H. I. CALL.

ROTARY ENGINE.

APPLICATION FILED JAN. 29, 1907. RENEWED JULY 27, 1910.

985,974.

Patented Mar. 7, 1911.

4 SHEETS—SHEET 1.

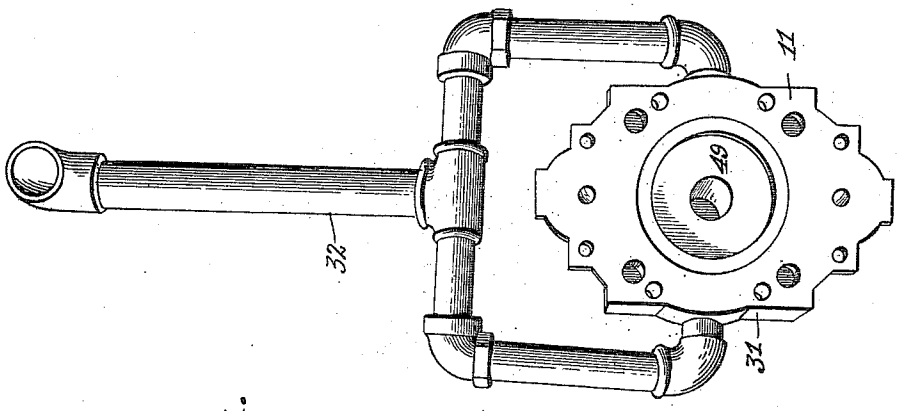
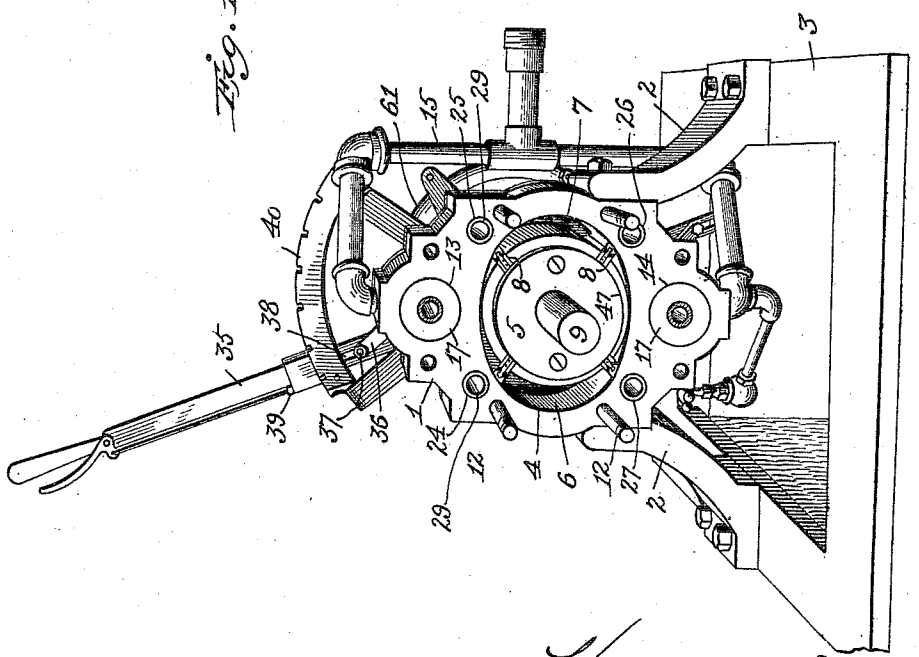



Fig. 1.




Witnesses

Edwin L. Jewell

Robert A. Lowe

Inventor

Hubert I. Call

By Hugh M. Fleming

Attorney

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4 SHEETS—SHEET 2.

Fig. 3.

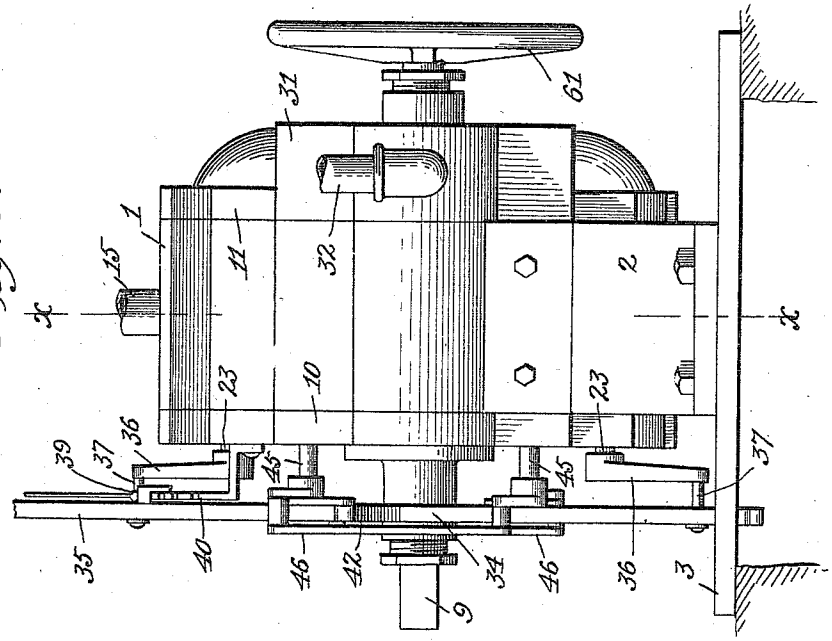
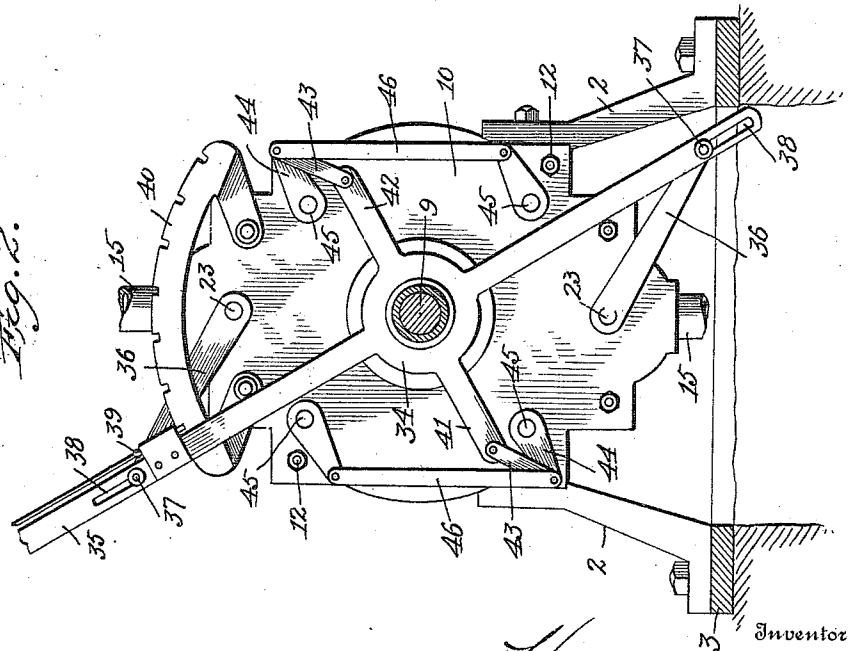



Fig. 2.




Witnesses

Edwin L. Yewell

Robert Moore

Inventor

Hubert I. Call

By Hoyt M. Sterling

Attorney

H. I. CALL.

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4 SHEETS—SHEET 3.

Fig. 3.

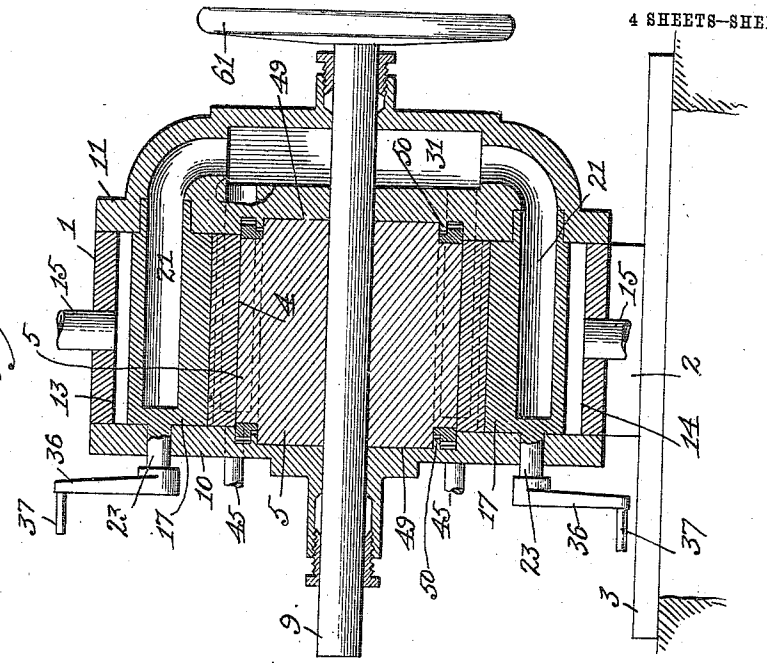
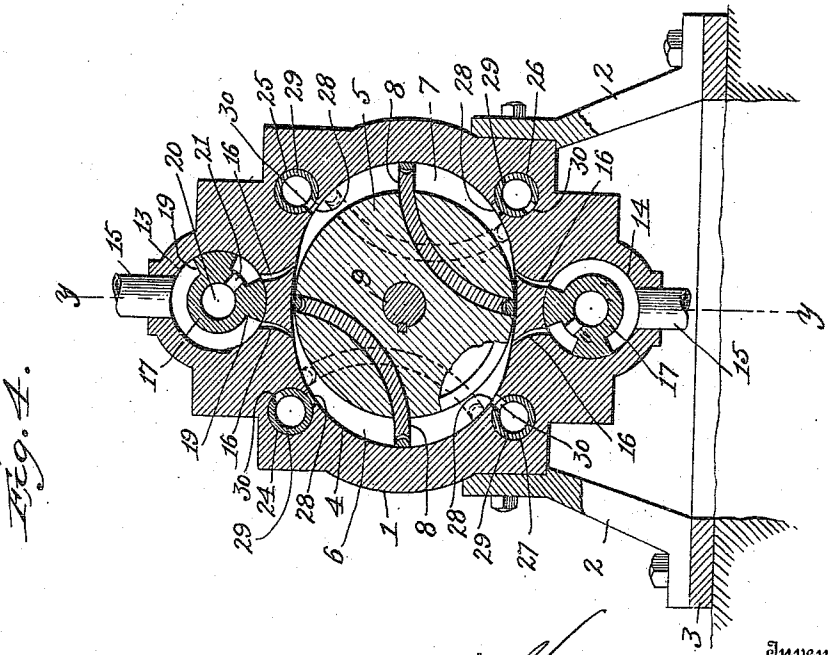



Fig. 4.




Witnesses

Edwin J. Jewell

Robert N. Lorz

Inventor

Hubert I. Call

By Huy & McStenning

Attorney

H. I. CALL.

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4 SHEETS—SHEET 4.

Fig. 8.

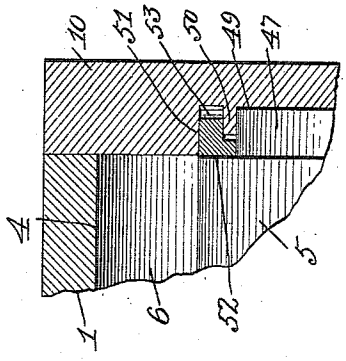



Fig. 7.

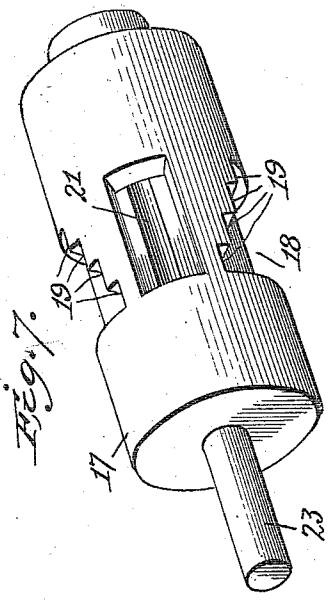



Fig. 9.

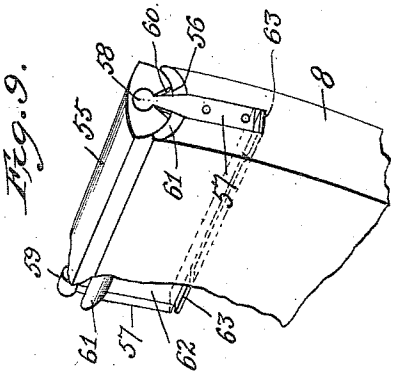



Fig. 10.

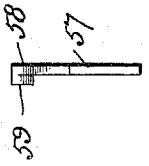
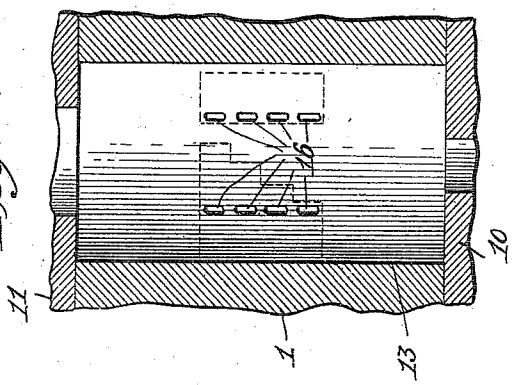



Fig. 6.




Witnesses

Edwin L. Yewell

Robert H. Loos.

Inventor

Hubert I. Call

By Hugh M. Strieby

Attorney

# UNITED STATES PATENT OFFICE.

HUBERT I. CALL, OF SPOKANE, WASHINGTON, ASSIGNOR TO THE HERCULES ROTARY ENGINE COMPANY, LIMITED, OF WETASKIWIN, CANADA, A CORPORATION.

## ROTARY ENGINE.

985,974. Specification of Letters Patent. Patented Mar. 7, 1911.

Application filed January 29, 1907, Serial No. 354,712. Renewed July 27, 1910. Serial No. 574,211.

*To all whom it may concern:*

Be it known that I, HUBERT I. CALL, a citizen of the United States, residing at Spokane, in the State of Washington, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

This invention relates to improvements in engines of the rotary type, or to analogous rotary devices, and has especial relation to the engine forming the subject matter of the patent issued to me August 14, 1906, numbered 828,712.

One object of the invention is to greatly simplify and improve the construction of this type of engine by providing within the cylinder casting the steam admission and exhaust passages, and mounting therein the valve for the control of said passages.

Another object is to provide for the introduction of the steam to the engine cylinder at substantially boiler pressure by providing against expansion of the steam intermediate the admission valve and said cylinder, and further to provide against the loss of pressure in the steam spaces, resulting from the formation of a pocket by the dead exhaust port included therein, and also to provide for the expulsion of the exhaust without the usual back pressure due to the expansion of the exhaust steam on leaving the cylinder.

Another object is to provide for regulating the quantity of steam admitted to the engine, in a manner to prevent loss of power from expansion within the valve and during its passage therefrom to the cylinder, by employing a series of ports one or more of which may be cut out or brought into operation according to the quantity of steam admitted.

Another object is to provide for the admission of steam to the cylinder through alternately operating ports for the purpose of driving the engine in either direction, and the alternate conversion of said ports into exhaust ports when the other port is admitting steam, and further to control said ports in pairs by a common valve.

Another object is to utilize the heat radiated by the engine cylinder and the heat of the exhaust steam to prevent condensation or cooling of the active steam, by the formation of an exhaust chamber common to all the exhaust passages, which chamber will form a protective steam jacket about one end of the steam cylinder.

Another object is to provide for the admission to each steam space of the cylinder of subsequent charge or charges of steam before the preceding charge has begun to exhaust, by causing each blade to enter successively each steam space before its predecessor has reached the exhaust port thereof, thereby dividing each steam space into two active steam pockets during a part of the engine's rotation, thus adapting each steam space to receive steam charges of different degrees of expansion simultaneously.

Another object is to so dispose a packing ring between the piston and the face plate of the engine as to insure against leakage of steam with the minimum of friction, and another object is to provide the piston blades with a movable wear-head designed to automatically adjust itself to the surface of the cylinder and maintain proper contact pressure at all times.

To the end of accomplishing the above objects, the invention consists in the novel construction and combination of parts, all as hereinafter described, and specifically pointed out in the appended claims.

In the accompanying drawings, illustrating the invention, Figure 1 is a perspective view of the engine as viewed from the exhaust end, and showing the head or exhaust box removed. Fig. 2 is a view in elevation of the end of the engine carrying the valve gears and main operating lever. Fig. 3 is a view in side elevation. Fig. 4 is a transverse sectional view on the line $x$—$x$ of Fig. 3. Fig. 5 is a detail view showing a portion of the interior of the bores containing the steam admission ports. Fig. 6 is a perspective view of the valve barrel for controlling the steam ports. Fig. 7 is a view showing the exhaust port of the steam controlling valve barrel. Fig. 8 is an enlarged view of a portion of the engine, partly in section, showing the disposition of the packing ring at each end of the rotary piston. Fig. 9 is a perspective view of a section of one of the piston blades and the pivoted wear-head therefor. Fig. 10 is a side view of one of the pivotal end supports for the wear-head of the piston blades.

Referring to the drawings, 1 designates the cylinder casting, which in the present instance constitutes the main inclosing element of the

engine and the main supporting element, and is mounted upon side supports 2, carried by the base plate 3. This casting is formed with a cylindrical bore 4 of unequal cross section whereby to form on each side of the drum or piston 5, rotatably mounted therein, oppositely disposed crescentic steam spaces 6 and 7 in which the curved blades 8 project to receive the steam impact and which are controlled in their movements in said drum by the cam action of the cylinder walls on the ends of said blades. The drum 5 is provided with trunnions or axial shaft 9 which finds a bearing in the cylinder heads or face plates 10 and 11, which are secured to the cylinder casting by means of the bolts 12.

The cylinder casting is made preferably in the form shown to provide for the formation therein of oppositely disposed bores 13 and 14, one above and one below said cylinder, and parallel to the axis of rotation. These bores provide primarily a chamber for the introduction of steam to the cylinder, and into which chamber the steam is conducted by the branch steam pipe 15. The bores 14 are each connected with the adjacent ends of the opposing crescentic steam spaces by a series of inwardly tapering steam ducts 16, each steam space having a separate series (see Fig. 5), which are controlled by a valve 17 within the bore 14, to alternately make one or more of one set of ducts steam admission ports, while one or more of the other adjacent set will form exhaust ports. By reference to Fig. 6, it will be seen that the valve 17 constitutes a hollow barrel fitting the bore 14 and provided with a peripheral recess 18 having end walls formed into steps which form stops 19 corresponding in number to the ducts of each series, and which, as said barrel is turned, will, according to its direction, cover or uncover one or more of said ducts, and while thus making communication between the said steam recess and the steam space of one series, communication is established at the same time between the adjacent series of ducts and the interior space 20 of said valve barrel by means of the opening 21 which is brought into register with said adjacent series of ports, so that the exhaust steam will be conducted through said barrel and out at one side thereof. The valve barrel is provided at its closed end with a stem 22 which projects through the face plate 10 which is provided with bores 23 which form a continuation of the bores 14 and a mounting for the said valve stem.

From the foregoing, it will be seen that the valves are located in such close proximity to the engine cylinder that the steam in passing from the valve to the cylinder has practically no space for expansion, and that such space as does exist is made in the form of a series of ducts which are used only as may be required by the quantity of steam admitted, thereby avoiding unnecessary expansion, and that further these ducts are each so formed with tapering orifice that the tendency of the steam to expand therein is reduced or checked and the steam delivered into the steam space of the cylinder so that its progressive expansion will begin from the time the piston blade has passed the opening of these ports, which from their location as shown, produce a steam pocket on the impact side of the piston blade that will begin with the smallest practicable space. By these protective provisions the steam is delivered to the cylinder not only in a way to conserve its high potentiality, but in a manner to utilize its full potentiality from the moment it enters the cylinder.

The cylinder casting 1 is also provided with the bores 24, 25, 26 and 27, which are formed parallel to the cylinder bore and closely adjacent thereto. These constitute two sets of primary exhaust passages, one set for each direction of engine movement, and each connects with the steam space adjacent thereto by a port 28. Within each of these bores is provided a barrel valve 29 having a port 30 through which the exhaust steam is conducted into the interior of the valve and thence out through one side of the same into the exhaust box 31, which is so formed as to constitute a face plate or head for the cylinder casting, the said box being formed preferably with openings to continue the bores 14 and the primary exhaust bore into the exhaust box from which the exhaust steam will be carried to the open air by means of the exhaust pipe 32, which as shown, is preferably divided into connecting branches which connect with the exhaust box on opposite sides thereof. By reason of the construction and location of the exhaust valve in such close proximity to the interior space of the cylinder, the set of inactive exhaust ports are prevented from forming pockets intermediate the cylinder and valve, into which the steam would expand with a consequent loss of its progressive expansion power upon the blades, while the elimination of these pockets causes the active exhaust ports to relieve in great measure the back pressure incident to the exhausting of steam.

The primary exhaust ports are each so located with respect to the steam admission ports active with each, that the exhaust port is not uncovered or passed by one end of a piston blade before its other end has moved past the steam admission port and well into the same steam space, as shown by the dotted position of blade in Fig. 4. By this provision each blade will receive during a part of its movement with the piston

drum, a steam impact simultaneously on each end thereof and on opposite sides, thus forming of each steam space two pockets during a part of the piston revolution, in which the steam is of different degrees of expansion, thereby securing more power from the steam than if the steam was admitted during an equivalent period to a single pocket and at the same time by the production of opposing pockets tend to equalize the pressure on each side of that portion of the blade separating the two steam pockets with a consequent reduction of friction in the sliding movement of the blade.

In order to provide a common control for the valves of the steam admission ports and those of the exhaust ports there is rotatably mounted on the engine shaft a hub or spider 34 which forms a fulcrum bearing for the valve operating lever 35, which lever is connected with the stems of each steam valve by a crank arm 36 having a pivotal connection by means of pin 37 with the operating lever, which connecting pin is adapted for sliding movement on said lever by virtue of the slot 38 in which said pin operates, which sliding movement allows for the difference of arc described by the end of the crank arm 36 and any fixed point on the operating lever. The operating lever is provided with the usual spring actuated pawl or friction device 39 for locking said lever to, or holding the same by binding contact with, a guide and set segment 40.

The lever 35 will be neutral or inoperative upon the valve when brought into a vertical position, as shown by the dotted position in Fig. 4, in which it will divide the segment 40 and thus be in a position to control the valve to admit steam to either of the two sets of ports according to the direction of rotation which will be governed by the movement of the operating lever to one side or the other of the neutral or closed position. In Fig. 4 the parts are shown in a position to open the valves to the full, and the movement of the lever to the other end of the segment 40 will cause the reversal of the engine and the driving of the same under full pressure of steam in an opposite direction.

In order to control the two sets of exhaust ports through the operating lever there are provided arms 41 and 42 extending from the hub 34 in opposite directions and at right angles to the operating lever, each of which arms connects at its end with a crank arm 44, through the agency of a link 43, whereby the valve stem 45 upon which said crank arm is fixed is partially rotated. Preferably, and as shown, the exhaust valves thus geared are those of each set that are simultaneously made active or dead ports together, while by means of the link or bar 46 the crank shafts of opposing sets of valves are coupled in such position that the opening of the port of one set will, through the agency of the bar, close the port of the other set, and vice versa, but the relative arrangement of the valves is such that while both in each set are simultaneously moved, one will be rotating through an arc of movement in which the port of the valve barrel is out of register with the exhaust port thereof.

By reference to Fig. 8 it will be seen that the piston drum 5 at each end is slightly reduced at its rim to provide a portion 47 to project within a recess 49 within the adjacent face plate, which recess is provided with an annular rib or partition 50 that extends but part way of the depth of the recess and fits closely around the end of the reduced portion 47, while further provision is made for preventing leakage of steam at this point by fitting about the reduced portion of the drum, and within an annular surrounding recess 51 included within the recess 49, a packing ring of metal or other suitable material that is provided with a bearing surface to correspond in width to the rabbeted face 52 of the drum and adapted to be maintained in contact therewith by suitable means such as spring 53 disposed between the ring and the inner wall of its recess. By the construction here set forth, while the drum is provided with a reduced portion to fit within a corresponding recess, it is also provided with a spring pressed packing ring which not only bears against the rabbeted face of the drum but also carries a face which bears against the peripheral face of the reduced portion 47, thus interposing an effectual packing at or adjacent the circumference of the drum, and in a manner to prevent leakage and at the same time relieve friction to a considerable extent. As a further provision for obviating steam leakage and reducing friction, there is provided at each end of the solid piston blade 8 a wear-head 55 of semicircular cross section, the contact surface of which is slightly convex. This wear-head is of semicylindrical form as shown in order to seat and at the same time provide for oscillation thereof within a semicylindrical groove 56. To relieve the friction of these parts, and to fix a definite center of oscillation for the wear-head, supports 57, which also act as end packing strips, are countersunk within the contact ends of the blades and suitably secured thereto, each support projecting above the blade proper, and being provided with a circular head 58 having a pintle 59. The ends of the wear-heads are each recessed to receive the pintle 59 and countersink the supports, and below the head 58 a recess 60 is provided to permit the wear-head to turn upon its support and at the same time limit the turning movement thereof by abutments

formed by the walls of the recess to the support.

Preferably the wear-head 55 is yieldably supported in the blades, as shown clearly in Fig. 9. In the construction here shown the groove 56 is provided by the transversely curved seat-piece 61 which is fitted in the end of the blade. This seat-piece is formed with a depending strip 62 which fits within a recess 63 therefor within the end of the blade, thus providing a packing and at the same time permitting an adjustment movement to and from the blade. At the base of the recess 63, and confined under tension between it and the strip 62 is a spring 64, which maintains a pressure to force the seat 61 outward, and, by virtue of the supports 57 being secured to the said strip 62, to maintain a yielding outward pressure against the wear-head 55.

By reason of the location of the axis of operation of the wear-head close to the wear surface thereof the major portion of the head is brought below the pivot making its movement oscillatory in character and tending to maintain the head in the normal position in which it is shown. As before stated, the adjustment of the wear-head will be automatic, the oscillation or tilting of the head being brought about primarily by the pressure of steam, which will also produce a contact of a pressure that will be more or less according to the steam pressure, but independent of such regulation the head is adapted to accommodate itself to the wall of the cylinder and to be influenced by centrifugal force in opposition to the steam pressure with the advantage of reducing the steam pressure thereon.

While the drum of the engine is a balanced structure and constitutes, as is well known, a balance wheel, there is provided in the present instance on the engine shaft and in the rear of the exhaust box a hand wheel 65 by which an initial movement may be given the drum or the same controlled exteriorly by hand for any desired purpose.

In the foregoing description the engine has been described solely in connection with steam as the source of power, but it will be obvious that the invention is applicable to the use of any fluid under pressure as a source of power, and that the device is adapted for use as a motor, pump or meter as is common with rotary devices of this type, and such is within the scope and spirit of the invention.

Having thus fully described my invention, what I claim and desire to secure by Letters Patent is:

1. In a rotary device, the combination with a rotary piston and an inclosing shell therefor adapted to form steam space or spaces between said shell and piston, said shell having a series of ports for each steam space, a valve for controlling said series of ports, having a steam way adapted to register with one or more said ports according to the degree of valve movement, whereby to open or close each port in succession, substantially as and for the purpose set forth.

2. In a rotary device, the combination with a rotary piston and an inclosing shell therefor adapted to form steam spaces between said shell and piston, said shell having a row of ports for each steam space, of means for controlling said ports having a steam way with adjacent stops arranged in steps, substantially as described, whereby the said ports may be opened or closed in succession, substantially as and for the purpose set forth.

3. In a rotary device, the combination with a rotary piston and an inclosing shell therefor adapted to form steam spaces between said shell and piston, said shell having a row of ports for each steam space, of means for controlling said ports, having a tapering steam way adapted to move in open relation with one or more of said ports, substantially as described, whereby said ports may be opened or closed in succession, as and for the purpose set forth.

4. In a rotary device, the combination of a rotary piston and an inclosing shell therefor adapted to form steam space or spaces between said piston and shell, said shell having a steam passage formed therein parallel to the axis of rotation and communicating with the steam space or spaces through a series of inwardly tapering ports, said steam passage being provided with means for controlling the admission of steam to said ports, substantially as and for the purpose set forth.

5. In a rotary device, the combination of a rotary piston and an inclosing shell therefor adapted to form steam space or spaces between said piston and shell, said shell having a steam passage formed therein parallel to the axis of rotation having communication with the steam space or spaces through a series of ports for each steam space, and communication with a steam inlet and outlet, said steam passage being provided with means for alternately placing one or the other of said series of ports into communication with the steam inlet and steam outlet, substantially as and for the purpose set forth.

6. In a rotary device, the combination with a rotary piston and an inclosing shell therefor adapted to form steam space or spaces between said shell and piston, said shell having two sets of inlet and outlet ports for each steam space adapted for alternate use according as the piston is driven in one or the other direction, of a valve for each port, each having an operating stem carrying a crank arm, a main operating le-

ver fulcrumed on the axis of rotation having a sliding connection with the crank arms of opposing valves, and carrying arms having a link connection with the crank arms of another set of opposing valves, and means connecting said arms of opposing sets of valves, as and for the purpose set forth.

7. In a rotary device, the combination with a rotary piston and an inclosing shell therefor adapted to form steam space or spaces between said shell and piston, said shell having two sets of inlet and outlet ports for each steam space adapted for alternate use according as the piston is driven in one or the other direction, of a valve for each port, each valve having an operating stem carrying a crank arm, a main operating lever fulcrumed on the axis of rotation, means for suitably connecting said lever with the crank arms of the inlet valves and those of one set of outlet valves, and a link for connecting the crank arms of the opposing set of outlet valves, substantially as and for the purpose set forth.

8. In a rotary device of the character described, the combination with a piston blade, of a wear-head, a seat piece therefor slidably mounted within said blade and carrying end supports for pivotally mounting the wear-head, as and for the purpose set forth.

9. In a rotary engine, the combination of a drum and an inclosing shell adapted to form steam space or spaces between them, one adapted to revolve with reference to the other, said drum having its ends reduced, and said shell having a recess in each face to receive said reduced portions, and a surrounding annular recess, a packing ring to fit said reduced portion of the drum, adapted to seat within said annular recess, and means for maintaining said ring in yielding contact with the face of said drum intermediate its periphery and said reduced portion, substantially as and for the purpose set forth.

10. In a rotary engine, the combination of a drum and an inclosing shell adapted to form steam space or spaces between them, one adapted to revolve with reference to the other, said drum having its ends reduced, and said shell having a recess in each face to receive said reduced portion, and a surrounding annular recess, a packing ring to fit said reduced portion of the drum, adapted to seat within said annular recess, and a spring within said annular recess, for maintaining said ring in contact with the face of said drum intermediate its periphery and said reduced portion, substantially as and for the purpose set forth.

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

HUBERT I. CALL.

Witnesses:
A. H. KENYON,
O. B. SETTERS.