolts or guide-rods F pass, thus securing the accurate alignment and adjustment of the gate and preventing it from binding, wearing, or turning.

In Figs. 1, 2, and 3 the guide-rods F are shown as passing through guide sleeves or boxes L′, composed of Babbitt metal, cast inside the chutes, and held in place therein by lugs l^2.

In Figs. 11, 12, and 13 the guide-rods F are shown as passing through boxes or brasses L′, bolted to the outer side of the rear wall *l′* of their respective chutes.

The top surface of the gate-flange k^2 and the bottom surface of the cover-flange *e′*, as well as the corresponding under sides of the stationary water-guides I, are accurately turned, so as to make a close joint when the gate is closed, at which time the top of the flange k^2 is held close against the under side of the cover-flange and stationary guides above mentioned. The inner walls of the chutes, it will be observed, lie outside of the cover-flange and slide past it in opening and closing the gate. Gate-arms *m*, which, together with the central hub M, constitute a spider, are secured to the top of the chute portion *m′*.

A rack N, secured vertically on one side of the hub M, engages with a worm-gear *n* on a vertical shaft N′, turning in bearings n^2 n^3 on the cover to raise and lower the gate. The advantage of this worm-gearing over an ordinary rack and pinion is very great, as the worm, being applied directly to the rack on the hub of the gate-arms, exerts great power, and besides holds the gate at any desired adjustment without fastening devices, such as would be necessary with ordinary gearing.

Spiral springs O are secured at one end to the gate-flange k^2 and at their other end to

the overhanging cover-flange *e*. As shown in Fig. 7, these springs may advantageously pass inside the walls of those chutes not occupied by the guide-rods, where they are well protected and act effectively. The strength of these springs is preferably such as to balance the weight of the chutes, gate, spider, and rack when the gate is one-third open, which counterbalancing is obviously of great advantage in adjusting the gate. This device answers very well for small gates; but to counterbalance large gates, which with their appurtenances sometimes weigh more than a ton, would require very strong springs, so strong in fact as to be practically inconvenient. I have therefore devised a method of counteracting the weight of the gates and moving parts, which in effect constitutes a floating gate. This I do by combining with the gate a buoy or float of sufficient buoyancy to sustain the weight of the gate and its parts without other mechanism. I preferably make this buoy of an annular form divided vertically into segments, so as to facilitate its attachment to and removal from the gate. Fig. 1 shows one of these segments P as made of a semicircular or half-ring form. It may be of sheet metal and connected with the gate by upright standards *p*, respectively bolted thereto and projecting above the gate, so that the bottom of the buoy is above the top of the chuteway, thereby leaving the water-way at all times unobstructed. The buoy is preferably of sufficient capacity to support the gate and its attachments at any stage of adjustment. The buoy and springs may of course be used either separately or together, as occasion requires.

I am aware that a water-wheel and its casing have been so constructed with a central air-chamber combined therewith as to counteract to some extent the weight of the wheel; but so far as I am aware I am the first to combine a buoy or float with a gate movable independently of the wheel.

Waste-pipes P′ pass from each section of the float down through the floor of the penstock, (not shown,) so as to let out any water that may leak into the float, the pipe being long enough to pass through the penstock when the gate is raised to its highest point.

The crown or hub of the water-wheel C is shown as bell-shaped or concave from its upper circumference to its lowest point near the shaft, so that the water impinging against the under side of this curved hub tends to lift the wheel and exert its full power upon the buckets, which are preferably of the shape shown.

When lowered to its greatest extent, the gate is wide open. As it rises, the water is gradually cut off from the bottom, the flange k^2 always constituting the bottom of the chuteway. The attachment of the bolts or guide-rods F to the upper outwardly-inclined flange-sections permits the gate-bearings L to rise above the cover or crown-plate E without obstruction, which it could not otherwise do. The chutes rise with the gate-ring, sliding past the cover-flange *e′* and the fixed water-guides I, thus causing the water to impinge in the most effective manner upon the wheel so long as the gate is open to any degree, as will be readily understood.

Having thus fully described the construction, organization, and operation of my improved cylinder-gate turbine water-wheel, what I claim therein as new and as of my own invention is—

1. The combination, substantially as hereinbefore set forth, of the supporting-cylinder or draft-tube, its external flange, the crown-shaped cover, its upwardly-projecting outwardly-inclined sections, their external flanges, and the shouldered rods connecting the flanges of the draft-tube and cover-sections.

2. The combination, substantially as hereinbefore set forth, of the supporting-cylinder or draft-tube, its external flange, the crown-shaped cover, its upwardly-projecting outwardly-inclined sections, their upper flanges, the lower flange of the cover, the central tubular standard, the shouldered rods or bolts connecting the supporting-cylinder and cover, the bridge or cross, the shaft, its adjustable bearings in the tubular standard, and the bell-shaped hub of the wheel, the upper portion of which rotates inside of the downwardly-projecting edge of the lower cover-flange.

3. The combination, substantially as hereinbefore set forth, of the supporting-cylinder or draft-tube, its external flange, the cover, its upper flanges, the shouldered bolts or rods connecting the draft-tube and cover, respectively, the gate-cylinder inside the supporting-cylinder, its upper flange, the chutes mounted thereon, and the guide-bearings in the chutes sliding on the rods connecting the draft-tube and cover.

4. The combination, substantially as hereinbefore set forth, of the supporting-cylinder, its external flange, the cover, its upper external flanges, the rods connecting the flanges of the cylinder and cover, the vertically-moving cylinder-gate having its lower portion inclosed by the draft-tube, its chutes, and the guide-bearings of the gate sliding on the rods.

5. The combination, substantially as hereinbefore set forth, of the supporting-cylinder, its external flange, the cover, its upwardly-projecting outwardly-inclined flange-sections, the rods connecting the draft-tube and upper cover-flanges, the lower flange of the cover, the gate-cylinder sliding inside the supporting-cylinder, the gate-cylinder flange, the chutes secured thereon outside the lower flange of the cover, guide-bearings therefor traversing the rod, the hub sliding on the tubular standard, and the gate-arms connecting the hub and chutes, whereby the chutes work entirely outside of the cover.

6. The combination, substantially as hereinbefore set forth, of the supporting-cylinder

or draft-tube, its external flange, the crown-shaped cover, its external flanges, rods connecting these flanges, a packing-ring projecting inside the supporting-cylinder, the gate ring or cylinder working inside the packing-ring, its external flange, chutes mounted on this flange, and guide-bearings in the chutes traversing the rods connecting the supporting-cylinder and cover.

7. The combination, substantially as hereinbefore set forth, of the supporting-cylinder, its external flange, the gate-cylinder movable therein, the flanged ring-holding segments, and the self-adjusting packing-ring movable between the flange and segments and interposed between the cylinders to prevent leakage.

8. The combination, substantially as hereinbefore set forth, of the supporting-cylinder, its external flange, the cover, its upper flanges, the bolts connecting the cylinder and cover, the lower flange of the cover, the gate-cylinder moving within the supporting-cylinder, the packing-ring interposed between these cylinders, the chutes on the gate sliding past the lower flange of the cover, and the spider connecting the tubular standard and gate.

9. The combination, substantially as hereinbefore set forth, of the supporting-cylinder, its external flange, the cover, its upper flanges, the rods connecting the cylinder and cover, the lower flange of the cover, the water-guides fixed thereon, the cylinder-gate working inside the casing, its flange, the chutes mounted thereon, guide-bearings on the chutes sliding on the rods, and the spider connecting the chutes and tubular standard, the organization being such that the depth of the chute-openings diminishes as the gate rises by the sliding of the chutes outside the gate-cover and between the fixed guides.

10. The combination, substantially as hereinbefore set forth, of the supporting-cylinder, its external flange, the cover, its upper flanges, the rods connecting them, the lower flange of the cover, the gate-ring inside the supporting-cylinder, its external flange projecting over that of the supporting-cylinder, chutes or guides on the gate-flange, fixed water-guides on the lower cover-flange, between which guides the chutes traverse, guide sleeves or bearings on the chutes traversing the rods connecting the supporting-cylinder and cover, and the bell-shaped hub of the water-wheel, having the under and outer surface of its crown flush with the bottom of the lower cover-flange and fixed guides.

11. The combination, substantially as hereinbefore set forth, of the flanged supporting-cylinder, the flanged crown-shaped cover, the rod connecting their flanges, the cylinder-gate movable vertically in guide-bearings on the rods past the lower flange of the wheel-cover, the standard mounted on the wheel-cover, the hub sliding on the standard, arms connecting the hub and gate, a straight vertical rack mounted on the side of the hub, and a worm-gear on a vertical shaft turning in bearings on the cover and engaging with the rack to adjust and hold it in the desired position.

12. The combination, substantially as hereinbefore set forth, of the crown-shaped flange, wheel-cover, the flanged draft-tube, the rods connecting the flanges of the draft-tube and cover, the cylinder-gate, its guide-bearings on these rods, its chutes surrounding the cover, the tubular standard mounted on the cover, the hub surrounding the standard, arms connecting the hub and chutes, a rack carried by the hub, and a worm-gear engaging with the rack and carried by a shaft parallel with the standard and turning in bearings on the wheel-cover.

13. The combination, substantially as hereinbefore set forth, of the supporting-cylinder, its external flange, the crown-shaped cover, its external flanges, the rods connecting them, the lower flange on the cover, the gate ring or cylinder inside the draft-tube, its external horizontally-projecting flange, chutes thereon movable vertically outside the lower cover-flange, the central tubular standard of the cover, the spider connecting the chutes and standard, the rack on the hub of the spider, and a worm-gear mounted in bearings on the cover and engaging with the teeth of the rack to adjust and hold the gate in the position desired.

14. The combination, substantially as hereinbefore set forth, of the supporting-cylinder, the cover, the bolts connecting them, the cylinder-gate, its chutes, guide-bearings on the chutes sliding on the rods, and counterbalancing-springs connecting the cover and gate.

15. The combination, substantially as hereinbefore set forth, of the supporting-cylinder, the cover, their connecting-rods, the gate-cylinder, the chutes mounted thereon, the spider and rack connected with the chutes, and the spring connecting the cover and gate and counterbalancing its weight and that of the moving parts connected therewith.

16. The combination, substantially as hereinbefore set forth, of the supporting-cylinder, its external flange, the cover, its upper flange, the rods connecting the cover and supporting-cylinder, the gate-ring inside the latter, its externally-projecting flange, the chutes mounted thereon, and the counterbalancing-springs attached to the cover passing down inside the chutes and secured to the gate-ring flange.

17. The combination, substantially as hereinbefore set forth, of a supporting-cylinder or draft-tube, its external flanges, a cover, its external flanges, rods connecting the draft-tube and cover, a gate-ring, means for moving it vertically relatively thereto, chutes carried by the gate-ring, and an annular circumferential buoy or float connected directly with the gate-ring.

18. The combination, substantially as hereinbefore set forth, of a supporting-cylinder,

a cover, rods connecting them, a gate-ring movable vertically in guides on these rods, counterbalancing-springs connecting the gate-ring and cover, and a counterbalancing-buoy connected with the gate-ring.

19. The combination, substantially as hereinbefore set forth, of a supporting-cylinder or draft-tube, a cover, rods connecting them, a gate-ring movable vertically in the supporting-cylinder, its externally-projecting flange, chutes carried thereby and movable on the rods, and a counterbalancing-buoy secured to the gate-ring above the chutes so as to leave the water-way unobstructed.

20. The combination, substantially as hereinbefore set forth, of the flanged supporting-cylinder, the flanged cover, the rods connecting them, the tubular standard, the spindle passing therethrough, the wheel, the gate-ring inside the supporting-cylinder, its external flange, chutes carried thereby, guide-bearings on the chutes traversing the connecting-rods, a spider connecting the gate-ring and standard, a rack on the spider, worm-gearing on the cover actuating the rack, and counterbalancing mechanism connected with the gate-ring.

In testimony whereof I have hereunto subscribed my name.

NATHAN F. BURNHAM.

Witnesses:
W. T. NELSON,
J. E. BAKER.