(No Model.) 3 Sheets—Sheet 1.

H. A. TOBEY.

ROTARY MOTOR.

No. 296,894. Patented Apr. 15, 1884.

Fig. 1.

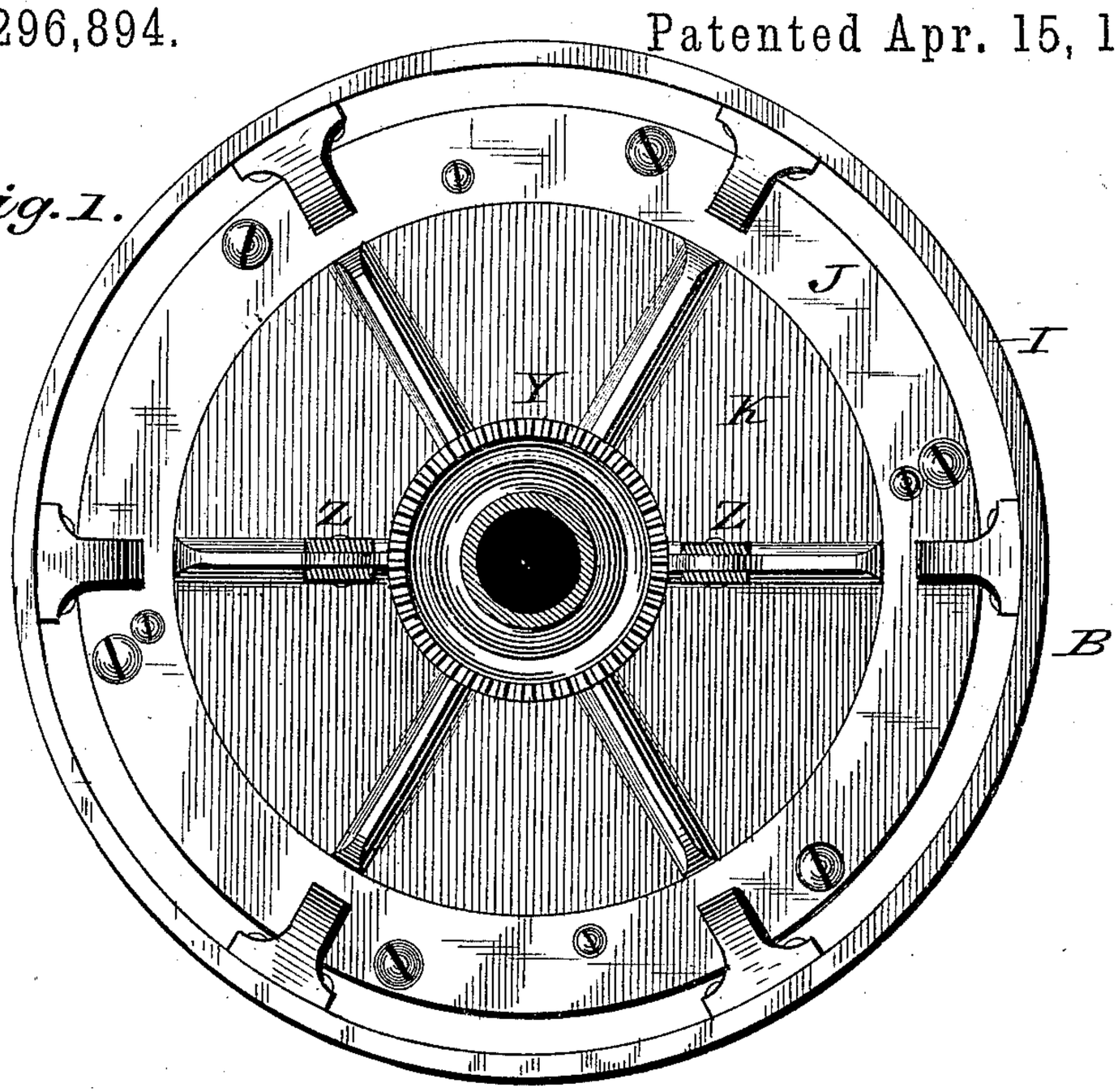
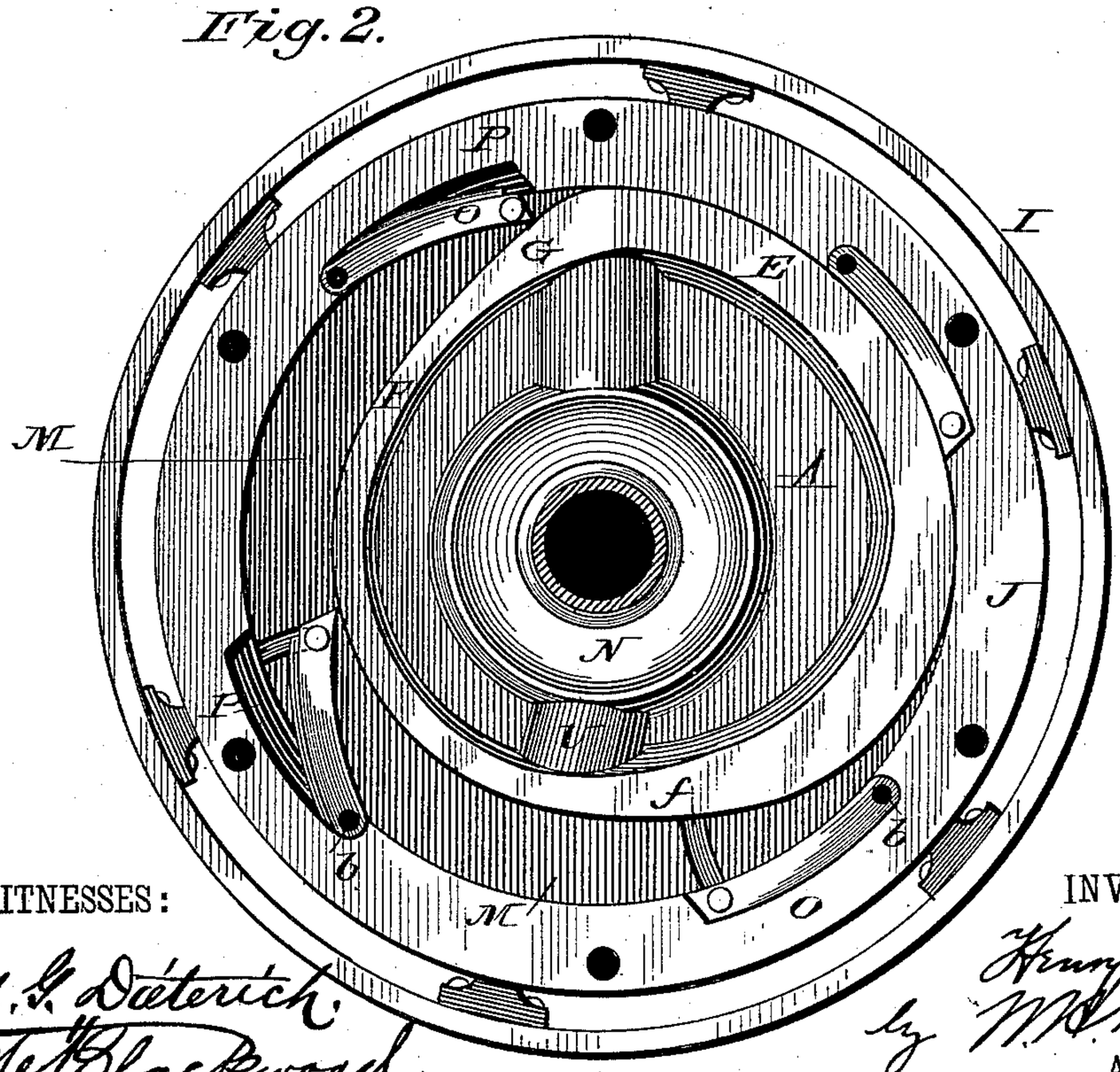


Fig. 2.



WITNESSES:

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(No Model.)

3 Sheets—Sheet 2.

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Fig. 3.

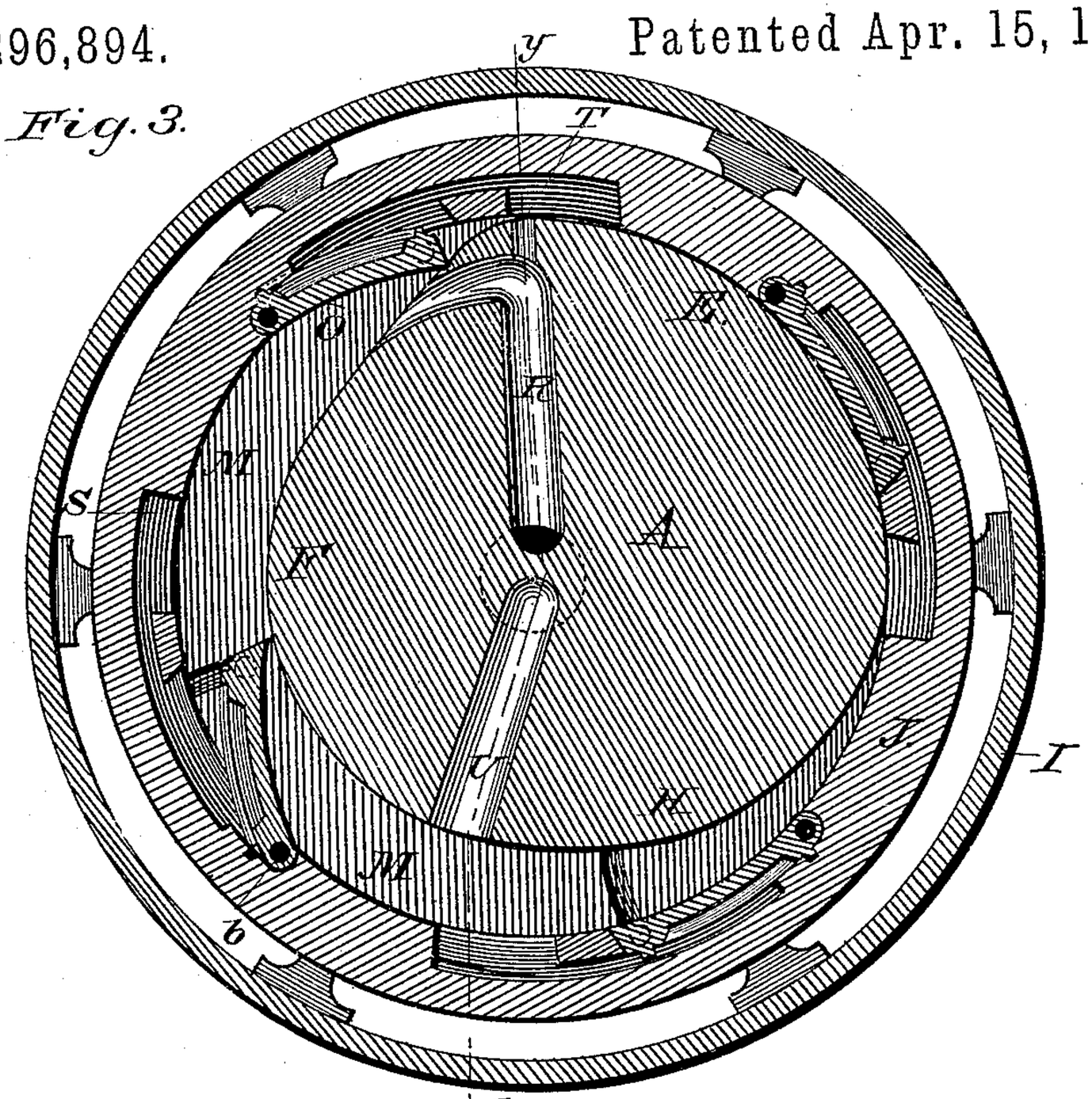

Fig. 4.

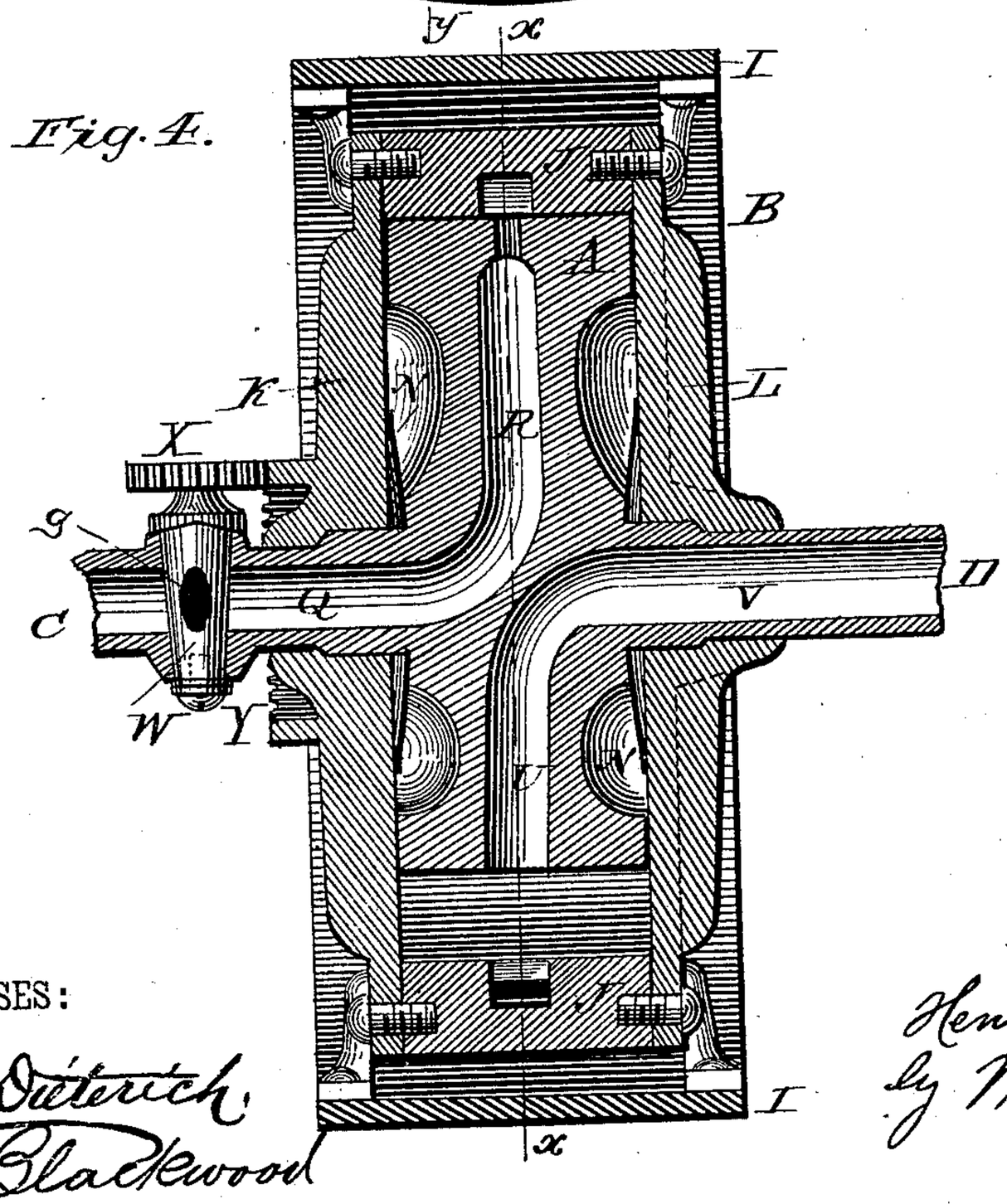

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Fig. 5.

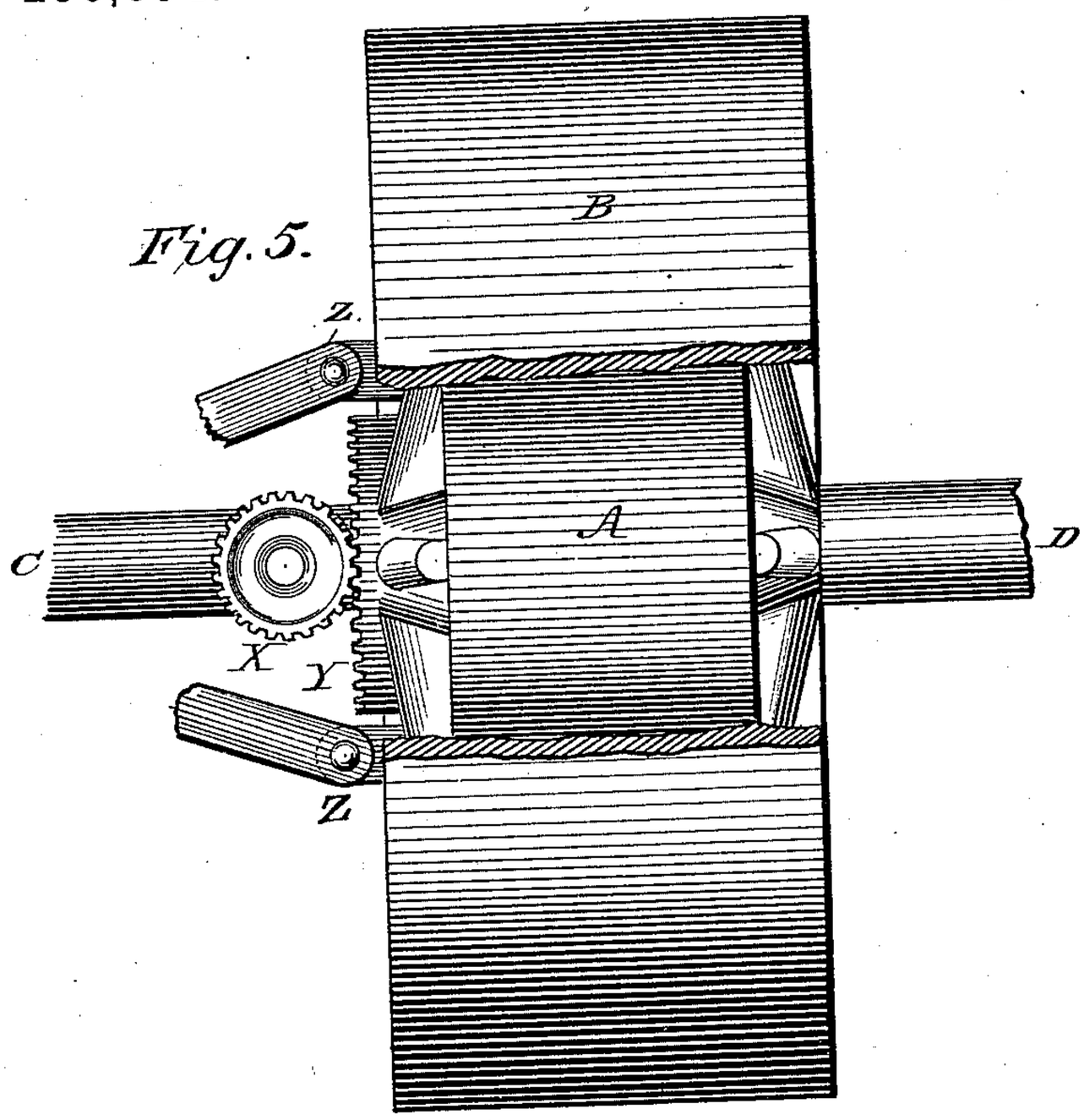


Fig. 6.

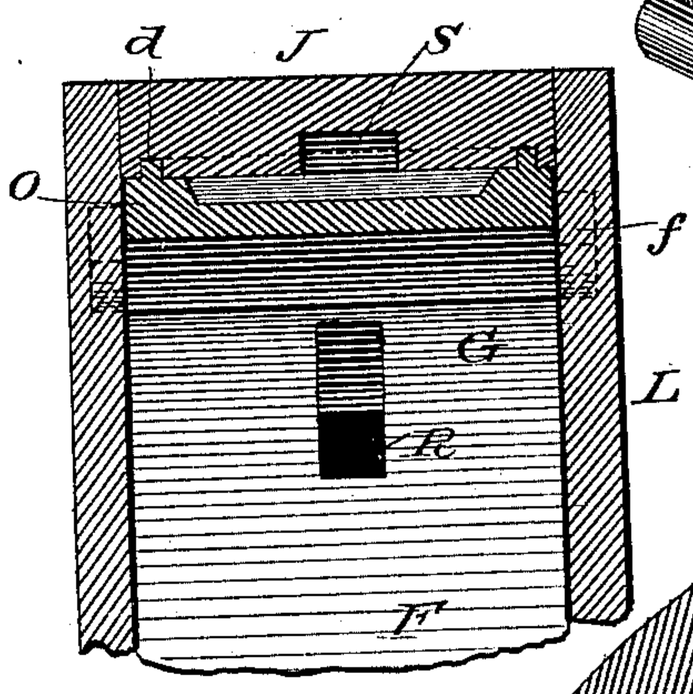


Fig. 7.

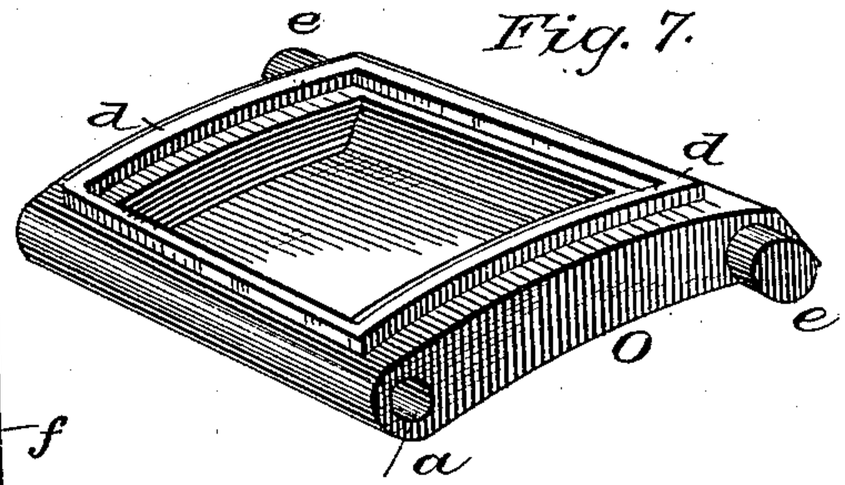
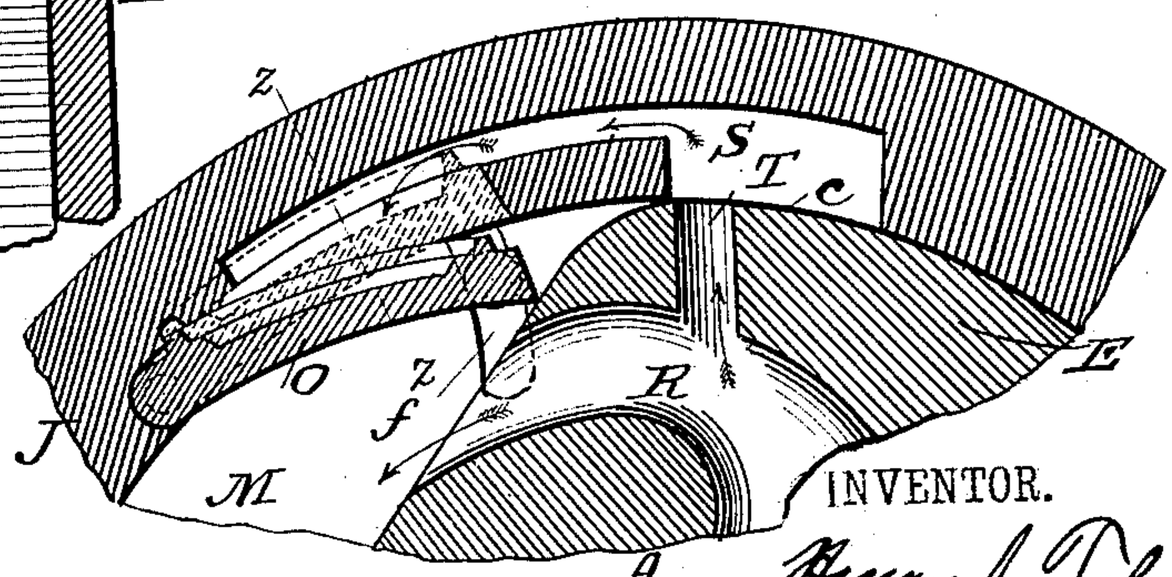


Fig. 8.



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UNITED STATES PATENT OFFICE.

HENRY A. TOBEY, OF DAYTON, OHIO.

ROTARY MOTOR.

SPECIFICATION forming part of Letters Patent No. 296,894, dated April 15, 1884.

Application filed September 8, 1883. (No model.)

To all whom it may concern:

Be it known that I, HENRY A. TOBEY, a citizen of the United States, residing at Dayton, in the county of Montgomery and State of Ohio, have invented certain new and useful Improvements in Rotary Motors; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention consists in an improved rotary motor composed, essentially, of two cylinders or casements, one encircling the other. The inner cylinder is an eccentric one and is stationary, and through passages extending through it steam, water, or other motive power is introduced and the exhaust-steam, &c., is discharged. The outer casement, which incloses the inner cylinder, is adapted to rotate, the motive power being introduced behind pistons or wings hung to swing at their forward ends from the outer casement. The axes upon which the outer casement rotates are rigidly held on a supporting-frame, and are rigidly secured to or cast with the inner stationary cylinder, and through them the steam or other motive power is communicated to the passages in the stationary cylinder mentioned, so that there is nothing to break the circumference of the outer casement. Power from the motor can be communicated directly from the casement by belting or other similar means without the intervention of other mechanism.

Although my motor is especially designed to utilize steam as the motive power, I do not wish to confine myself to steam, as water or compressed air may also be used. For convenience, however, of description, I shall refer only to steam as the motive power.

In addition to the main features already referred to, my invention consists, further, in special devices for reducing the friction of the pistons to a minimum; for rendering the casements practically steam-tight with a minimum amount of friction; in means for automatically controlling the admission of the steam, so as to economize the steam as much as possible; and in minor details, which are hereinafter more specifically set forth.

The obstacles heretofore existing to the practical and effective operation of rotary motors consisting of an outer and inner cylinder, one of which rotates, are due to the power required to work complicated or clumsy mechanisms for operating their pistons, and the friction arising from the employment of means to make them steam-tight, whereby but a small percentage of the steam-power employed has been utilized.

The object of my invention is to overcome these difficulties or reduce them to a minimum, and practical experiments have demonstrated that the invention will accomplish this result.

In the accompanying drawings, which illustrate my invention and form part of this specification, Figure 1 is a side view of my improved motor. Fig. 2 is a side view with a head removed, showing the interior arrangement. Fig. 3 is a central vertical longitudinal section in a plane indicated by the line *x x*, Fig. 4. Fig. 4 is a central vertical transverse section in a plane indicated by the line *y y*, Fig. 3. Fig. 5 is a top view, with a portion of the outer rim broken away. Fig. 6 is a sectional view of the outer casement in a plane indicated by the line *z z*, Fig. 8. Fig. 7 is an enlarged perspective view of one of the buckets or pistons, showing the top or inner side thereof; and Fig. 8 is a view, on an enlarged scale, of a portion of the motor as shown in Fig. 3.

Like letters designate corresponding parts in all the figures.

The motor consists, principally, of two casements or cylinders, an inner stationary cylinder, A, and an outer rotating casement, B, inclosing said inner cylinder. The power of the motor is applied directly from the rotating cylinder by means of belts or equivalent mechanism. The inner stationary cylinder, A, is hollowed on the sides, as shown, to economize metal. To this cylinder are attached hollow shafts C D, which either form integral parts of the cylinder or are rigidly secured thereto. By means of these shafts the stationary cylinder is rigidly mounted upon any suitable frame-work or support, and is placed eccentrically on its shafts. Its periphery is composed of two arcs, E F, of different radii, each having a common center which is coincident with the center of the shafts C D, and connecting the two arcs are cam-surfaces G H. When the cylinder A is placed in position,

it is preferably arranged so that the arc E, reckoning from right to left, terminates at the highest vertical point. The cam-surface G, which connects the arcs E and F at the top, is much shorter than the cam-surface H, which connects them at the bottom, thus making the descent from the arc E to the arc F much more abrupt than the ascent from the arc F to the arc E, which ascent is quite gradual. The outer rotating casement, B, is composed of an outer rim, I, and an inner rim, J, both perfectly circular in shape, which are connected together in any suitable manner to leave open air-spaces between them, so as to prevent the outer rim, I, upon which the belt runs, from becoming heated. Side plates, K L, are secured steam-tight to the inner rim, J, and surround and inclose the inner cylinder, A. The width of the rim J is the same as that of the inner cylinder, A, so that when the side plates, K L, are put in position they fit exactly over the sides of the cylinder A, as near steam-tight as possible. The plates K L are formed with apertures, so that they can be passed over the shafts C D, said shafts serving as bearings on which the outer casement, B, rotates. The inner radius of the inner rim, J, of the rotating casement is equal to that of the arc E of the stationary cylinder, so that when the outer casement is placed in position over the stationary cylinder it fits exactly over said arc and leaves a space, M, between the inner surface of the rim J and the arc F and the cam-surfaces G H.

To prevent the escape of steam between the shafts C D and the side plates, K L, which rotate on said shafts, I adopt a peculiar device and dispense with the use of packing or stuffing boxes, which entail friction and consequent loss of power, and which also require much attention to keep in order. This device consists of thin concave metal plates N N, secured to the sides of the cylinder A, which is suitably hollowed out for their reception, and which hollow spaces are less than the height of the plates. Each of said plates, when in position, has its apex against the cylinder A, to which it is rigidly attached, with its free edge outward. When the side plates, K L, are secured in position, they press against the edges of the concave plates N N, which have sufficient spring to allow the plates K L to be properly secured. When in position, the edges of the concave plates press exactly and evenly upon the inner faces of the plates K L. As only their edges are in contact, and as they are circular and concentric with the shafts C D, the friction is very slight. Now, if any steam should force its way between the stationary cylinder and the rotating casement, it will be unable to reach the bearings of the casement upon the shafts, as it will encounter the concave plate N, and any pressure from the steam upon that plate will cause it to press tightly upon the face of the side plates of the casement. The spring of the concave plate will take up the wear upon its edges, and as the wear continues the edges are worn smoother and the joint is made still tighter. Thus the replacing of this plate by reason of wear will be rarely necessary.

For rotating the outer casement I pivot or hinge to said casement a number of wings or pistons, O O, equidistant apart, upon which the steam operates. I have shown four of these pistons as the preferred number; but any desired number may be used, as convenience and economy may suggest.

The casement is shown in the drawings as adapted to rotate from right to left, and, without regard to the motive power, if the casement should be slowly rotated, the action of the pistons would be as follows: Considering the direction of rotation, the pistons are pivoted or hinged at their forward ends, and when they pass from behind the arc E at the highest vertical point of the inner cylinder, their weight will cause their free ends to follow down the cam-surfaces G and along the arc F until they reach the lowest point, when they will drop back into the rim J, and be carried in that position up to the starting-point. I have detailed the operation of the pistons when the casement rotates slowly, as with a rapid rotation the pistons would be constantly held against the rim J by the centrifugal force. The centrifugal force which tends to keep the pistons folded against the rim J has the least effect when the pistons pass out from behind the arc E, being then partly counteracted by the weight of the pistons, and it has the greatest effect at the bottom or lowest point of the motor, as there the weight of the pistons is an assistance. The pistons are of a width equal to the width of the rim J or the thickness of the cylinder A, so that they completely close the space M. As the inner surface of the rim J fits exactly over the arc E, I cut sockets or recesses P P in the rim J, in which the pistons O O exactly fit, so that they will pass over the arc E without hinderance. The pistons are hinged or pivoted to the casement in such a manner that they may be easily removed, if desired, and be replaced by others in case they become worn out. The forward ends of each of the pistons are semi-cylindrical in shape, and are bored out through the entire width of the piston, or to a suitable distance in each side thereof, as may be desired. Into this aperture extend nicely-fitting pivots or bearings *b b* on either side. These pivots or hinges, (one or both) extend through the side plates, K L, of the casement, and are preferably made removable, so as to facilitate the removal of the pistons. The cylindrical forward ends of the pistons fit in corresponding curves formed in the forward portions of the recesses or sockets P P. The steam is admitted to rotate the casement through a passage, Q, provided by making one of the shafts—say C—hollow, and communicating with this passage is a second passage, R, which is a continuation of the passage Q, and leads through the cylinder A to the space M, between the casement and the

cylinder, which constitute the pressure-chamber. The passage R in the cylinder A preferably extends upward in a nearly vertical direction, so that if extended it would reach the periphery of the cylinder at the junction of the arc E and the cam-surface G; but just before reaching the periphery the passage R makes an abrupt turn of about ninety degrees and opens into the pressure-chamber M just beyond the junction of the arc E and cam-surface G, as shown in Figs. 3 and 8, so that the steam-pressure commences to act just at the commencement of the chamber M, at the point where the pistons first open out to permit the steam-pressure to act on their rear or top sides. The mouth of the passage R should have a less area than the area of a cross-section of the passage itself, so that the pressure within the passage shall be greater than the pressure in the chamber M; but as the tendency of the centrifugal force of the motor is to retain the pistons in their sockets when the casement is rotating, and as the pressure of the steam which must necessarily be exerted on the lower or front sides of the pistons before their free ends can travel down the cam-surface G tends further to retain the pistons in their sockets, I have devised the following means for overcoming this difficulty: Behind each piston there is formed in the rim J a groove or recess, S, and this groove extends backward a suitable distance, forming an opening, *c*, in the rim J. From the main steam-admitting passage R extends radially to the periphery of the cylinder A a branch passage, T, which communicates with the open space *c* of the groove S when said groove is brought over said branch passage by the rotation of the casement. This communication takes place as soon or nearly as soon as the free end of the piston passes out from behind the arc E to over the cam-surface G. As soon as this communication is established, the steam is admitted through the branch passage T and the opening *c* to that part of the groove S which extends behind the piston, so that the pressure of the steam is admitted behind the piston as soon as its free end is ready to travel down the cam-surface G. One advantage of having the pressure-chamber begin at the highest vertical point of the motor is that at this point the centrifugal force is opposed to its greatest extent by the weight of the piston, so that the minimum quantity of steam is required to cause the free end of the piston to travel down the cam-surface G. The space or opening *c* in the rim is of sufficient length to permit the steam to be introduced into the groove S until the free end of the piston passes into the current of steam from the main passage R, where it receives the full force of the steam-pressure. By the adoption of this means for compelling the piston to travel down the cam-surface I avoid the employment of any of the ordinary mechanical devices for accomplishing the same purpose, which are usually clumsy and liable to get easily out of order and cause loss of power in operating them. At the point in the periphery of the cylinder A where the mouth of the inlet-passage R stops, and where the piston is first acted on by the full volume of the steam, the arc F begins, so that the maximum force of the steam is exerted at the point where it can first be fully utilized. The arc F is made of such length and uniformity that the full force of the steam is constantly applied on each piston until a succeding piston takes its place on the arc, when it is exhausted. As soon as the succeeding piston has received the full volume of the steam and has fully reached arc F and is receiving the full volume of steam, the preceding piston has reached the opening of the exhaust-passage U, and the exhaust takes place. By the passage of the piston over the opening of the exhaust-passage all pressure upon its rear side is relieved, and it is free to be governed by the centrifugal force of the rotating casement, which folds it into the recess P, out of the way, so that it may pass freely and without hinderance over the arc E. The centrifugal force is assisted in folding the pistons in the recesses by gravitation, as when the pistons have entirely passed the mouth of the exhaust-passage they are at or near their lowest position. Thus all mechanical devices, with their attendant inconveniences, for folding the pistons are dispensed with. Should the centrifugal force of the rotating casement, for any reason, fail to fold the pistons, they would be gradually pressed in by the action of the cam-surface H, which merges into the arc E.

In order to make the ascent from the arc F to the arc E over the cam-surface H as gradual as possible, so as to avoid much friction by an abrupt rise, the cam-surface H is made as long as is consistent with the proper lengths of the arcs E and F and the cam-surface G. The length of the arc E is determined by the distance between the pivoted end of the piston and the extreme rear point of the groove S, which distance must be covered by the length of the arc between the branch passage T and its junction with the cam-surface H. The length of the cam-surface G may be quite small, it being sufficient if it covers the mouth of the inlet-passage R. The remainder of the periphery of the cylinder A may consist of the cam-surface H.

Practically, my experiments have shown that the centrifugul force, except when the motor is rotating very slowly, never fails to fold the pistons into their sockets. For, in practice, while the arc F was brightly polished by the friction of the pistons upon it, the cam-surface H showed no indications of any friction whatever, the original markings of the casting not having been altered in the slightest degree. More than this, the experiments referred to, consisting in the putting to work of the machine, showed that the centrifugal force was more than sufficient to produce the results desired, as there was produced

a continuous rapid clicking noise, caused by the pistons flying back into their sockets. I have also designed a construction of the pistons to avoid this difficulty. The pistons are hollowed out on their inner sides, as shown in Fig. 7, and a raised rim, *d*, is formed, extending entirely around the hollowed part. The interior of the rim J is suitably grooved for the reception of the raised rim, as shown in Fig. 6. When the piston is folded in its socket, the rim is not high enough to close the groove S entirely nor interfere with the ready admission of steam behind the piston. When the piston passes over the arc F, the hollow of the piston becomes filled with steam, and when the piston flies back into its socket, under the action of the centrifugal force, the inclosed steam acts as a cushion and prevents any disagreeable noise. The only friction arising from the piston, which practical experience shows, is that which occurs when the free end of the piston passes over the arc F.

In order to operate the motor, the pistons must completely close the pressure-chamber M, and to do this thoroughly the free edges of the pistons must press the arc F, which necessitates friction. To reduce this friction to a minimum I have adopted a device which permits the free ends of the pistons, while closing the pressure-chamber, to only just graze the arc F, so that the friction from this source almost entirely disappears. At or near the free ends of the pistons I provide on both sides lugs or projections *e e*. (See Fig. 7.) These lugs fit and play in grooves or ways *f f*, cut or formed on the inner faces of the side plates, K L, of the casement. These ways *f f* are cut in arcs of circles having the pivots of the pistons as centers, so that the lugs play freely back and forward in them without friction. When the motor is first constructed, the ways *f f* are preferably cut a trifle too long, so that the lugs *e e* cannot quite reach their limit therein. By this means the free edges of the pistons will at first bear against the arc F until both are worn smoothly and evenly away, when the lugs *e e*, coming in contact with the innermost faces of the grooves *f f*, will limit and prevent any further wear of the pistons upon the arc F, and eventually the pistons and arc will be so worn that, while they are in steam-tight contact and no more, all friction will be overcome. These lugs and grooves interfere in no way with the other features of the invention. The exhaust-passage U extends upward through the cylinder A to near its center, where it communicates with the passage V, formed by the other hollowed stationary shaft, D.

Another feature of my invention consists in automatically controlling a cut-off valve in the steam-admitting pipe, so that the steam may be admitted only when needed. As I have shown four pistons which require the admission of steam four times with each rotation of the casement, so I have shown a valve which will admit and cut off steam four times with each rotation. The valve W, which I have shown, has an aperture or port, *g*, extending through it, so that a complete rotation of the valve will admit and cut off the steam twice. I do not, however, limit myself to this form of valve, as any other suitable one may be used, and the number of rotations to be given to it will vary with the kind of valve and the number of pistons used. This valve W is located in the steam-admitting passage Q in the stationary shaft C. It is extended upward through the shaft and terminates in a cog-wheel X. This cog-wheel is engaged and operated by a gearing, Y, upon the outer face of the side plate K of the rotating casement. The diameter of the wheel Y is shown just double that of the wheel X, so that the valve W shall admit and cut off the steam four times with each rotation of the casement for each piston shown. When the motor is first constructed, the valve is set to time properly with the rotation of the pistons, so that the steam shall always be admitted and cut off at proper intervals.

I also contemplate a governor attachment to regulate the pressure of the steam, which shall be operated by the rotating casement, it being attached to the casement by the lugs Z Z. (See Figs. 1 and 5.)

What I claim is—

1. In a rotary motor, a fixed interior cylinder the periphery of which is composed of two arcs of different radii connected by cam-surfaces, in combination with an outer rotating casement provided with freely-swinging pistons, and adapted to fit closely over the arc having the long radius, whereby a pressure-chamber having a constant area in cross-section is formed between the outer casement and the arc of the cylinder having the short radius, substantially as set forth.

2. In a rotary motor, a rotating casement provided with pistons hung freely at their forward ends to the casement at equal distances apart, in combination with a fixed interior cylinder the periphery of which is composed of two arcs of different radii connected by cam-surfaces, of which arcs the one having the long radius is adapted to be fitted closely to the inner surface of the casement, whereby a pressure-chamber having a constant area in cross-section is formed between the outer casement and the arc having the short radius, the length of said arc being determined by the distance between adjacent pistons, substantially as set forth.

3. In a rotary motor, a rotating casement provided with pistons hung freely thereto at their forward ends, in combination with an inner stationary cylinder the periphery of which is constructed as described, whereby a pressure-chamber is formed between said casement and said cylinder, and a steam-admitting passage constructed in said cylinder and opening into said pressure-chamber at or near its be-

ginning, the steam being admitted in the direct line in which its force is to be applied, substantially as set forth.

4. In a rotary motor, a rotating casement provided with pistons hung freely at their forward ends thereto, in combination with an interior fixed cylinder having its periphery composed of arcs and cam-surfaces, substantially as herein described, and a steam-admitting passage formed in said cylinder opening into said pressure-chamber at its commencement, whereby the full force of the steam is constantly and uniformly exerted upon each piston, substantially as set forth.

5. In a rotary motor, the rotating casement provided with pistons, substantially as described, in combination with a fixed interior cylinder the periphery of which is composed of arcs and cam-surfaces, as described, and inlet and exhaust passages for steam formed in said cylinder, the inlet-passage having its mouth at the commencement of the arc having the short radius, and the exhaust-passage having its opening at the termination of said arc, the length of said arc being determined by the distance between adjacent pistons.

6. The outer rotating casement, in combination with pistons hung to said casement and swinging freely thereon, whereby the centrifugal force of the casement causes the pistons to fold into the rim of said casement, and suitable means whereby the pistons are swung out from the rim, so that they may be operated upon by the motive power, substantially as described.

7. The stationary cylinder having its periphery composed of arcs and cam-surfaces, as described, in combination with a rotating casement inclosing said cylinder, as described, whereby a chamber is formed between said casement and cylinder, the arrangement being such that the chamber commences at the highest point of the cylinder, as set forth.

8. The stationary cylinder having its periphery composed of arcs and cam-surfaces, as described, in combination with a rotating casement provided with freely-swinging pistons inclosing said cylinder, whereby a chamber is formed between the cylinder and casement, the arrangement being such that the chamber commences at the highest point of the cylinder, and a steam-admitting passage formed in said cylinder opening into said chamber at or near its commencement, substantially as described.

9. The combination of the stationary cylinder, the rotating casement, the pistons, the pressure-chamber, the steam-admitting passage, grooves in the rim extending behind said pistons, and a branch steam-passage adapted to communicate with said grooves, substantially as set forth.

10. The outer casement provided with pistons equidistant apart, and with steam-admitting grooves extending behind the pistons, as described, in combination with an inner stationary cylinder, its periphery being composed of two arcs of different radii and connecting cam-surfaces, and provided with the inlet and exhaust passages, the length of the arc having the short radius being determined by the distance between adjacent pistons, the length of the arc having the long radius being determined by the length of a piston and the groove extending behind it, and the length of one cam-surface being determined by the extent of the inlet-opening, whereby the other cam-surface is made as long as possible, substantially as set forth.

11. The combination of the stationary cylinder, the rotating casement, the pistons, the main steam-admitting passage, the branch admitting-passage, and a groove extending behind each piston and adapted to communicate with said branch passage, the length of the mouth of said groove being determined by the distance between the mouths of the main and branch admitting-passages, substantially as set forth.

12. The pistons provided with hollowed-out inner sides adapted to retain steam, which acts as a cushion to prevent the noise made by the pistons, substantially as set forth.

13. The concave plate N, secured to the stationary cylinder, in combination with the side plate of the casement, substantially as and for the purpose described.

14. The concave plate N, secured to the stationary cylinder at its apex, in combination with the side plate of the casement, against which the free edge of the concave plate is adapted to rest.

15. The stationary cylinder, hollowed out on the side, as described, and the concave plate N, secured to said cylinder on said hollowed part, in combination with the head of the casement, substantially as described.

16. The stationary cylinder, hollowed out on the side, as described, and the concave plate N, secured to said cylinder on said hollowed part, the depth of which part is less than the height of said plate, in combination with the head of the casement, substantially as set forth.

17. The piston formed with lugs at or near its free end, in combination with grooves or ways cut in the heads of the casement, substantially as and for the purpose described.

18. The pistons provided with lugs at or near their free ends, as described, in combination with the inner stationary cylinder, and the heads of the casement provided with grooves in which said lugs are adapted to slide, substantially as and for the purpose set forth.

19. The cut-off valve situated in the steam-admitting pipe and provided with a cog-wheel, as described, in combination with the rotating casement provided with gearing adapted to engage directly with the cog-wheel on said valve, substantially as set forth.

In testimony whereof I affix my signature in presence of two witnesses.

HENRY A. TOBEY.

Witnesses:
W. H. DOOLITTLE,
H. A. HALL.