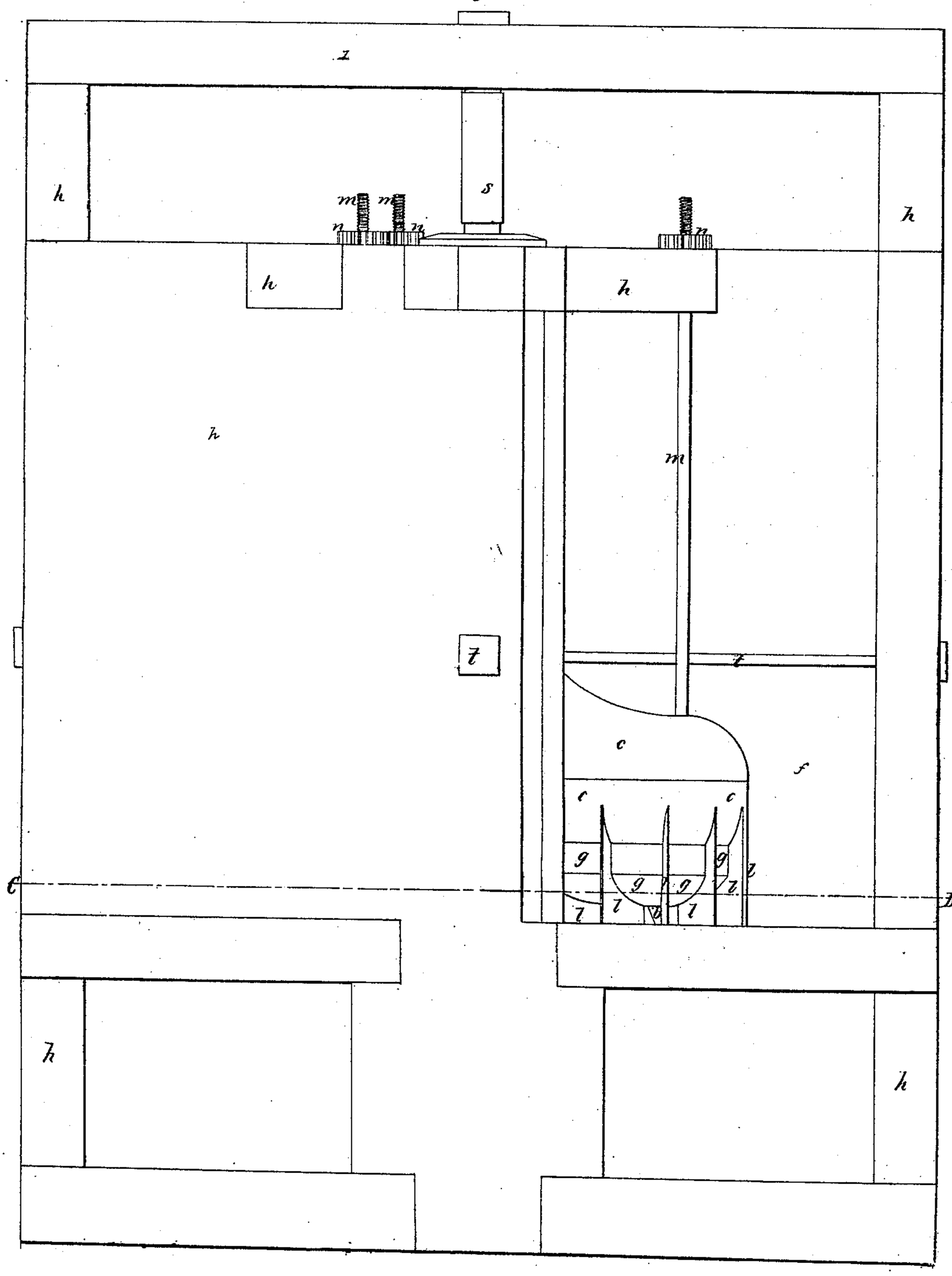
No. 10,027. PATENTED SEPT. 20, 1853.

U. A. BOYDEN.

HYDRAULIC MOTOR.

5 SHEETS—SHEET 1.

Fig. 1.



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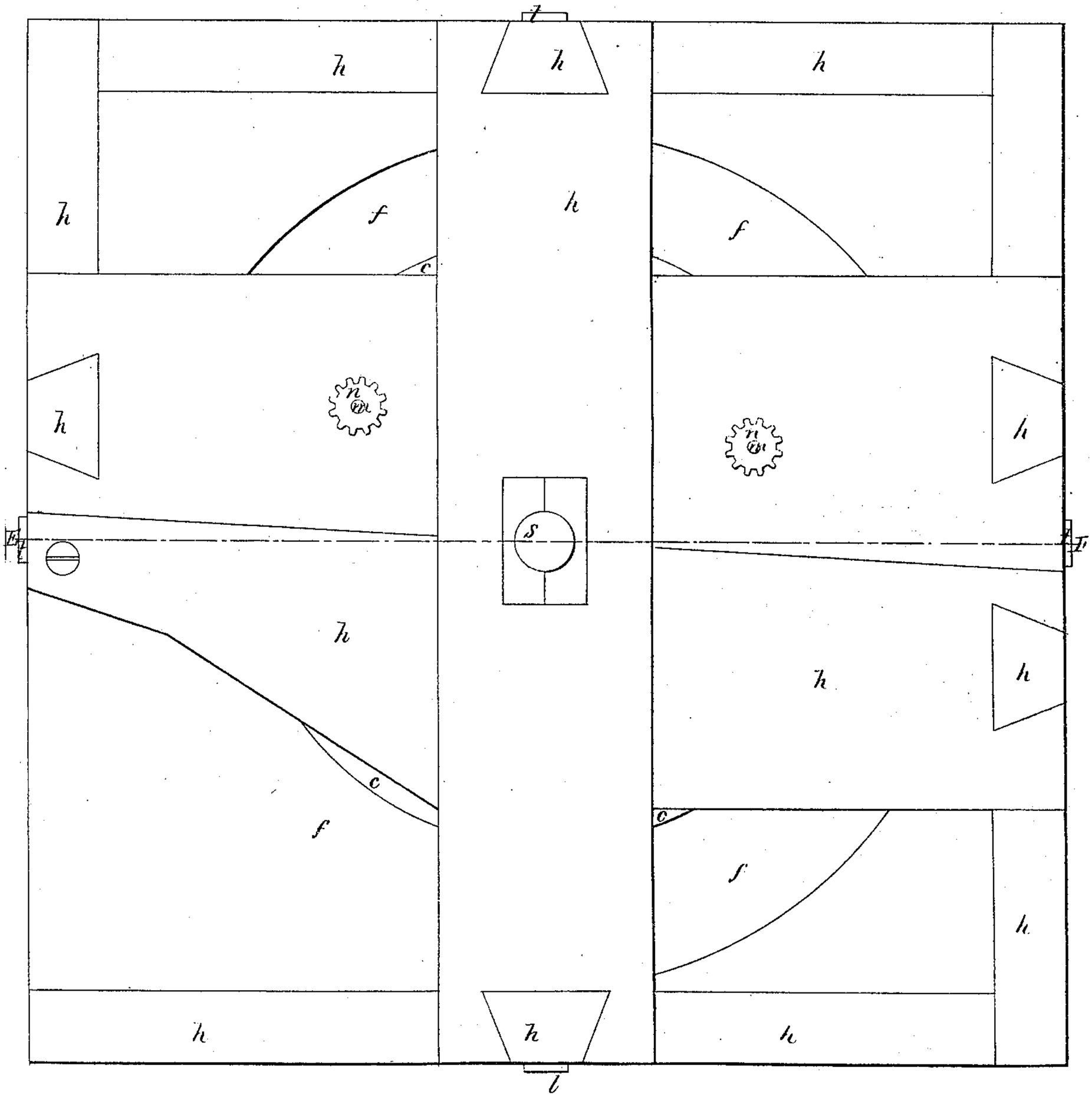
5 SHEETS—SHEET 2.

Fig. 2.



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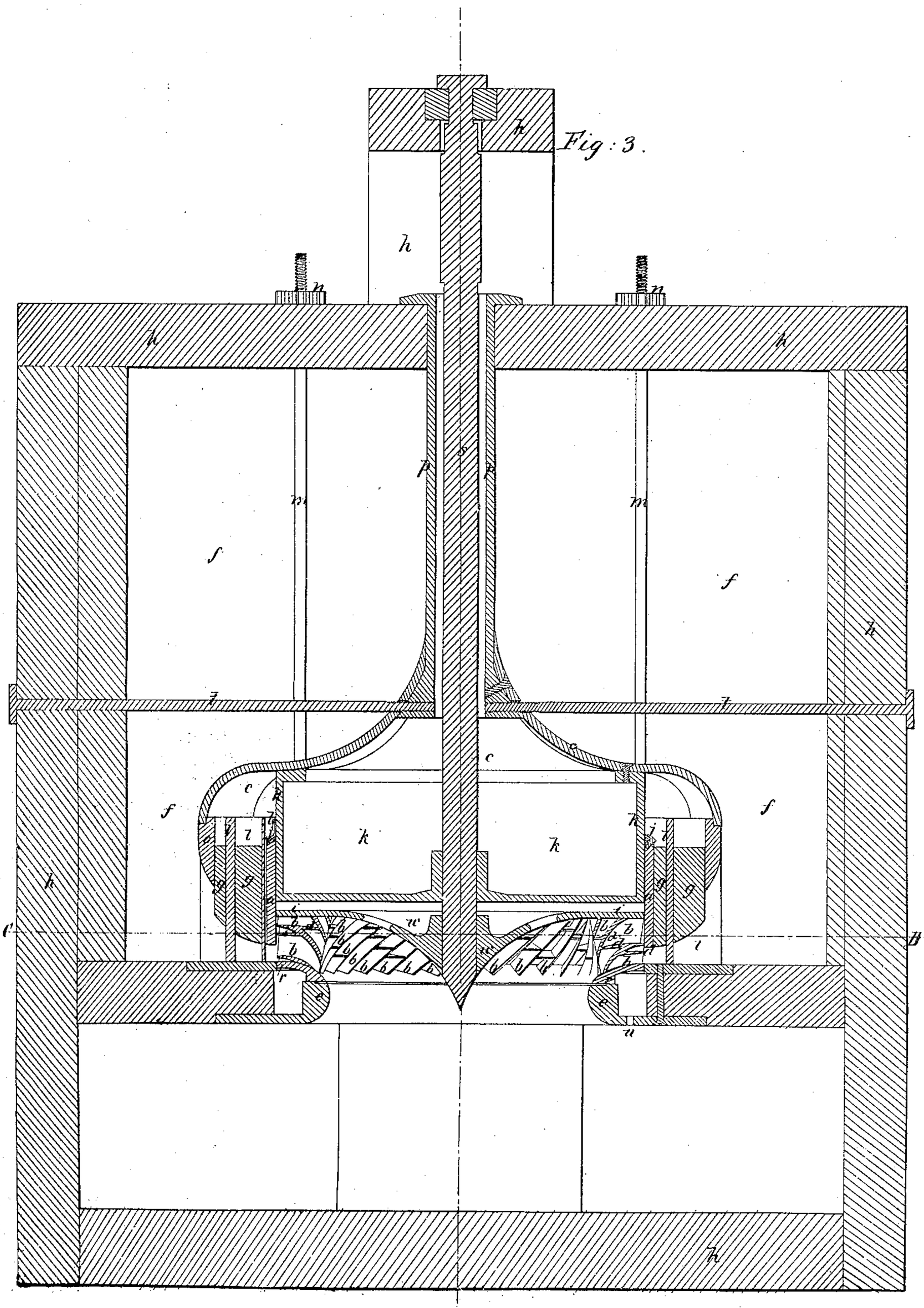
5 SHEETS—SHEET 3.

Fig: 3.



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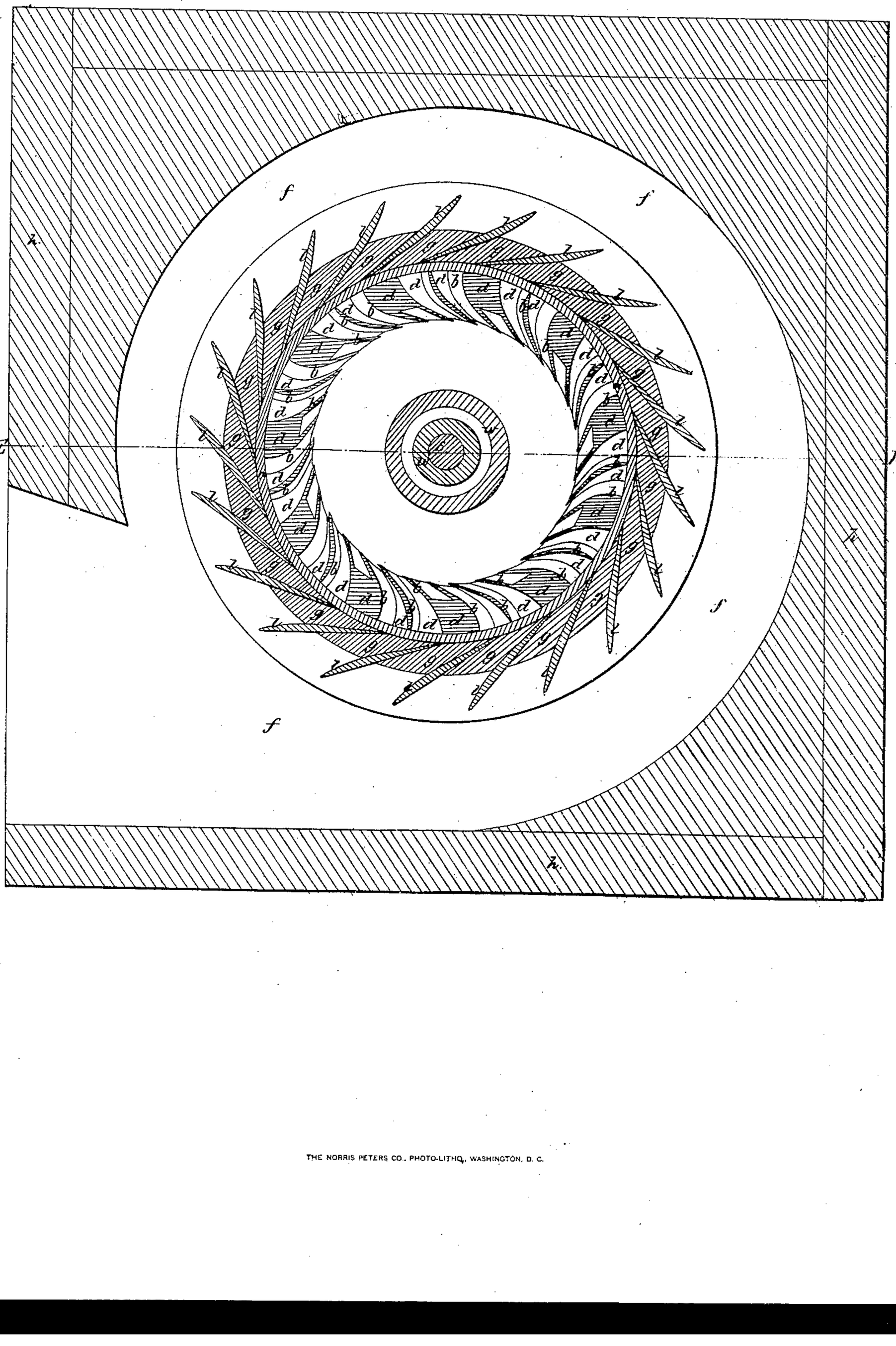
5 SHEETS—SHEET 4.

Fig: 4.



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5 SHEETS—SHEET 5.

Fig: 5.

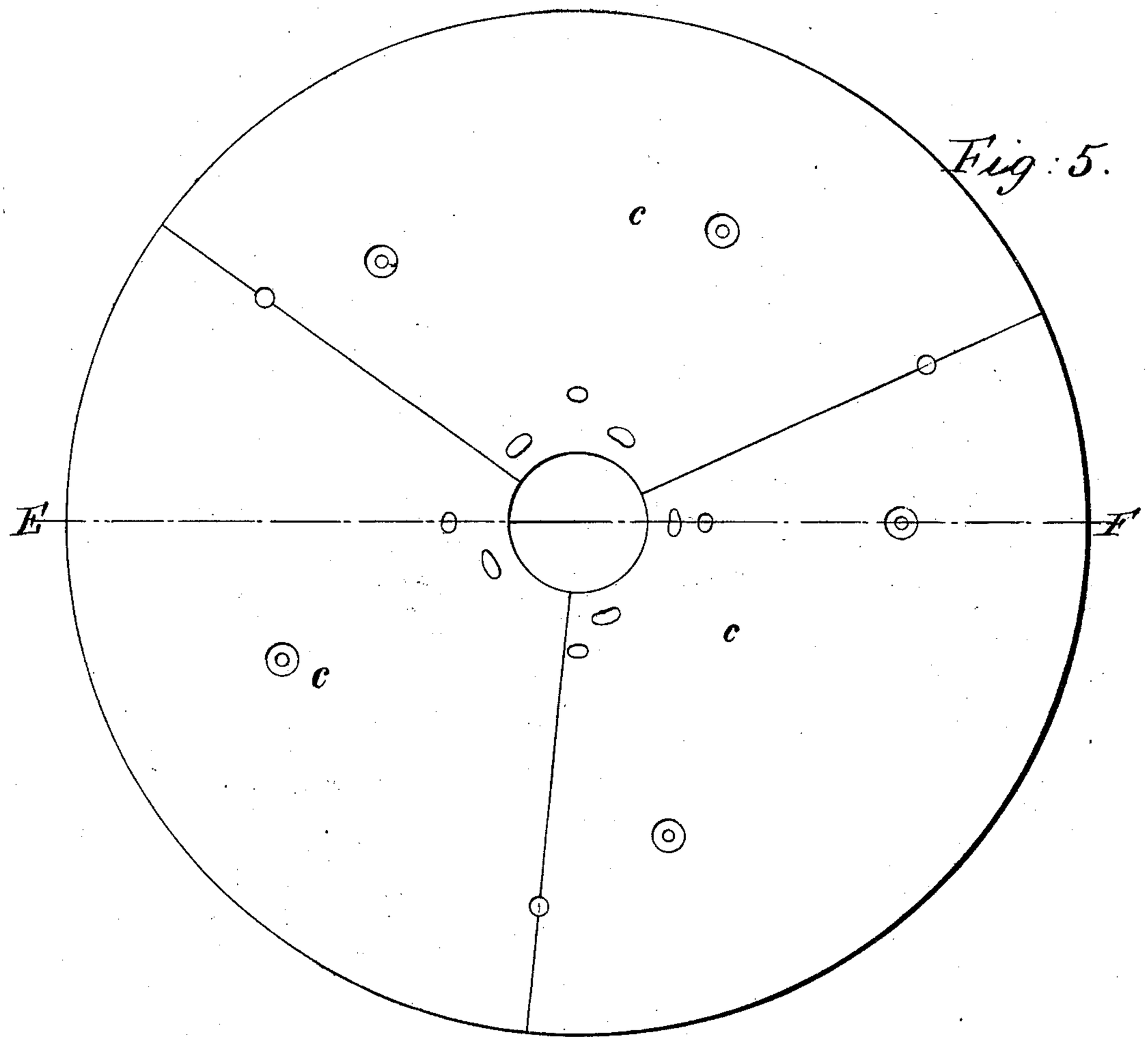
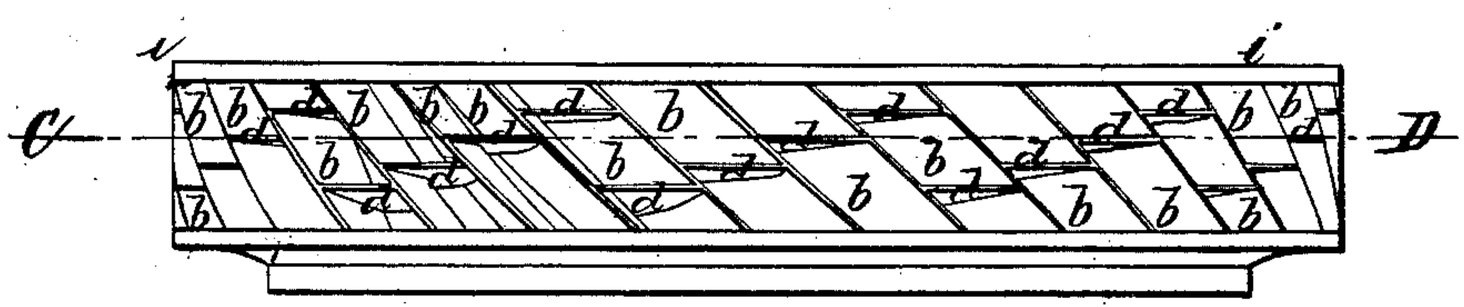


Fig: 6.



UNITED STATES PATENT OFFICE.

URIAH A. BOYDEN, OF BOSTON, MASSACHUSETTS.

HYDRAULIC MOTOR.

Specification of Letters Patent No. 10,027, dated September 20, 1853.

To all whom it may concern:

Be it known that I, URIAH ATHERTON BOYDEN, of Boston, in the county of Suffolk and State of Massachusetts, have invented new and useful improvements in a kind of hydraulic motors which are sometimes called "Poncelet turbines," whereby the efficiency of water in actuating them and their convenience are increased; and I do hereby declare that the following is a true description thereof.

My invention consists, firstly, in placing the gate about the water wheel, between the wheel and the guides or other things which direct the water into the wheel, so as to economize water when the wheel is working at less than its full power; secondly, in causing the water to press the wheel upward with a force nearly or quite constant, though the height of the water or fall, varies; thirdly, in combining a gate around and near the wheel, with floats which have their outer portions curved so that the water will strike them on their concave sides, so as to diminish the spreading of the streams of water in the wheel, when the gate is partially open; fourthly, in making the distances between the rims of the wheels at the ends of the floats next the axes of the wheels, greater than at their outer ends.

To enable others, skilled in the art, to make and use my invention, I will proceed to describe its construction and operation, by explaining the annexed drawings, which make a part of this specification.

Figure 1 is an elevation of the hydraulic motor, the flume and frame which supports them; though in this view, the frame and flume conceal nearly all the other parts; Fig. 2 is a plan of the same things; in this view also the frame and flume conceal the interior parts; Fig. 3 is a vertical section of the hydraulic motor, the flume and the frame which sustains them, through and parallel with the axis of the water wheel; Fig. 4 is a horizontal section of the same; Fig. 5 is a plan of the covering of the wheel, gate and parts next them; and Fig. 6 is an elevation of the water wheel.

The same small letters in all the figures, refer to the same parts.

h h, etc., is the frame which sustains the flume and hydraulic motor; *f f f f*, is the flume.

This hydraulic motor or Poncelet turbine consists of the water wheel *w w*, including its upper rim *i i*, its lower ring *r r*, its floats or buckets *b*, *b*, etc., and several appendages, as the shaft *s;* the guides *l*, *l*, etc.; the garniture *o o*, *g*, *g*, etc.; the annular gate *a a;* the 3 rods *m*, *m*, *m*, for moving the gate; the 3 pinion nuts *n*, *n*, *n*, on the rods *m*, *m*, *m*, for moving these rods and the gate; the curb *k k k k;* and in the one represented by these drawings, the pipe *p p*, Fig. 3; the 4 rods *t*, *t*, *t*, *t*, for holding the pipe; the covering *c*, *c*, *c*, which is fastened by screws to the pipe *p p*, and to the curb *k k k k*, and sustains this curb; the diaphragms or partitions *d*, *d*, etc., in the water wheel, for diminishing the spreading of the streams in the wheel when the gate is partially open; and the ring *e e*, Fig. 3, under and next the lower rim of the wheel; and some other parts not necessary to mention here.

In this kind of hydraulic motors, the water acts on the floats chiefly by percussion, the water having a velocity equal to about five eighths of that due to the whole fall, when it first strikes the floats, and its velocity gradually diminishes till it leaves the floats, or till it arrives at near the place of leaving; which is an essential difference between this, and simple reacting wheels, in which the water acts on the wheels rather by pressure, and has its velocity gradually increased as it passes through the wheels.

The outer part of the garniture *o o*, Figs. 1 and 3, is detached from the annular gate *a a*, and so united with the covering *c*, *c*, *c*, over this gate, as to prevent the water from running to the top of the gate by any other way than by the bottom of this stationary garniture, and upward; so that dirt or small substances cannot be carried by the water to the upper part of this gate, or to the packing *j j* on this gate, or to the upper parts of the garniture *g*, *g*, etc., which is attached to the gate, except by passing under the lower edge of the immovable portion of the garniture *o o*, and afterward, ascending; which it is not liable to do. This method of preventing the motion of the gate being obstructed by dirt or other substances, is claimed by me as a subject of another patent.

The floats or buckets *b*, *b*, etc., Fig. 6,

lean or incline to the rims of the wheel, so that when the wheel is working, the parts of the floats next the wheel which the water strikes when the gate is only partially open, will be in advance of the other parts of the floats which are above the streams, so that this leaning of the floats will diminish the spreading of the streams in the wheel. This means of diminishing the spreading of the streams in wheels, is claimed by me as a subject of another patent.

The first branch of my invention, consisting in placing a gate, as *a a*, Figs. 3 and 4, around the water wheel, between the wheel and the guides *l*, *l*, etc., or between the wheel and volute or spiral flume *f f f f*, or other things which give the water the proper direction before it enters the wheel, is for economizing water when it is wished to use the wheel at less than its full power. The gate is opened and used at various heights, that is, it is opened to various widths so as to admit just sufficient water to give the power required; and the principal advantage of this arrangement consists in nearly confining the action of the water to a part of the wheel, and causing it to act with nearly the full force due to the fall on such part of the wheel, when it is not necessary to have the full force of the water acting on all parts of the floats. With the Poncelet turbine formerly made, the power which it was wished to have the wheel give, was regulated by a gate which circumscribed the guides *l*, *l*, etc., which are intended to give the water the proper directions, or by a gate of a different form, farther from the wheel; or by such other means that the water sometimes entered the wheel at all heights between the upper and lower rims, but with a less force and less velocity than that which is due to the whole fall; whereby a very considerable part of the power of the water was frequently lost in the Poncelet turbines. And sometimes in such as had the gate circumscribe the guides, when the gate was raised or opened only a small portion of the height of the wheel, the water passed into the wheel at the bottom of its circumferential parts, and by centrifugal force, was thrown out of the wheel at the top of its circumferential parts, into the upper parts of the spaces between the guides and gate, where its momentum was lost by its striking the guides; and it descend to near the bottom of the gate, and again entered the wheel, but with a velocity much less than that of the floats, and the floats struck it, and the motion of the wheel was obstructed thereby, which caused a very considerable loss of the power of the water. In turbines in which the water escapes from the wheels at their peripheries, as in the one described in my patent issued the fifth day of June A. D. 1847, and antedated Dec. 5, 1846, the gate is between the wheel and some parts which give the water the desired direction before it enters the wheel. But with this arrangement, when the gate is only partly open, the water enters the wheel with nearly the full force due to the fall, but the centrifugal force of the water in the other parts of the wheel, which are not opposite the aperture or apertures which admit the water into the wheel, causes the water to flow out of these other parts of the wheel forcibly and tends strongly to produce vacuums in these parts of the wheel, so that the streams spread into these parts of the wheel and the force is diffused over the parts which are above the lower edge of the gate; and because the water flows into the wheel through only a part of the space between the inner edges of the rims, and flows out of the wheel through the whole space between their peripheries; it passes out through too large a space comparative to that through which it enters the wheel, to utilize much of its force; and this spreading and so passing out through too large a space, causes a very large portion of the force of the water to be lost in this kind of turbines when the gates are not opened nearly the full heights of the wheels; often more force is lost in this way than is utilized. But in the arrangement which I now claim, the centrifugal force of the water above the lower edge of the gate, that is, above the streams where they enter the wheel, when the gate is not opened the full height of the wheel, keeps the water so pressed into these parts of the wheel next the gate, as to diminish or prevent the spreading of these streams, into these parts: the centrifugal force diminishing the loss of power, instead of increasing the loss, as in the Fourneyron turbines. And the gate being next to the periphery of the wheel, and closing so much of the apertures as it is not necessary to use, prevents the water either passing into the wheel through these parts of the apertures, or out of the wheel through them.

The weights of water wheels have often been sustained by the upward pressure of the water under some parts of them; but in such a way that as the height of the fall varies, the degree of upward pressure of the water on the wheel, varies; hence where the fall is variable, the water will at some times press up too forcibly, or at some times not press up sufficiently to sustain the wheel. The second branch of my invention consists in making the upward pressure of the water on a water wheel nearly or quite constant at all times when it is working, as by constructing the wheel and parts about it as shown at *r r* and *e e* in Fig. 3; so that when the wheel is working, a little water is continually passing down by the periphery of

the lower rim of the wheel *r r*, and pressing it up. But when the height of the water above the wheel, or the height of the fall increases, so as to force more water under the rim of the wheel, this rim will be separated a very little farther from the ring *e e* below it, which will increase the discharge of water from the space under the lower rim of the wheel, and thereby prevent the upward pressure of the water on the wheel, being increased much; so that the upward pressure of the water on the lower rim of the wheel, will remain very nearly constant, though the fall of the water varies greatly. The same effect may be produced by making the ring *e e* below the wheel, vary in height by variations in the pressure of the water; instead of having the water wheel vary in height. As some earth may pass down by the periphery of the lower rim of the wheel, into the cavity under the rim, the hole shown at *u* in Fig. 3, is made to let such earth pass out of the way.

This second branch of my invention, is very applicable to such reacting wheels as have the water ascend in entering them. Such water wheels as have the water enter them at their peripheries, moving the way the wheels turn, and discharge from between their floats toward the axes of the wheels, commonly have the floats straight; and so placed that when the wheels are working, the outer ends of the floats are forward of their inner ends next the axes of the wheels; the directions of the parts of the floats nearest the axes of the wheels, being nearly as these parts are shown in section in Fig. 4; and in such wheels it is generally necessary that the parts of the floats nearest the axes of the wheels, should be so directed back, to utilize the most power from the water. If when the inner parts of the floats be so placed, the floats be straight through their whole length, their outer ends will be so directed that the water will strike them quite obliquely; which obliquity of percussion will cause considerable loss of the force of the water, if there be gates next the wheels partially open; because the streams of water which pass through the spaces between the guides *l*, *l*, etc., Fig. 4, tend toward one another, so that each stream strikes the next one obliquely, at or near the peripheries of the wheels; that is, the streams are converging where they first strike the floats, instead of diverging, as in the common turbines in which the water is discharged at the peripheries of the wheels; and when the outer ends of the floats meet the peripheries of the wheels obliquely, as above mentioned, the outer ends of the floats also tend to turn each stream against the next; so as to make the pressure of the water rather greater at the peripheries of the wheels, which will cause a part of the water to glance up or ascend in the spaces between the floats above the lower edges of the gates, so as to cause a considerable part of the force of the water to be lost. When these gates are open the full heights of the space between the peripheries of the rims, and also when there are no gates at the wheels, the streams not being too much contracted immediately before entering the wheels, the velocity of the water into the wheels is much less, and no such loss of force as above described occurs. To avoid said loss of power, I make the outer portions of the floats curved, as represented by the section Fig. 4, so that their outer ends are directed nearly or directly from the axis of the wheel, that is, so that the end of each float farthest from the axis of the wheel, is normal or nearly normal to the part of the periphery of the wheel which it meets or is nearest to; so as to facilitate turning the water toward the axis of the wheel, and thereby diminish the pressure of the water at the outer ends of the floats, which accordingly diminishes the spreading of the streams into the spaces between the floats above the lower edge of the gate. And the third branch of my invention consists in combining the gate around and near the wheel with floats which have their outer portions curved, so that the water will strike them on their concave sides and thereby be more easily deflected toward the axis of the wheel, so as to diminish the pressure and consequent spreading of the streams in the wheel near the gate when the gate is partially open. Because the water, when it enters the wheel, must be approaching the axis of the wheel, if the outer extremities of the floats be radial, that is, parallel with the radii of the wheel which pass through them, respectively, the water will strike them so obliquely as to cause the water to glance toward the axis of the wheel. This curvature of the float is of some use in diminishing losses of power caused by shocks and eddies. The amount of curvature or bend of each float may be about fifty degrees; the part of each float nearest the axis of the wheel, including about one-fifth of the length of the float, may be nearly or quite straight. The radius of the curvature of the outer ends of the floats at the periphery of the wheel may be about one-half of the length of a float, or one-tenth of the diameter of the wheel; and the radii of the curvature of the floats gradually increase from the outer ends of the floats to their straight parts; that is, the parts of the floats to be nearer straight the farther they are from their outer ends, till they become quite straight at about four-fifths of the length of the float from their outer ends. If the floats be longer than I have sup-

posed, about one-fifth of the diameter of the wheel, this excess of length on their inner parts may be reversed a little—that is, bent a little toward the axis of the wheel, to prevent the passages between them being too much contracted.

In wheels of this kind, with which the water is directed obliquely to the wheels by the guides *l*, *l*, etc., Fig. 4, or by other things, the velocity of the water diminishes, or should, from the time it strikes the floats till it leaves them or till near the time it leaves them; and the change of the directions of its motion which should be produced during the same time, is not sufficient to compensate the effects of the diminution of its velocity and the less space the water has in consequence of its approaching the axes of the wheels, so that the passages between the parts of the floats nearest the axes of the wheels, are choked some. To produce the greatest possible effect of the water with this kind of motors, it is necessary that the resistance to the moving of the water through the wheels, should be less than it is in them as usually made, so that the velocity of the water on entering these wheels, should be greater than it usually is. There is no such disadvantage of partial choking in mere reacting wheels, in which the velocity of the water increases as it passes through the wheels; and in which much contraction of the passages is needful. And this partial choking is also different from anything which happens in the common or Fourneyron turbines, in which the water diverges as it passes between the floats and out of the wheels at their peripheries, instead of converging as in the Poncelet turbines. This disadvantage cannot be obviated by placing the inner parts of the floats farther apart, without their being directed so nearly toward the axis of the wheel, as to cause a part of the force of the water to be lost. The fourth branch of my invention, consists in making the distances between the rims of the wheels at the ends of the floats next the axes of the wheels, greater than at their outer ends; as shown at *i i* and *r r*, Fig. 3. This difference in distances may be made by making so much of the upper part of the wheel as the upper edges of the floats touch, plane or flat; and the upper surface of the lower rim next its periphery, including about one eighth of the width of this rim, also plane; and from this place gradually curving downward, as by an arc of a circle; the curvature of this part being such that it will join the plane part without any sensible angle at the place of joining, and the distance of that part of the lower rim at the inner ends of the floats, from the upper rim, will be about twenty-five per cent. greater than at their peripheries. It is well to have the upper edges of the floats rather longer than their lower edges, so that the tops of their inner ends, will be rather nearer the axes of the wheels than the bottoms of their inner ends; somewhat as shown in Fig. 3.

What I claim as my invention, is,

1. The arrangement of the gates around and next outside of the peripheries of water wheels, between the wheels and the guides or other things which cause the water to move obliquely toward the wheels in the way the wheels turn, when the water first strikes the floats or buckets; essentially as above described.

2. The device to cause the height of the wheel, or the position of the parts which partially confine the water which presses the wheel upward, to vary as the height of the water or fall varies, so that the width of the aperture which lets the water escape from the place where it presses the wheel upward, varies proportionally to the quantities of water pressed into it; so that the force with which the water presses the wheel upward, will be nearly or quite constant, though the height of the fall varies greatly.

3. The combination of a gate around and near the periphery of a water wheel, between the wheel and the guides or other things which direct the water the way the wheel turns, into the wheel, with the parts of the floats near the gate, curved, so that the water will strike their concave sides; as above described; though I do not limit my claim exactly to any curvature of the floats, but extend it to all curvatures which will essentially answer the same purpose; nor do I limit my claim to an annular gate between the wheel and the things which cause the water to move the way the wheel turns before it enters the wheel, but I extend it to all things which will substantially answer the purpose of a gate, in varying the height, thickness, width or number of streams that enter the wheel.

4. The shape of the spaces between the rims of water wheels which the floats are fastened to, in which they flare toward the axes of the wheels; as above described; though I do not limit my claim to exactly the flaring above described, but extend it to all flaring which will essentially answer the same purpose.

The first, third and fourth branches of my claim, apply only to such hydraulic motors as have guides or other things which cause the water to move obliquely toward the wheels in the way in which the wheels turn, and pass into the wheels at their corcumferential parts, and after acting on the floats, discharge from the floats inward. I do not extend these divisions of my claim to the class of tub wheels and undershot wheels, in which the water generally flows

into the wheels in streams with spaces between the streams, at which spaces the water does not flow into the wheels.

Though I have described these water wheels as being horizontal, and the gates as being opened by raising, it is abvious that all these four branches of my claim, are quite applicable to wheels in other positions, and to cases in which the gate is opened by lowering; and I do not limit either branch of my claim to cases in which the wheels are horizontal or to cases in which the gates are opened by raising.

URIAH ATHERTON BOYDEN.

Witnesses:
LUTHER BRIGGS, Jr.,
JAMES CARR.