(No Model.) 2 Sheets—Sheet 1.

E. B. BENHAM & H. B. RICHARDSON.

HYDRAULIC MOTOR.

No. 276,520. Patented Apr. 24, 1883.

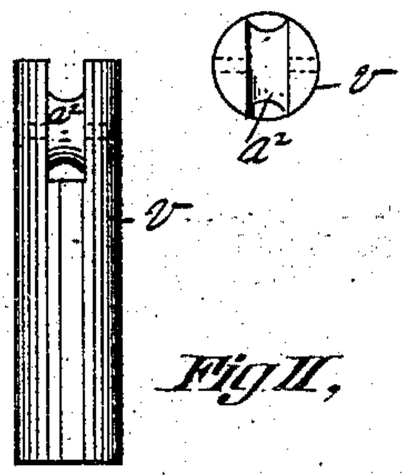

Fig II,

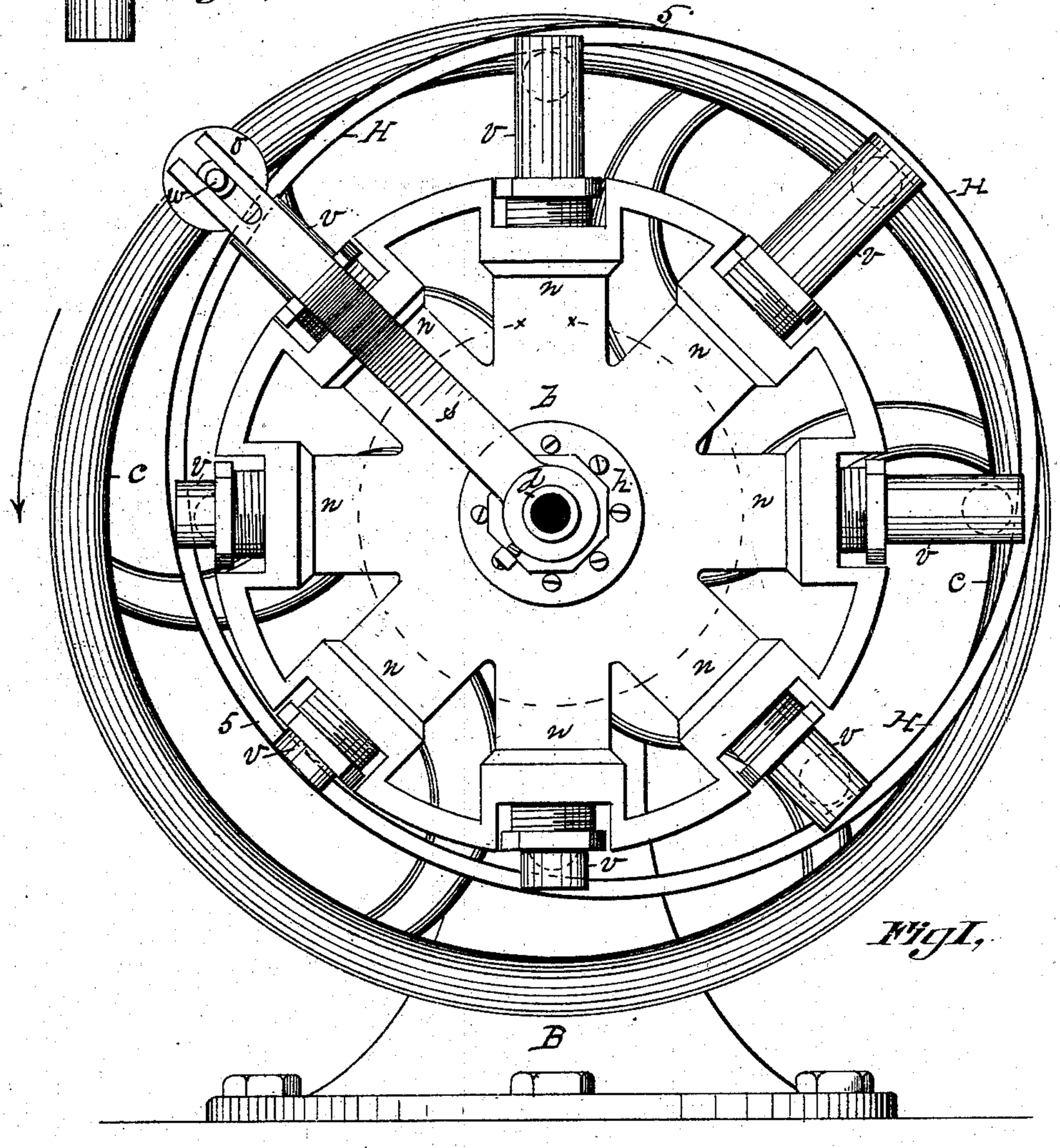

Fig I,

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(No Model.) 2 Sheets—Sheet 2.

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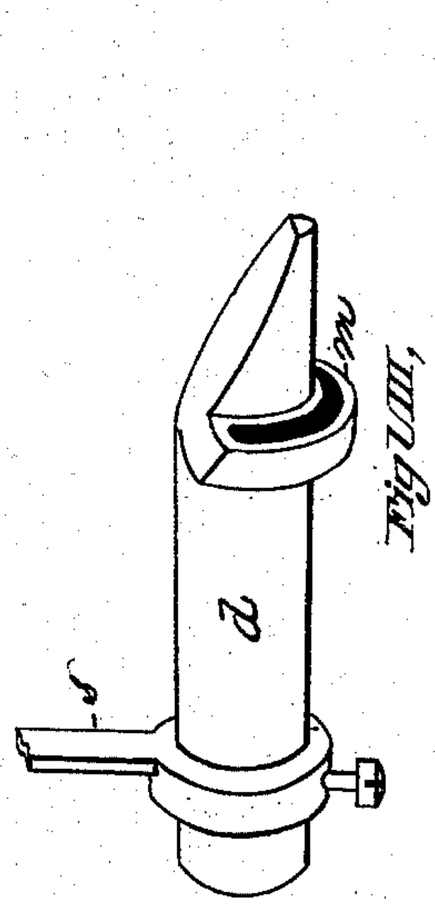

Fig. III.

Fig. I.

Fig. II.

Fig. IV.

Fig. V.

Fig. VI.

Witnesses,
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UNITED STATES PATENT OFFICE.

ELIJAH B. BENHAM, OF MYSTIC, CONNECTICUT, AND HENRY B. RICHARDSON, OF AMHERST, MASSACHUSETTS, ASSIGNORS TO THE AMHERST HYDRAULIC MOTOR COMPANY, OF BOSTON, MASSACHUSETTS.

HYDRAULIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 276,520, dated April 24, 1883.

Application filed September 4, 1882. (No model.)

To all whom it may concern:

Be it known that we, ELIJAH B. BENHAM and HENRY B. RICHARDSON, citizens of the United States, residing respectively at Mystic, New London county, and State of Connecticut, and at Amherst, in the county of Hampshire and State of Massachusetts, have jointly invented new and useful Improvements in Water-Motors, of which the following is a specification.

This invention relates to water-motors, and has reference to that class thereof denominated "piston-motors;" and it consists in the arrangement of a series of pistons within a cylinder-disk and radiating from the center thereof, wherein, through suitable valve-connections for admitting and discharging water, said pistons are caused to have successive reciprocating motions, which motions are so communicated to a ring which rests upon the ends of said pistons and co-operatively acts with the latter as to cause the periphery of said ring to present a continuous succession of curved inclines under a roller-arm, which is attached to a pulley located by the side of said disk, whereby said pulley is given a continuous rotary motion in the plane of the movement of said pistons.

This invention further consists in the combination, with said pistons and their cylinders, of a valve adapted to be rotated through devices connecting it with said ring, whereby water is properly admitted to and discharged from said cylinders.

In the drawings forming part of this specification, Figure I is a front elevation of a water-motor embodying our invention. Fig. II is a side elevation and end view of one of the pistons. Fig. III is a side elevation showing the operative parts in vertical section. Fig. IV is a side elevation of the valve-box. Fig. V is a side elevation of the valve and a portion of the valve-lever. Fig. VI is an end view of the valve and of the inner face of the valve-box, and showing a portion of the valve-lever. Fig. VII is a front elevation of that portion of the cylinder-disk within the dotted line *x x*, Fig. I, from which the valve-box is removed. Fig. VIII is perspective view of the parts shown in Fig. V. Fig. IX is a vertical section of the portion of said disk shown in Fig. VII, together with a portion of its rear hub.

In the drawings, B is a standard. A is a supply-pipe, secured in a sleeve on said standard by a set-screw, *a*. *b* is the cylinder-disk, having a hub, e^2, extending rearwardly. *e* is a circular valve-seat. *n* indicates the cylinders. *v* are pistons. a^2 are rollers in the latter. *z* indicates cylinder-ports. *c* is a balance-wheel. D is a driving-pulley. *w* is a roller-arm on wheel *c*. *o* is a roller on arm *w*. *d* is the valve. *h* is the valve-box. *s* is the valve-lever. *m* indicates the hollow valve-face. H is the lever-ring.

Like letters refer to like parts in the several figures.

The cylinder-disk *b* is a circular metallic piece having a series of cylinders, *n*, formed therein in lines radiating from its center. The outer ends of said cylinders are provided with the ordinary stuffing-boxes, as shown. Said cylinder-disk is provided with a rearwardly-projecting hub, e^2, at its center, through which and said disk is made a suitable water-passage opening into a circular valve-chamber counterbored in the front face of said disk, and that portion of the surface of said valve-chamber which surrounds and stands at a right angle to said water-passage constitutes the valve-seat *e*. Port-holes *z* are formed, running from the lower ends of cylinders *n* toward the center of disk *b*, which terminate in like perforations made in the face of said valve-seat and extending rearwardly, whereby a series of water-passages is provided from said valve-chamber into said cylinders. A valve-box, *h*, having a hub provided with the ordinary stuffing-box, and a flat rim, as shown, is adapted to be secured on the front side of said cylinder-disk by screws or other suitable means, as shown, over said valve-chamber. A valve, *d*, provided with a hollow stem, and with a semicircular face, *m*, having a chamber therein, which communicates with the interior of said stem, and its interior end closed and of taper form, is adapted to be rotated within said valve-chamber and valve-box. The aforesaid semicircular chambered face *m* of valve *d* is adapted

to bear and rotate against the valve-seat *e*, covering a portion of the ports *z*, and leaving the rest of them open into said valve-chamber, the latter being in communication with said water-passage through disk *b*, an opening between said passage and chamber being made by the tapering form of the end of valve *d*, whereby the face of its inclined end is sufficiently removed from the inner border of said chamber to afford a suitable water-passage into any part of the latter which happens to be opposite to that which is occupied by the hollow valve-ring *m*.

The pistons *v* are properly fitted to have a reciprocating motion in the cylinders *n*, and are provided with friction-rollers a^2 in their outer slotted ends.

A lever-ring, H, is adapted to rest in the slotted ends of a certain number of said pistons, and upon said rollers a^2 when the machine is not in motion, and is of such diameter as will permit certain of said pistons on one side of said disk to move while engaged with said ring to the extent of their full stroke outward, while the opposite side of said ring is engaged with certain of said pistons which have made their full stroke inward. Thus when the motor is in operation the successive reciprocating movements of the pistons *v* cause said ring to assume such varying positions relative to the center of disk *b* that the periphery of said ring is made to present a succession of curves eccentric to the center of said disk, which are sharply inclined toward the center thereof, one of which is illustrated between the points 5 5 on said ring in Fig. I.

The supply-pipe A is rigidly secured in a sleeve on the stand B by the set-screw *a*, and, entering the hub e^2 on the rear side of disk *b*, is firmly secured to the latter. A balance-wheel, *c*, having a hub of sufficient length to permit of securing thereon the driving-pulley D, is fitted to rotate on said hub e^2 on disk *b*, and said wheel *c* has an arm, *w*, on its rim, which extends therefrom in a line parallel to the axis of said wheel and across the periphery of said ring H, and carries on it a friction-roller, *o*, which is adapted to ride on the latter.

A valve-lever, *s*, is secured on the aforesaid hollow stem of valve *d*, and its free end engages with the end of said arm *w* on wheel *c*.

The operation of the above-described improvement is as follows: Water is admitted through the pipe A, flowing in the direction of the arrow at the right in Fig. III, and, passing through the center of disk *b*, moves in the direction indicated by the arrow in said figure above the end of valve *d*, flowing into that part of the valve-chamber not occupied by the valve-face *m*, and thence into the cylinders *n*, whose ports *z* are uncovered in said valve-chamber. The pressure of the water now acts against such pistons as are exposed thereto in said cylinders, moving them outward, as shown at the top and at the right in Fig. I, and forcing the periphery of ring H against roller *o* on arm *w*. When said pistons move outward, as aforesaid, the face *m* of valve *d* covers the ports leading to the cylinders on the opposite side of disk *b*, preventing any water from entering them, and providing a free exit for any that may be in them by presenting its open chamber directly before their ports, whence it may flow through said chamber and valve-stem and freely run off. Thus when certain of said pistons move outward, carrying ring H with them, the latter unobstructedly retires the pistons opposite the former into their cylinders. As a consequence of forcing ring H against arm *w*, as aforesaid, and allowing that portion of said ring beyond said arm (or below it in Fig. I) to swing toward the center of disk *b*, such a curved incline is formed and forced to act against said arm that wheel *c* is rotated, and with it valve *d*, through lever *s*, is made to revolve, whereby the cylinder-ports *z* are successively closed and opened. The wheel *c*, it is seen, must revolve in the direction indicated by the arrow, Fig. I, and the action of valve *d* is such as to cause the pistons in the rear of arm *w* to move outward in proper succession to maintain said curved incline, and the pistons which arm *w* is approaching to move inward in like degree.

If desired, the valve *d* may be perforated near the outer face of disk *b* to allow the waste water to run off, instead of discharging it from the extreme end of the valve-stem.

It is obvious that the devices herein described and shown may, in a construction adapted thereto, be advantageously employed with steam or compressed air instead of water.

In fitting the valve *d* to a proper bearing against the valve-box *h*, water may be allowed to flow back of the valve-ring *m* and into said box sufficiently to partially balance said valve and decrease its friction against the latter.

What we claim as our invention is—

1. In a piston-motor, a series of cylinders provided with pistons adapted to have reciprocating motions therein in lines radiating from a common center and in the same plane, ports and valve devices, and operating mechanism, substantially as described, for permitting water to enter and leave said cylinders, a ring surrounding and engaging with the ends of said pistons, a driving-wheel adapted to be rotated in the plane of the reciprocating movement of the latter, and means, substantially as described, for engaging said ring with said driving-wheel, combined and operating substantially as set forth.

2. A series of cylinders provided with pistons adapted to have reciprocating motions in the same plane and in lines radiating from a common center, induction and eduction valve devices, ports, and operating mechanism, substantially as described, a driving-wheel adapted to be rotated in the plane of the movement of said pistons, and appliances, substantially as described, interposed between said

pistons and said wheel, whereby the reciprocating movements of the former are converted into a rotary movement of the latter, combined and operating substantially as set forth.

3. In combination, the wheel *c*, provided with the arm *w*, the ring H, the cylinder-disk *b*, provided with a series of cylinders, *n*, and pistons *v*, the valve *d*, and lever *s*, substantially as set forth.

4. The combination, with the cylinder-disk *b*, provided with the valve-seat *e*, and ports *z*, of the valve *d*, having the chambered semicircular valve-face *m*, and an eduction-opening leading from the rear side of the latter, substantially as set forth.

5. The combination, with a series of pistons, *v*, of the ring H, adapted to be oscillated by said pistons to cause its periphery to describe in succession curved inclines eccentric to the center of motion of said pistons, substantially as and for the purpose described.

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