(No Model.) 2 Sheets—Sheet 1.

W. C. EDWARDS.

WATER WHEEL.

No. 390,847. Patented Oct. 9, 1888.

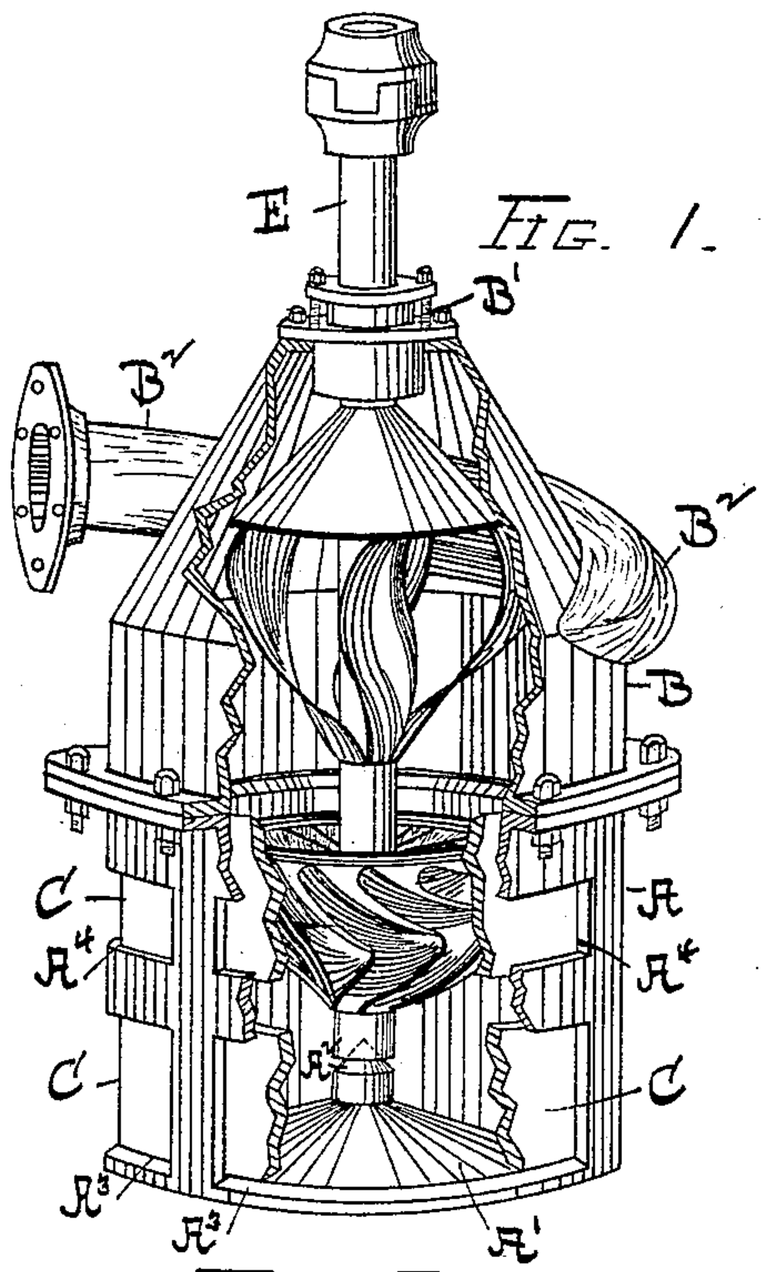

FIG. 1.

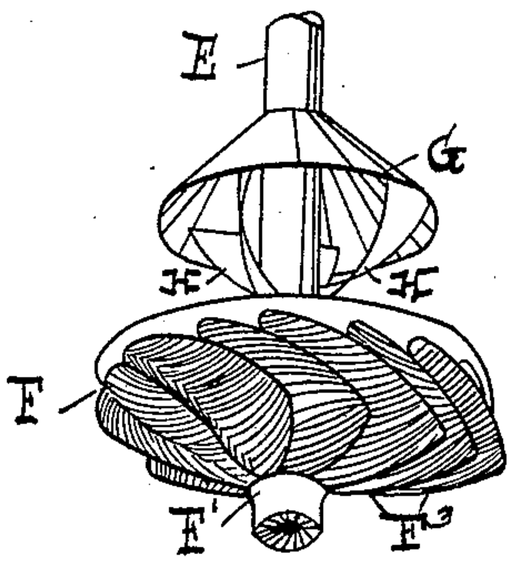

FIG. 2.

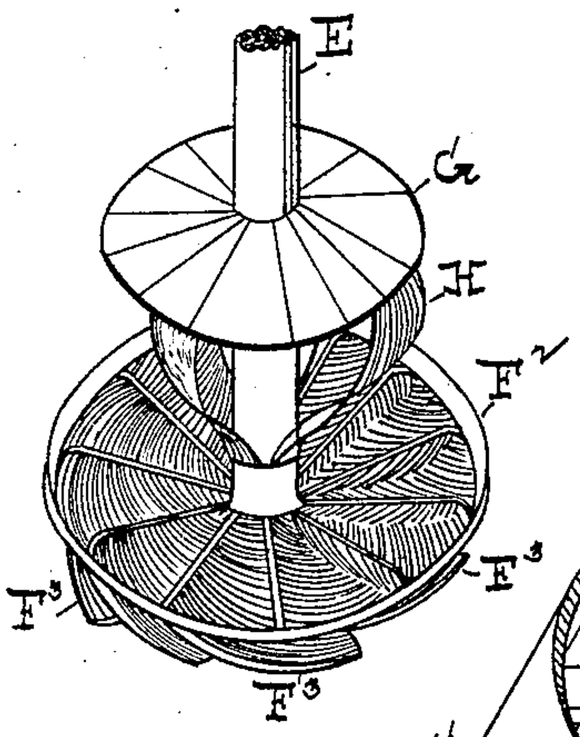

FIG. 3.

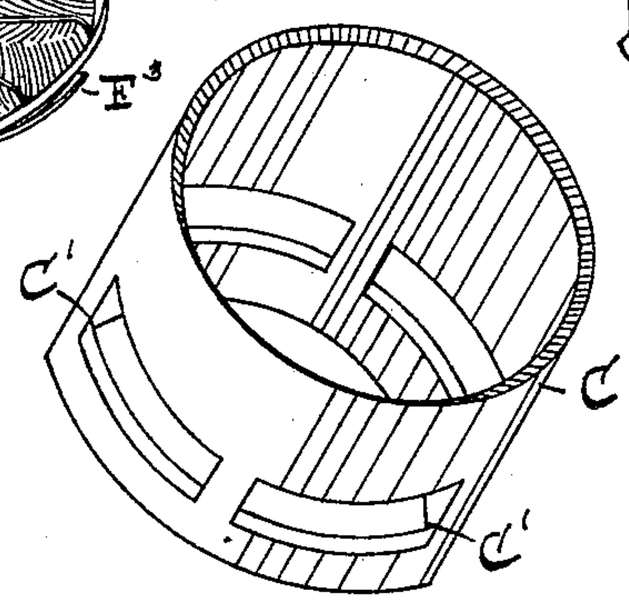

FIG. 4.

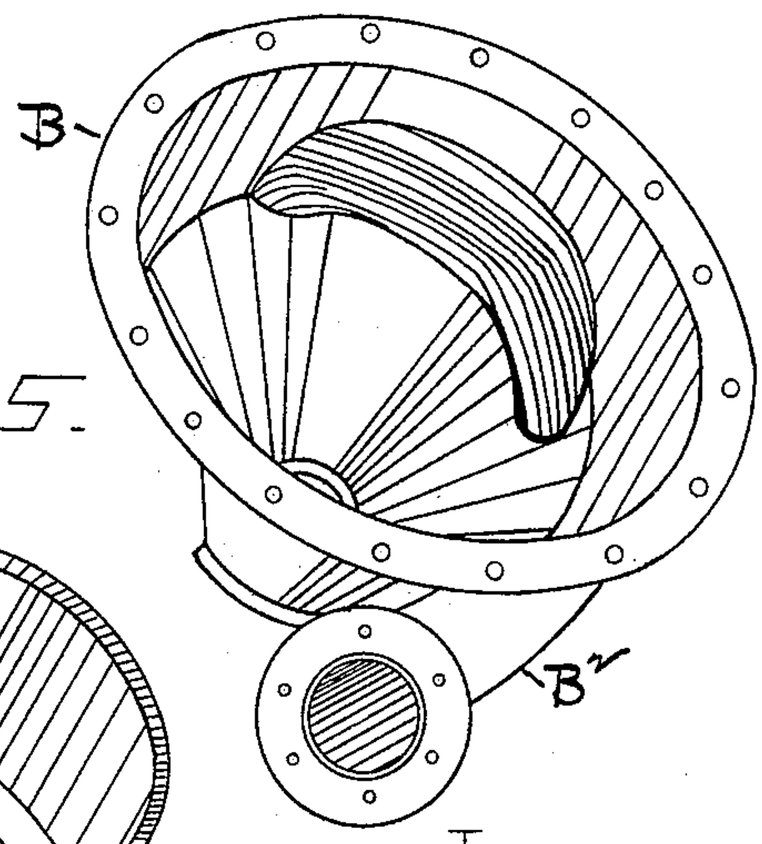

FIG. 5.

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 6.

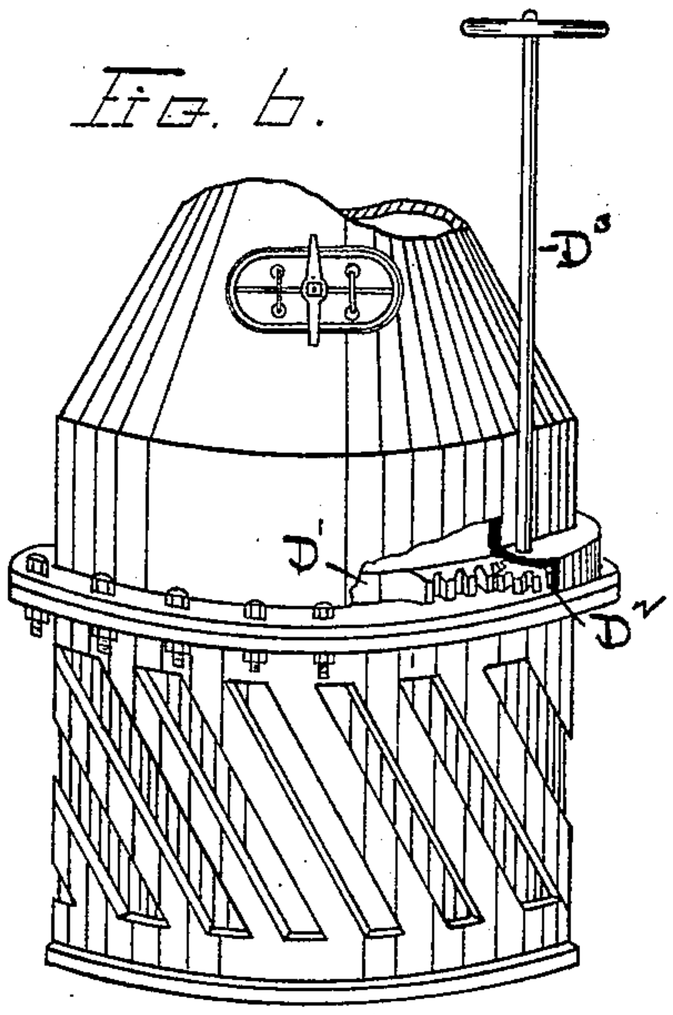


Fig. 7.

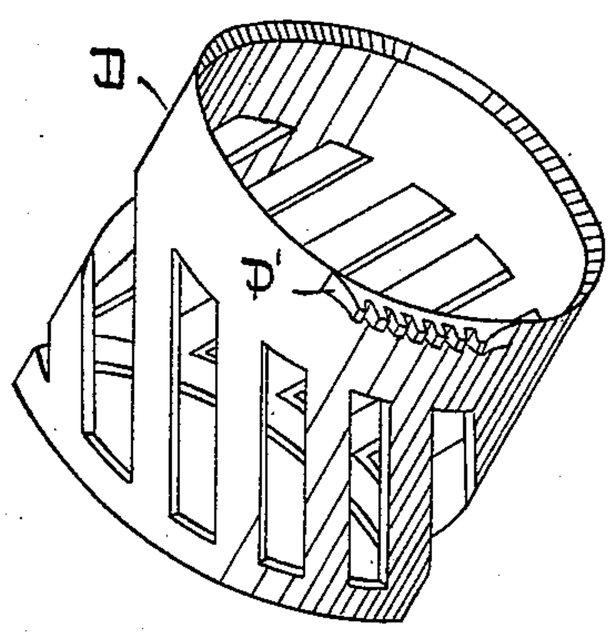


Fig. 8.

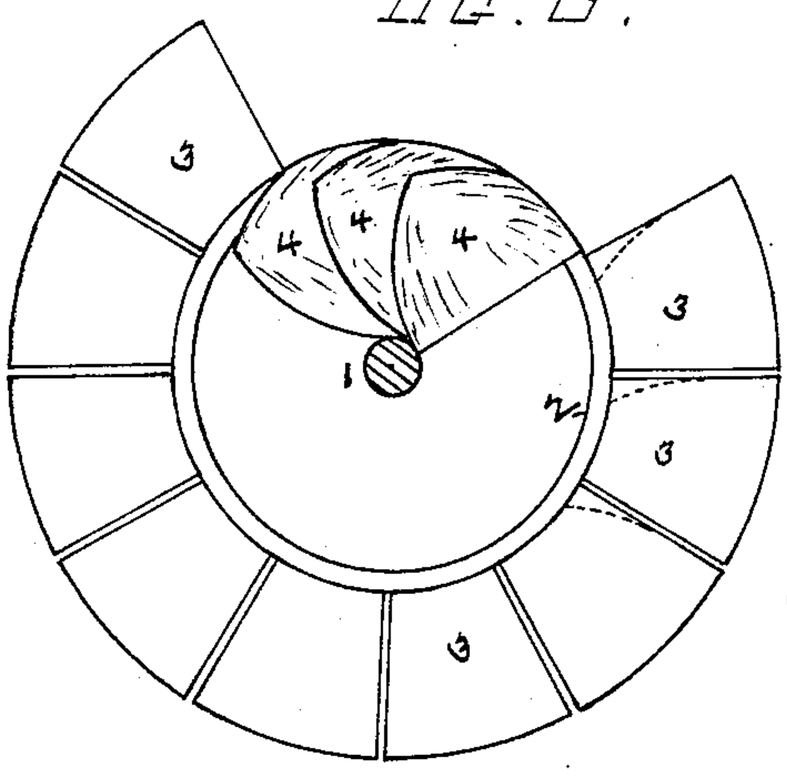
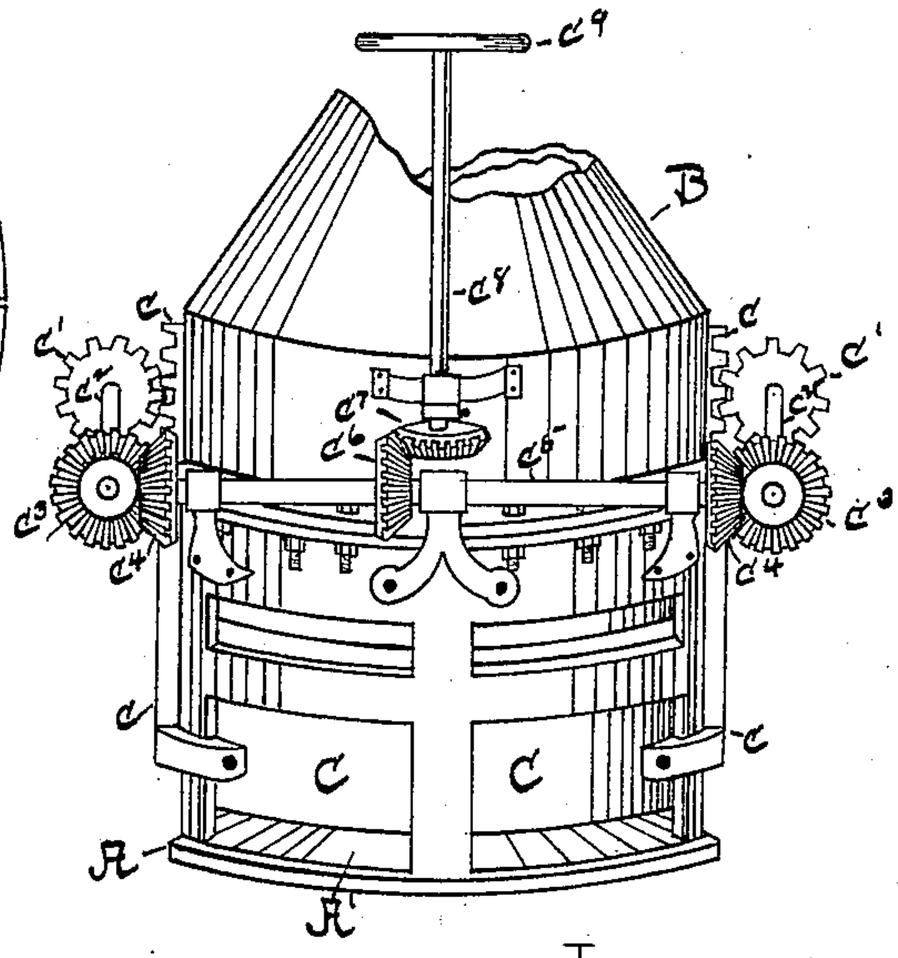


Fig. 9.



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UNITED STATES PATENT OFFICE.

WILLIAM C. EDWARDS, OF HOLYOKE, MASSACHUSETTS.

WATER-WHEEL.

SPECIFICATION forming part of Letters Patent No. 390,847, dated October 9, 1888.

Application filed September 19, 1887. Serial No. 250,000. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM C. EDWARDS, of Holyoke, in the county of Hampden and Commonwealth of Massachusetts, have invented a new and useful Improvement in Water-Wheels, of which the following is a specification, reference being had to the accompanying drawings, forming part thereof.

My invention relates to water-wheels of the turbine class, and has for its object to improve the construction of such wheels and their cooperating parts in such manner that their capacity for effective work is greatly increased, while their structure is much simplified.

To this end my invention consists in the water-wheel constructed as hereinafter fully described, and particularly pointed out in the claims.

Referring to the drawings, in which like letters designate like parts in the several figures, Figure 1 is a side view of the wheel-casing having a portion thereof broken out to show the parts within the same. Fig. 2 is a perspective view of the wheel, its shaft, and the auxiliary parts attached thereto, looking toward the lower or discharge side of the wheel. Fig. 3 is a similar view of the same parts, looking toward the upper or inlet side of the wheel. Fig. 4 is a view in perspective of the interior of the upper section of the casing. Fig. 5 is a similar view of the cylinder-gate removed from the casing. Fig. 6 is a side elevation of a modified form of my invention, in which a register-gate is employed instead of a cylinder-gate. Fig. 7 is a perspective view of the register-gate detached. Fig. 8 is a diagram illustrating the construction of the wheel. Fig. 9 is a front view showing means for operating the cylinder-gate.

The letter A designates the lower and B the upper section of the wheel-casing, which sections are provided with projecting flanges at their meeting edges, whereby they can be securely bolted together, as shown in Figs. 1 and 9. The lower section, A, is cylindrical in form, and is provided with the cone-shaped bottom or bridge-tree A′, having at its apex the wooden step A^2, upon which the wheel-shaft revolves. Said lower section is also provided with discharge-openings A^3 at the lower end thereof, and preferably with additional discharge-openings A^4, of less area, located above said openings A^3, for a purpose presently to be described. These discharge-openings are of such length and width that, while enough of the wall of the casing remains to secure the requisite strength and durability, a practically free discharge of the water in every direction in a substantially horizontal plane is afforded.

The upper section, B, of the casing is cylindrical for a short distance from its lower end and then tapers to its upper end, where it receives the stuffing-box B′ in which the wheel-shaft revolves. An inlet-pipe, B^2, which is preferably made integral with said upper section, curves spirally around one side of the conical portion thereof and enters the same at the junction of its conical and cylindrical portions, as shown in Figs. 1 and 4, whereby a stream of water entering the casing through said pipe is given a revolving motion around the interior of the casing. The upper section will also preferably be provided with a manhole, as shown in Fig. 6, to give access to the interior of the casing whenever necessary or desirable.

In the preferred form of my invention the casing will be provided with a cylinder-gate, C, the outer diameter of which is slightly less than the inner diameter of the lower section of the casing, so that while the gate closely fits in said section it is capable of easy vertical movement therein. This gate C, which is shown detached in Fig. 5, has the upper inner edge of its cylindrical wall beveled, as shown, and is preferably provided with openings C′ corresponding in size to the openings A^4 in the casing. The gate may be raised and lowered by any of the mechanisms usually employed for such purpose, one example of which is shown in Fig. 9, wherein the letters *c c* designate two rack-bars having their lower ends formed into brackets which project through the openings A^3 in the casing and are bolted to opposite sides of the gate, as shown. Pinions *c′* at the ends of shafts c^2 mesh with the teeth of said rack-bars, which pinions receive motion through bevel-gears c^3, at the opposite ends of said shafts c^2, which mesh with bevel-gears c^4 at each end of a transverse shaft, c^5, having an intermediate bevel-gear, c^6, which meshes with a bevel-gear, c^7, at the end of a vertical shaft, c^8, which has at its upper end a hand-wheel, c^9, or other device, whereby it

can be manually operated. It will be understood without further description that revolution of shaft c^3 in one direction will raise the gate C and that revolution of said shaft in the opposite direction will lower said gate.

In Figs. 6 and 7 I have shown the casing as being provided with a register gate, D, instead of the cylinder gate just described. In such case both the casing and gate will have corresponding discharge-openings, which will preferably be arranged at an angle, as shown, to facilitate the free discharge of water from the wheel. I have shown as the means for revolving the gate D to cause its openings to register with those in the casing, and vice versa, a rack-bar, D′, secured to the gate at its upper end, and a pinion, D^2, meshing with the teeth of said rack-bar, said pinion being secured to the lower end of a shaft, D^3, having a hand-wheel at its upper end, whereby it may be manually operated, but other well-known means for revolving said gate may be employed, if desired. With either form of gate shown the same result is obtained—viz., a practically unobstructed discharge-passage around the bottom of the casing, below the wheel, which passage can be increased or diminished in size at will by movement of the gate.

The letter E designates the wheel-shaft, which has a conical bearing at its lower end to receive the step A^2, and, passing through the stuffing-box B′, as shown, may be provided above the casing with any of the usual appliances by which power can be transmitted therefrom to the milling or other machinery operated by it.

The wheel proper, which is designated by the letter F, is keyed to the shaft E at such point that, when placed within the casing, said wheel will lie slightly below the line of connection between the upper and lower sections thereof, as shown.

The wheel is composed of a hub, F′, rim F^2, and a series of buckets arranged between the hub and rim in such manner as to render the wheel concave upon its upper or inlet side and convex upon its lower or outlet side. Each of the buckets is composed of a single plate of metal, F^3, of a substantially triangular shape, the top of which extends in a slight upward curve from the hub to the rim, and the sides of which taper gradually to a point, each of said plates being also curved downwardly and rearwardly, with respect to the movement of the wheel upon its axis, beneath the succeeding bucket, as shown in Figs. 1, 2, and 3. In order to more clearly illustrate the shape and arrangement of the buckets, I have shown in Fig. 8 a diagram, which represents the lower or convex side of the wheel, the numeral 1 designating the hub; 2, the rim; 3, 3 3, the flat plates secured to the rim from which buckets are to be formed, and 4 4 4 said plates after being joined to the hub and curved transversely and longitudinally to form buckets. Each bucket is entirely open beneath the rim of the wheel, thus permitting the water to discharge therefrom radially as well as tangentially with respect to the wheel.

Secured to shaft E above wheel F is an auxiliary wheel and weight-equalizer consisting of a conical hood surrounding the shaft above the plane of the discharging end of inlet-pipe B^2, and wings H—preferably four in number—extending spirally from the base of said hood to the shaft at a point below the plane of the discharging end of inlet pipe B^2 and above wheel F.

The said hood and wings can be secured directly to the shaft or to a sleeve surrounding the shaft, as may be preferred.

The wings H consist of thin strips of metal, the sides of which taper gradually from the center toward each end, and they are so disposed that as the shaft E revolves the central portion of the inner face of each wing is presented successively at substantially a right angle to a stream of water entering the casing through inlet-pipe B^2.

Before proceeding to describe the operation of the wheel I desire to call particular attention to some of the features of the construction thus described. In the first place, it will be observed that the gate, instead of governing the admission of water to the casing and wheel, as is customary with turbine wheels, governs the discharge of the water from the casing and wheel, whereby the use of a flume other than the inlet-pipe B^2 is avoided and the cost of setting the wheel much decreased. Such location of the gate with respect to the wheel, moreover, causes the weight of the water upon the wheel to be the same whether the gate be at one-quarter, one-half, or full gate, and consequently the percentage of loss of power at less than full gate is very slight. Again, it will be noted by reference to Figs. 1 and 4 that the inlet stream of water in passing through pipe B^2 and around the inner side of conical section B of the casing is given an initial revolving movement in the direction of the forward movement of the wheel F before it reaches said wheel, whereby a greatly-increased impulse is imparted to the wheel; and in the same connection it will be noted that, the upper edge of the gate being beveled upon its inner side, there are no angular surfaces to obstruct in any degree the free passage of the water to and through the wheel.

With regard to the wheel itself, it will be observed that it receives the water upon its upper concave side and discharges it from its lower convex side and also centrifugally beneath the rim, and that the buckets are so shaped that the water in passing through the wheel exerts its full force upon each bucket to drive the wheel forward, so that, even with a partial gate, a very high percentage of power is obtainable.

The action of hood G and wings H is also important to be noted, the former receiving the inflowing stream of water against its lower side as said stream is directed toward the top of the casing by the converging wall of the up-

per section and deflecting the same toward the wheel F, while the upward pressure exerted by the water against said hood equalizes the weight of the shaft and its attached parts in such manner as to very materially reduce the wear of step A^2, and said wings H, by receiving the direct impulse of the inflowing stream against their widened central portion, serve as an auxiliary wheel and greatly augment the effective capacity of wheel F, while at the same time they do not obstruct or retard the passage of the water to the latter.

The operation of the wheel is as follows: The casing being set in such manner that the lower section, A, thereof is submerged in the water in the wheel-pit, the flange by which it is joined to the upper section being substantially on a level with the water in the tail-race, the inlet-pipe B^2 being connected by pipes or otherwise with the head-race, and the gate C being closed, the water from the head-race will enter the casing and fill it, the wheel F and shaft E remaining stationary. If now the gate be raised to the position shown in Fig. 9, or about one quarter gate, the water is permitted to discharge through the openings A^3 into the wheel-pit, and the wheel F, shaft E, hood G, and wings H at once begin to revolve. The conformation of the bottom or bridge-tree A′ greatly facilitates the direct discharge of the water from the wheel through the openings A^3; but to still further facilitate such discharge I prefer to employ the additional openings A^4, as hereinbefore described, which permit the water centrifugally expelled from the wheel to leave the casing in a direct line, when a partial gate only is used, as the openings C′ in the gate are then coincident with said openings A^4. By raising the gate still farther to one-half or full gate a correspondingly greater quantity of water is permitted to discharge from the casing in a given time, and a proportionate increase in the velocity and power of the wheel is gained. The water from the time it enters the casing through pipe B^2 until it contacts with the wheel F has a revolving movement in the direction of the forward movement of said wheel, as previously stated, and has no sharp angles to turn to diminish its force. By lowering the gate again the discharge is stopped and the wheel ceases to revolve, while the casing remains full of water ready to start the wheel again instantly upon the raising of the gate. Access to the interior of the casing is afforded by the man-hole shown in Fig. 6 for the purpose of removing any obstructions which may have entered through the inlet-pipe. The step A^2, being submerged in water as well when the wheel is idle as when it is in operation, will be preserved in such manner that its renewal will be required only at long intervals; but such renewal can readily be made without disturbing the lower section of the casing or the wheel-pit by closing the gate, removing the upper section, B, withdrawing shaft E and the wheel from the lower section, and removing the water contained therein, whereby direct access to said step is afforded.

It will be observed that by locating the wheel below the level of the water in the tail-race I secure the effect of the full head of the water upon the wheel, and thus effect a material gain in power over wheels which receive the water at the side from a flume and which are necessarily located above the level of the water in the tail-race.

The wheel will operate with the casing and shaft arranged horizontally equally as well as in the position shown, the only change necessary to be made in such case being the addition of a draft-tube to conduct the water discharged to the wheel-pit, which can readily be done by any one familiar with the construction and operation of water-wheels.

In addition to the advantages hereinbefore enumerated, it should be added that the wheel herein described is simple in construction and can be manufactured at a comparatively slight cost.

I do not wish to limit myself to the exact details of construction shown and described, as it is obvious that various modifications therein can be made without departing from the spirit of my invention.

Having thus fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The combination, with the turbine water-wheel herein described, having both a radial and downward discharge, of a cylindrical casing wholly inclosing said wheel, said casing having a conical bottom provided at its apex with a step to receive the end of the wheel-shaft, and having at its lower end a series of circumferential discharge-openings, of a tangential inlet-pipe entering said casing at or near its upper end, and a cylindrical gate located within said casing adjacent to said discharge-openings, arranged and operating substantially as and for the purpose set forth.

2. The combination, with the water-wheel herein described, having a radial and also a downward discharge, of a cylindrical casing inclosing said wheel, said casing having a series of circumferential discharge-openings at the bottom thereof, and having an additional series of circumferential discharge-openings located in the plane of the radial discharge from the wheel, an inlet-pipe entering said casing above the wheel, and a cylindrical gate located within said casing at the bottom thereof, said gate having a series of circumferential openings so located that when the gate rests upon the bottom of the casing said openings will lie immediately beneath the upper series of discharge-openings in the casing, whereby an upward movement of the gate will open both series of openings in the casing simultaneously, substantially as and for the purpose set forth.

3. The combination, with the casing having the cylindrical body and conical top, as shown,

and having the discharge-openings A^3, of inlet-pipe B^2, curved, as shown, and entering said casing at the junction of its cylindrical and conical portions, shaft E, centrally disposed within said casing, wheel F, mounted upon said shaft adjacent to said discharge-openings A^3, conical hood G, mounted upon said shaft above the plane of the junction of the conical and cylindrical portions of the casing, and spirally-disposed wings H, secured at one end to said hood and at their opposite ends to the shaft at a point below the plane of the discharging end of pipe B^2, arranged and operating substantially as and for the purpose described.

4. The combination, with the casing composed of section A, having a conical bottom, and section B, having a conical top, said section A having the circumferential discharge-openings A^3 A^4, located in different horizontal planes, as shown, of inlet-pipe B^2, curved, as shown, entering section B, and cylindrical gate C, located within section A, said gate being beveled upon its inner edges, as shown, and having circumferential openings C′ therein, which lie immediately beneath the openings A^4 when said gate rests upon the bottom of the casing, substantially as and for the purpose described.

5. The combination, with the casing A B, having discharge-openings at its lower end and a gate for closing said openings, of an inlet-pipe entering said casing at a tangent at or near the upper end thereof, a centrally-disposed shaft mounted in bearings at the top and bottom of said casing, wheel F, mounted upon said shaft near its lower end, said wheel having buckets F^3, arranged as shown, whereby it is adapted to be revolved in a horizontal plane by water passing from the top to the bottom of casing A B, and an auxiliary wheel having vertically-disposed buckets mounted upon said shaft above wheel F and adjacent to the point where the inlet-pipe enters the casing, whereby said auxiliary wheel is adapted to be operated by the direct impulse of the stream of water entering the casing, substantially as set forth.

6. The combination, with a water-wheel constructed to discharge the water therefrom outwardly and downwardly, of a cylindrical casing wholly inclosing said wheel, said casing having a conical bottom and circumferential discharge-openings at its lower end, an inlet-pipe leading into said casing above the wheel, and a cylindrical gate located within said casing adjacent to said discharge-openings, said gate having its lower end beveled to correspond with the inclination of the bottom of the casing, whereby a direct passage for the water discharged from the wheel is afforded and a tight joint between the gate and the bottom of the casing, when the former is closed, is secured, substantially as described.

7. The wheel F, composed of hub F′, rim F^2, and buckets F^3, each of said buckets consisting of a single plate of metal or other suitable material substantially triangular in shape, one side of which curves outwardly and upwardly from the hub to the rim and the remaining two sides of which curve downwardly and rearwardly beneath the succeeding bucket, whereby a free discharge of water from said buckets both radially and downwardly is afforded, substantially as set forth.

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