(No Model.) 2 Sheets—Sheet 1.

W. E. PRALL, Jr.

ROTARY ENGINE.

No. 562,152. Patented June 16, 1896.

Fig. 2

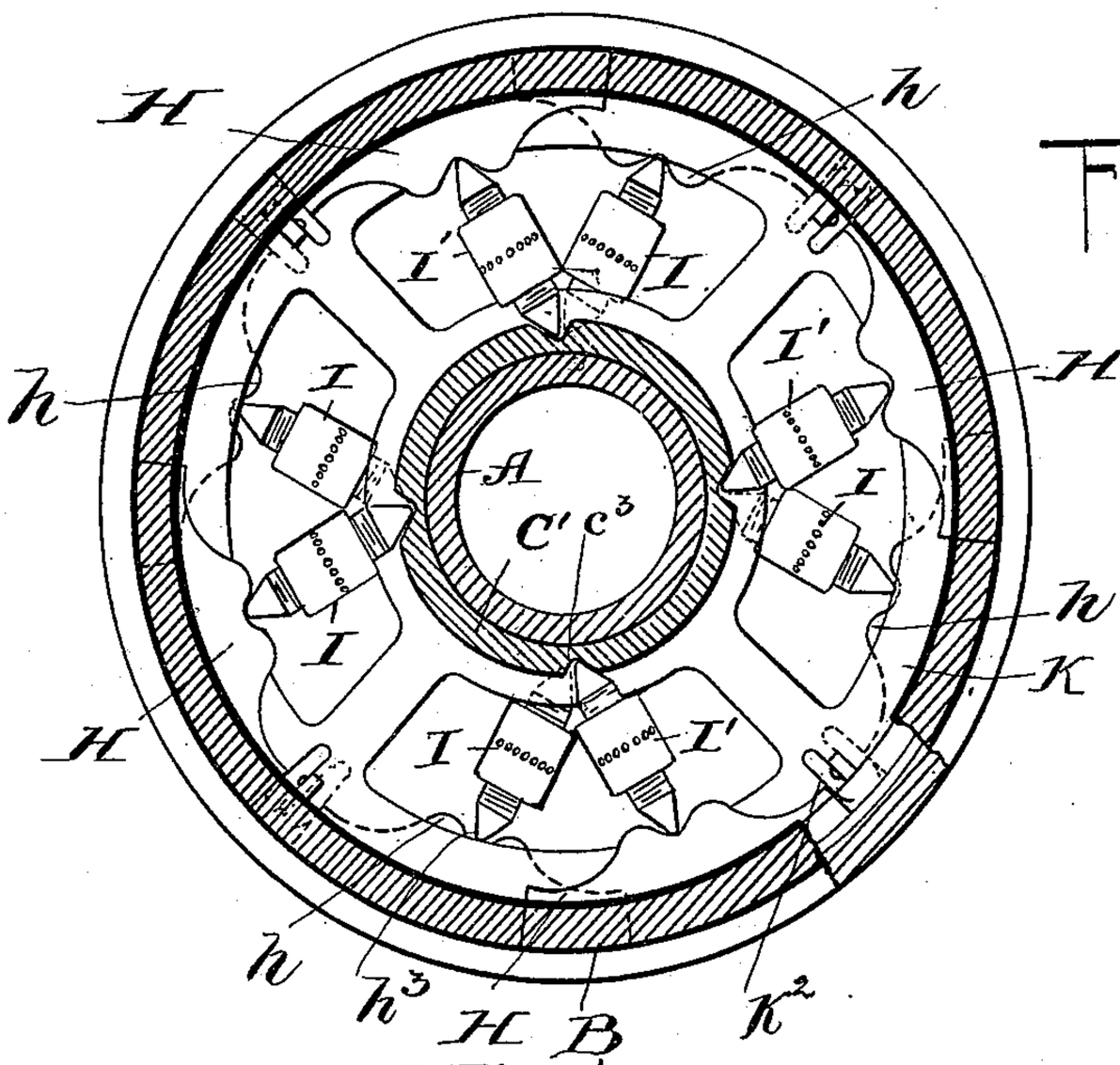


Fig. 2*

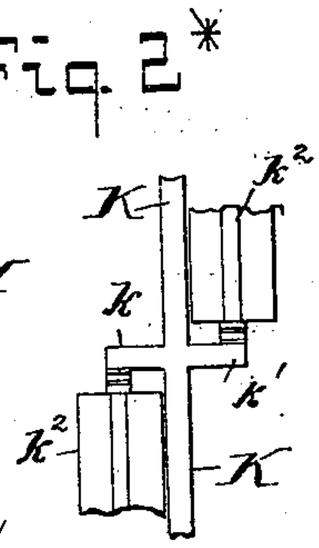
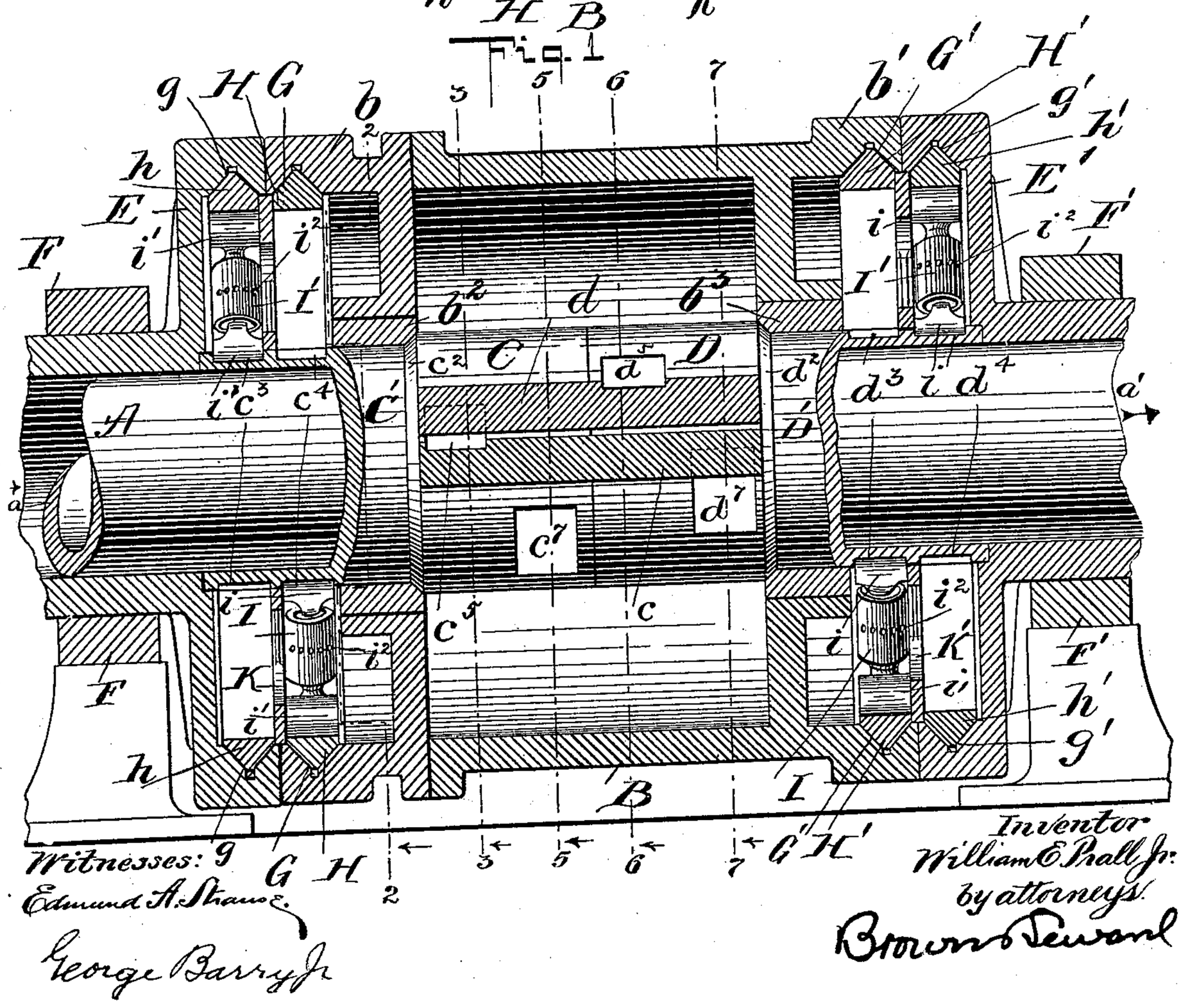


Fig. 1



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(No Model.) 2 Sheets—Sheet 2.

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Fig. 3

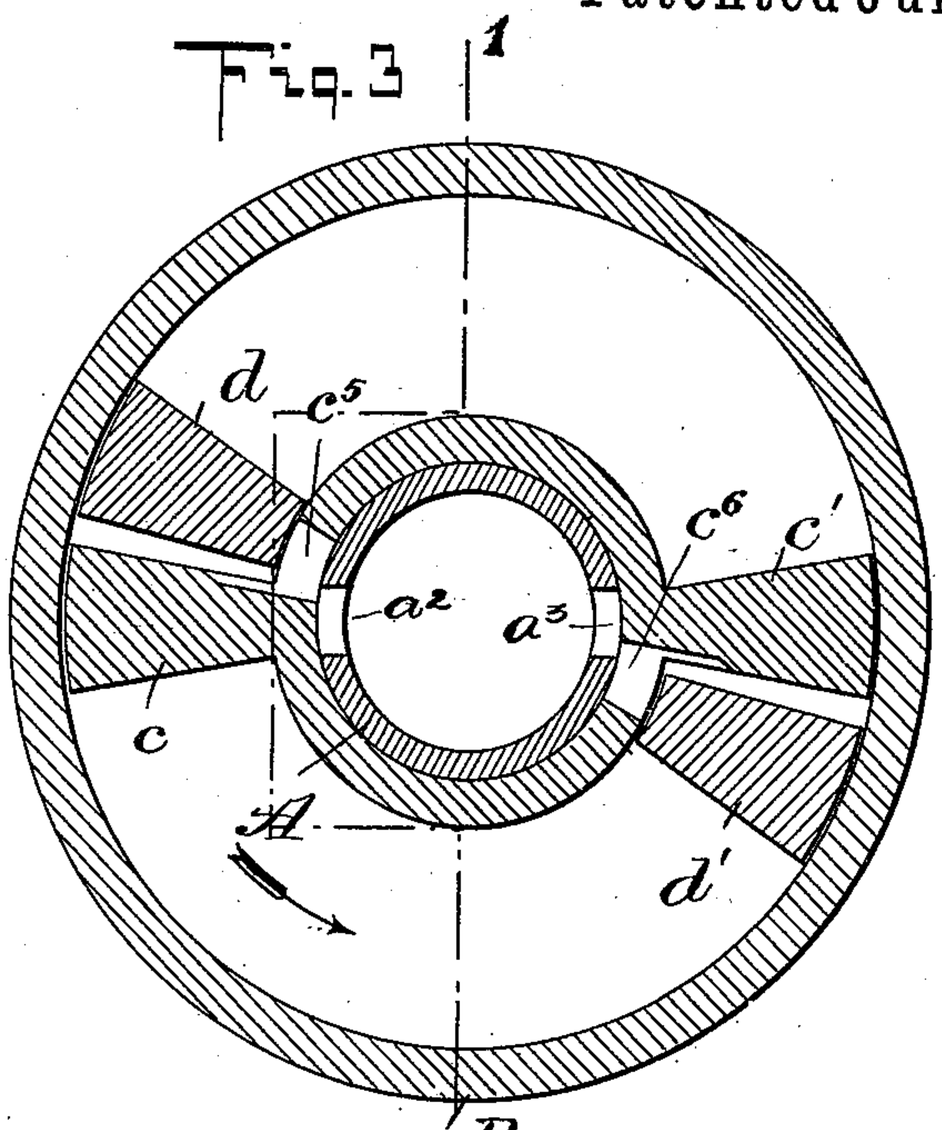


Fig. 4

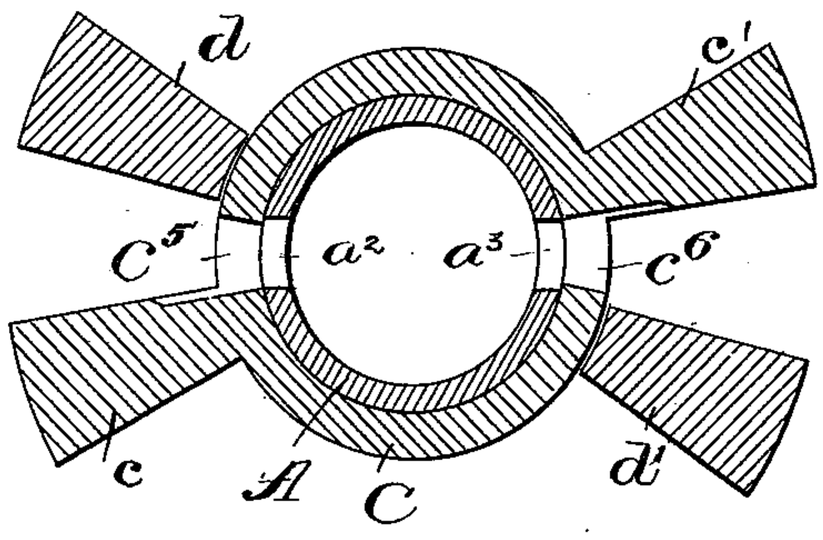


Fig. 5

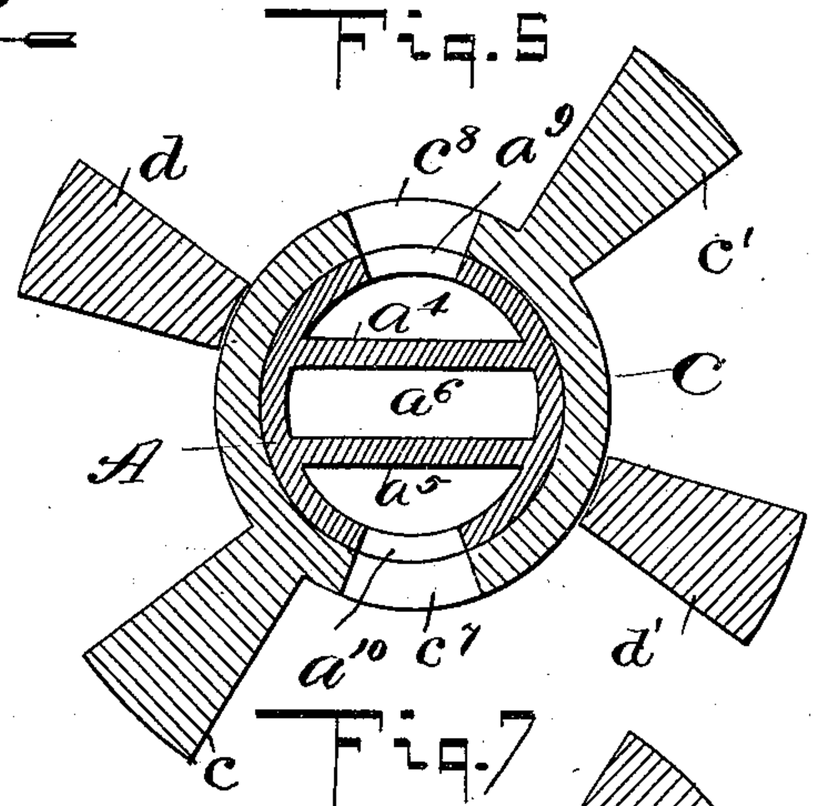


Fig. 6

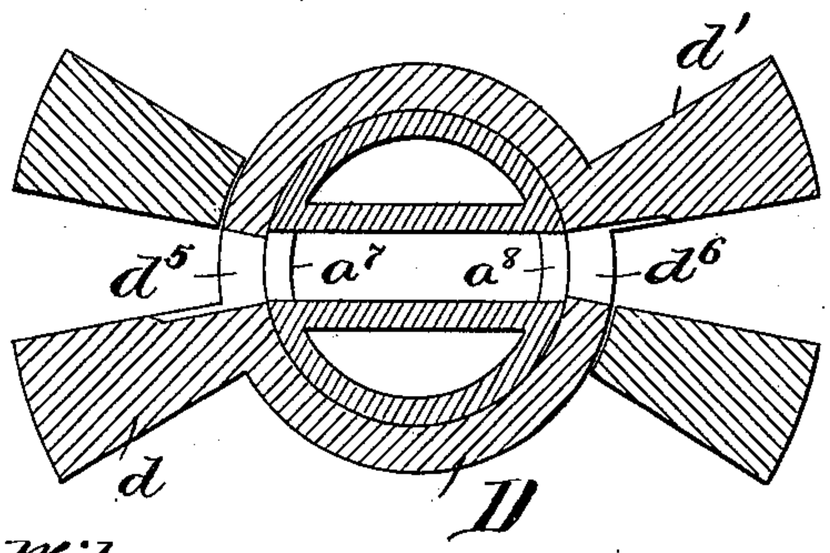
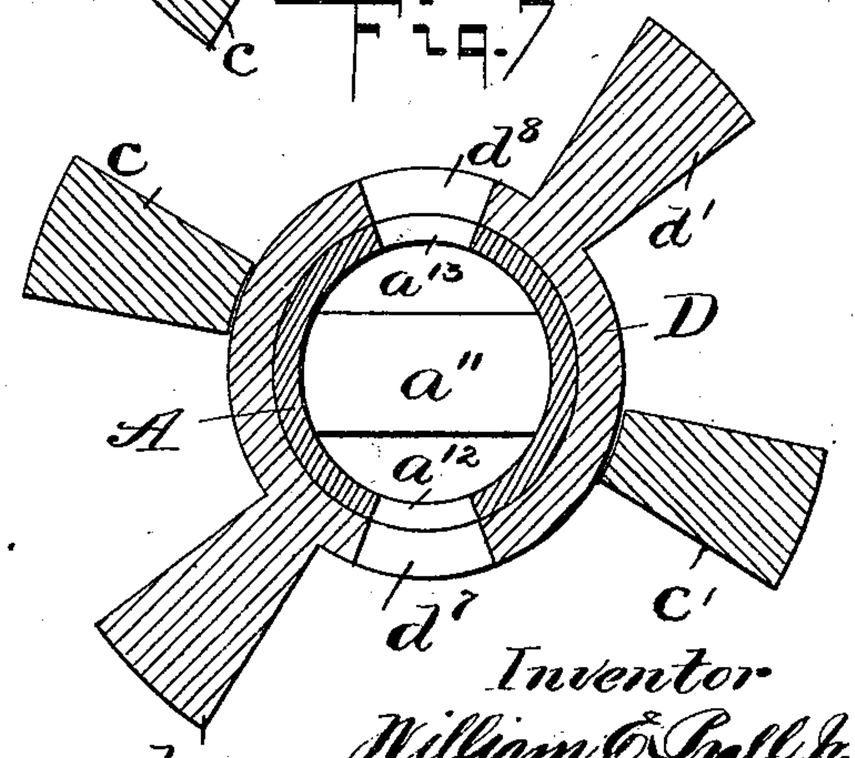


Fig. 7



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UNITED STATES PATENT OFFICE.

WILLIAM E. PRALL, JR., OF NEW YORK, N. Y.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 562,152, dated June 16, 1896.

Application filed March 3, 1896. Serial No. 581,693. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM E. PRALL, Jr., of the city and county of New York, in the State of New York, have invented a new and useful Improvement in Rotary Engines, of which the following is a specification.

My invention relates to an improvement in rotary engines in which pistons are mounted to freely rotate in the same direction about a common axis and carry along with them in their rotary movement either the cylinder or the shaft—in the present instance the cylinder—the pistons, each in turn, becoming an abutment for causing the actuating fluid, either steam or gas, to advance the other piston and the cylinder locked temporarily thereto.

A practical embodiment of my invention is represented in the accompanying drawings, in which—

Figure 1 is a longitudinal section of the engine in the plane of the line 1 1 of Fig. 3. Fig. 2 is a transverse section in the plane of the line 2 2 of Fig. 1 looking toward the left as the drawing is held in reading. Fig. 2* is a fragmentary edge view of one of the shoe-advancing rings with portions of the clutching-shoes in position relative thereto. Fig. 3 is a transverse section in the plane of the line 3 3, Fig. 1, looking toward the left. Fig. 4 is a transverse section through the shaft and pistons in the same plane as Fig. 3, but showing the moving piston advanced from the position where it begins to take steam (shown in Fig. 3) to the position of full-open steam-inlet ports. Fig. 5 is a transverse section in the plane of line 5 5 of Fig. 1 through the shaft and pistons, showing the aforesaid moving piston advanced to the position of full-open exhaust-ports. Fig. 6 is a transverse section in the plane of line 6 6 of Fig. 1 through the shaft and pistons, showing the companion piston in the position of full-open steam-inlet ports; and Fig. 7 is a transverse section in the plane of line 7 7 of Fig. 1 through the shaft and pistons, showing the companion piston in the position of full-open exhaust-ports.

In the type of engine which I have chosen to illustrate my invention the cylinder is mounted to rotate freely on the shaft and is utilized as a driving-pulley to transmit motion from the engine to the mechanism which it is intended to actuate. The pistons are mounted to rotate freely in the same direction about the shaft within the cylinder, and, in turn, as they are submitted to fluid-pressure between them, become temporarily locked, the one to the cylinder and the other to a part fixed in space, whereby the cylinder is rotated by the piston for the time being locked thereto.

The shaft about which the cylinder and pistons revolve is denoted by A. It is made hollow and is utilized for the purpose of the introduction of steam to and its exit from the cylinder, the steam in the present instance being arranged to enter at the end *a* of the shaft and exhaust at the end *a'*.

The cylinder, which is utilized at the same time as the driving-pulley, is denoted by B. Its heads *b b'* are chambered on their outer faces for the reception of the clutching mechanism to be hereinafter described, and they are provided with central openings for the reception of the shaft A and the hubs of the pistons and provided with boxes b^2 b^3 to take the wear and form a smooth bearing for the rotary movement of the cylinder. One of the heads, in the present instance *b*, is made separable from the body of the cylinder for convenience in assembling the parts.

The pistons, two in number, each consist of a hub loosely mounted on the shaft A and a pair of wings or blades extending in opposite directions from the hub, each constructed to extend from the hub to the inner curved surface of the cylinder forming a loose joint with the interior faces of the ends of the cylinder and with the interior curved surface of the cylinder. The hubs of the pistons are represented, respectively, by C and D, the oppositely-extending wings or blades on the hubs C are denoted by *c c'*, and the oppositely-extending wings or blades on the hub D are denoted, respectively, by *d d'*. The hubs C and D each preferably extend about one-half of the length of the interior of the cylinder B, the wings which are fixed to the hub C projecting over the hub D and the wings fixed to the hub D projecting over the hub C, making a close easy joint with the exterior of the hub. The hubs C and D are preferably beveled at points opposite the inner faces of the cylinder-heads, as shown at c^2 and d^2, and extend thence—reduced in diameter—through the cylinder-heads and within

chambered end caps E E′, fixed to the shafts A and its supports F F′, respectively, the extended ends of the piston-hubs of reduced diameter being denoted, respectively, by C′ D′. The end caps E E′ are chambered on their faces toward the chambered faces of the cylinder-heads for the reception of clutching mechanism to be hereinafter particularly described.

Within the chambered heads $b\,b'$ of the cylinder there are formed annular interior grooves G G′ for the reception of curved-faced sliding shoes H H′. (Shown in side elevation in Fig. 2 and in transverse section in Fig. 1.) In the present instance I have shown four of the shoes H H′ in each of the grooves G G′ located a quadrant's distance apart. The number may, however, be greater or less than four, as may be found most desirable. In like manner there are formed within the chambered faces of the end caps E E′ annular interior grooves $g\,g'$ for the reception of curved-faced sliding shoes $h\,h'$, in the present instance four in each of the grooves, located a quadrant's distance apart, although the number may be greater or less than four, if so desired.

The shoes in the grooves G G′ are held in position radially by toggle-dogs I, one for each shoe, provided with V-shaped ends which loosely rest, one end in recesses h^2 in the inner faces of the shoes and the opposite end in recesses c^3 in the periphery of the hub extension C′ at one end of the cylinder and in recesses d^3 in the hub extension D′ at the opposite end of the cylinder. In a similar manner the shoes $h\,h'$ in the end caps are held in position radially by means of toggle-dogs I′, quite similar to the toggle-dogs I and having their V-shaped ends resting, respectively, in recesses h^3 in the shoes and in recesses c^4 in the hub extension C′ at one end of the cylinder and in recesses d^4 in the hub extension D′ at the opposite end of the cylinder.

The toggle-dogs I I′ are in length slightly more than the radial distance from the bottom of the recess in the hub extension to the bottom of the recess in the shoe, so that they normally assume a slanting position with respect to the radial line, as clearly shown in Fig. 2, and any tendency to swing the shoe in a direction to throw the toggle-dog into a radial position will have a tendency to crowd the shoe outwardly against the walls of the annular grooves in which the shoes slide and thereby clutch the shoe to the wall of the groove. For the purpose of varying the lengths of the dogs to account for wear or for exact adjustment at any time I prefer to make one or both of their V-shaped ends adjustable with respect to the body portion of the dog, and in the present instance I have shown the V-shaped ends represented by i and i' (see Fig. 1) as having a right and left screw threaded engagement with the ends of the body portion and have provided the body portion with a series of holes i^2 for the purpose of inserting a pin for turning the body portion and thereby drawing the V-shaped ends toward one another to shorten the length of the dog or to force the end portions away from each other to lengthen the dog.

The series of shoes H H′ are separated from the series of shoes $h\,h'$, respectively, by rings K K′, fixed, respectively, to the hub extensions C′ and D′ and preferably formed skeleton, as shown. At the ends of the shoes H H′, which have a tendency to slide past each other under the influence of the slanting direction of the toggle-dogs, I provide the ring K with laterally-extending lugs $k\,k'$ to form a stop for the circumferential movement of the shoe, and I interpose between the lugs $k\,k'$ and the ends of the shoes H H′ springs k^2, the tension of which tends to hold the shoe against which they press yieldingly in position in close proximity to the walls of the grooves in which they slide, so that the clutching action will take place the instant the toggle-dog is thrown in a direction toward the radial position.

The ports through the wall of the shaft A and through the hubs of the pistons for the inlet and exhaust of the actuating fluid are arranged as follows: Through the hub C there are formed inlet-ports $c^5\,c^6$ at the base of the wings $c\,c'$, respectively, and exhaust-ports c^7 c^8, arranged in a different transverse plane from the ports $c^5\,c^6$ and located diametrically opposite each other and preferably at about a quadrant's distance in a circumferential direction from the ports $c^5\,c^6$. The hub D is in like manner provided with inlet-ports $d^5\,d^6$, located at the bases of the wings $d\,d'$, and with exhaust-ports $d^7\,d^8$, located in a different transverse plane and a quadrant's distance circumferentially from the ports $d^5\,d^6$.

The shaft A, which forms a conduit for the actuating fluid to and from the inlet and exhaust ports, has its interior conveniently left unobstructed from the end a up to a point just to the right of the plane of the inlet-ports $c^5\,c^6$ in the hub C, where it is provided with two diametrically opposite ports $a^2\,a^3$ (see Fig. 4) to correspond with the ports $c^5\,c^6$ in the hub C. Intermediate of the planes of the inlet-port c^5 and the exhaust-port c^7 the interior of the shaft A is provided with bulkheads $a^4\,a^5$, which partially obstruct its interior, leaving an open central conduit a^6 for the further passage of the actuating fluid to the diametrically opposite ports $a^7\,a^8$, (see Fig. 6,) which correspond to the ports $d^5\,d^6$ in the hub D. The wall of the shaft A is provided with exhaust-ports $a^9\,a^{10}$, which communicate with the interior chambers upon opposite sides of the central conduit a^6, and which, being shut off from the high-pressure fluid by bulkheads a^4 and a^5 at one end, communicate freely with the interior of the shaft at the exhaust end a'. The conduit a^6 for conducting the high-pressure fluid to the ports $d^5\,d^6$ has its end toward the end a' of the shaft A closed by a bulkhead a^{11}, (see Fig. 7,) while the interior of the shaft at the exhaust end a' is in free

communication with a second set of exhaust-ports a^{12} a^{13} to correspond with the exhaust-ports d^7 d^8 in the hub D.

Suppose the pistons to occupy the position shown in Fig. 3, which is also the position presented in Figs. 1 and 2, with the ports c^5 c^6 just open to the ports a^2 a^3 for receiving the actuating fluid. The pressure between the wings c d and between the wings c' d' will tend to throw them in opposite directions. Because of the clutch mechanism hereinbefore described, the wings d d' cannot move in the direction in which they are pressed, because the clutching-shoes h', connected with the hub D of the piston, will be, by means of their toggle-dogs I', thrown into frictional contact with the walls of the groove g' in the stationary end cap E'. The wings c c' will at the same time, by their tendency to rotate, clutch their hub tightly to the groove G in the cylinder-head by means of the toggle-dogs I, engaged with their hub, but as the cylinder is free to rotate, the wings c c', together with the cylinder clutched thereto, will rotate in the direction of the arrow. (See Fig. 3.) As the hub C rotates it will gradually bring the inlet-ports to a full open, as shown in Fig. 4, and then will gradually cut off the entrance of the actuating fluid as the ports c^5 c^6 pass from register with the ports a^2 a^3, and the exhaust-ports c^7 c^8 will gradually open to a full exhaust (shown in Fig. 5) and then gradually cut off the exhaust as the wings c c' approach the position of the wings d d', which have remained stationary. As the wings c c' approach the position of the wings d d' they will press against them through the cushion of the actuating fluid between them and overcome their inertia, starting them (the wings d d') on their advance movement into the position shown in Fig. 6, the wings c c' forming, in turn, abutments while the wings d d' complete their half-revolutions, carrying with them the cylinder, to which they are in turn clutched in the same manner in which the wings c c' were clutched thereto, the wings c c' being held in turn against a retrograde movement by the pressure of the clutching-shoes h, connected with the hub C by the toggle-dogs I', with the groove g in the stationary end cap E. As the wings d d' approach the wings c c' they will in turn start the wings c c' on their advance movements, as hereinafter described. In this manner the pistons will be alternately clutched and released from the cylinder and released and clutched to the stationary end caps, thereby imparting to the cylinder a constant rotary movement, the cylinder making a complete revolution, while each piston moves relatively to the cylinder only a half-revolution or less.

By the above structure the wearing friction which has hitherto been so objectionable in rotary engines is materially reduced, both on account of the material reduction in the number of revolutions which the piston makes relative to the cylinder and on account of the mounting of the pistons upon the central shaft by means of an extended bearing longitudinally of the shaft, which prevents them from pressing against the interior of the cylinder and holds them steadily in close relation to the interior surfaces of the ends of the cylinder without any tendency to cut out by undue frictional contact. The cut-off, after the pistons are once started, will be automatically taken care of by the pistons themselves, as the piston which follows the advancing piston will not come to a stop and form an abutment until the pressure of the actuating fluid between the pistons becomes greater than the momentum of the cylinder and pistons. Hence there will be very little of the actuating fluid used when the cylinder is running under its own momentum, or its own momentum increased by that of the balance-wheel employed, and yet whenever the work put upon the engine becomes sufficient to require it the actuating fluid will promptly escape and carry its pressure between the wings to force one of them, and the cylinder with it, forward, while the other forms the abutment.

It is obvious that by making the end caps free to revolve and the cylinder stationary the movement of the parts might be reversed.

Where I have referred to "steam" in the foregoing description I wish to be understood as referring to the actuating fluid, whether it be steam or gas.

What I claim is—

1. A rotary engine comprising two parts, a shaft and a cylinder, a plurality of pistons mounted within the cylinder and serving as valves for the admission and discharge of the actuating fluid, the said pistons being free to rotate independently of one of the said parts and the other of said parts being at the same time free to rotate independently of the pistons and means for clutching the pistons to one of said parts and to a stationary part, substantially as set forth.

2. A rotary engine comprising a cylinder, pistons mounted to rotate within the cylinder and serving as valves to admit and discharge the actuating fluid, means for clutching the pistons to and releasing them from the cylinder, parts located in proximity to the cylinder, means for clutching the pistons to and releasing them from said parts, the cylinder and the clutch-receiving parts adjacent to the cylinder being the one supported to rotate and the other stationary, and means for conducting the actuating fluid to and exhausting it from the interior of the cylinder, substantially as set forth.

3. A rotary engine, comprising a shaft, pistons mounted on the shaft to rotate freely, a cylinder mounted on the hubs of the pistons to rotate freely, end caps located at the opposite ends of the cylinder and independent of the cylinder, means for clutching the pistons to and releasing them from the cylinder and end caps, and means for supplying the

actuating fluid to and exhausting it from the interior of the cylinder, substantially as set forth.

4. A rotary engine, comprising a cylinder, pistons mounted to rotate freely within the cylinder and having hub portions projecting through the ends of the cylinder sliding clutching-shoes in position to engage the heads of the cylinder, end caps located in proximity to the heads of the cylinder, sliding clutching-shoes engaged with said end caps, toggle-dogs engaged with the projecting hubs of the cylinder and the inner faces of the sliding clutching-shoes for forcing the shoes into frictional contact with their respective bearings and means for supplying the actuating fluid to and exhausting it from the interior of the cylinder, substantially as set forth.

5. The combination with the chambers for the supply and escape of the actuating fluid and provided with inlet and exhaust ports, of the rotary pistons having hubs which serve as valves for opening and closing said inlet and exhaust ports and provided with corresponding ports for admitting the actuating fluid between and exhausting it from between the pistons, a cylinder surrounding the pistons, chambered caps at the ends of the cylinder and means for clutching the pistons to and releasing them from the caps and cylinder, substantially as set forth.

6. The combination with the cylinder, the chambered caps at the ends of the cylinder, the pistons provided with hubs extending through the ends of the cylinder and clutching-shoes engaged with the cylinder-heads and end caps, of toggle-dogs loosely engaged with the said piston-hubs and clutching-shoes and arranged to normally assume a position oblique to the radial line, substantially as set forth.

7. The combination with the rotary pistons, the cylinder and the end caps, of the sliding shoes engaged with the cylinder and end caps, the toggle-dogs engaged with the shoes and the pistons and occupying a normally oblique position to the radial line, abutments for holding the shoes from displacement under the pressure of the toggle-dogs and spring-cushions inserted between the shoes and said abutments for holding the shoes in position to clutch, substantially as set forth.

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