(No Model.) 3 Sheets—Sheet 1.

T. C. LUCE.

ROTARY ENGINE.

No. 604,254. Patented May 17, 1898.

FIG. 1.

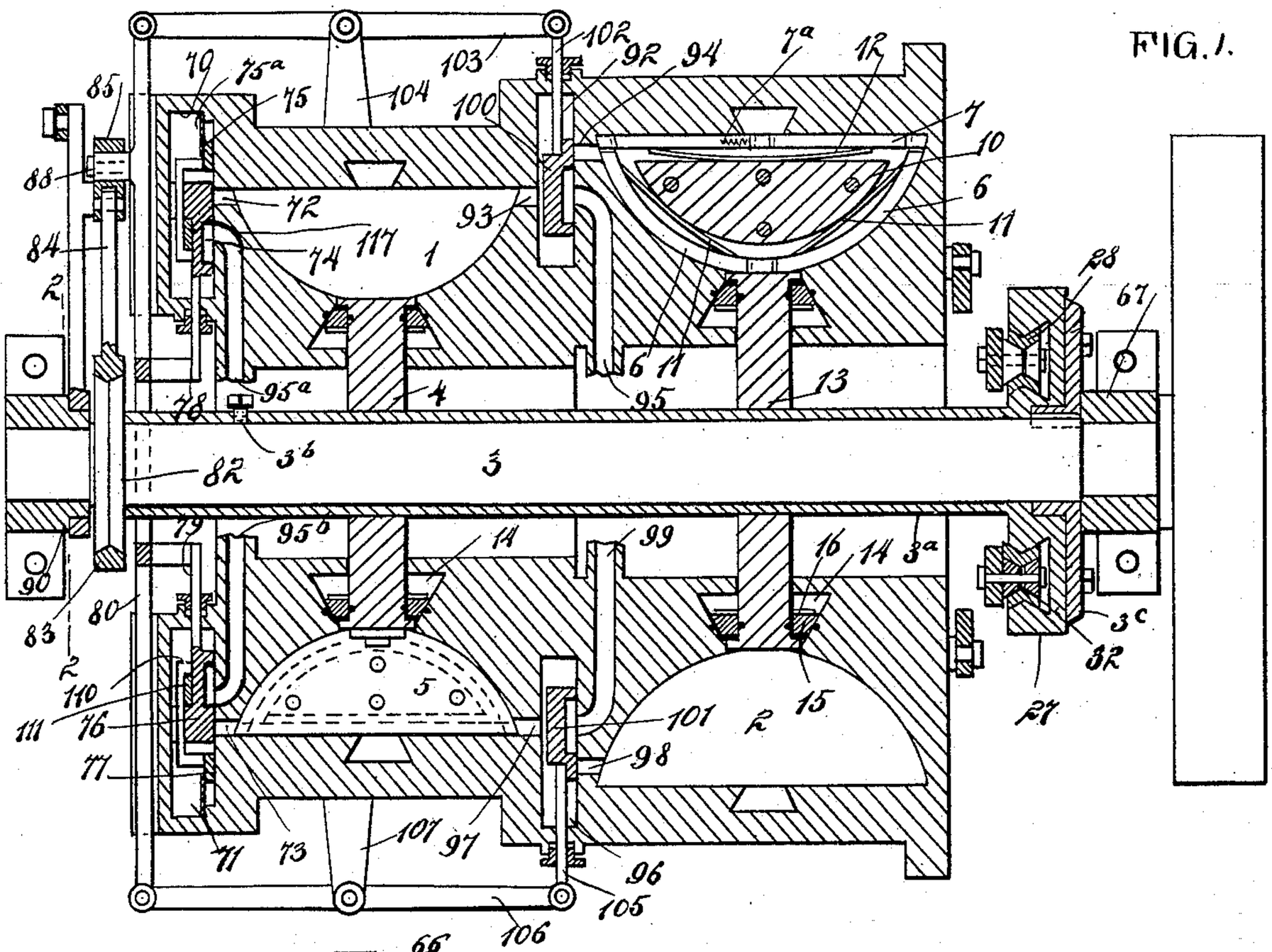

FIG. 2.

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FIG. 3.

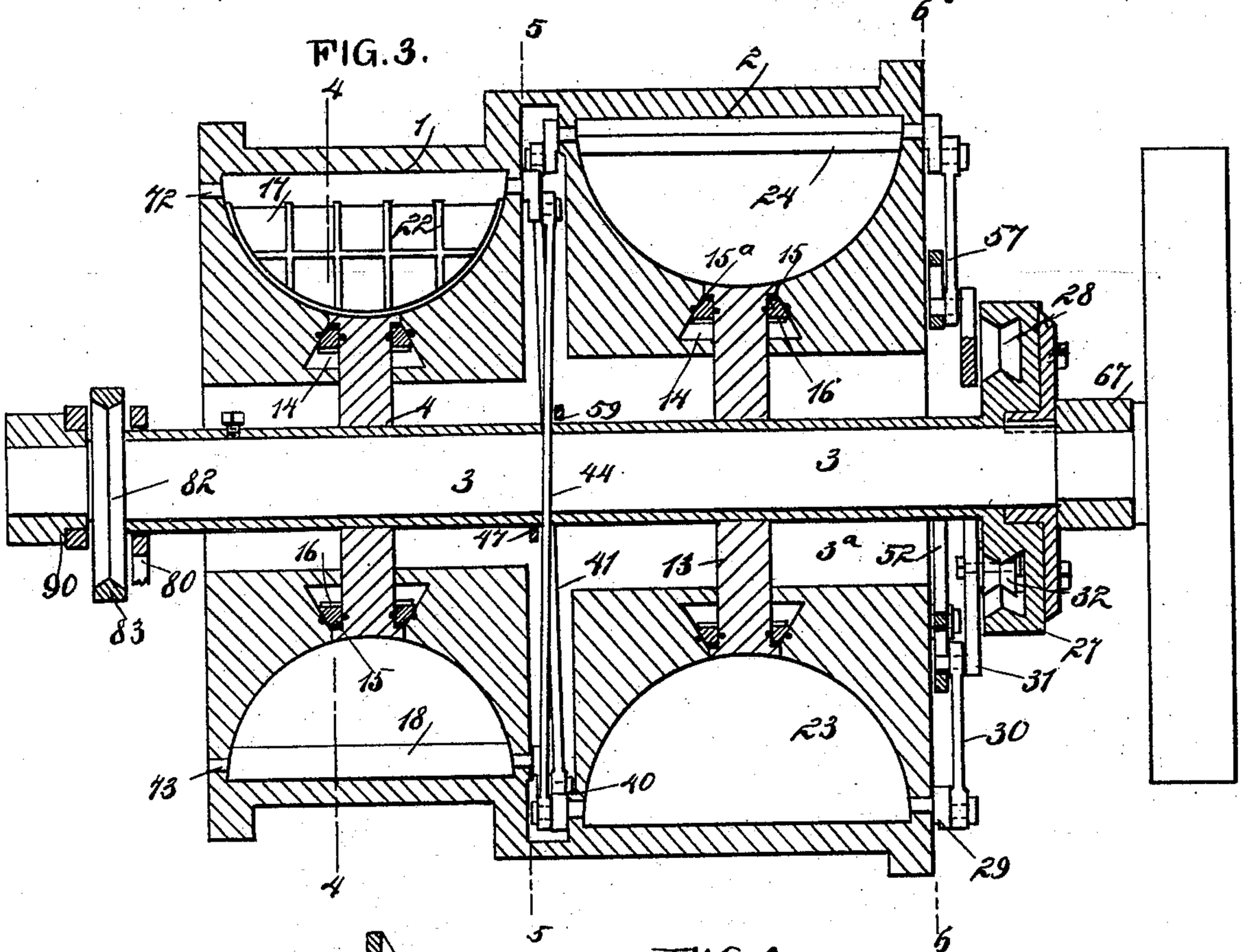

FIG. 4.

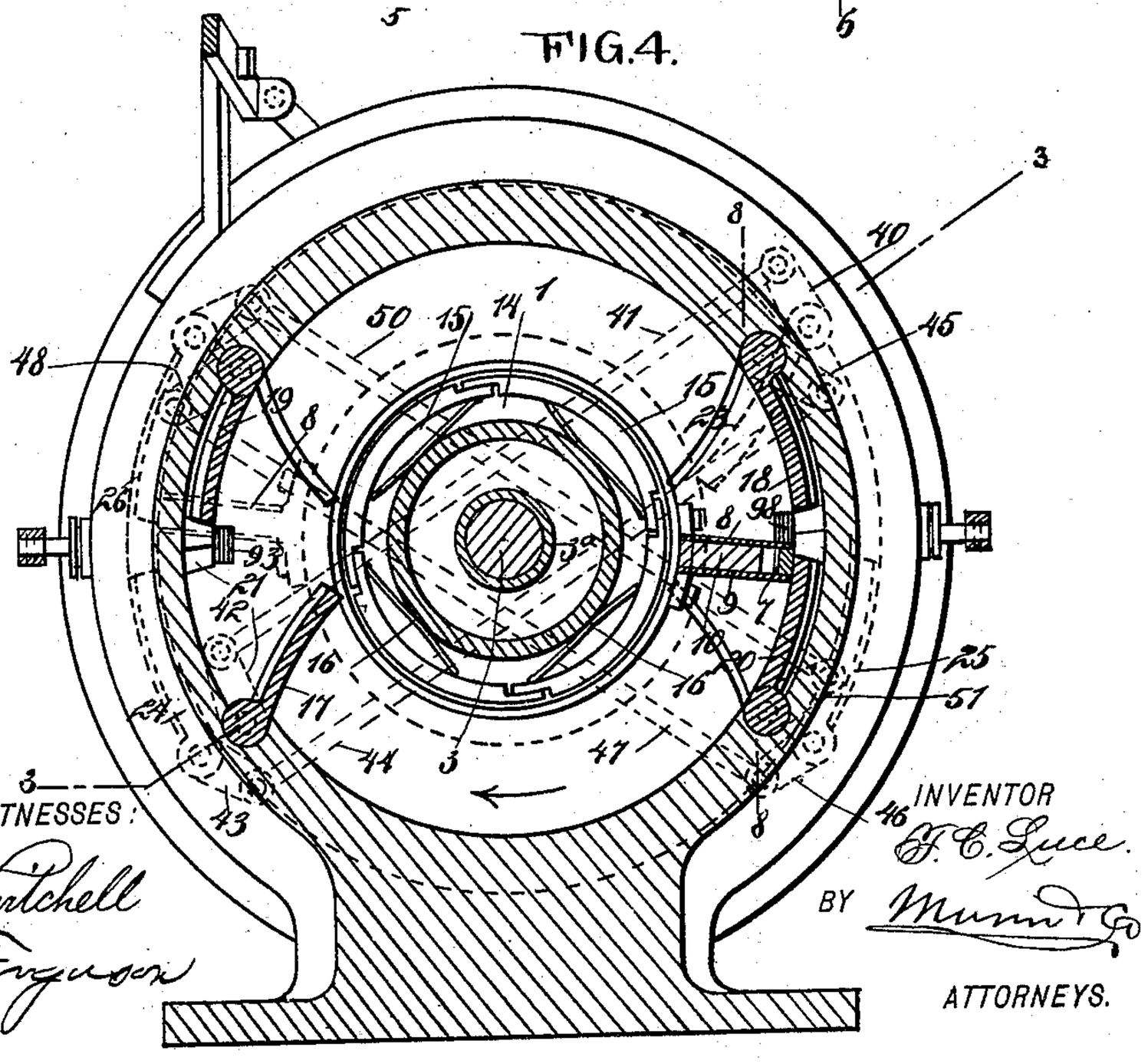

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FIG. 5.

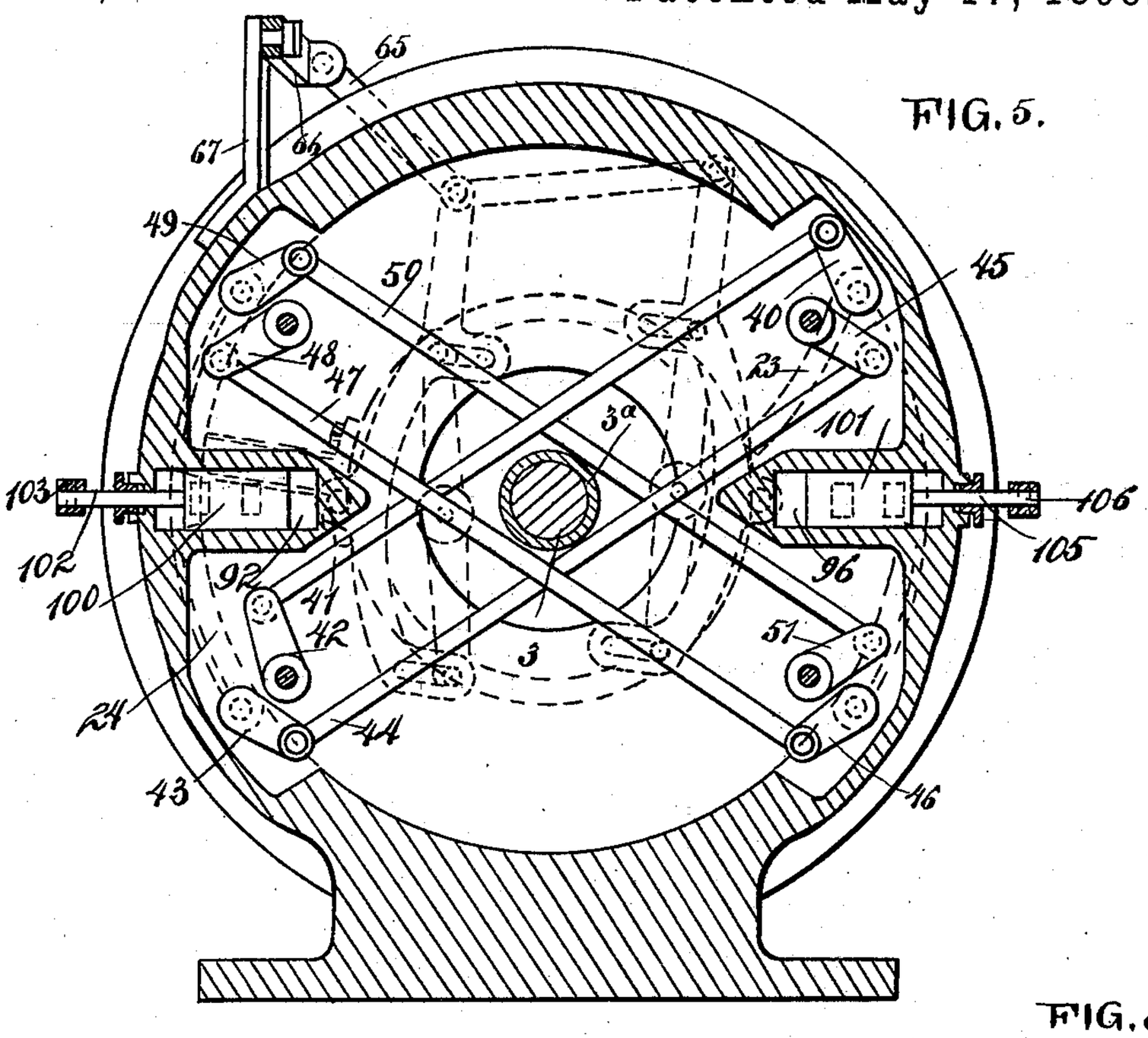


FIG. 8

FIG. 7.

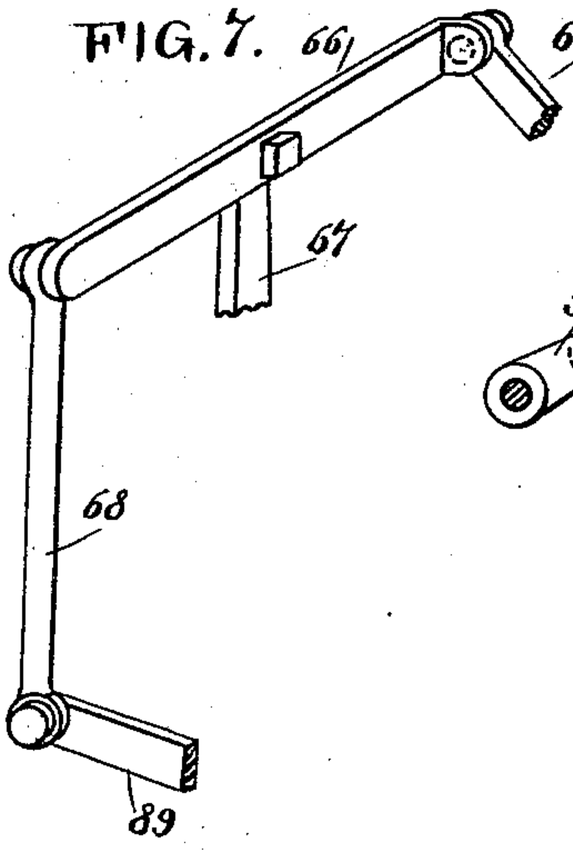
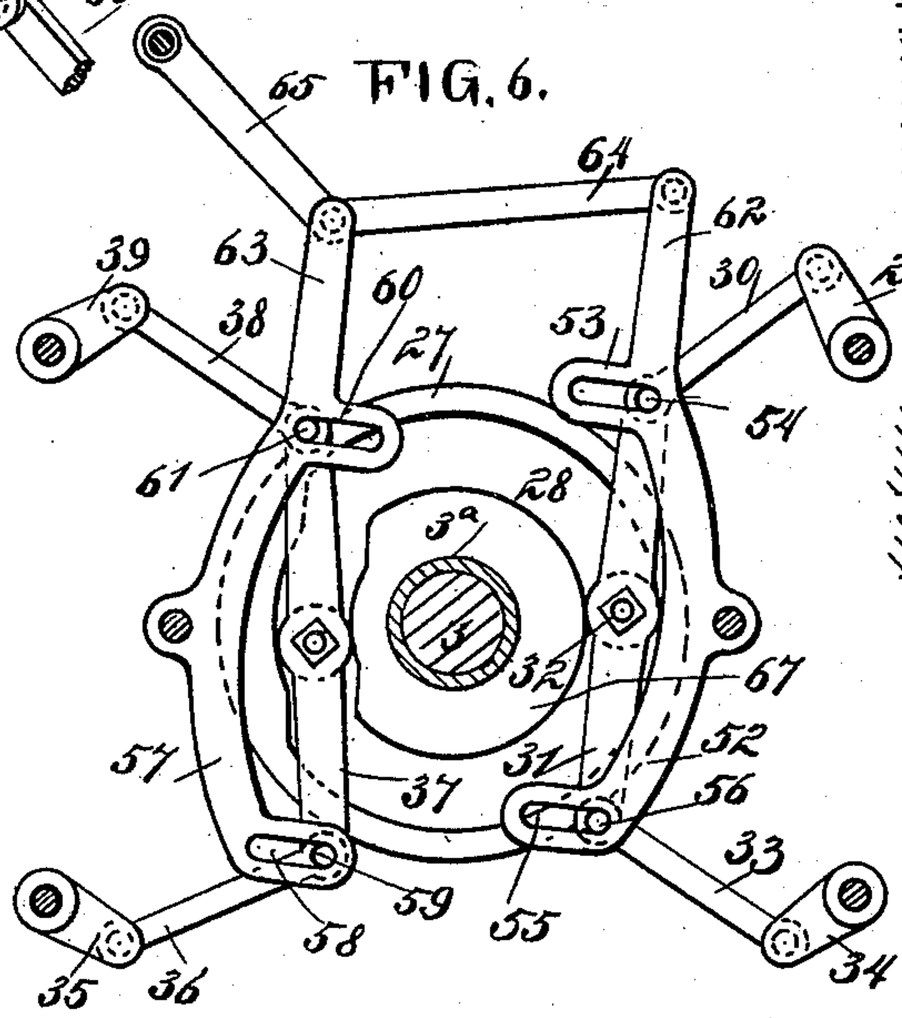
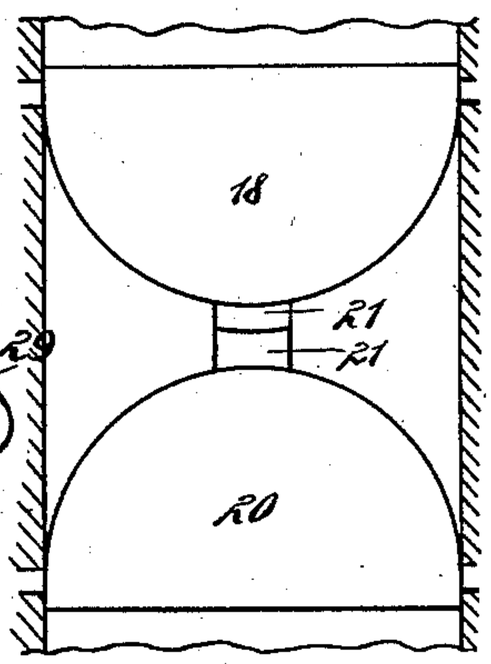


FIG. 6.





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INVENTOR

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UNITED STATES PATENT OFFICE.

THOMAS C. LUCE, OF RICHMOND, MASSACHUSETTS, ASSIGNOR TO HIMSELF, AND J. HARRY COX, OF NEW LEBANON, AND THEODORE W. HARRIS, OF NEW YORK, N. Y.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 604,254, dated May 17, 1898.

Application filed September 24, 1897. Serial No. 652,810. (No model.)

To all whom it may concern:

Be it known that I, THOMAS C. LUCE, of Richmond, in the county of Berkshire and State of Massachusetts, have invented new and useful Improvements in Rotary Engines, of which the following is a full, clear, and exact description.

This invention relates to engines of the rotary type and driven by steam or any other suitable motive agent; and the object is to provide an engine of this character in which a smaller percentage of the motive agent will be employed than is ordinarily the case, thus resulting in economy of operation.

A further object is to so construct the parts that friction will be reduced to a minimum, and, further, to reduce the side pressure and wear on the shaft so objectionable in other rotary engines.

I will describe a rotary engine embodying my invention, and then point out the novel features in the appended claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts of all the views.

Figure 1 is a section on the line 1 1 of Fig. 2 of a rotary engine embodying my invention. Fig. 2 is an end elevation and partial section on the line 2 2 of Fig. 1. Fig. 3 is a section on the line 3 3 of Fig. 4. Fig. 4 is a section on the line 4 4 of Fig. 3. Fig. 5 is a section on the line 5 5 of Fig. 3. Fig. 6 is a section on the line 6 6 of Fig. 3. Fig. 7 shows the reversing mechanism employed, and Fig. 8 is a sectional detail view on the line 8 8 in Fig. 4.

In the drawings I have illustrated a compound engine, or one having a high-pressure cylinder and a low-pressure cylinder; but it will be obvious from the description that the low-pressure cylinder may be omitted and leave an operative one-cylinder engine.

Referring to the drawings, 1 designates a high-pressure cylinder, and 2 the low-pressure cylinder. Each cylinder is here shown as transversely concave. The casings of the cylinders are secured together and are made in ring form and surround a power-shaft 3. Mounted to rotate on the shaft 3 and extended nearly its entire length is a sleeve 3^a, the object of which will appear hereinafter.

Rigidly affixed to the sleeve 3^a is a disk 4, which extends through a circumferential opening in the inner wall of the high-pressure cylinder 1, and mounted on this disk 4 and movable in the cylinder 1 is a piston-blade 5. This piston-blade 5 is made in the form of a half-circle or conformed to the cross-section of the cylinder, and to make a tight connection between the walls of the cylinder and said piston-blade I employ segmental packing-strips 6, adapted to engage against the sides of the cylinder, and a straight packing-strip 7 (see Fig. 1) extends across the end of the piston-blade. These strips 7 are movable between side pieces 8 and 9, secured to a block 10, (see Figs. 1 and 4,) and pressed outward by means of springs 11 and 12. (See Fig. 1.) The packing-strips 7 are each made in two sections joined at the center, with a spring 7^a pushing the sections apart, so as to make tight joints at the corners. (See Fig. 1.)

It will be noted that the springs 11 bear at their central portions against the block 10 and at their ends against the segmental packing-strips 6 and that the spring 12 bears with its central portion against the block 10 and has its outwardly-curved ends bearing against the packing-strip 7. This particular construction is shown on the piston-blade operating in the low-pressure cylinder, said blade being mounted on a disk 13, secured to the sleeve 3^a and extended through an annular opening through the inner wall of the low-pressure cylinder. The piston-blade in the high-pressure cylinder is constructed in the same manner, but of course it is somewhat smaller. The inner wall of each cylinder is provided with an annular channel 14, having its opposite walls converging, and in each channel is a packing-ring consisting of segments 15, the end of one segment overlapping that of another, and these segments are held yieldingly against the inclined walls of the channel by means of spring-plates 16. The spring-plates bear at one end at the joint of the sections and at the other end bear upon the segments at about the center, and thus the lapped

joints will be kept tight. To insure a tight joint, a packing of asbestos or similar material 15ª may be seated in channels formed in the walls of the channel 14, said packing bearing against the segments.

Mounted to swing in the high-pressure cylinder 1 are opposite abutment-plates 17 and 18 and also opposite abutment-plates 19 and 20. The abutment-plates 17 and 18 are designed for alternate action—that is, in movement from their place in the recess formed within the wall of the cylinder to engage upon the periphery of the disk 4 when the engine is operating in one direction—that is, in the direction indicated by the arrow in Fig. 4. When, however, the engine is reversed, the abutments 17 and 18 will be inactive and the abutments 19 and 20 will be alternatively moved into operative position, as will be hereinafter described.

To prevent the entrance of steam to the rear side of an inactive abutment, stop-lugs 21 are extended from the wall of the cylinder, and against the sides of these stop-lugs the ends of the abutments are designed to engage. To secure lightness with a sufficient amount of strength, I provide the under side of the abutments with ribs 22. (See Fig. 3.) Similar abutments 23 24 and 25 26 are arranged in the low-pressure cylinder 2, and the abutment in the high-pressure cylinder is designed to act coincidently with the opposite abutment in the low-pressure cylinder, the said opposite abutment 23 being indicated in dotted lines in Fig. 4. All of the abutments may be provided on the edges with suitable packing-strips on the portion bearing on the disk 4, the other parts dropping into depressions in the steam-chest.

I will now describe the means for swinging the abutments. Affixed to the sleeve 3ª at the outer side of the low-pressure cylinder is a wheel 27, having a cam-groove 28. The abutment 23 has a trunnion extended outward through the head or side wall of the low-pressure cylinder, and to this trunnion a crank 29 is attached. From the crank 29 a link 30 extends to a pivotal connection with a lever 31, to the center of which is pivoted a roller 32, engaging in the cam-groove 28. From the other end of this lever 31 a link 33 extends to a crank 34 on the outwardly-extended trunnion of the abutment 25. On the outwardly-extended trunnion of the abutment 24 is affixed a crank 35, from which a link 36 extends to a connection with a lever 37, having a roller at its center engaging in the cam-groove 28, and from the opposite end of this lever 37 a link 38 extends to a connection with a crank 39 on the outwardly-extended trunnion of the abutment 26. The inner trunnion of the abutment 23 extends through the inner wall of the low-pressure cylinder and is provided with a crank 40, from which a rod 41 extends to a connection with a crank 42 on the trunnion of the abutment 17 in the high-pressure cylinder. From a crank 43 on the inner trunnion of the abutment 24 a rod 44 extends to a connection with a crank 45 on the trunnion of the abutment 18 in the high-pressure cylinder. From a crank 46 on the trunnion of the abutment 25 a rod 47 extends to a crank 48 on the trunnion of the abutment 19 in the high-pressure cylinder, and from a crank 49 on the inner trunnion of the abutment 26 a rod 50 extends to a connection with a crank 51 on the trunnion of the abutment 20. It will be seen that there is a space between the two cylinders in which the shifting rods for the high-pressure-cylinder abutments operate.

Fulcrumed to the outer side of the low-pressure cylinder at one side of the shaft 3 is a rock-lever 52, having an arc slot 53 at one end, in which the pivot-pin 54 on one end of the lever 31 extends, and at the opposite end the lever 52 is provided with an arc slot 35, into which a pivot-pin 56 on the lever 31 extends. The pivot-pin 54 is that upon which the link 30 swings, and the pivot-pin 56 is that upon which the link 33 swings. Fulcrumed to the opposite side of the high-pressure cylinder above the shaft 3 is a rock-lever 57, having an arc slot 58 at one end, into which the pivot-pin 59 of the link 36 extends. The opposite end of this lever 57 has an arc slot 60, into which the pivot-pin 61 of the link 38 extends. The levers 52 and 57 have outwardly-extended arms 62 63, connected by a link 64, and from the pivotal point of the link 64 with the arm 63 an arm 65 extends to and is connected with a bar 66, mounted to rock on a standard 67, and from the other end of the rock-bar a link 68 extends to a lever 89.

I will now describe the means for governing the admission of steam to the cylinders. Arranged within the outer head or wall of the high-pressure cylinder are steam-chests 70 and 71. The steam-chest 70 has a port communication 72 with the high-pressure cylinder, and the steam-chest 71 has a port communication 73 with the high-pressure cylinder. Movable in the steam-chest 70 and controlling the port 72 is a slide-valve 74, and also arranged in this steam-chest is a regulating-valve 75. The regulating-valve 75 is movable relatively to the slide-valve 74 and is designed to regulate the amount of steam entering the cylinder. In the steam-chest 71 is a similar slide-valve 76, controlling the port 73, and coacting with this slide-valve 76 is a controlling or cut-off valve 77. The slide-valve 74 has a stem 78, extended outward through a suitable stuffing-box, and the valve 76 has a stem 79, also extended outward through a suitable stuffing-box. These stems 78 79 are connected to a rod 80, extended across the outer side of the high-pressure cylinder and movable transversely thereof. The said rod 80 has a yoke portion 81, through which the shaft 3 extends, so as not to engage therewith.

Mounted on the sleeve 3ª is an eccentric 82,

from the strap 83 of which an arm 84 extends to a pivotal connection with a segment-arm 85, having an arc-shaped slot 86, with which a block 87 on a pin 88, extended from the rod 80, engages. The central portion of the segment-arm 85 is pivotally connected to a lever 89, mounted to rock on the standard 90. As the lever 89 is connected to the arm 65 by the bar 66 and link 68, both of the parts may be operated together when it is desired to reverse the engine.

The low-pressure cylinder has a steam-chest 92, communicating with the high-pressure cylinder through a port 93 and communicating with the low-pressure cylinder through a port 94. This steam-chest 92 also has an exhaust-port 95. Opposite the steam-chest 92 is a similar steam-chest 96, having a port communication 97 with the high-pressure cylinder, a port communication 98 with the low-pressure cylinder, and an exhaust-port 99 for the low-pressure cylinder. Operating in the steam-chest 92 is a slide-valve 100, and operating in the steam-chest 96 is a similar slide-valve 101. These slide-valves 100 and 101 are chambered at one side, so as to provide communication through said chambers between the ports 94 and 95 and 98 99. The valves 72 and 76 will also be chambered to exhaust a portion of the steam through ports 95^a 95^b. From the slide-valve 100 a stem 102 extends outward and is pivotally connected to a lever 103, fulcrumed on a stud 104, projected from the high-pressure cylinder, and the opposite end of this lever 103 is pivotally connected to one end of the rod 80. Extended outward from the slide-valve 101 is a stem 105, pivoted to a lever 106, fulcrumed on a stud 107, projected outward from the high-pressure cylinder, and the opposite end of this lever 106 is pivotally connected to the rod 80.

I will now describe a means for adjusting the slide-valves 74 and 76 relatively to the valve portions 75 and 77, so as to allow for the admission of more or less steam. From the regulating-valve 77 a plate 108 extends over the slide-valve 76 and between lugs 109, extended outward from said slide-valve, and this plate 108 has its end turned inward toward the slide-valve, as indicated at 110. (See Fig. 1.) Between this inwardly-turned end 110 and the lugs 109 a wedge 111 is movable. This wedge 111 has a link connection 112 with a stem 113, extended through a stuffing-box in the wall of the steam-chest, and at its outer end this stem 113 connects pivotally with a lever 114, the pivotal point of which is at 115. The longer end of this lever 114 is pivoted to an operating-rod 116. A wedge 117 is similarly placed in relation to the regulating-valve 75 and the slide-valve 74, as plainly indicated in Fig. 1, and this wedge 117 has connection with a lever 118, fulcrumed at 119, and the forward end of this lever 118 is also pivotally connected to the rod 116. Steam is admitted from the steam-pipe 120 to the steam-chest 70 through the branch 121 and to the steam-chest 72 through the branch 122.

It will be noted that the sleeve 3^a is held from rotation relatively to the shaft 3 by means of a set-nut 3^b and by bolts passing through a disk 3^c, keyed to the shaft 3. The object of this construction is to provide for rotary adjustments of the shaft relatively to the sleeve and the parts supported by it to compensate for wear to the shaft due to side thrusts. It must be understood that the parts 3 and 3^a are, in effect, the driving or power shaft.

The operation is as follows: In Fig. 1 the valve 74 is just about to move to open the port 72. As it uncovers said port the steam from the chest 70 will enter the high-pressure cylinder and, bearing upon the abutment 17 and piston-blade 5, will cause the piston to move about one-half rotation. At this time the steam forward of the blade will have passed through the port 98 into the low-pressure cylinder, rearward of its piston-wing 23, and the steam that may have been forward of the piston-wing 23 will have exhausted through the port 94, the chamber of the valve 100, and the port 95. On a continued movement of the valve 74 the regulating-valve 75, which is held yieldingly by a spring 75^a, will be drawn over and close the port 72. Then as the valve 74 is returned by means of the eccentric 82 on the shaft 3 it will strike against the regulating-valve 75 and move said regulating-valve over the port 72, and the valve 74 will continue and cover said port. At this time of course the valve 76 will be moved to admit steam through the port 73. Just before the opening of the port 73 the eccentric-wheel 27 on the shaft 3 will cause the lever 37 to rock, with the pin 61 as the fulcrum-point, and this rocking motion will move the pin 59 to the opposite end of the slot 58, which will, by means of the link 36, operate the crank 35 to swing the abutment 24 of the low-pressure cylinder into position, and at the same time the abutment 18 in the high-pressure cylinder will be turned into position. Then as the cam portion of the cam-wheel 27 reaches the roller on the lever 31 said lever 31 will be rocked, with the pin 56 as its fulcrum, and during this rocking movement the pin 54 will be carried to the opposite end of the slot 53, which will, by means of the link 30, turn the crank 29 and move the abutment 23 back into its seat, and at the same time the abutment 17 of the high-pressure cylinder will be moved back into its seat. Then the steam will be admitted through the port 73, and the exhaust from the high-pressure cylinder will enter the low-pressure cylinder through the ports 93 and 94, and the exhaust from the low-pressure cylinder will be through the ports 98 and 99, and of course this operation will be continued back and forth. The eccentric 82 will operate the valves through the medium of the segment-arm 85—that is, by rocking said arm on its pivotal con-

nection with the lever 89—and it will be seen in Fig. 2 that this pivotal connection of the segmental arm is above the connection with the rod 80.

When it is desired to reverse the movement of the engine, the levers 89 and 65 will be forced downward by rocking the bar 66. This will cause the pivotal point of the arm 85 to come below the connection of said arm with the bar 80, and it will also shift the position of the rock-levers 52 and 57, so that the cranks 34 and 39 will be operated by the rocking of the arms 31 and 37 and the cranks 29 and 35 will remain stationary.

A full head of steam is designed to impart a substantially half-revolution to a piston-blade. Should it be desired to cut off the steam before such half-revolution, so that the motion may be continued by the expansion of steam, an upward pull on the rod 116 will rock the levers 114 and 118 to force broader portions of the wedges 111 and 117 between the ends of the stems or plates on the regulating-valves and the lugs on the slide-valves, so that the openings between the regulating-valves and the slide-valves will be reduced and the port 72 will be closed sooner. The advantage of this arrangement is that at all times the steam enters as soon as the piston-blade passes the port and can be stopped from entering at any time thereafter.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. In a rotary engine, a cylinder, semicircular in cross-section, a slide-valve for governing admission of steam, a regulating-valve movable with and adjustable relatively to the slide-valve, an abutment movable in the cylinder, a semicircular piston in the cylinder, comprising a center block and side pieces, segmental packing-strips between the side pieces and adapted to engage against the sides of the cylinder, springs for forcing the segmental packing-strips outward, a packing-strip made in two sections and arranged between the side pieces at the end of the piston, a spring exerting longitudinal pressure on said sections, and a spring for forcing the sections outward, substantially as specified.

2. In a rotary engine, a cylinder, abutments mounted to swing into recesses formed in the wall of the cylinder, the said abutments being ribbed on the under side, stop-lugs extended from the wall of the cylinder and against the sides of which the ends of the abutments are designed to engage and prevent the entrance of steam rearward of inactive abutments, and a rotary piston in the cylinder, substantially as specified.

3. A rotary engine, comprising a cylinder, a driving-shaft, a piston carried by the driving-shaft and movable in the cylinder, opposite slide-valves for governing ports leading into the cylinder, regulating-valves movable with the slide-valves, and means for adjusting the regulating-valves relatively to the slide-valves, substantially as specified.

4. A rotary engine, comprising a cylinder, a driving-shaft, a piston carried by the driving-shaft and movable in the cylinder, opposite slide-valves for governing the ports leading into the cylinder, regulating-valves, plates extended from the regulating-valves to projections on the slide-valves, said plates having hook ends, wedge-blocks movable between said hook ends and the first projection, and levers for moving said wedge-blocks, substantially as specified.

5. In a rotary engine, a cylinder, a power-shaft extended through the cylinder, a sleeve mounted to rotate on the shaft, a piston attached to the sleeve, an eccentric on the sleeve, abutments in the cylinder and operated from the eccentric, and means for securing the sleeve as rotatively adjusted to compensate for wear of the shaft due to side thrusts, substantially as specified.

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Witnesses:
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