(No Model.)

3 Sheets—Sheet 1.

R. H. ISBELL.

ROTARY ENGINE.

No. 348,217. Patented Aug. 31, 1886.

FIG. 1.

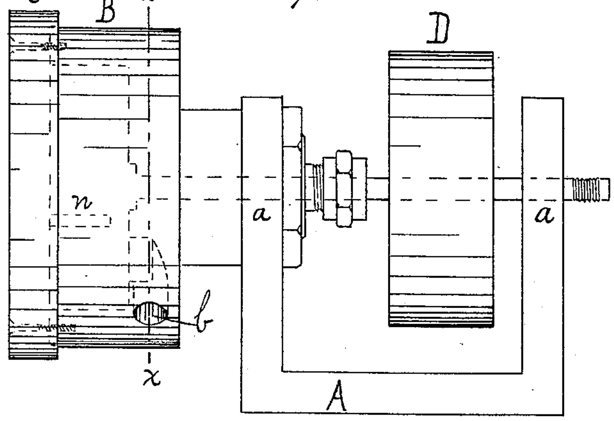


FIG. 3.

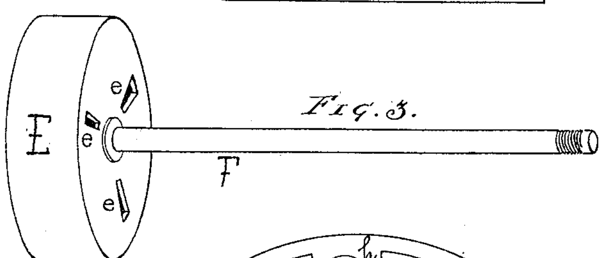


FIG. 4.

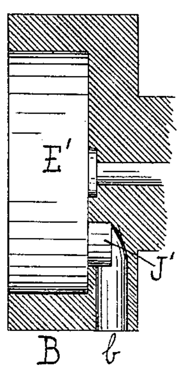
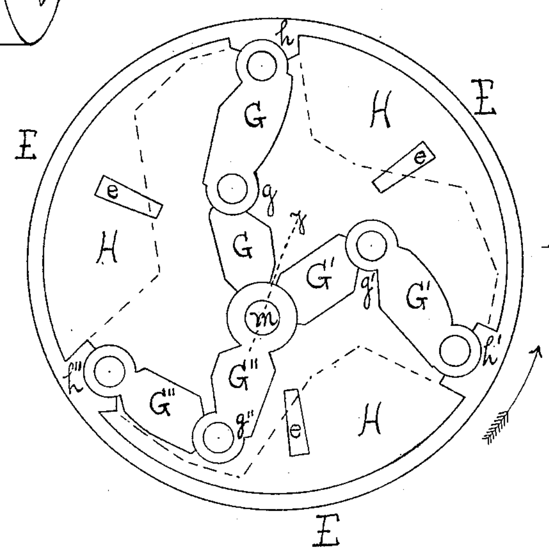


FIG. 2.



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(No Model.)

3 Sheets—Sheet 2.

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Fig. 11.

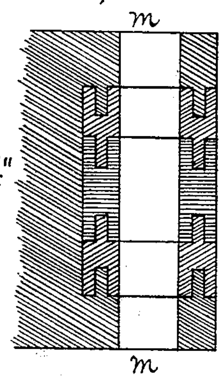

Fig. 6.

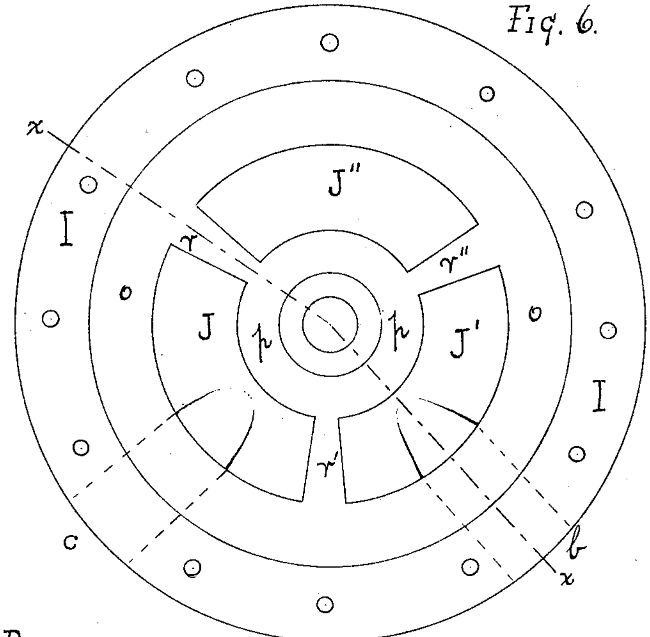

Fig. 5.

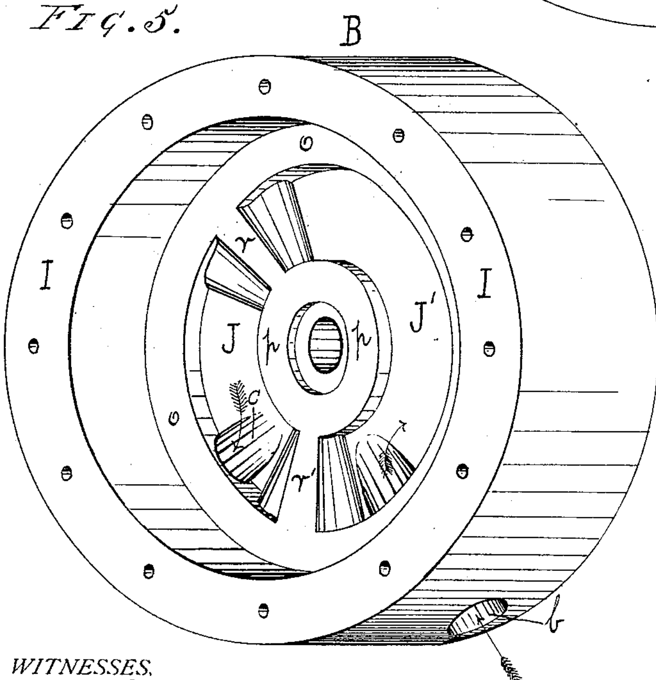

Fig. 7.

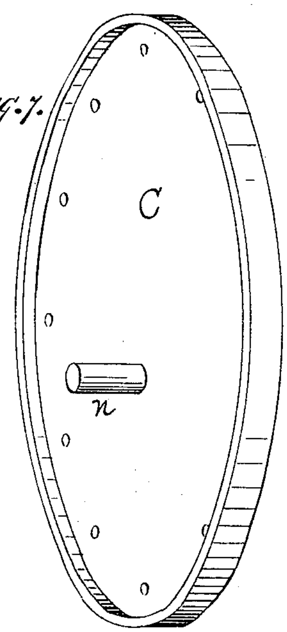

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Fig. 8.

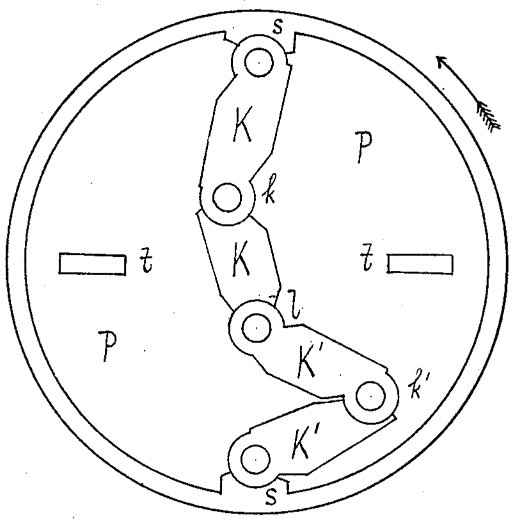


Fig. 10.

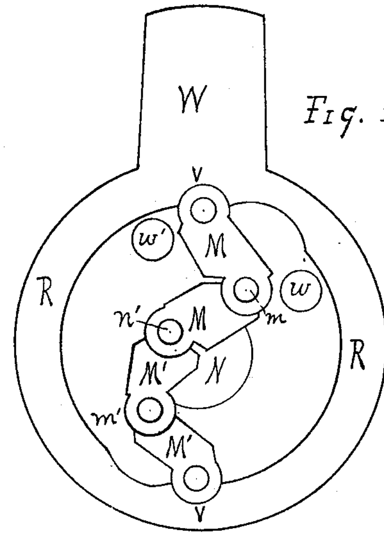
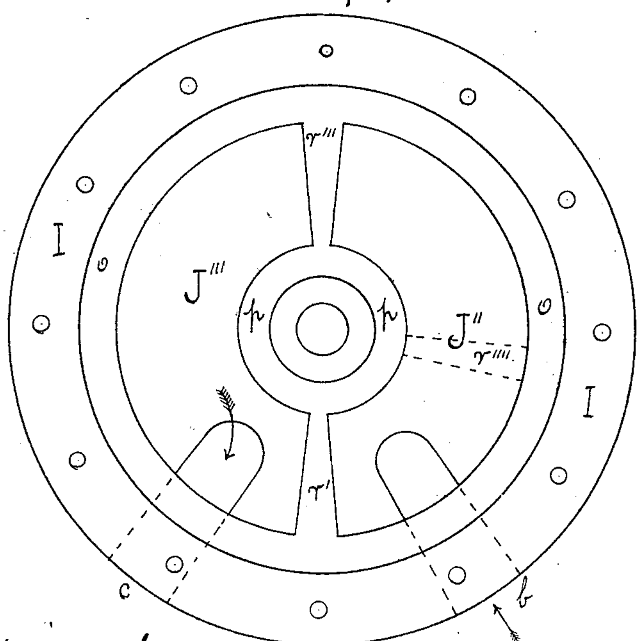


Fig. 9.



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UNITED STATES PATENT OFFICE.

ROBERT H. ISBELL, OF NEW YORK, N. Y.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 348,217, dated August 31, 1886.
Application filed June 4, 1886. Serial No. 204,118. (No model.)

To all whom it may concern:

Be it known that I, ROBERT H. ISBELL, a citizen of the United States, residing at the city and county of New York, in the State of New York, have invented a new and useful Rotary Engine or Motor for Steam, Water, or other Motive Power, of which the following is a specification.

My invention consists of a series (two or more) of jointed arms playing within a shallow cylinder and dividing the cylinder into separate variable chambers, the arms being pivoted together at one end eccentrically as to the center of the engine-shaft, and at the other end pivoted at different points upon the sides of the cylinder. Motion around the center of the shaft is produced by the chambers alternately enlarging and contracting through the force of the power applied against the movable arms. The central pivot may be one attached to the shaft, the other ends of the arms being pivoted at stationary points upon the circumference of the cylinder, or the central pivot may be stationary and the outer ends revolve, in which latter case the outer ends would be attached to the circumference of an inner cylinder itself attached to the shaft. In each case the principle would be the same. My invention is entirely distinct from that class of rotary engines which consist of a smaller cylinder placed eccentrically within a larger one and made to rotate by means of pistons sliding in and out of the smaller one. I know also that prior to my invention rotary engines have been made with several cylinders arranged upon the circumference of a rotating circle, and with their pistons all attached to a point fixed eccentrically as to the shaft, that point being stationary and the cylinders themselves rotating; but I know of no application prior to mine of the principle of jointed arms to divide the cylinder or engine in which the power acts into variable chambers. There are various ways in which it may be applied, of which the drawings show several.

The objects of my invention are various, comprising simplicity of construction, reduction of friction, a proportional increase of surface for the power to act upon, a more steady application of the power, less oscillation of the machine, and greater speed.

The accompanying drawings are made with special reference to a small engine operated by steam, but the same principles and description are applicable in the main to an engine of any size or power and to a water-motor.

Figure 1 is a side elevation of an entire machine. Fig. 2 is a plan of the jointed arms which play the part of pistons. Fig. 3 is a perspective of the shaft, and attached to it the inner cylinder containing the arms. Fig. 5 is a perspective of the outer cylinder in which the other revolves, showing the entrance and exit for the steam. Fig. 7 is a perspective of the cap to close the outer cylinder, showing the pivot upon which the jointed arms turn. Fig. 6 is a plan showing a variation of the outer cylinder, suited to a case where the entrance of further steam is to be cut off before the end of the stroke. Fig. 4 is a side section of the outer cylinder along the line *x x*, showing how the steam enters. Figs. 8 and 9 are plans, respectively, of the inner cylinder with its jointed arms, and of the outer cylinder, in which it turns, suited to the case, where two arms are to be used instead of three. Fig. 11 is a section on the line *y* of Fig. 2 of the inner ends of the jointed arms pivoted together.

All of the figures from 1 to 9, inclusive, are adapted to the case where the inner ends of the jointed arms are stationary and the outer ends revolve, while Fig. 10 is a plan of the arms in a machine where the outer ends are stationary and the inner ends revolve. Figs. 2, 5, 6, 7, 8, 9 are upon the same scale. Figs. 1, 3, and 4 are upon a reduced scale, but the the same scale as each other. Fig. 10 represents a smaller machine. Fig. 11 is upon an enlarged scale.

A, Fig. 1, is the frame upon which the machine rests, having bearings for the shaft F at *a a*.

B, Figs. 1 and 5, is the outer cylinder, solidly affixed to the frame.

C, Figs. 1 and 7, is a cap fitting upon I of the outer cylinder, B, and closing it, and having a bar, *n*, affixed to it at right angles on the inside.

D is a pulley by which to take the power from the machine.

E, Figs. 2 and 3, is a shallow cylinder, solidly affixed to the shaft F and forming part of it. This cylinder E fits into the cavity E′ of the outer cylinder, B, and revolves in it.

The operating part of the mechanism lies within the cylinder E. It is a hollow cylinder, with one end open toward the cap C, but closed by the said cap when in operation, and with the other end—*i. e.*, the inner end—attached at its center to the shaft F, and with that end closed, except for the ports or openings *e*. The jointed arms G G, G′ G′, and G″ G″ are all of the same depth as the cylinder E, so that when in position they form, with the side of the cylinder E and the cap C, three separate compartments, which are in all positions steam-tight, except for the openings *e*. They are pivoted together like a hinge at their inner ends around the hole *m*, are jointed at the points *g g′ g″*, respectively, and are pivoted at the points *h h′ h″*, respectively, upon pivots affixed to the circumference of the circle, equidistant from each other. All the joints of the arms are made steam-tight. When the parts are in position, the hole *m* receives the bar *n*, which is affixed to C at a point one side of its center.

J′, Fig. 5, is the steam-chest, being a cavity in the cylinder B, underlying the cylinder E and admitting steam through the hole *b*. J is a like cavity to serve as the exhaust through the hole *c*. The partitions *r* and *r′* between them are upon a level with the rings *o* and *p*, and upon them the inner disk of the cylinder E revolves steam-tight. The sides of the cylinder E need not be steam-tight against the sides of the cavity E′. The inner ends, at *m*, Fig. 2, of the jointed arms, I provide with annular elevations or ribs, which set into corresponding depressions or grooves, the rib of one arm just fitting in the groove of another. This is shown in Fig. 11, which is a vertical section of the circular ends of the arms hinged together, showing a part of one arm and only the circular ends of the other two. The arm G′ incloses G, and G″ incloses both. Even when the bar *n* is removed they remain locked together. The object of these ribs and grooves is to render the motion smoother and also keep the joint steam-tight. Two of the three arms must be made in parts. A similar construction may be used at the joints *g g′ g″*, or even at the pivots *h h′ h″*, when made advantageous by the size of the machine.

In small machines no packing of the moving parts will be necessary; but in larger machines, if necessary, the jointed arms may have appropriate packing inserted upon their upper and under surfaces. Packing may be used at other points when necessary.

The operation of the three-armed machine is as follows: The steam enters at *b*. When one of the ports or openings *e* passes the partition *r′*, steam enters the chamber with which that port communicates. The pressure of the steam acting upon the jointed arms revolves the cylinder E in the direction of the arrow, (shown in Fig. 2,) and that chamber begins to enlarge through the movements of the jointed arms, and continues to enlarge until the port passes the partition *r*, at which point the chamber has reached its largest possible position. In the meantime a second chamber has been filled by steam by its port passing the partition *r′*. Each chamber discharges its steam into J as soon as its port has passed the partition *r*, so that during the time it is contracting there is no pressure of steam within it to resist the enlargement of the other two chambers. As the points *h*, *h′*, and *h″* are distant one-third of the circumference from each other, the partitions *r* and *r′* must be at a corresponding distance from each other. Thus the steam acts in each chamber for two-thirds of the distance around, and is at every moment acting in two chambers. There is thus no dead-point.

When the machine is first started, the steam must enter one or both of the chambers, where pressure will turn it in the direction of the arrow. The force exerted is at all times the same or nearly so, being greatest in any chamber when it reaches about the position of G G G′ G′, as shown in Fig. 2. Each chamber is smallest when the outer ends of its inclosing-arms (*h′* and *h″*, for instance) are upon opposite sides of and equidistant from the partition *r′*, or nearly so, and in that position the outer end of the other arm, *h*, is directly opposite *r′*. Consequently the ports *e* are arranged directly opposite the outer ends of the arms, and they must be put in such position that the arms will not cover them in movement, at least enough to obstruct the passage of the steam. The inner pivotal point, *m*, of the jointed arms I place inside the circle running through the pivotal points of their outer ends, *h h′ h″*, and distant from the circumference of that circle one-third of its diameter. This determines the position of the bar *n* upon the cap C. I have discovered that this proportion (two to one) produces better results than any other. The inner pivotal point—that is, the bar *n*—can, however, be placed at other distances from the center of the cylinder, and motion will result. The distance may be varied for the same purposes for which the length of a crank is varied in other engines, and upon the same principles.

The bar *n* in the drawings is represented as being directly over the partition *r′*, and the partition *r′* as in a line perpendicular to the center. Neither of such positions is essential, nor is the position of the port *e* in its chamber exactly as represented essential; but it is essential that the ports *e* and the partition *r′* shall be so placed with reference to each other that steam shall not begin to enter any chamber until such chamber is at its smallest capacity, and that the partition *r* shall be so placed that the steam shall begin to exhaust as soon as it reaches its largest capacity. These positions may be calculated exactly.

The spaces H, lying between the dotted lines and the sides of the cylinder E, Fig. 2, represent those parts of the cylinder which the jointed arms in their movements never occupy or touch. These spaces may be entirely filled or manufactured solid with the side and rear plate of the cylinder E. When steam is used as the motive power, they should be filled, so as to make as small as possible the chambers which the steam enters and thereby prevent waste of force; but the filling must be so arranged around the ports *e* as not to obstruct the entrance or exit of the steam.

The two legs into which the jointed arms are divided I make equal to each other. I have discovered that that arrangement produces better results than any other. The machine will, however, work with the two legs unequal. The arms are so arranged as to length that they will be slightly bent when extended the farthest, and thus will be always bent in the direction of the arrow, which is the direction of the application of the power. The object of this arrangement is to avoid all possibility of an arm catching upon the center of its joint when fully extended and becoming jammed, as might happen if it were straightened out fully. The object should be to bring the arm as nearly straight as possible when extended, and yet avoid that danger.

Besides the use of jointed arms, as described, another important feature of my invention lies in the relative positions of the steam-chest J′ and the cylinder E. I place the steam-chest behind the revolving disk of the inner cylinder, E. In other engines, whether reciprocating, rotary, or otherwise, oscillation is produced, especially when run at high speed, on account of unbalanced pressure against non-moving parts. In this invention the greater part of the force which is not used in rotating the machine is, as it were, divided in two, and one half balanced against the other. Thus the steam-chest J′ should be made of such a size that the rear surface of the inner disk of the cylinder E, exposed to the pressure of the steam in the steam-chest J′, shall be as nearly equal to the opposite surface of the same disk exposed to the steam in the chambers as it can be without relieving the disk of sufficient pressure to keep it steam-tight upon its bearing-surfaces *o*, *p*, *r*, and *r*′. The rear surface of the disk exposed to the steam should be about three-fourths of the inner surface so exposed in the chambers. Some pressure will be exerted against the bar *n*, but it will be continuous and in one direction, and may thus be easily resisted without oscillation of the machine.

In Fig. 6, which is a plan of the outer cylinder varied, the parts are all exactly the same, with the addition of a third partition, *r*″, also made steam-tight with the inner disk of the revolving cylinder. This operates as a cut-off, preventing the further entrance of steam into the successive chambers after their ports *e* have passed the partition *r*″, and thus utilizing the expansive force of the steam already in the chamber while the port is passing from *r*″ to *r*. The chamber J″ has no outlet. The partition *r*″ may be arranged at any point between *r* and *r*′, so as to cut off the steam in any desired proportion.

Figs. 8 and 9 show the application of the same principles to a machine with two arms instead of three, operating in the same way and having analogous parts. The inner cylinder revolves within the outer one in the same way, the outer ends of the jointed arms K K, K′ K′ being pivoted at its rim at points opposite each other and going around with it, and the inner ends being pivoted at *l* upon the bar *n* of the cap C. The ports *t t* allow steam to enter the two chambers successively, so they pass the partition *r*′, which is exhausted as they pass the partition *r*‴. If it is desired to cut off the steam before the ports reach *r*‴, another partition, *r*⁗, must be put in. The chambers P P, Fig. 8, should also be filled up wherever the arms do not extend where steam is the motive power.

The action of a two-armed machine is in general the same as that of the other, except that the steam acts in each chamber during one-half instead of two-thirds of a revolution, and there are consequently two dead points in the circle, to overcome which difficulty a fly-wheel must be used.

In Fig. 10 we have an application of the jointed-arm principle to a machine, where the inner ends of the arms revolve and the outer ends are stationary. In such a machine there is only one cylinder and it is stationary. R represents its sides. M M, M′ M′ are two arms jointed at *m m*′, with their outer ends pivoted at *v* to opposite sides of the cylinder, and pivoted together at their inner ends upon a pivot, *n*′, which is affixed eccentrically to the shaft N and serves as a crank. W is an ordinary steam-chest, with steam and exhaust ports and a valve to alternately supply steam to and exhaust it from the two chambers formed by the arms. *w w*′ are the openings into the cylinder for that purpose, so arranged as to be out of the way of the arms. The arms move steam-tight, as before, against the inner end of the cylinder and the inner surface of the cap to be placed over the other end, such cap not being shown in the drawings. In this machine, too, a fly-wheel is necessary to carry the shaft and arms past the dead-points.

Any number of arms may be used in that kind of machine where the outer ends revolve (see Figs. 2 and 8) without altering the main principle, and I do not confine myself to two or three or any particular number; but the best mode in which I have contemplated applying the principle of the jointed arms is that of the three arms illustrated in Fig. 2, being a decided improvement over other methods. Reversing I would accomplish in a jointed-arm engine in the following way: When the outer ends of the jointed arms are stationary, Fig. 10, it is done in the usual way by reversing the current of steam. In a machine where the inner ends of the arms are stationary, Figs. 2 and 8, it may be done by leading the steam in at *c* and out at *b*, Figs. 5 and 9. About two-thirds of the power will be obtained in the reverse direction unless the arms are made to come straight, which is not feasible, for the reason before stated.

For use as an engine or motor to be driven by the pressure of water, the only change necessary in the construction shown in Figs. 2 and 8 would be an enlargement of the ports *e* and *t* to a size a little larger than the pipe admitting the water to the machine. In Fig. 10 all the places of entrance and exit for the water would have to be enlarged in the same ratio. With water there would probably be little if any advantage in closing the spaces which the arms did not reach, (see H, Fig. 2,) as the water would escape only as fast as it was supplied.

The advantage of the use of a machine upon this principle over the ordinary water-motor is that it utilizes all the power of the water, since not a drop escapes through the machine, and yet the friction of the parts is less than in any other machine of which I know.

What I claim as my invention, and desire to secure Letter Patent for upon this application, is—

1. A rotary engine or motor consisting of a series (two or more) of jointed arms within a closed cylinder or chamber pivoted together at one end at a point within the cylinder and eccentrically as to the center of the engine-shaft, and at the other end pivoted at different points upon the sides of the cylinder, one end of each arm being pivoted to some stationary part and the other end pivoted directly or indirectly to the shaft, in combination with appropriate devices to supply steam or other motive power successively to the different variable chambers thus formed by the jointed arms and the sides of the cylinder.

2. A rotary engine or motor consisting of a series (two or more) of jointed arms contained within a closed cylinder, and dividing such cylinder into variable chambers, pivoted together at their inner ends upon a stationary pivot which is affixed to the machine eccentrically as to the shaft, and at the outer ends pivoted at different points upon the sides of the cylinder, such cylinder being affixed to the shaft and turning with it, substantially as described, in combination with appropriate devices to supply steam or other motive power successively to the different variable chambers formed by the jointed arms and the sides of the cylinder.

3. A rotary engine or motor consisting of two jointed arms contained within a closed cylinder or chamber, and dividing such cylinder into variable chambers pivoted together at their inner ends upon a pivot attached eccentrically to the shaft, and at their outer ends pivoted at stationary pivots placed at different points upon the sides of the cylinder, in combination with appropriate devices to supply steam or other motive power successively to the different variable chambers formed by the jointed arms.

4. The three-armed machine shown in the drawings, consisting of the combination of the inner cylinder, E, the outer cylinder, B, and the cap C, the inner cylinder having three jointed arms pivoted at their outer ends at different points upon the sides of the cylinder, and at their inner ends pivoted together upon a stationary bar, *n*, affixed to the cap C, and having openings *e* into the chambers formed by the arms, the outer cylinder having cavities J and J′ and partitions *r* and *r′*, to supply and exhaust the steam or other motive power, substantially as described.

5. In a rotary engine or motor consisting of one cylinder rotating within another by means of the pressure of steam or other power exerted within the inner cylinder, the combination of the inner cylinder with its ports to admit the steam or other power and the outer cylinder with a chamber or steam-chest lying behind the disk of the inner cylinder, substantially as and for the purpose described.

6. In a rotary steam-engine having an inner revolving cylinder and an outer cylinder with steam-chest J′, as described, the partition *r″*, arranged between the partitions *r* and *r′*, substantially as and for the purpose described.

7. A rotary engine or motor operated by jointed arms, as described, so arranged that the pivotal point of the inner ends of the arms is one-third of the way across the circle, which runs through the pivotal points of their outer ends upon its diameter, substantially as and for the purpose described.

8. In a rotary engine or motor operated by jointed arms, as described, a jointed arm, which is just a little longer than the distance between its two ends when farthest extended, substantially as and for the purpose described.

9. In a rotary engine or motor operated by jointed arms playing within a chamber, as described, a jointed arm consisting of two equal legs or parts, substantially as and for the purpose described.

10. In a rotary engine or motor, as described, the jointed arms provided at one or more of their pivotal points with corresponding ribs and grooves, substantially as and for the purpose described.

11. In a rotary steam-engine operated by jointed arms, as described, the cylinder or chamber which contains the arms, with the spaces in it which are not touched by the arms filled up, substantially as and for the purpose described.

In witness whereof I have hereunto set my hand this 2d day of June, 1886.

ROBERT H. ISBELL.

Witnesses:
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F. ESTELLE BRIGGS.