(No Model.) 4 Sheets—Sheet 1.

J. W. & F. M. BOOKWALTER.

WATER WHEEL.

No. 488,056. Patented Dec. 13, 1892.

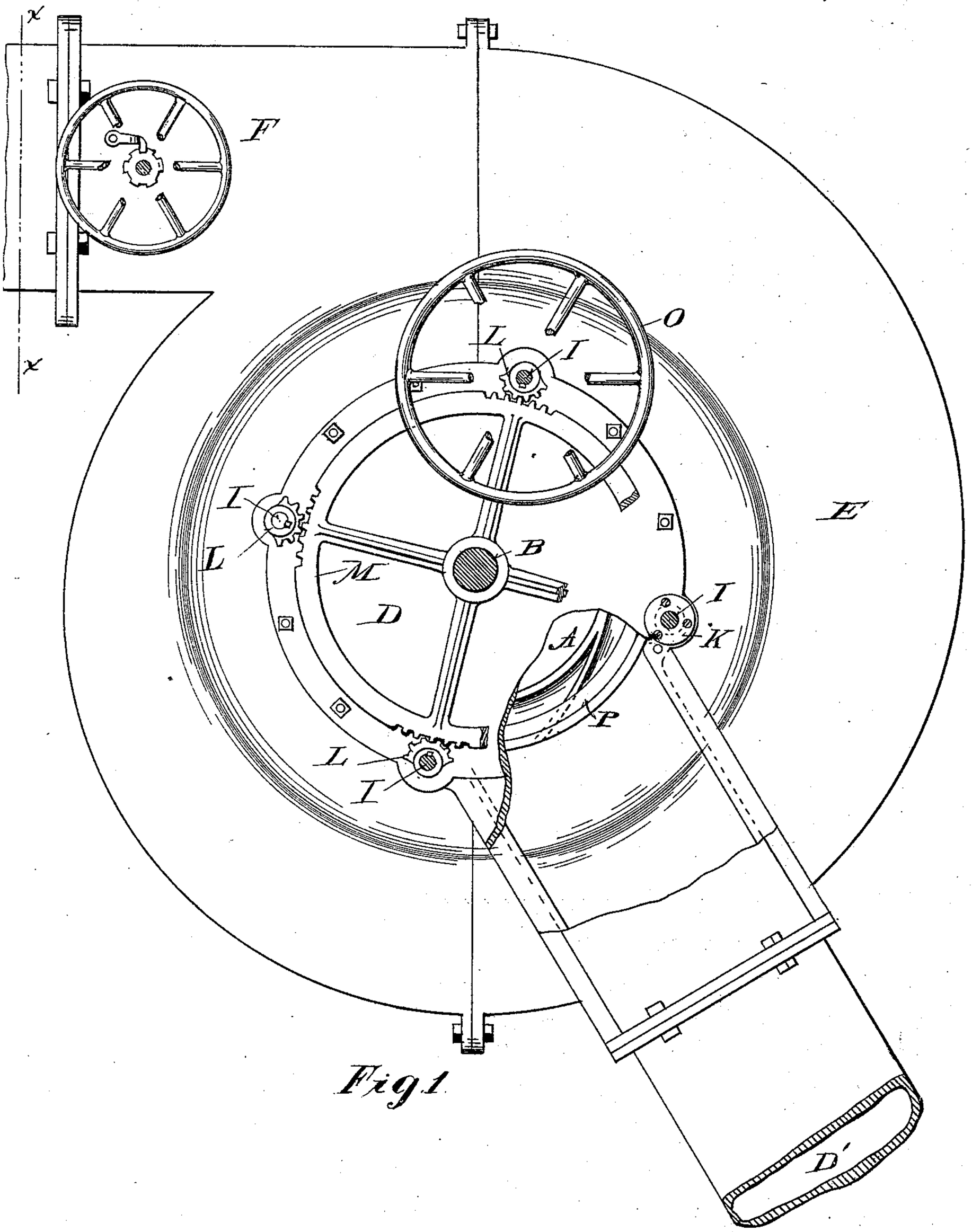

Fig 1.

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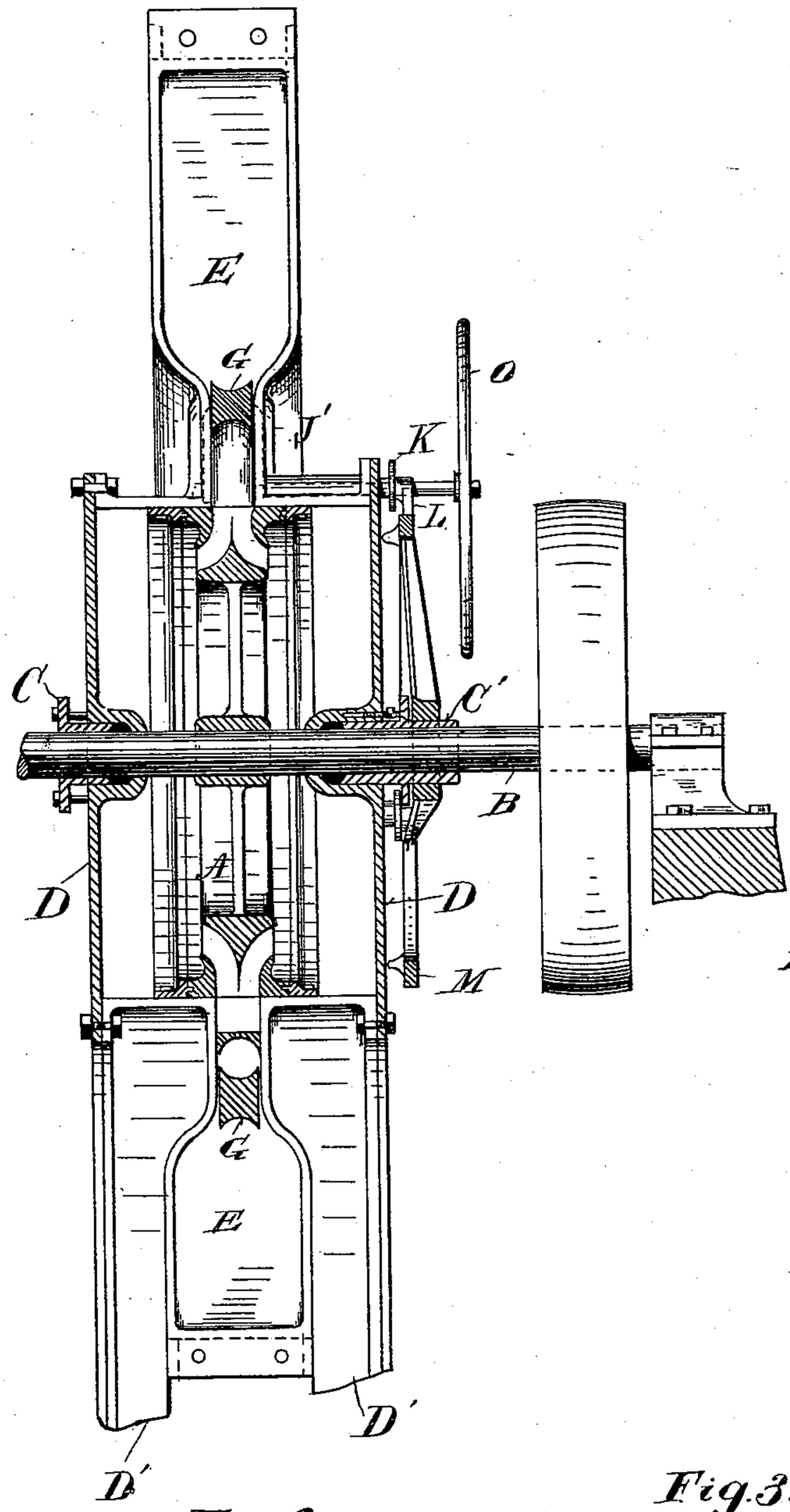

Fig. 2.

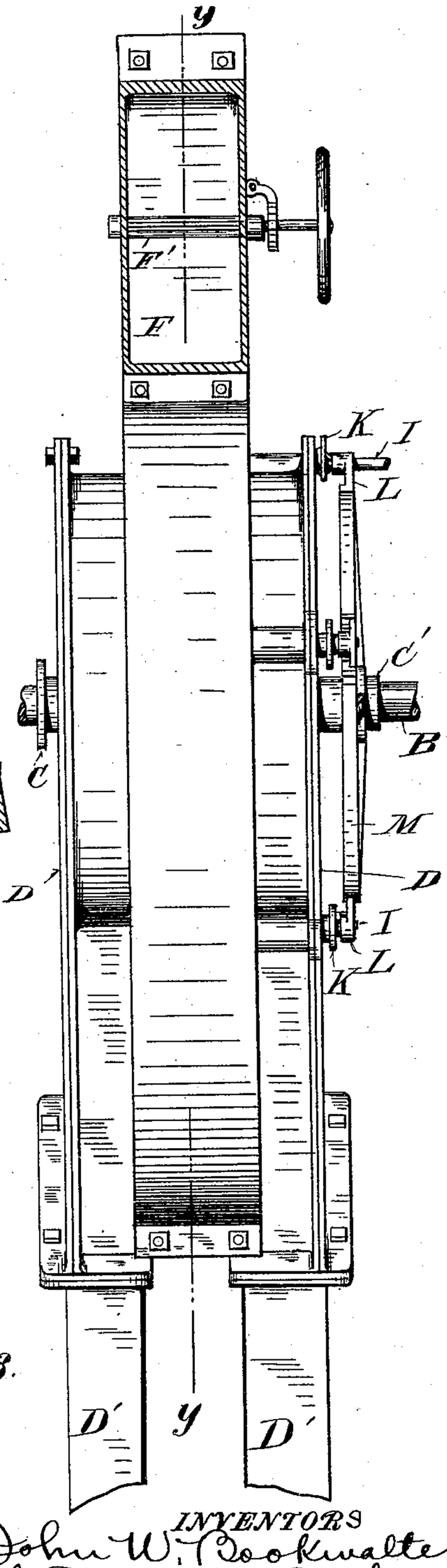

Fig. 3.

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J. W. & F. M. BOOKWALTER.

WATER WHEEL.

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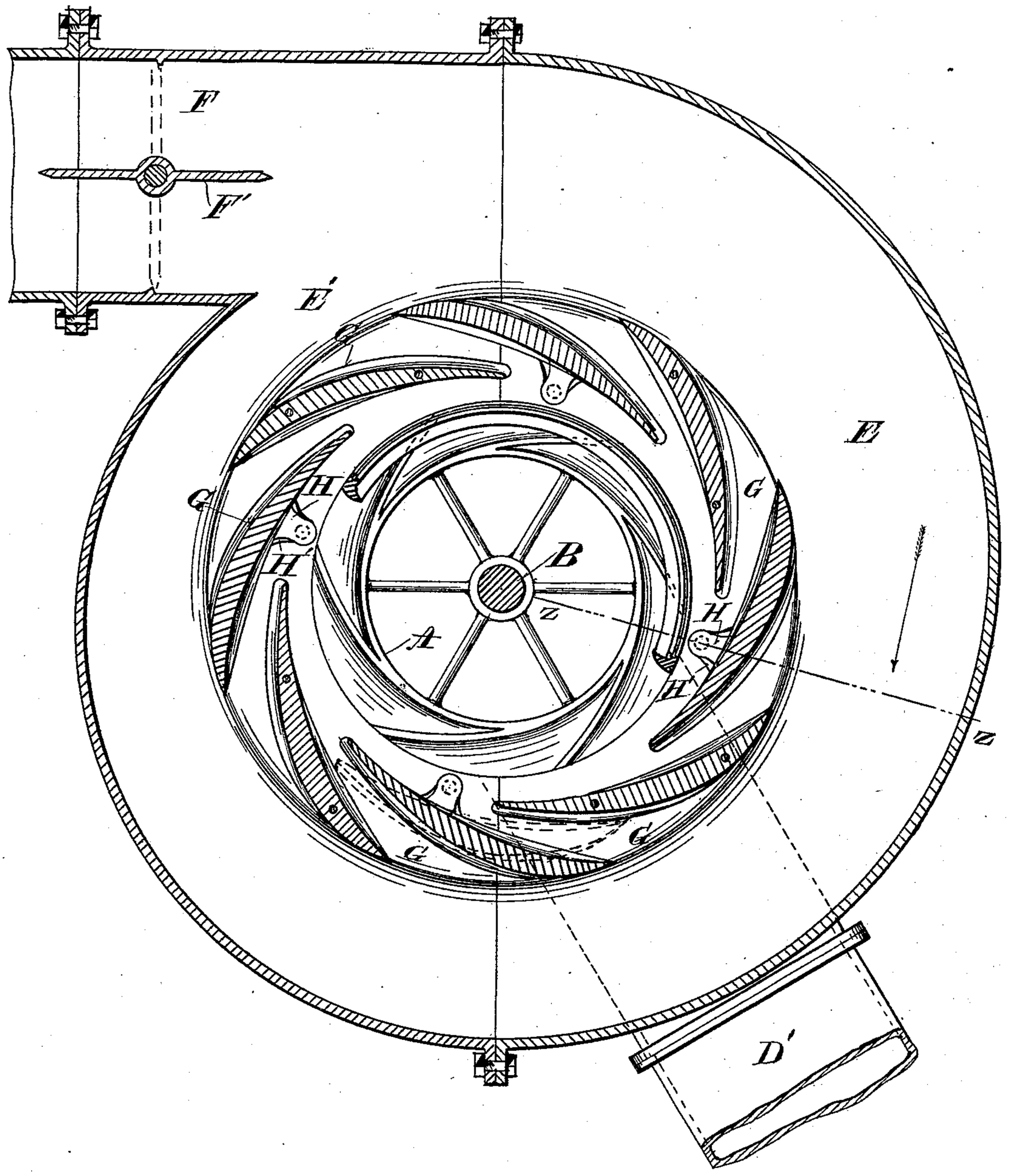

Fig. 4.

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J. W. & F. M. BOOKWALTER.

WATER WHEEL.

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Fig. 5.

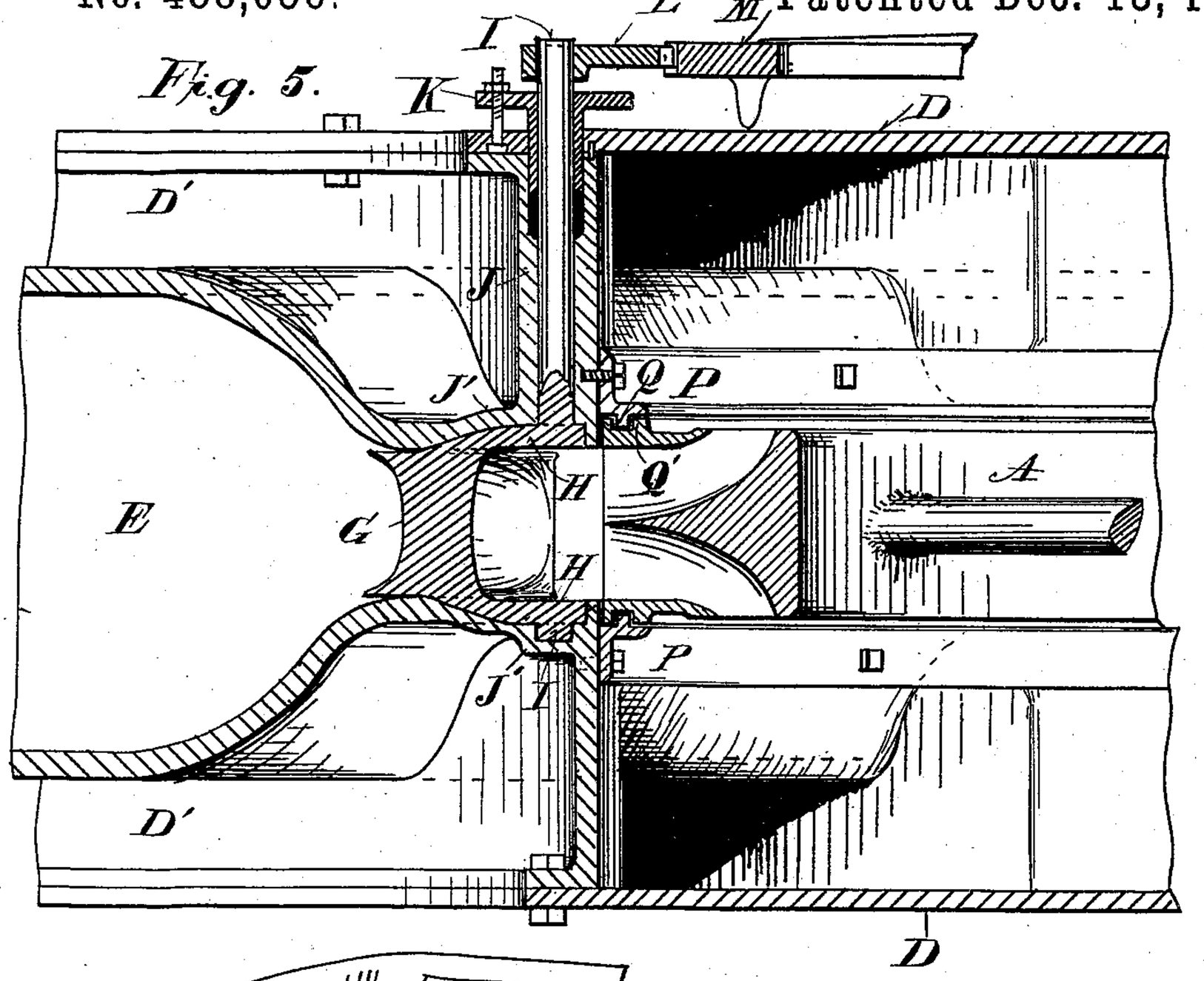


Fig. 6.

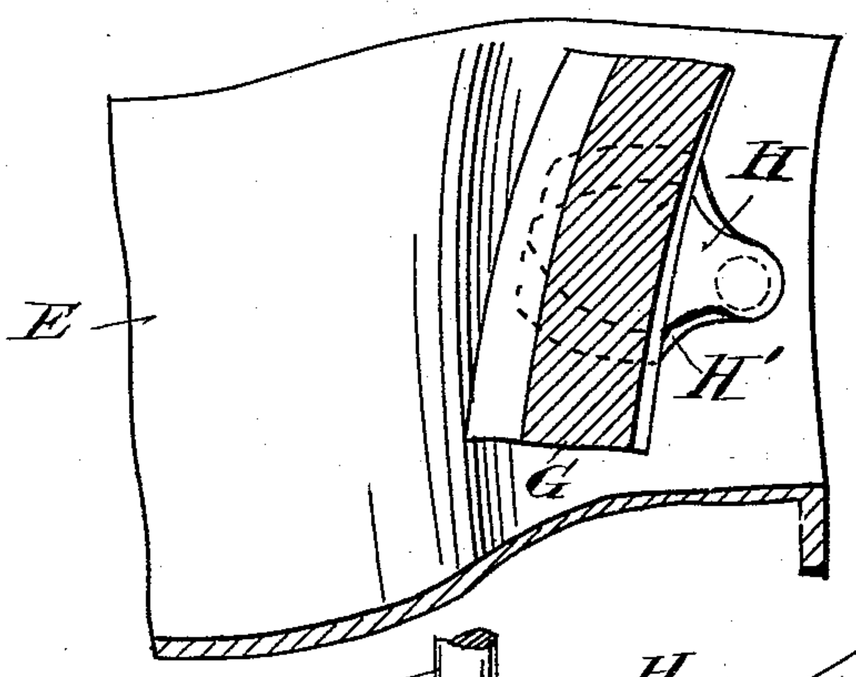


Fig. 7.

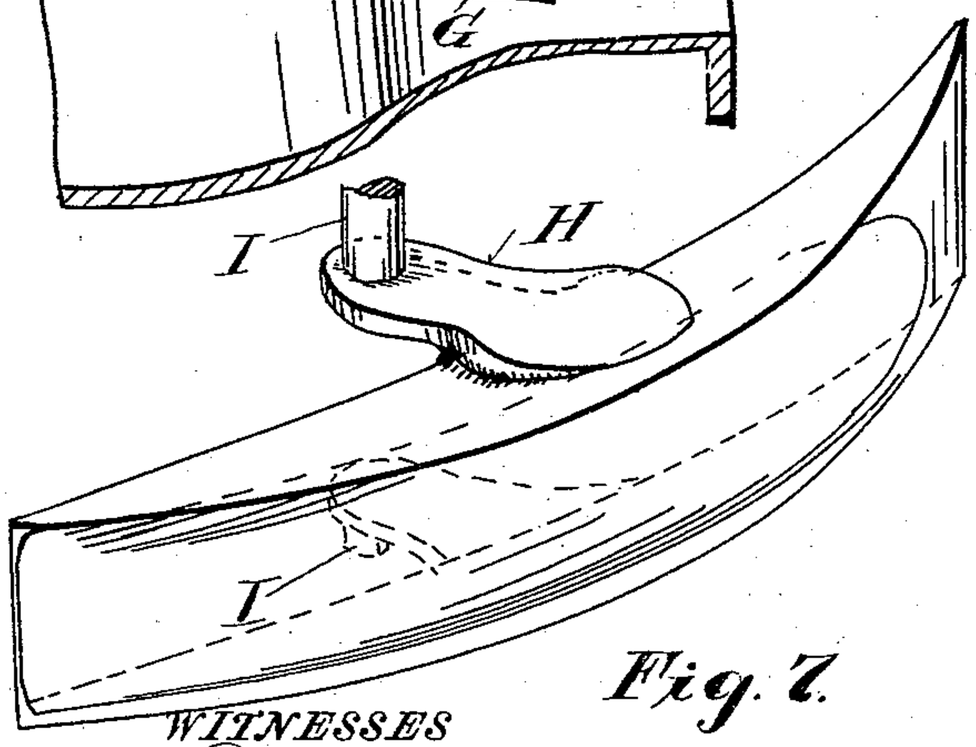
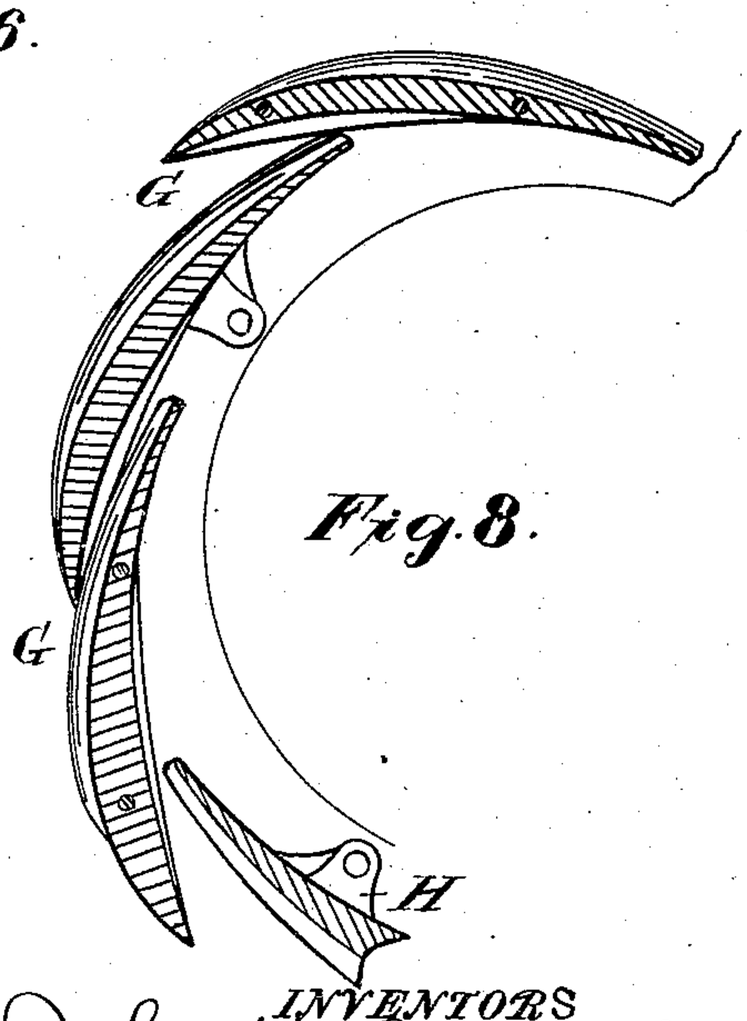


Fig. 8.



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UNITED STATES PATENT OFFICE.

JOHN W. BOOKWALTER AND FRANCIS M. BOOKWALTER, OF SPRINGFIELD, OHIO.

WATER-WHEEL.

SPECIFICATION forming part of Letters Patent No. 488,056, dated December 13, 1892.

Application filed April 29, 1892. Serial No. 431,136. (No model.)

To all whom it may concern:

Be it known that we, JOHN W. BOOKWALTER and FRANCIS M. BOOKWALTER, citizens of the United States, residing at Springfield, in the county of Clark and State of Ohio, have invented certain new and useful Improvements in Water-Wheels, of which the following is a specification, reference being had therein to the accompanying drawings.

Our invention relates to certain new and useful improvements in water-wheels.

Our improvements have reference to a peculiar form of gate whereby a substantially-circular form of cross-section is provided for the delivery of the water to the wheel from each gate-opening; have reference to varying the size of said gate-openings to regulate the amount of water by mounting a number of the gates upon trunnions; have reference to providing said gates with arms extending toward the wheel and recessing said arms within the side plates to avoid obstruction of the water; have reference to trunnions for said oscillating gates, the trunnions extending out through the side plate and each provided with a stuffing-box bearing, and have reference to other points hereinafter described, and pointed out in the claims.

In the accompanying drawings, on which like reference-letters indicate corresponding parts, Figure 1 represents a side view of the casing and gate mechanism, a portion of the draft-tube being broken away to show the interior; Fig. 2, a transverse section of the wheel proper and draft-tubes, the section being taken at the joint of the casing in Fig. 1 and a driving-pulley shown on the wheel-shaft; Fig. 3, an edge view of the casing, the supply-pipe being shown in section on the line *x x*, Fig. 1; Fig. 4, a central sectional view through the casing and gates on the line *y y* of Fig. 3, the wheel being shown in side view; Fig. 5, an enlarged sectional view of a portion of the wheel and adjacent gate and outer annular chamber, the upper ends of the draft-tube being shown and the section being taken on the line *z z*, Fig. 4, looking in the direction of the arrow; Fig. 6, a partial sectional view of an oscillating gate and adjacent guide-plate, showing the recessed trunnion-arm; Fig. 7, an enlarged detailed perspective view of an oscillating gate; Fig. 8, a plan view of a number of gates partially closed, the gates being shown in section.

The letter A designates a water-wheel proper of any convenient form, but preferably of the lateral-discharge type, in which the buckets are mounted on each side of the central cutting-edge and discharge laterally. A shaft B supports said wheel proper in the usual manner and is mounted in bearings formed by glands C C′ of stuffing-boxes in the sides D D of the upper ends of the draft-tubes D′, through which the water is discharged after passing through the buckets. Surrounding the wheel proper is an annular chamber E of gradually-decreasing area of cross-section as it proceeds from the entrance pipe or penstock F around the wheel proper, as shown in Fig. 4. The sides of this chamber are enlarged at its periphery and contracted sidewise to approximately the width of the wheel proper, as shown in Figs. 2 and 5, in order to form a contracted vein of water in the direction of the width of gates and in order to form guide-plates, between which are mounted a series of gates G G′, part being stationary and part oscillating respectively, or all may be oscillating. These gates are adapted to take their supply from the outer annular stream of water and deliver it with substantially uniform and high velocity to the buckets of the wheel proper. The supply-pipe F delivers the water tangentially to the annular convolute chamber with a certain predetermined velocity, according to circumstances, which velocity is maintained with comparative uniformity as the current proceeds around the supply-chamber, the regularly-contracting sides of which decrease the cross-sectional area of the chamber. By thus decreasing the cross-section of the spiral according to the amount of water taken from the chamber as the stream passes the gates and supplies the same the remaining water passing on beyond the gates near the end of the spiral is maintained at substantially the same velocity as it enters the spiral and reenters the larger body of water or larger portion of the chamber, instead of losing such initial velocity by continuing in a chamber of uniform size, while the stream itself is constantly diminished in volume. In the ordi-

nary style of supply-chamber, in which the cross-section is substantially-uniform at all portions of the circumference, the water entering the chamber will lose its velocity as it proceeds around the gates, since the successive portion of the stream remaining as it supplies the gates is not sufficient to fill the said chamber at the velocity at which it entered. This results in an unequal pressure and a lessened effect on the wheel. By our device this pressure is maintained, so that all parts of the wheel are supplied with water at substantially the same velocity, always in the direction the wheel is operating, the high velocity against the buckets necessary to operate the wheel being produced uniformly in passing through the gate or guide openings, which are supplied with water to their fullest capacity. This high velocity at the outer points of the buckets is not obtained in the ordinary scroll-casing, which closes completely at its smallest end against the wheel, and in which the buckets take their water directly from the scroll without the intermediate gates or guides, any overplus of water remaining at the end of the spiral in our casing being merged in the entering-stream at substantially the same velocity as it passes the point E′, Fig. 4.

The shape of the buckets of the wheel is such as to engage tangentially with a supply of water, which in passing between the tapering gate or guide-openings increases its velocity and is delivered by the gates or guides to an inner annular current of water of extremely high velocity between the inner ends of the gates or guides and the buckets of the wheel proper. From this inner circular stream the buckets are supplied uniformly with water at a high velocity and discharge into draft-tubes D′. The sum of the area of the bucket-openings is approximately the sum of the area of the gate-openings. The gates themselves are of peculiar form, their sides being concave in cross-section, whereby the stream of water passing between them is substantially round, as shown in Fig. 2, effecting a better form of delivery to the buckets of the wheel proper. The supply of water to the wheel is regulated by these oscillating gates, while the entrance of water to the casing is shut off by a closing-gate F′, Fig. 4, of any convenient style, mounted in the penstock F or elsewhere.

Each oscillating gate is provided with inwardly-extending arms H, operating in recesses H′ of the guide-plates, whereby the passage of the water is unobstructed, while the point of oscillation of said gates is carried inward as far as possible. The effect of thus mounting the oscillating gate is to give a more gradual closure and opening between the stationary and movable gates, the inner end of each oscillating gate being carried to the position shown by dotted lines, Fig. 4. It also effects a better balance of pressure on each end of gate in opening and closing. This gate-mounting is shown in Figs. 4, 5, and 6. In the inner end of each arm is a trunnion I I′, the one mounted in a boss or socket J′ of the adjacent guide-plate and the other having a similar boss and passing up through a stuffing-box J, provided with a gland K, whereby a bearing is formed and the exit of water prevented. On the upper end of trunnion I is mounted a gear-segment L, connecting with the master-gear or gate-ring M, Fig. 1, surrounding the shaft B. The gate-ring is operated by a hand-wheel O, mounted on the extended trunnion-shaft of one of the gates, as shown in Fig. 2, or is otherwise operated, whereby the gates are regulated.

In order to form the water-joint between the periphery and the wheel proper and the case, we provide a ring P, bolted or otherwise secured to the case and having a regular annular tongue or projection Q adjacent to the wheel proper, and adapted to fit in a corresponding groove in the latter and constituting a series of angles, whereby the water in seeking exit between the periphery of the wheel proper will be retarded and obstructed by said angles, the distance between the rim of the wheel proper and the ring being preferably only sufficient to provide the proper working clearance between the parts. This tongue Q and matching groove Q′ on the ring and wheel proper, respectively, may be reversed in their location and the angles be formed of other than right angles, if desired. The angles check the flow of water by presenting an opposing wall to the thin stream of leakage, and a series of such checks being provided the leakage is reduced to a minimum. In the form shown in Fig. 5 there are five such opposing walls, constituting five successive checks to the leaking water. The water is thus directed into the buckets of the wheel, and the influence of the draft-tubes is exerted wholly thereon without appreciable leakage between the case and the rim of the wheel proper. We do not claim, broadly, in this application the inwardly-drawn sides of said case and the outwardly-flared portion beyond the gates, since such are broadly claimed in Patent No. 445,844, dated February 3, 1891.

It will be further observed that by the convolute form of our casing and by the flared form of the convolute, as shown in Fig. 5, the diameter of the casing may be made less and so will occupy less space. It will also be noted that by reason of the convolute form and of the tail discharging into the entrance or first portion the movement of the water is maintained always in the direction of the rotation of the wheel and all reacting and opposing currents prevented.

Referring again to the gates or guides, we would state that when they are stationary they act as guides for the water, and that therefore we claim them irrespective of their movability.

We do not lay broad claim in this application to the inwardly-drawn side plates of the

casing without the recesses for the gate-arms, since such construction is shown and broadly claimed in Patent No. 445,844, dated February 3, 1891.

Having thus fully described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. In a water-wheel, the combination, with a casing and a wheel proper, of pivoted gates having the front and the back of each gate scooped or concave, substantially as shown and described, and means to operate said gates.

2. In a water-wheel, the herein-described spout-gate, consisting of a curved body portion acting as a chute at the outer end and provided with lateral flanges at the front and rear sides toward the inner end, and having trunnion-bearing arms projecting above and below the flanges, substantially as shown and described.

3. In a water-wheel, the combination, with a casing and a wheel proper, of alternately stationary and oscillating gates, each set having their front and rear sides concaved along portions matching with adjacent gates to constitute spouts, and the oscillating gates adjustable in the same direction to effect an increase or a lessening of the size of opening, while preserving the spout form of gate-opening.

4. In a water-wheel, the combination, with a wheel proper and a convolute casing therefor having the inner walls of the side plates drawn in nearer together than the outer portions of the casing and rounded the one into the other, of oscillating gates concave along their front and rear sides and having inwardly-extending trunnion-bearing arms above and below the said sides and mounted in recesses in the drawn-in portion of said side plates, the outer ends of the gates being adapted to extend outward into the convolute chamber and to close up within said narrowed portion when closed, and means to oscillate said gates.

5. In a water-wheel, the combination, with a wheel proper and its shaft, of an inclosing casing therefor, gates mounted in said casing between the side plates thereof and provided with arms extending inward toward the wheel proper and located in recesses within said side plates, trunnions at the ends of said arms, stuffing-boxes constituting bearings for said trunnions, extending outside the casing, and operative mechanism connecting said trunnion-mounted gates outside said stuffing-box bearings.

6. In a water-wheel, the combination, with a wheel proper and its shaft, of an inclosing casing, oscillating gates mounted between the side plates thereof and concave in cross-section at opposing points of the respective gate-openings, having arms extending in toward the wheel proper and mounted in recesses within the side plates, trunnions on said arms extending outward through the casing, stuffing-box bearings for said trunnions, and operative connections for said trunnions outside said bearings.

In testimony whereof we affix our signatures in presence of two witnesses.

JOHN W. BOOKWALTER.
FRANCIS M. BOOKWALTER.

Witnesses as to the signature of John W. Bookwalter:

R. M. HOOPER,
J. H. HOBSON.

Witnesses to signature of Francis M. Bookwalter:

H. M. PLAISTED,
W. M. MCNAIR.