2 Sheets—Sheet 1.

W. D. ANDREWS.

CENTRIFUGAL PUMP.

No. 175,895. Patented April 11, 1876.

Fig. 1.

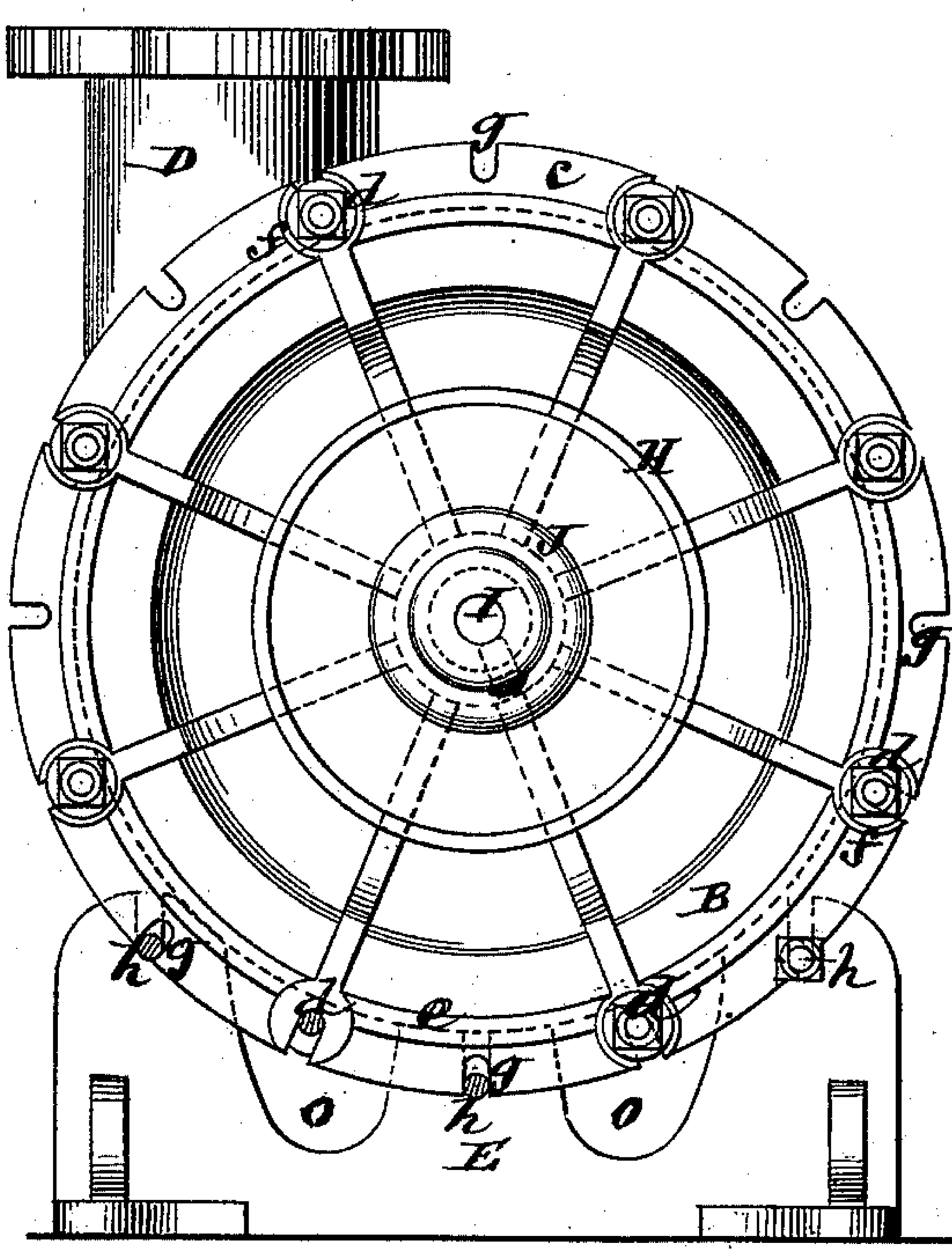


Fig. 2.

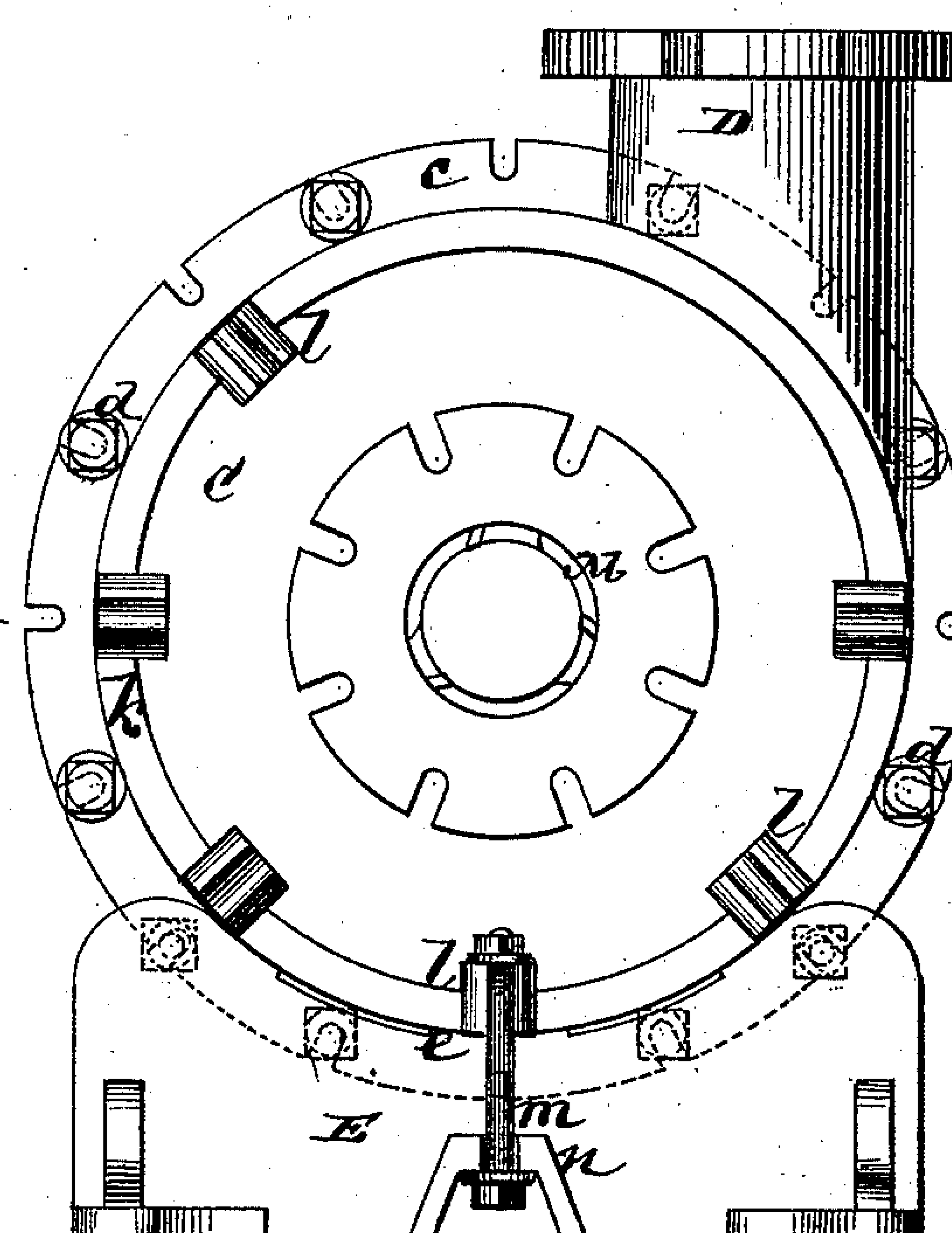
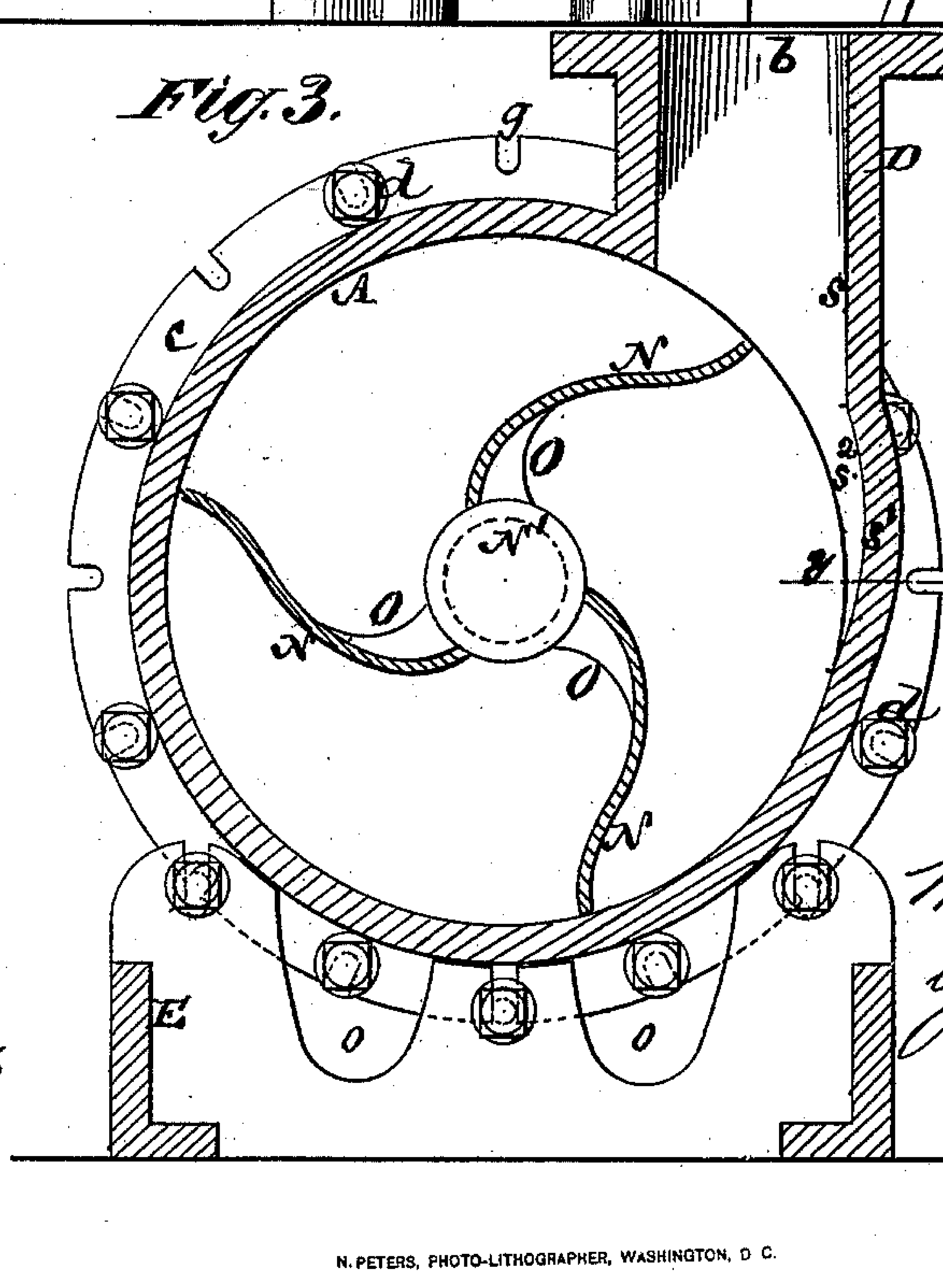


Fig. 3.



Witnesses
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2 Sheets—Sheet 2.

W. D. ANDREWS.

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Fig. 4.

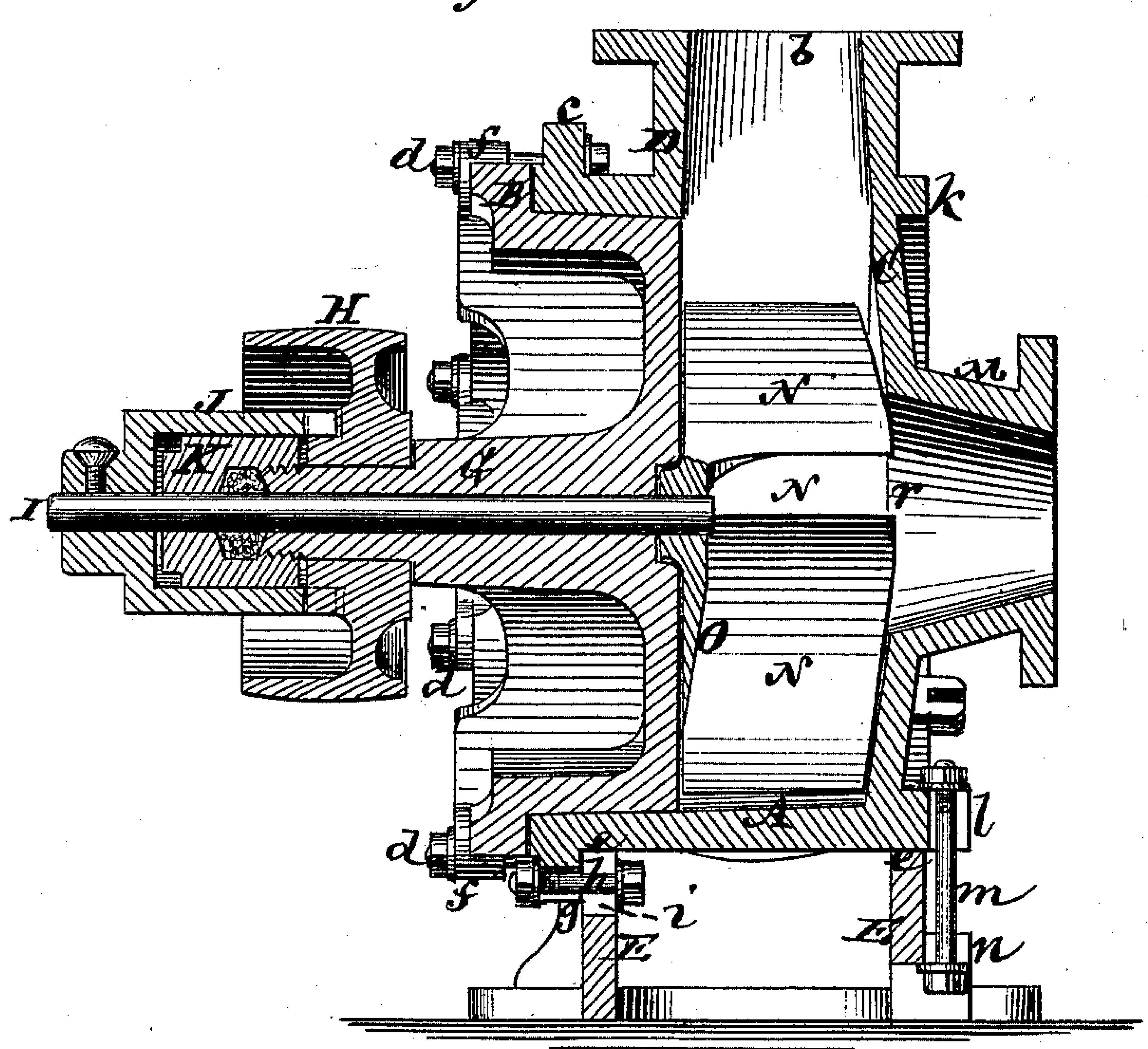


Fig. 6.

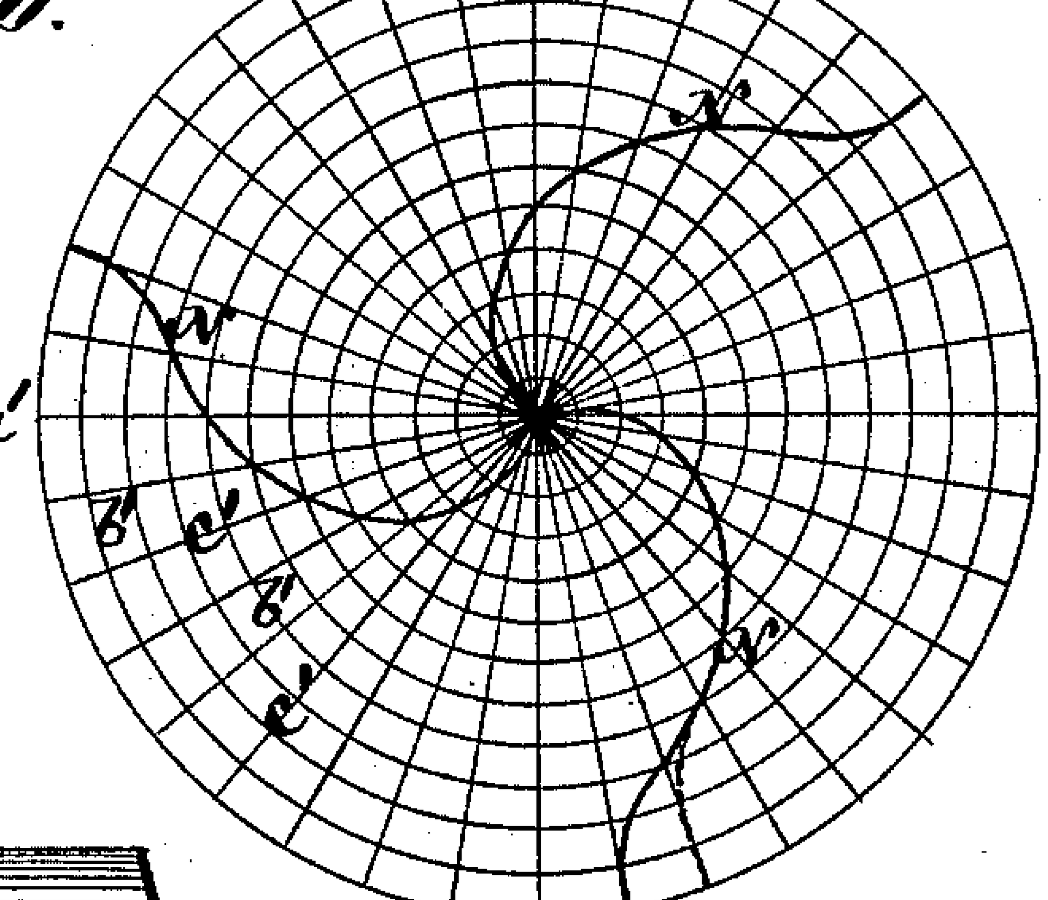
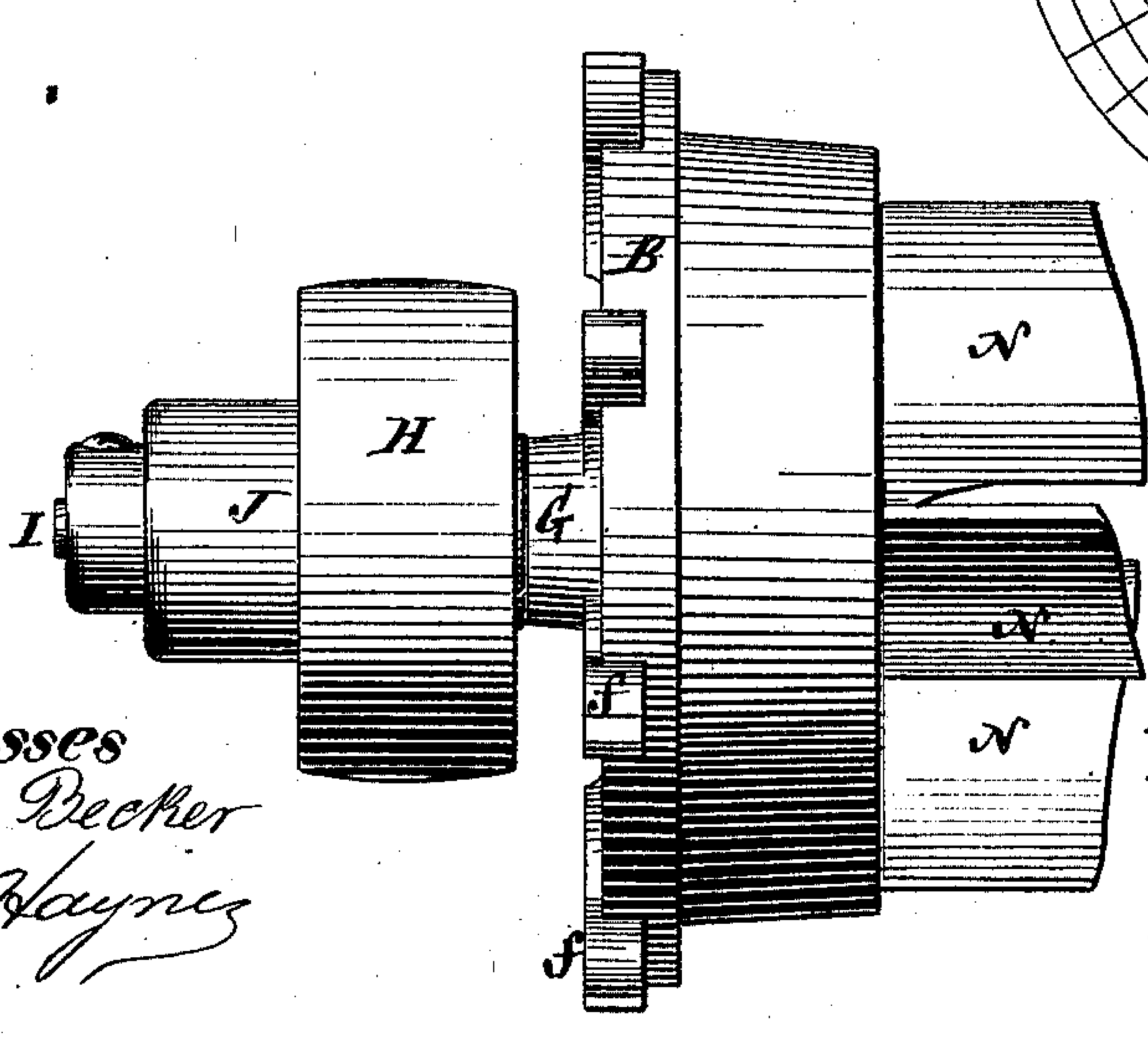


Fig. 5.



Witnesses
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UNITED STATES PATENT OFFICE.

WILLIAM D. ANDREWS, OF BROOK HAVEN, NEW YORK.

IMPROVEMENT IN CENTRIFUGAL PUMPS.

Specification forming part of Letters Patent No. **175,895**, dated April 11, 1876; application filed May 21, 1875.

To all whom it may concern:

Be it known that I, WILLIAM D. ANDREWS, of Brook Haven, in the county of Suffolk and State of New York, have invented a new and useful Improvement in Centrifugal Pumps; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawing, which forms part of this specification.

This invention consists in various novel constructions and combinations of parts, whereby a more copious discharge is obtained for a given diameter of pump case or cylinder; power is economized in the operation of the pump, and the construction of the latter cheapened; also, its capacity or ability to pass foreign bodies or substances enlarged; likewise increased facilities afforded for putting together and removing the working-parts without disturbing either the suction or discharge connections, and other advantages are obtained, including an increased facility for varying the working position of the pump.

In the accompanying drawing, Figure 1 represents a face elevation of the pump from its pulley side; Fig. 2, a similar view from the reverse or suction side of the pump; and Fig. 3, a vertical section in a plane transverse to the working axis. Fig. 4 is an irregular vertical section lengthwise of the working axis; Fig. 5, a view of the removable head of the cylinder or case, with the wheel, driving-shaft, and other parts attached, showing the whole as removed bodily from the pump cylinder or case. Fig. 6 is a diagram in illustration of the construction of the wings or blades of the propelling-wheel.

In proportioning these details of the pump, which are immediately connected with the working of it, I find that the greatest efficiency is attained by making the size of the discharge-orifice *b* a leading feature or starting-point. This being determined, the other details are proportioned to accord.

A is the body or case of the pump, which is of cylindrical form, with one removable head, B, on the pulley side of the pump, and a fixed head, C, on the opposite or suction side of the pump, which fixed head may be cast with the body A. The width of the body or inside space between the heads B C should be at least equal to, and, for purposes hereinafter explained, somewhat larger than the diameter of the discharge-orifice *b*. The cylindrical shell of the body or case A is extended in direction of the working axis upon the pulley side of the pump, and is formed at such extended portion with an outer straight flange, *c*, around its entire edge, leaving a sufficient space between said flange and the discharge-branch D to accommodate nuts or heads of bolts *d*, which connect the removable head B with the cylinder or case A, and to form a bearing around the case for the support of the latter on a stand or bed, E, with facility for turning the pump on or in its bearings *e* of the stand to facilitate changing the pump to discharge in different directions.

The flange *c* of the case has a series of slotted bolt-holes having open outer ends, and the head B similarly slotted bosses *f* for the insertion and removal the bolts *d* without detaching their nuts. Furthermore, said flange *c* is constructed with a series of intermediately disposed open outer ended slots, *g*, to rereceive bolts *h* within them, and corresponding slots *i* in the one side of the stand E, to bolt the pump to the stand on its one or pulley side, and the fixed head C of the case is made with an overhanging rim or horizontal flange, *k*, and a series of radially open slotted projections, *l*, for a holding-down bolt *m*, which is fitted to pass through the lowermost one of said projections, and a slotted projection, *n*, on the side of the stand. This mode of securing the pump to its stand not only forms a secure hold and provides for the ready attachment and detachment of the pump or of its removable head as required, but the slots *g* and the slotted projections *l* are in sufficient number and so arranged as to secure the pump to its stand in six (more or less) varied positions, as regards the discharge-branch D, by the turning or adjustment of the pump-case on or in its stand E.

By constructing the pump-case with an extension on its pulley side and an overhanging rim or horizontal flange, *k*, on its opposite side, not only is a broad bearing secured for the pump-case on its stand, but the range of the case's circular adjustment may be extended to an extent that will admit of the discharge-branch D entering in between the sides of the stand.

To provide for the removal of the undermost bolts d from the open ended slots in the flange c, and in the removable head B, when it is required to draw out or remove said head with its attachments for cleaning purposes, or otherwise, without disturbing the pump-case, the stand E on such side is constructed with openings o, which allow of the ready removal of said bolts by slackening their nuts.

The stand E is an oblong frame with the bearings or seats e, for the pump-cylinder or case, formed by concave circular formation of the upper edges of its sides, for the support of said case on its opposite sides, and to provide for the adjustment of the case around its axis, and which may ordinarily extend for about three-fourths of a circle, and the discharge-pipe be caused to deliver water at different points in the plane of that movement.

The removable head B is recessed on its outer side, or otherwise constructed to project within the pump-case A to bring its inner face in line with the side of the opening into the discharge-branch D.

This head B carries a hollow projecting arbor, G, upon which the driving-pulley H revolves. Through this arbor as a bearing the shaft I of the propelling-wheel passes, and is connected by a coupling, J, with the driving-pulley H. Upon the outer end of said arbor, and within and inclosed by the coupling J as a cap, a stuffing-box, K, is arranged to prevent leakage. This outside bearing for the pulley and inside bearing for the shaft of the arbor G, in combination with the free coupling J, does away with all lateral strain on the shaft, and provides for the removal of the belt without cutting or separating it; also for the belt being led in any direction in the plane of the pulley's motion, without obstruction from any portion of the pump or its stand, as in Letters Patent No. 156,523 issued to me November 3, 1874. By combining with this arrangement the stuffing-box K, and inclosing the latter by the cap-like coupling J, not only outside leakage is prevented, but the coupling protects and conceals the stuffing-box, thereby performing a double function or use.

The propelling-wheel is secured upon the inner end of the shaft I, and the same and other working parts of the pump, excluding the case A and stand E, are all carried by the removable head B, and can be removed and replaced with said head without disturbing the suction or discharge pipe, and without change of relative position; also dispensing with all outside bearings or connections, and insuring the retention of the parts under all circumstances.

The suction or induction opening r in the center of the fixed head C, I find from experiment it is most advisable to make about one and a half time the diameter where it joins the case A as the discharge-orifice b, as such proportion gives better or more economical results; but these proportions may be changed if desired. This induction-opening r is extended centrally outward to form a suction branch or nozzle, M, which it is preferable to contract at its outer end to an equal area with the discharge-orifice b, and which is provided with a flange for attachment of the suction-pipe. This tapering or contracted construction at its outer end of the induction-branch M, to which, however, the invention is not restricted, economizes the cost of the suction-pipes, and avoids the necessity of a strainer, as when connecting by a suction-pipe of the same area as the opening r.

The fixed head C is made slightly conical or dish-shaped on its inside face, to insure a width of space at the center, between said head and the hub of the wheel in proximity to the opposite head, equal at least to the distance between the heads at the circumference. This width at the center may be increased, not exceeding say, one-fourth, and for passing large substances through the pump, as in dredging and removing gravel, shells, coal, grass, sea-weed, and other irregular substances for which this class of pumps is extensively used, there will be an important gain by increasing the size of the central passages.

The discharge-branch D I make mainly of square or rectangular form in its cross-section where it unites with the cylindrical case A, and of a width about equal to the width of the space between the heads at their circumference, and gradually contract said branch to a circular form at the orifice b. This gradual change of form in the discharge-branch insures a sufficient discharge without using a very large cylinder or case, and gives a concentrated or solid discharge.

The interior surface of the outer side of the discharge pipe or branch D is tangential to the inner periphery of the case, thus directing the water in the course it is thrown from the case. This too, combined with the varying shape of the discharge-branch, is important to secure a perfect and economical action.

The discharge-opening through the periphery corresponding with an oblique section of the rectangular portion of the discharge-branch is oblong in form, and should have a superficial area as compared with the discharge-orifice b as 22 to 7. The contracted orifice b is not necessarily circular.

To obtain this proportion, the diameter of the case may be varied between two and a half and six times that of the discharge-orifice, and the distance between the heads at the inner periphery of the case and width of the discharge-opening from the case should be between one and one and a quarter time the diameter of the orifice b.

As here represented, the contracted discharge-orifice b has a circular form, and the discharge-branch is enlarged by its rectangular shape where it joins the case A, but the proportions hereinbefore specified for the opening from the case and the circular orifice *b* are not so applicable to pumps of any considerable capacity, or at least these proportions make such pumps unwieldy in size and weight, unduly enlarge the surface exposed to friction and the bulk or weight of water in constant motion by the wheel that is revolving with the latter, which causes much wasteful consumption of power. To reduce the size of the pump and retain the tangential discharge while securing the proper size of opening from the case, I observe the following peculiarities as regards the construction of the discharge-branch D: Whereas a decreased diameter of case, with the tangential surface *s* extended until it unites with the periphery at *y* would leave an insufficient opening from the case, therefore I start at a point on the periphery sufficiently beyond *y* to secure the proper length of opening, and by a convex curved surface, s^1, connect that point with the tangential surface *s* at a point about twice as far on the other side of *y* as it started beyond it, thereby forming a relief-opening, s^2. The shape of this curved space or opening s^2, however, may be varied.

The proper opening from the case may also be secured by increasing the distance between the heads of the case, making the discharge the same width, and tapering into the discharge-orifice *b*, and it will be often a matter of convenience to avail of this arrangement, in whole or in part; but it increases the surface exposed to friction and weight of the water carried by the wheel, though to nothing like the extent as does enlarging the diameter of the pump-case.

The propelling-wheel is not restricted to carry any precise number of wings, N, but three are preferable. These wings are equidistant from each other, and are attached to and carried by a small central hub, N′, which at its back is connected to and carried by the driving-shaft I, no portion of the shaft projecting into the case beyond the hub to obstruct the influx of water into the central portion of the case, between or within the wings of the wheel.

The wings N connect with the hub N′ at their inner ends, and are strengthened and supported by re-enforces, O, attached to the edge of the hub and to the wings along their backs.

By attaching the wings N to a small hub at their inner ends, even when said ends are extended over the face of the hub, but leaning much their larger portion beyond its outer edge, the wheel is relieved from end pressure, and for all practical purposes balances it, or nearly so. By use of the re-enforces O, said hub also admits of the inner ends of the wings stopping short of the center of the wheel, as shown, thus leaving a free space in the center of the case A of a width and diameter equal to that of the discharge-orifice *b*, thereby permitting the passage into and through the wheel of substances as large as can pass through the discharge-pipes, and perfectly balancing the wheel. Such omission from the center of the wheel of the wings N also reduces the speed at which the wheel requires to be driven and power required to drive it, and the clear passage through the wheel obviates the necessity for a strainer upon the suction-pipe to exclude substances which otherwise could not pass through the pump, consequently diminishing the friction of the water.

The propelling arms or wings N extend outward to the perimeter of the case without coming into actual contact with it, and are of a width corresponding with that of the case without touching, however, the heads of the latter. Said wings thus sweep the whole body of the case, excepting the small central space between the inner ends of the wings when the latter stop short of the center, as shown, and they deliver water only through the small portion of the inner perimeter of the case, where it is interrupted by the discharge-branch or space forming the opening into the latter from the case, thus dispensing with the extended circular or eccentric passage ordinarily used.

Thus confining the water within the diameter and grasp of the wheel and allowing of its escape therefrom in a nearly direct line into the tangential discharge pipe or branch in a compact body not only provides a free discharge-passage for large foreign substances and reduces the surfaces exposed to friction, but permits a reduction of the speed of the wheel and of the power required to drive it to perform a given amount of work. Furthermore, the size of the pump for a given capacity is diminished, and its cost of manufacture reduced.

The wings N of the pump are of peculiar construction, substantially as follows, and as illustrated by the diagram Fig. 6 of the drawing. Thus, to lay out the wings, I divide a circular space equal to the intended diameter of the wheel into any number of parts by equidistant concentric circles *b′*, and by radial lines *c′* into any given number of segments. The following division I find answers in practice: I lay out the aforesaid circular space by twelve equidistant concentric circles and by thirty-six equidistant radial lines, and traverse nearly one-third the circular space to form each wing. For instance, in laying out each wing N, I commence at the center of the circular space bounded by the circular line *a′*, Fig. 6, and draw a curved line that shall intersect the first circle at a point where it crosses the next radial line, and so on outwardly toward the circumference, crossing each succeeding concentric circle at its intersection with the next succeeding radial line until I reach the ninth circle from the center. When the wings N are required to be cut away at the center, then, instead of commencing to lay out the wings from the center of the circular space, of which *a′* is the boundary-line, I commence at a concentric circle corresponding with the diameter of the suction-pipe, but otherwise retain the hereinbefore-specified construction of the wing to or about the ninth concentric circle from the center. This gives a volute form to each wing and from where the volute terminates—that is, about the ninth concentric circle—a reverse curve or segment of a circle is made, having its center on the circle a', said reverse curve being extended to the next radial line at its junction with the second concentric circle from the boundary circle or line a', and the wing then being continued outward in the last-named radial line to the periphery.

These proportions and directions, however, may be varied. Thus the pitch of the volute and its points of starting and ending may be changed, but in all cases it is proposed to use the reverse curves in combination with the outer radial termination of the wing, whether said radial termination be longer or shorter, as shown by full and dotted lines in Fig. 6, and whatever may be the proportions of the volute and reverse curve. The greater the distance the water is to be raised, the less should be the pitch of the volute, the proportion of which, as hereinbefore given, is good for deliveries of from ten to twenty feet high.

The improved pump herein described may be made without turning, boring, or drilling, excepting the boring of the stuffing-box and turning of the pulley-bearing. Its castings, also, may be made almost entirely without coring.

I claim—

1. In a centrifugal pump, having a cylindrical case, A, the discharge branch or nozzle D, of an enlarged rectangular construction at its junction with the case, and coincident with the sides thereof, but terminating externally in a contracted orifice, b, and arranged so that the interior surface s of its outer side is in tangential relation with the inner periphery of the case, and with the circular path described by the outer ends of the propelling wheel or its wings, substantially as specified.

2. The discharge branch or nozzle D, having the interior surface s of its outer side in tangential relation with the cylindrical case A, and constructed or provided with a relief-opening, s^2, having a curved surface, s^1, arranged to connect with the inner periphery of the case, and with the tangential surface s of the discharge branch or nozzle D, essentially as shown and described, and for the purpose herein set forth.

3. The wings N of the propelling-wheel, constructed of reverse curves, constituting a volute for the greater portion of the length of the wings but having outer radial terminations, essentially as shown and described.

4. The combination of the wings N N, irrespective of their shape, having their inner edges terminating at a distance from the center of the wheel so as to provide an unobstructed central space within them, with a hub, N′, on one side only of the wheel, of a diameter approximating to that of said central space, and with re-enforces O O, the said hub and re-enforces extending equally into the cylinder, all substantially as herein described.

5. The removable head B of the pump-case, provided with an arbor, G, for the wheel-shaft, and constructed to independently carry the propelling wheel, shaft, and driving-pulley, substantially as described.

6. The combination of the pulley H, arranged on the arbor G, projecting from the removable head, with the shaft I and the coupling J, essentially as described.

7. The combination, with the removable head B constructed to independently carry the driving-pulley and wheel-shaft, having an attached clutch, of the pump-case A and its attached head C, induction nozzle M, and discharge-branch D, substantially as described.

8. The circularly-adjustable case A, formed with circular extensions on the opposite sides or faces to form broad or distant bearings in the support of the case by the stand E, beyond opposite sides of the discharge-pipe D, essentially as shown and described.

WM. D. ANDREWS.

Witnesses:
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