T. J. BIGGS.

ROTARY ENGINE.

APPLICATION FILED JAN. 7, 1914.

1,111,053.

Patented Sept. 22, 1914.

5 SHEETS—SHEET 1.

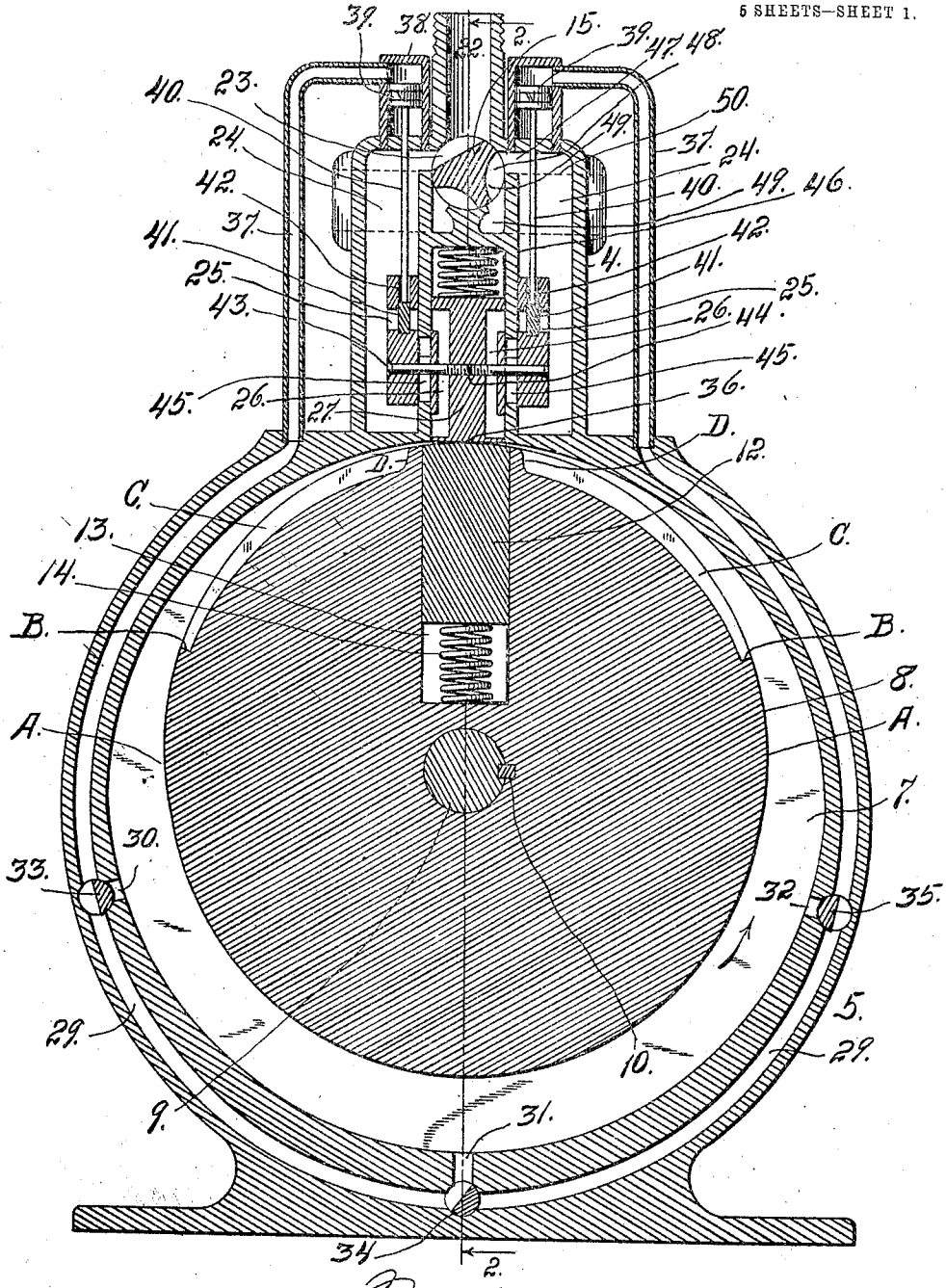


Fig. 1.

Witnesses

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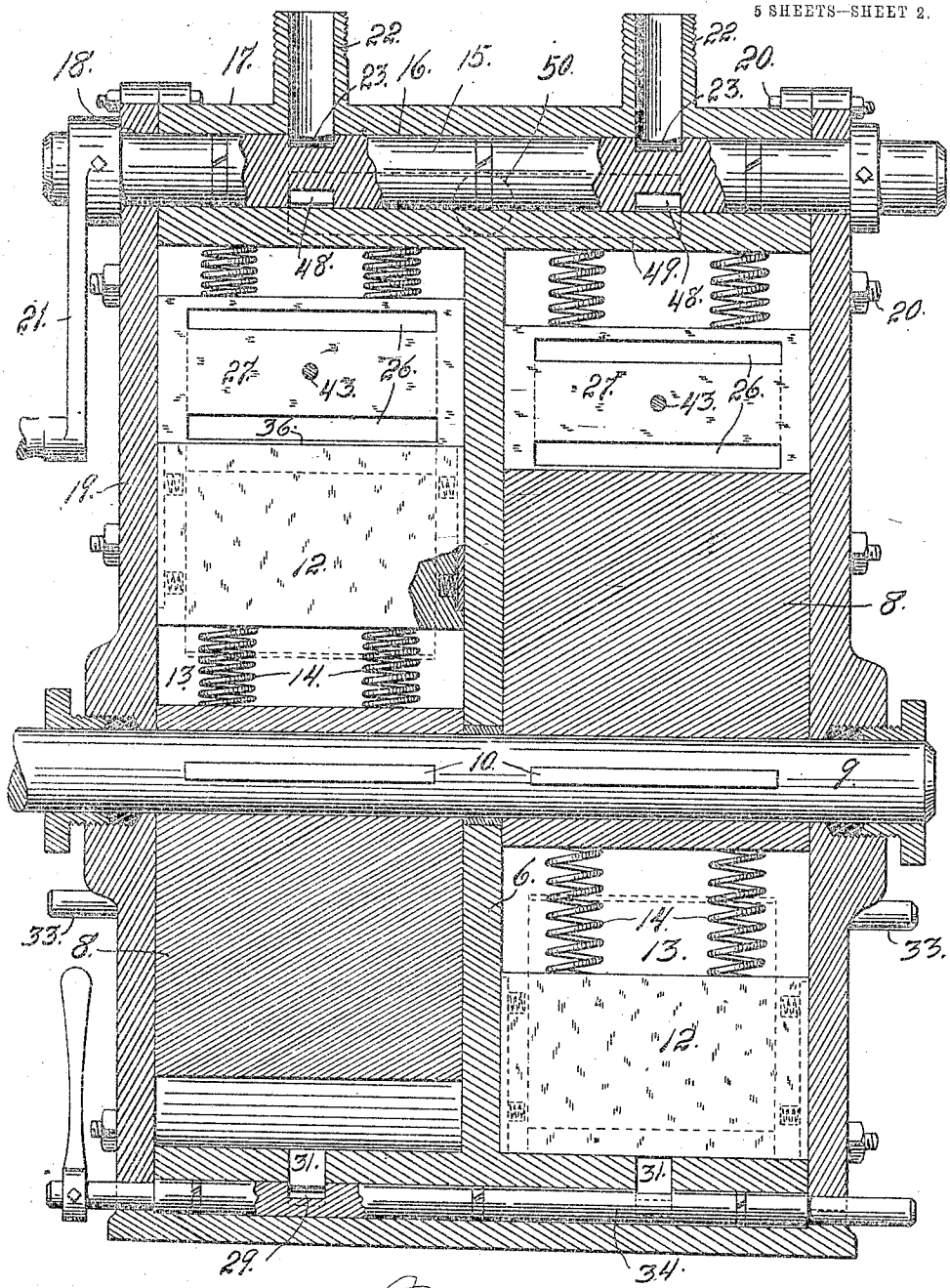


Fig. 2.

Witnesses

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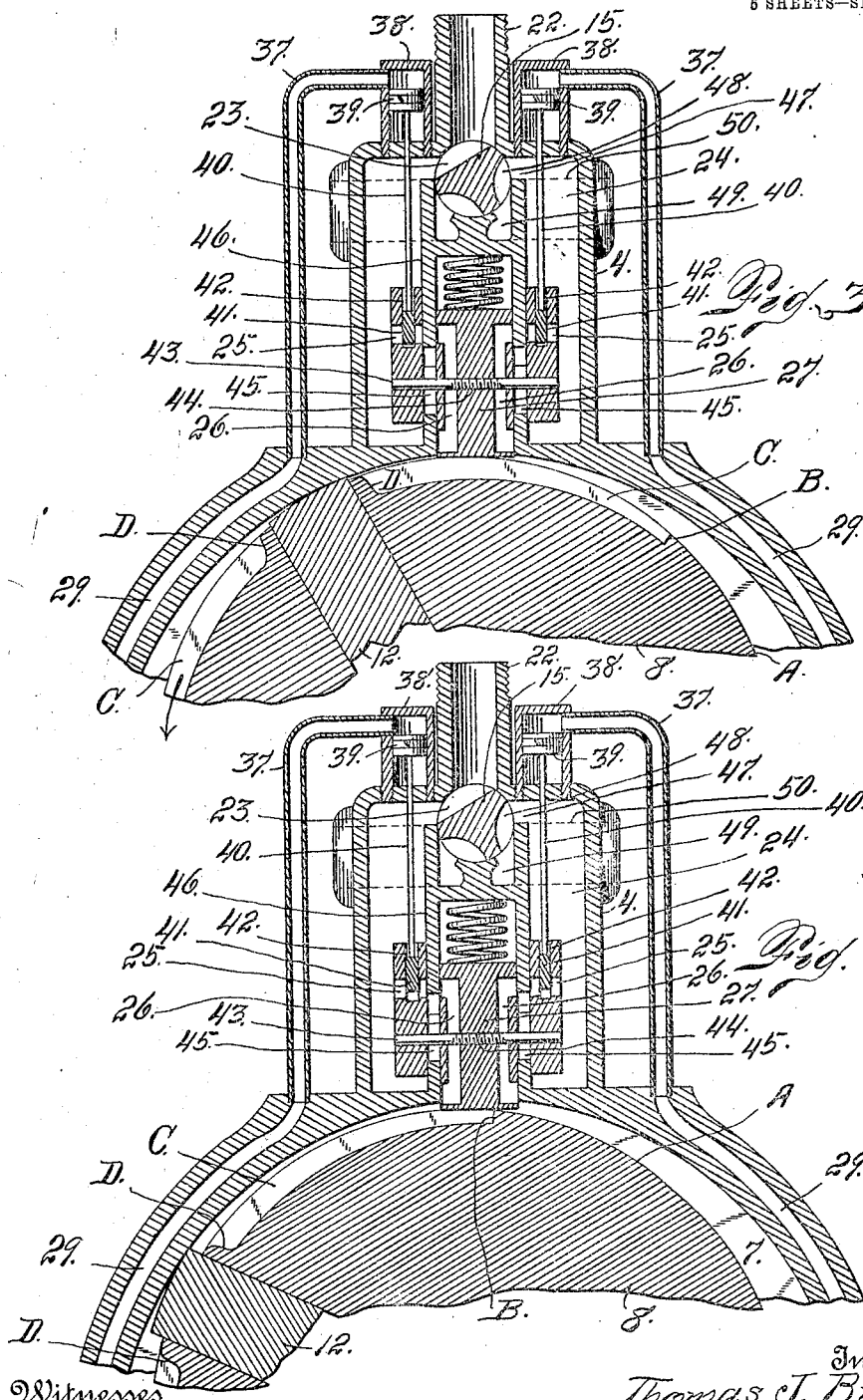


Fig. 3.

Fig. 4.

Witnesses

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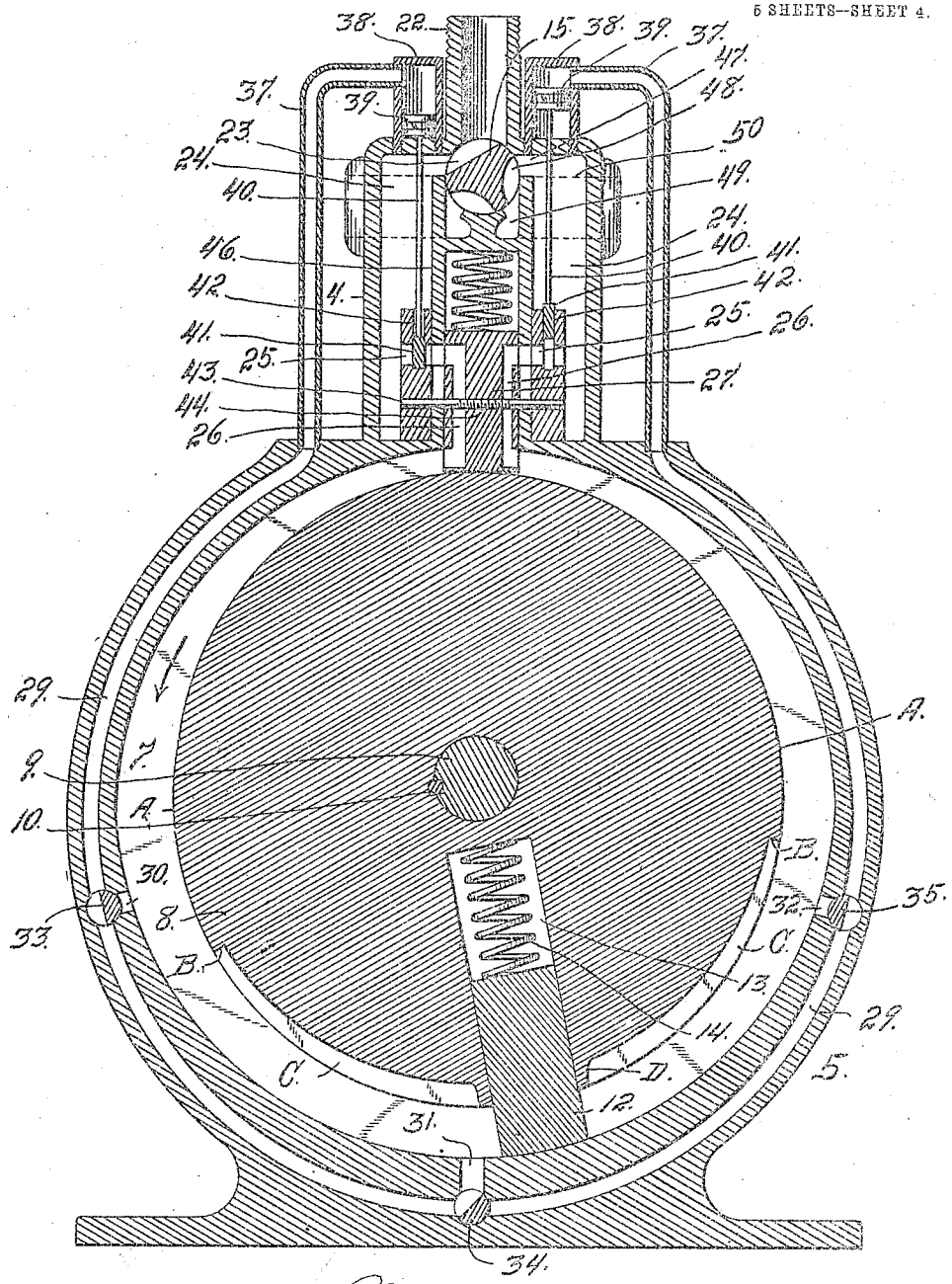


Fig. 5.

Witnesses

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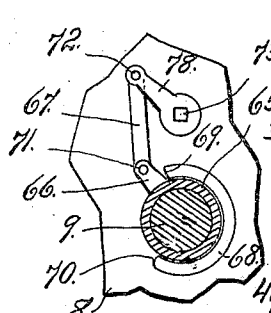


Fig. 7.

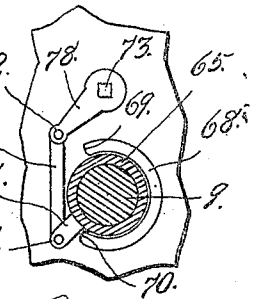


Fig. 8.

Fig. 6.

Witnesses

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UNITED STATES PATENT OFFICE.

THOMAS J. BIGGS, OF OAK CREEK, COLORADO.

ROTARY ENGINE.

1,111,053. Specification of Letters Patent. Patented Sept. 22, 1914.

Application filed January 7, 1914. Serial No. 810,694.

To all whom it may concern:

Be it known that I, THOMAS J. BIGGS, citizen of the United States, residing at Oak Creek, county of Routt and State of Colorado, have invented certain new and useful Improvements in Rotary Engines; and I do 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, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon, which form a part of this specification.

My invention relates to improvements in rotary engines adapted to be operated by steam, air, or other similar gas, my object being to provide a construction of this character which shall be exceedingly efficient for the purpose intended.

An important object of my improved construction consists in the fact that provision is made for cutting off the inlet of the steam, or other fluid, at predetermined points during the travel of the rotor, whereby the completion of the rotary movement of the latter is accomplished on expansion. It is evident that this construction may be operated by air, or other similar gas, as well as steam, though in this specification it will be assumed that the fluid employed is steam. Provision is also made for cutting off the exhaust, as the spring-actuated blade carried by the rotor approaches the completion of its revolution, the rotor for this purpose being made eccentric by enlargement on the side where the blade is located.

The rotor is eccentrically mounted in a casing whose wall is provided with a passage in communication with ports leading from the main chamber of the casing, said ports being controlled by manually operated valves. This passage communicates with a plunger, whereby the steam as it enters the passage from the main chamber of the casing operates the plunger and cuts off the supply of live steam to the main chamber, after which the rotor completes its stroke or revolution on expansion.

As illustrated in the drawing, three ports are employed, arranged at suitable intervals around the main chamber. Any one of these ports may be opened by the proper manipulation of its valve, to cause the live fluid to be shut off from the main chamber when the operating blade has passed any one of the ports.

In my improved construction it is assumed that when starting the engine the live steam will be permitted to enter the main chamber during the entire revolution of the rotor. However, after the rotor has reached its normal speed, one of the valves may be opened for permitting the escape of the steam into the aforesaid passage as soon as the actuating blade has passed the desired exit port.

Having briefly outlined my improved construction, I will proceed to describe the same in detail, reference being made to the accompanying drawing, in which is illustrated an embodiment thereof.

In this drawing: Figure 1 is a cross-section cutting the rotor of my improved rotary engine. Fig. 2 is a longitudinal section of the same, or a section cutting the axis of the rotor longitudinally. Fig. 3 is fragmentary section similar to Fig. 1, but showing the rotor in a different relative position. Fig. 4 is still another view illustrating the rotor in still another position. Fig. 5 is a view similar to Fig. 1, but showing the rotor in a different position, namely, in which its actuating blade has made slightly more than half a revolution, as compared with the position shown in Fig. 1. Fig. 6 is a section similar to Fig. 5, but showing a modified form of construction. Figs. 7 and 8 are detail views illustrating the manner of actuating a valve employed in connection with the construction shown in Fig. 6.

Referring first more especially to Figs. 1 to 5, inclusive, let the numeral 5 designate a main casing, which as illustrated in the drawing is centrally divided by a partition 6 forming the inclosed chamber into two approximately equal compartments 7. In each of these compartments is eccentrically mounted a rotary member 8, which is secured to a shaft 9 being splined thereon, by a key 10, or otherwise suitably attached to operate the shaft. Each of these rotary members or rotors carries a blade or piston 12, which is freely slidable in a chamber 13 formed in the rotor and in which is located a spiral spring 14, which acts upon the blade to force the latter outwardly into the chamber 7. The projecting part of the blade is acted upon by the steam from the

chest 4, the said steam being controlled by a cylindrical valve 15, located in a passage 16, formed in the top member 17 of the valve chest. This valve 15 is journaled as shown at 18 in the end walls 18 of the steam chest, these walls being secured to the body of the chest by means of bolts 20, or other suitable fastening devices.

To one extremity of the valve 15, which extends beyond the valve chest, a hand-crank 21 is applied for manually manipulating the valve. This valve controls the inlet and exhaust of the steam from the main chamber in which the rotor operates.

In my improved construction the rotors may, of course, travel in either direction. When it is desired to change the direction of travel of the rotors, the valve 15 is shifted accordingly, whereby the passages through which the live steam originally passed to the main chamber, become the passages through which the exhaust escapes therefrom and vice versa.

Assuming that the valve 15 is in the position best illustrated in Fig. 1, the live steam which enters the steam chest through a nipple 22, passes through the valve 15, as shown at 23, and enters the inlet side 24 of the steam chest, whence it travels through a port 25 and a passage 26 formed in a slide valve 27, into the chamber 7 of the main casing 5. The steam after entering this chamber acts upon the portion of the blade 12 which projects beyond the rotor, and drives the latter.

In the drawing it is assumed that each rotor is traveling in the direction indicated by the arrows. The wall of the casing is provided with a passage 29, which communicates with the main chamber 7 by means of ports 30, 31 and 32, the said ports being controlled by spindle valves 33, 34 and 35.

The valve 33 is located approximately one-fourth the distance around the valve chamber, from the point 36, which may be assumed is the point where the operating blade 12 commences its revolution. Now, if it is desired to permit the live steam to enter the chamber 7 during approximately one-fourth of the revolution of the rotor, only, the valve 33 may be opened to allow a small portion of the steam to enter the passage 29 through the port 30. This passage communicates at its upper extremity on each side of the casing with a pipe 37, which leads to a small chamber 38, in which is located a plunger 39 secured to one extremity of a rod 40, whose opposite extremity carries a cut-off valve 41, which when the plunger 23 is actuated from above, as the steam enters the chamber 38, is moved to the position shown in Fig. 1, whereby the travel of live steam through the port 25 is cut off. Hence, during the balance of the rotary stroke of the rotor the latter must be actuated by the expansion of the steam already within the chamber 7.

As illustrated in Fig. 1 of the drawing, the valve 34 is actuated to allow the live steam to pass from the main chamber 7 through the port 31 to the passage 29 and thence to the chamber 38 where it acts upon the plunger 39 to close the cut-off valve 41. In this event the live steam is cut off after the rotor has completed approximately one-half of its stroke and the balance of its stroke or revolution is completed on expansion. However, if it should be desired to cause the rotor to travel only a quarter, approximately, of its revolution by expansion, the two valves 33 and 34 would be left closed and the valve 35 opened. This is, of course, assuming that the rotor is traveling in the direction of the arrow in Fig. 1. Of course, if the rotors were traveling in the opposite direction the order in which the valves 33, 34 and 35 would be opened, in order to produce the result stated, would be reversed.

Each rotor of my improved construction is not a perfect cylinder, but is enlarged on the side where the operating blade 12 is located. The enlargement or variation from the cylindrical form, beginning at approximately the points A on opposite sides of the rotor, from which points the latter is gradually enlarged to the center of the blade, or to the point indicated by the numeral 36 in Fig. 1. By virtue of this enlargement of the rotor, the supply valve 27 is closed, while the rotor is traveling from the point A to one extremity B of a cavity C formed in the rotor on opposite sides of the enlarged portion of the rotor. These cavities increase in depth from the point B to the point D. The wheels of the rotor, however, beyond the cavities, act upon the slide valve 27 to raise the latter until the blade 12 reaches the said valve, in which went the blade serves to support the valve in the raised position against its spring.

By inspection of the drawing it will be seen that the blade 12 extends the full length of the rotor, while the cavities 13 are of less width than the rotor, (see dotted lines in Fig. 2) leaving the walls of the rotor intact on opposite sides of the cavities for slide valve operating purposes.

The slide valve 27 not only contains the ports and passages 25 and 26, but also openings 42, in which cut-off valves 41 operate. This slide valve changes its position with reference to the cut-off valves 41, but their range of movement, due to the length of the chambers 38 in which the plungers 39 are located is sufficient to make it practicable to cut off the live steam from the chamber 7 at any desired point during the revolution of the corresponding rotor. In order to properly guide the valve 27 during its open-

ing and closing movement, a stem 43 is threaded into the central portion of the valve as shown at 44, and passes through slots 45 formed in the inner wall 46 of the steam chest.

By reference to Fig. 1 of the drawing it will be understood that if the steam enters the chamber 7 on the left hand side of the slide valve, due to the position of the valve 15 in that view, the exhaust will take place on the opposite side, and consequently through a passage 26 and a port 25, which in this event becomes the exhaust port. However, as during the reverse operation of the rotor, the inlet ports and passages, as illustrated in Fig. 1, would become the exhaust ports and passages, I have chosen to give the ports and passages on both sides of the slide valves corresponding reference characters. The exhaust from either side 24 of the steam chest will pass from the upper portion of the compartment 24 through a port 47, into a passage 48 of the valve 15, and thence into and through a port 49 of the valve chest into a passage 50, whence it escapes to the atmosphere. (See dotted lines in Fig. 2).

From the foregoing description the operation of the construction, as thus far described, will be readily understood. Assuming that the live steam takes the course indicated in Fig. 1, by virtue of the position of the valve, illustrated in said figure, the steam will enter nipple 22 and travel thence through the valve opening 23 to the left-hand compartment 24 of the valve chest, thence through a port 25 in the slide valve to a passage 26 in the same valve, and thence into the chamber 7 of the main casing, assuming that the slide valve is in position to permit such action. (See Fig. 5) This steam will then act upon the blade 12 and drive the rotor in the direction indicated by the arrows in Figs. 1 and 5, or toward the left. Now, if we assume that the port 31 of the valve casing is open by virtue of the position of the valve 34 shown in Figs. 1 and 5, as soon as the blade 12 passes said port the steam will enter the passage 29 and travel thence through the pipe 37 upon the left-hand side of the valve chest to the chamber 38 and act upon the plunger 39 through the stem 40 to move the cut-off valve 41 downwardly a sufficient distance to close the port 25 and shut off the live steam from the passage 26 and consequently from the chamber 7 of the main casing. The steam within the chamber 7 between the slide valve and the blade 12 on the left-hand side, referring to Fig. 5, will act by expansion upon the blade 12 to complete the stroke or revolution of the rotor. As soon as the point located at A, approximately, on the right-hand side of the rotor, still referring to Fig. 5, reaches the lower extremity of the slide valve, the latter will begin to move upwardly and will be closed by the time the rotor has traveled sufficiently to bring the smaller extremity B of the cavity C beneath the adjacent portion of the slide valve. In this event, the exhaust from the portion of the chamber 7 on the right of the blade will be cut off. This exhaust, up to the time of its cut-off, has been escaping through the passage 26 on the right-hand side of the slide valve, the port 25 on the same side, into the adjacent compartment 24 and thence through the opening 48 of the valve 15, into the opening 49 of the valve chest, and thence into the passage 50 and out to the atmosphere through the opening. Assuming, namely, that the escape of this exhaust is cut off, by virtue of the fact that the point B of the rotor occupies a position directly below the nearest portion of the slide valve, the exhaust being trapped in the cavity C. However, were it not for this cavity the steam would be compressed within the portion of the chamber 7 between the point B of the rotor and the blade 12. However, as soon as the point B of the chamber C passes the lower extremity of the slide valve, the chamber C in question is brought into communication with the chamber 7 and the pressure on both sides of the blade 12 is equalized and this condition will exist until the blade 12 has passed the slide valve, after which the latter begins to open and allows the live steam to enter the chamber 7 in the rear of the blade and the operation continues. During the time that the slide valve remains closed and during the time the pressure on both sides of the blade 12 is balanced, as to one of the rotors, whereby this rotor is virtually inactive and asserts no power upon the shaft 9, the other rotor, whose position is the reverse, is acting to drive the shaft. It is, therefore, advantageous that these rotors should be operated in pairs and reversely arranged, as best illustrated in Fig. 2.

In order to insure the balancing of the pressure on both sides of the blade during the period heretofore explained, I may employ the construction illustrated in Fig. 6, in which event the blade 12 is chambered, as shown at 52, to receive the spring 14, and the rotor is provided with a cavity separated into two compartments 53 by a valve 84, having a passage 55, which is adapted to connect either of two passages 54 formed in the rotor with one compartment 53. These passages 54 communicate respectively with the chambers C by way of ports 85 formed in nipples 56, which are threaded into openings in the rotor which register with the enlarged extremities 57 of the passages 54. The ports 85 are normally closed by ball valves 58 which are acted on by spiral springs 59. Now, as the blade 12 approaches the slide valve after the latter

has been closed to shut off the exhaust, if there is any excessive pressure in the cavity 13 which is nearer the slide valve, this will act upon the corresponding ball valve 58 to open the latter and allow the steam to pass into the right-hand compartment 53, (assuming that the rotor is traveling in the direction indicated by the arrows in Figs. 1, 5 and 6) and this pressure within the compartment 53 will act upon a ball valve 60, which normally closes the inner extremity of a port 61 and is held seated by a spring 62 located between a threaded nipple 63 and the valve, a passage 64 being formed in said nipple. It is assumed that the springs 59 and 62 are under the same tension. Hence, a pressure which will open the valve 58 will also open the valve 60, assuming that the pressure acting upon the valve 60 in one chamber C is less than that acting upon the valve 58 in the other chamber C. Hence, by virtue of this arrangement the pressure may be equalized on both sides of the blade 12, during the period when said blade should be inactive. Of course, when the rotor is traveling in the opposite direction, the valve 84 must also be reversed, and in order to accomplish this, mechanism illustrated in Figs. 7 and 8 may be employed. In these views the numeral 65 designates a sleeve which is normally adjustable upon the shaft, but fixed thereto to turn therewith in either position of adjustment. This sleeve is provided with a lug 66 which is pivotally connected, as shown at 71, with one extremity of a link 67, whose opposite extremity is pivotally connected as shown at 72 with a crank-arm 78 which is made fast, as shown at 73, to one extremity of the valve 84.

The rotor is provided with a rib 68 which is interrupted to form two shoulders 69 and 70. The space between these shoulders indicates the movement of the sleeve 65 in order to shift the valve 84 from the position shown by full lines in Fig. 6 to the position shown by dotted lines in the same figure. For instance, assuming that when the valve 84 is in the full line position in Fig. 6 the parts just described are in the position shown in Fig. 7, if it is desired to reverse the engine, whereby the rotor is caused to move in a direction opposite that indicated by the arrow in Fig. 6, the throttle valve 15 will be shifted from the full line position in Fig. 6 to the dotted line position in the same figure, and at the same time the sleeve 65 will be manually shifted from the position shown in Fig. 7 to that shown in Fig. 8, whereby a partial rotary movement will be imparted to the valve 84 sufficient to change the position of the latter from the position shown in full lines in Fig. 6 to the dotted line position in the same view. In this event, the steam will enter the left-hand compartment 53 of the cavity in the rotor, and pass out of said cavity by unseating the left-hand ball valve 60, in order to equalize the pressure in the two recesses or relatively shallow cavities C.

The operation of the form of construction shown in Fig. 6 will now be connectedly described. Assuming that the rotor is traveling in the direction of the arrow in this view, it will be understood that as the blade 12 approaches the slide valve, as soon as the point B of the forward cavity, (This term being used with reference to the direction of travel) reaches the slide valve, the latter will be raised sufficiently to close the valve and cut off the exhaust from the chamber 7. Now, while the point B of the forward cavity C is traveling past the slide valve, there will be slight compression between the blade 12 and the last named valve, as the latter still protrudes slightly into the chamber 7. This excessive pressure will find its way into the left-hand compartment 53 of the interior cavity in the rotor by unseating the forward valve 58, this excessive pressure being thereby stored in the said compartment. As soon as the point B of the foremost cavity C passes the slide valve, the foremost cavity C will be placed in communication with the fluid pressure in the main chamber 7, whereby the pressure will be equalized on both sides of the blade 12 and this rotor member will be inactive until the blade has passed the slide valve and until the point B of the rearmost cavity 13 has also passed beyond the slide valve. As soon as this occurs, the slide valve will begin to open into the chamber 7 and by the time the forward point A of the rotor has passed the slide valve the latter will be fully open, as shown in Fig. 5, for both inlet and exhaust purposes, and the rotor will continue its forward travel in the direction of the arrow in Fig. 6, and under the influence of the live steam until the blade 12 has passed the port 31 of the casing in which event the motive fluid will enter the passage 29 and pass thence through the left-hand pipe 37 into the chamber 38 where it will act upon the left-hand plunger 39 through the stem 40 to actuate the auxiliary valve 41 to close the port 25 of the slide valve, whereby the inlet of live motive fluid to the chamber 7 and the rear of the blade or piston will be cut off and the balance of the stroke will be completed on expansion. In this last named description I have assumed that the valve 34 is open, so that one-half of the revolution of the rotor is accomplished on expansion. It is evident, however, that the valve 33 might be opened, whereby approximately three-fourths of the stroke would be accomplished on expansion. Furthermore, if desired, the valve 35 might be left open while the valves 33 and 34 were closed. In this case, approximately one-

fourth of the stroke only would be accomplished by expansion of the motive fluid.

Attention is called to the fact that immediately after the point B has reached the slide valve and actuated the same sufficiently to cut off the exhaust, whereby a slight excessive pressure results between the blade and the inner extremity of the slide valve, causing the foremost ball valve 58 to open to relieve such excessive pressure by causing it to enter the right-hand compartment 53 of the interior cavity of the rotor, if the pressure within this compartment is greater than that in the chamber 7, the ball valve 60 will open and relieve the same, producing a balanced result on both sides of the blade, even before the point B of the small cavity 13 has passed the slide valve. It will then be understood that the pressure on both sides of the slide valve is equalized because the chamber on both sides is continuous and this balanced condition will continue until the slide valve is allowed to open, as heretofore explained.

When it is desired to reverse the engine causing the rotors to travel in the direction opposite the arrow in Fig. 6, the throttle valve 15 will be shifted from the full line position to the dotted line position in Fig. 6, whereby the live steam will enter the casing chamber by way of the right-hand compartment 24 of the steam chest, the right-hand port 25 and the right-hand passage 26 of the slide valve. In this event the valve 84 will be shifted from the full line position to the dotted line position in Fig. 6, and the operation will be substantially the same as heretofore described, the only difference being that what was the foremost cavity C when the rotor was traveling in the direction of the arrow in Fig. 7 will become the rearmost cavity, while the rearmost cavity under the conditions originally assumed will now be the foremost cavity.

Having thus described my invention, what I claim is:

1. In a rotary engine the combination with a casing of a rotor eccentrically mounted therein and having a crescent shaped enlargement on one side whose point of maximum depth reaches the wall of the chamber at the point of minimum separation from the rotor, a blade carried by the rotor and spring-held in engagement with the inner surface of the wall of the casing, said position of the blade being coincident with that of the greatest radial depth of the rotor, and a valve for controlling the inlet and exhaust of the casing chamber and forced outwardly to the closed position by the enlargement of the rotor.

2. In a rotary engine the combination with a casing of a rotor eccentrically mounted therein and having a crescent shaped enlargement on one side whose point of maximum depth reaches the wall of the chamber at the point of minimum separation from the rotor, a blade carried by the rotor and spring-held in engagement with the inner surface of the wall of the casing, said position of the blade being coincident with that of the greatest radial depth of the rotor, and a valve for controlling the inlet and exhaust of the casing chamber and forced outwardly to the closed position by the enlargement of the rotor, the said enlargement having cavities on opposite sides of the blade to equalize the pressure on both sides of the latter after the said valve is closed.

3. In a rotary engine the combination with a casing of a rotor eccentrically mounted therein and having a crescent shaped enlargement on one side which is centrally interrupted by a radial recess, a blade located in said recess and spring-actuated to tangentially engage the inner surface of the wall of the casing at all times, and a valve spring-actuated to enter the casing for controlling the inlet and exhaust of the motive fluid, said valve being actuated by the crescent shaped enlargement of the rotor for closing purposes before the rotor reaches the position where the outer extremity of its blade is flush with its surface.

4. In a rotary engine the combination with a casing, of a rotor eccentrically mounted therein and having a crescent shaped enlargement on one side which is centrally interrupted by a radial recess, a blade located in said recess and spring-actuated to tangentially engage the inner surface of the wall of the casing at all times, and a valve spring-actuated to enter the casing for controlling the inlet and exhaust of the motive fluid, said valve being actuated by the crescent shaped enlargement of the rotor for closing purposes before the rotor reaches the position where the outer extremity of its blade is flush with its surface, the rotor having cavities in its enlargement on opposite sides of the blade to balance the pressure after the closing of the valve when the rotor is traveling in either direction.

5. In a rotary engine the combination with a casing of a rotor eccentrically mounted therein and having a spring-actuated blade tangentially engaging the inner surface of the walls of the casing a main valve controlled by the rotor, means for controlling the inlet and exhaust of motive fluid from the casing chamber in front and rear of the blade and means located at suitable intervals around the circumference of the casing chamber for shunting relatively small quantities of motive fluid, and an auxiliary valve acted on by said shunted fluid to cut off the fluid supply to the casing chamber via the main valve, whereby the rotor is operated on expansion during the remainder of the stroke.

6. In a rotary engine the combination of a casing, a rotor eccentrically mounted therein and having a blade tangentially engaging the inner surface of the casing a main valve controlled by the rotor, the wall of the casing having a passage, a fluid-inlet-cut-off-valve in communication with the said passage, and a third valve operable to permit a relatively small quantity of fluid to enter the said passage to move the fluid inlet cut-off valve to cut off the fluid from the casing, via the main valve.

7. In a rotary engine the combination of a casing, a rotor eccentrically mounted in the casing and having a blade tangentially engaging the inner surface of the casing a main valve controlled by the rotor, the wall of the casing having a passage, a fluid inlet cut-off valve in communication with the said passage and a plurality of valves arranged at suitable intervals around the circumference of the casing chamber and operable to admit small quantities of fluid to the said passage to move the fluid inlet cut-off valve to the closed position.

8. In a rotary engine the combination of a casing, a rotor eccentrically mounted in the casing and having a blade tangentially engaging the inner surface of the casing, the wall of the casing having a passage, a main valve for controlling the motive fluid inlet and exhaust of the casing chamber, said valve being positioned to enter the casing nearest the center of the rotor in a radial direction, an auxiliary fluid inlet cut-off valve in communication with the said passage, and a shunt valve operable to permit a relatively small quantity of motive fluid to enter said passage to move the auxiliary cut-off valve to the closed position after the blade of the rotor has passed the shunt valve.

9. In a rotary engine the combination of a casing, a rotor eccentrically mounted in the casing and having a blade tangentially engaging the inner surface of the casing, the wall of the casing having a passage, a main valve for controlling the motive fluid, inlet and exhaust of the casing chamber, said valve being positioned to enter the casing nearest the center of the rotor in a radial direction, the rotor having an enlargement on one side to force the said valve outwardly, the valve being normally spring-actuated toward the casing chamber, an auxiliary fluid inlet cut-off valve in communication with the said passage, and a plurality of shunt valves arranged at suitable intervals around the circumfrence of the casing chamber and operable to admit small quantities of fluid to the said passage to move the auxiliary fluid inlet cut-off valve to the closed position after the blade of the rotor has passed the shunt valve.

10. The combination with a casing, of a rotor mounted thereon and having a crescent shaped enlargement on one side, centrally interrupted by a recess formed in the rotor, a spring-actuated blade located in said recess and whose outer extremity when engaging the portion of the inner surface of the casing nearest the center of the rotor, is flush with the outer surface of the enlargement, a main valve controlled by the rotor to regulate the inlet and exhaust of the casing chamber, the rotor having cavities in the enlargement exposed on both sides of the blade and also an interior cavity composed of two compartments, the rotor also having a U-shaped passage extending inwardly and whose extremities communicate with the exposed cavities, inwardly opening check valves respectively located at the extremities of the said passage, a valve interrupting the passage and adjustable to connect either interior compartment therewith, and outwardly opening check valves respectively controlling ports connecting the exterior cavities with the interior compartments.

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

THOMAS J. BIGGS.

Witnesses:
L. F. HALL,
A. EBERT O'BRIEN.