

O. STAFF & W. LARSON.
 ROTARY ENGINE.
 APPLICATION FILED JULY 6, 1909.

1,047,323.

Patented Dec. 17, 1912.

4 SHEETS—SHEET 1.

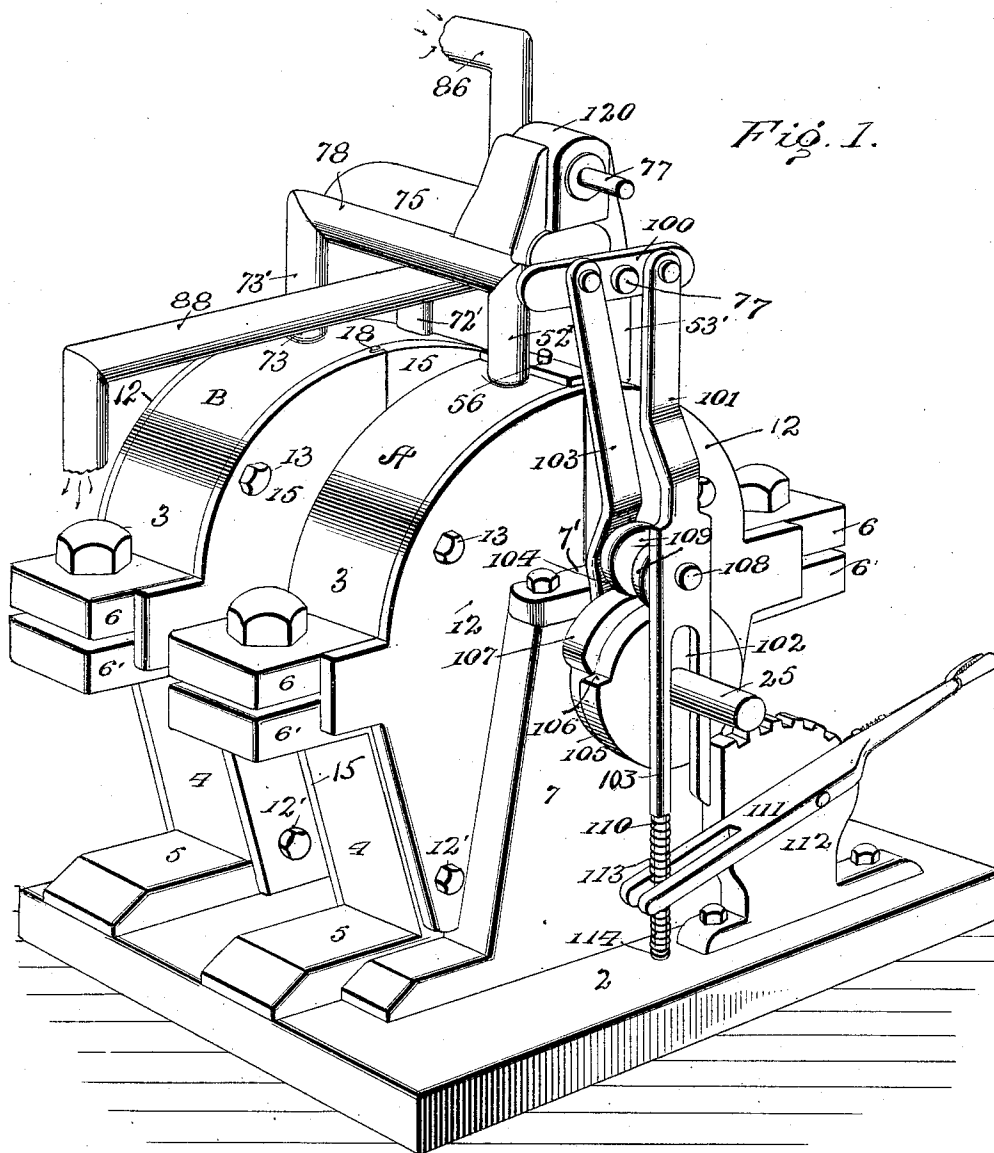


Fig. 1.

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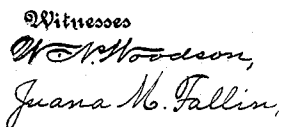
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4 SHEETS—SHEET 2.

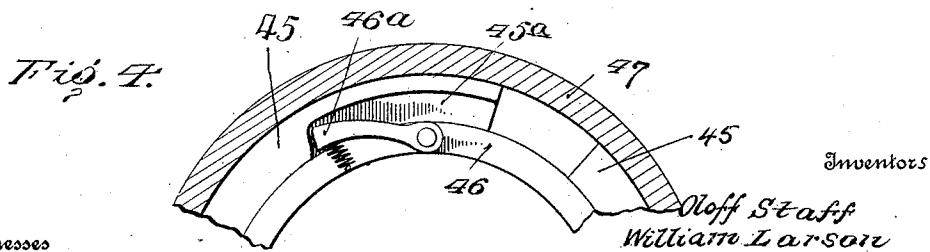
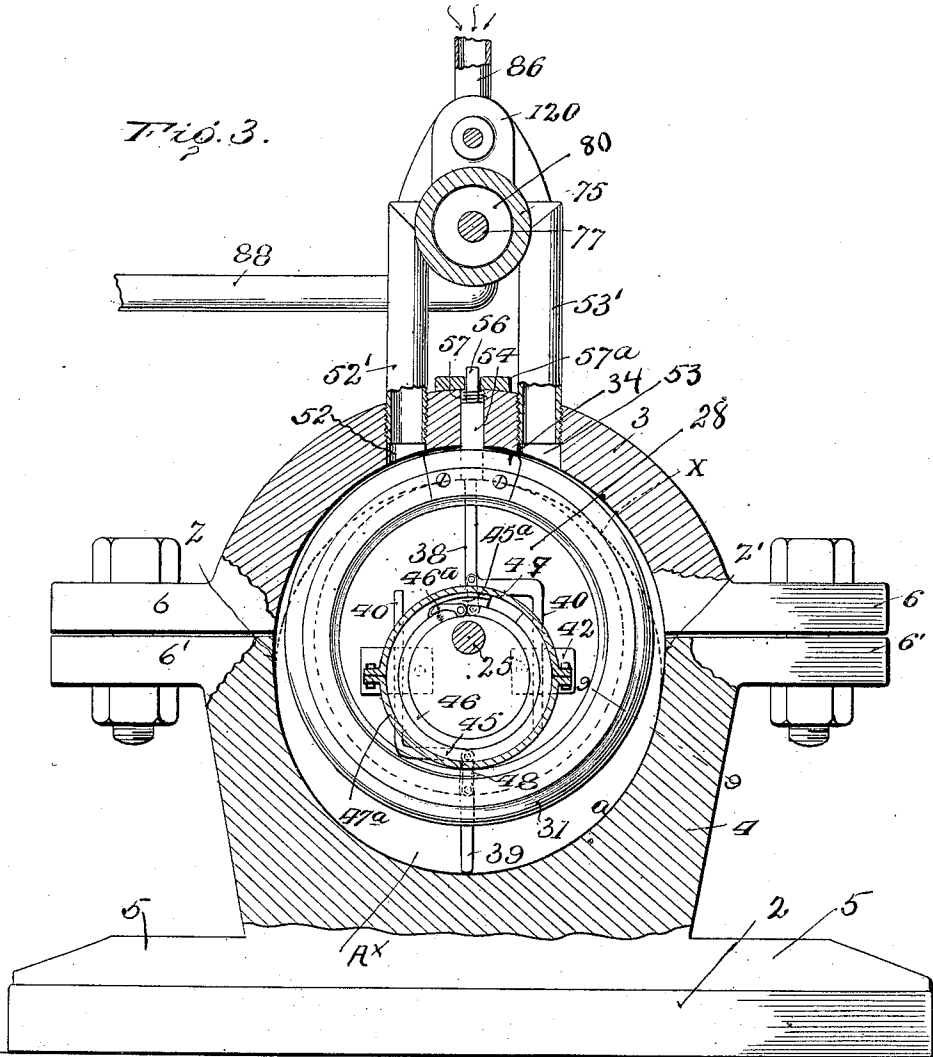


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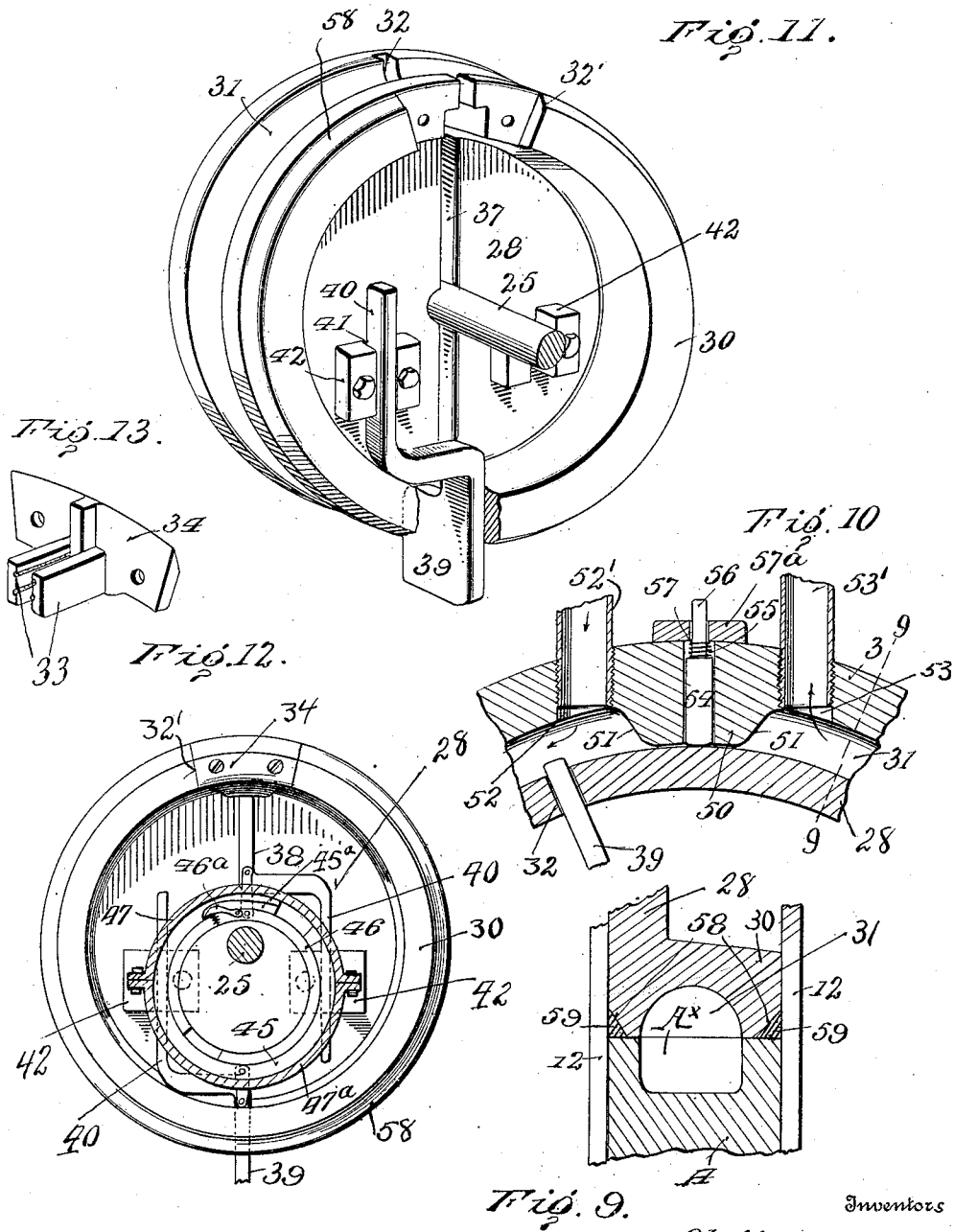
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4 SHEETS—SHEET 4.



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UNITED STATES PATENT OFFICE.

OLOF STAFF AND WILLIAM LARSON, OF LOTHROP, MONTANA.

ROTARY ENGINE.

1,047,323.

Specification of Letters Patent.

Patented Dec. 17, 1912.

Application filed July 6, 1909. Serial No. 506,143.

To all whom it may concern:

Be it known that we, OLOF STAFF and WILLIAM LARSON, citizens of the United States, residing at Lothrop, in the county of Missoula and State of Montana, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

Our invention relates to rotary engines, and more particularly to that class of rotary engines wherein a pair of rotors is provided, which have radially movable blades contacting with the inner face of an exterior cylinder or casing, these blades being retracted as the blade reaches an abutment fixed to the outer casing, this abutment being provided on each face with means for the outlet and inlet of steam or other motive fluid, one of the cylinders being connected to the other, so that one cylinder acts as a low pressure cylinder while the other acts as a high pressure cylinder, the motive fluid being conducted from the low pressure cylinder to the high pressure cylinder.

The objects of our invention are to provide a motor of this character, wherein the parts shall be relatively simple, wherein the blades shall be positively actuated to withdraw them from engagement with the abutment, and further to provide a valve mechanism therefor, whereby the rotors may be operated in either direction at will, and the inflow of the motive fluid be cut off at any desired point.

The invention consists in the arrangement of parts and details of construction set forth in the accompanying specification and particularly stated in the claims appended.

For a full understanding of the invention and the merits thereof, and to acquire a knowledge of the details of construction, reference is to be had to the following description and accompanying drawings, in which:

Figure 1 is a perspective view of our improved engine; Fig. 2 is a transverse vertical section of the same; Fig. 3 is a sectional view on the line 3—3 of Fig. 2; Fig. 4 is a view showing the connection of the outer eccentric ring to the inner, this view being a fragmentary section; Fig. 5 is a longitudinal horizontal section of the valve casing shown in Fig. 2; Fig. 6 is a section on the line 6—6 of Fig. 2; Fig. 7 is a section on the line 7—7 of Fig. 2; Fig. 8 is a section on the line 8—8 of Fig. 2; Fig. 9 is a fragmentary en-

larged section of the edge of one of the rotor casings and the rotor showing the channel therethrough, the section being taken on line 9—9 of Fig. 10; Fig. 10 is a fragmentary section of the rotor casing showing the abutment, the inlet and outlet ports therein, the packing strip movable therethrough, and a portion of the rotor passing the abutment; Fig. 11 is a perspective view of one of the rotors detached from the casing and partly broken away, and one of the blades being entirely removed; Fig. 12 is a face view of the rotor detached, the shaft and the eccentric hub whereby the blade rings are actuated being shown in section; and, Fig. 13 is a perspective view of the packing plate.

Corresponding and like parts are referred to in the following description and indicated in all the views of the drawings by the same reference characters.

In the drawings, 2 designates a base of any suitable character, adapted to support the low and high pressure cylinders of the engine.

A designates, generally, the casing of the high pressure cylinder, and B the casing of the low pressure cylinder. These casings are cylindrical and are each made in two parts 3 and 4. The lower part 4 has the outwardly extending base flanges 5 whereby it is attached to the base 2, and is also provided with the outwardly extending flanges 6' at its upper end. The upper portion 3 of each casing is also formed with outwardly extending flanges 6 which are complementary to the flanges 6', and thereby the upper portion of the casing may be attached to the lower. Both of the casings A and B are made precisely alike. The interior face of each casing is circumferentially channeled, as at A*, as shown in Fig. 9, thereby providing one-half of the piston space of the engine, the other half of the piston space being formed by a circumferential channel in the periphery of the rotor. A central shaft 25 passes through both of the casings and is supported at its ends in pillow blocks 7 having thereon any ordinary journal bearings. The rotors are mounted upon this shaft. These pillow blocks 7 are arranged adjacent to the outer faces of the casings. Between the two casings, A and B are located the upwardly extending pillow blocks 8 and 9 which support the transversely extending journal bearing 10 of any desired construction and provided with a cap 11.

held in place by bolts, as usual in journal box construction. The outer and inner ends of each of the casings are closed each by a pair of pivoted plates, those plates covering the outer ends of the casings being designated 12, while those closing the inner ends of the casings are designated 15. These are pivoted at their lower ends, as at 12' on each side of the pillow block 7, so that they may be opened in order to permit the rotors to be examined or repaired. Suitable packing is, of course, placed between the inner faces of the closing plates and the ends of the casings A and B. These covering plates are preferably held in place by stud bolts 13. The covering plates are each cut-away so as to fit closely over the pillow blocks. The covering plates 15 fit closely over the journal bearing 10 and its cap, and the cap is cut-away, as at 11' to receive the inner edges of the covering plates. The upper ends of these plates are provided with ears 16 through which a bolt passes, whereby the plates may be drawn together.

The shaft 25, at its ends, beyond the journal bearing 10, is reduced, and the reduced ends are supported, as before stated, in bearings mounted upon the pillow blocks 7. The rotors for the two casings A and B are designated 28. Both of these rotors are precisely the same (except as to size and piston space), and hence the description of one will suffice for the other.

Referring now to Figs. 9, 11 and 12 it will be seen that each rotor consists of a disk having on its outer edge the laterally projecting annular flange 30. The periphery of the rotor is formed with a circumferential channel 31 which registers with the channel A* formed in the inside face of the casing. At diametrically opposite points the circumferential wall of the rotor is radially slitted, as at 32, the face of the flange 30 being recessed, as at 32' on each side of this slit. Mounted in each slit 32 are the opposed packing strips 33 which are attached to a carrying plate 34, as shown in Fig. 13, this plate fitting in the recess 32' previously referred to, and being held in place by screws or other suitable means. The packing strips 33 are spaced from each other sufficiently to permit a piston blade to reciprocate through the periphery of the rotor, and yet not permit a passage of steam from the exterior of the rotor into the interior thereof. In other words, these packing strips act as stuffing boxes for the piston blades. The inner face of the rotor disk is radially grooved, as at 37, to receive the edges of the piston blades 38 and 39, as seen in Fig. 11. These grooves form guides for the piston blades in their outward and inward movement.

Each of the piston blades 38 and 39 is of the same character. They are rounded at

their outer ends to fit the rounded channel A* formed in the inside face of the rotor casing and the blades are slightly narrower than the peripheral flange 30 of the rotor. The inner end of each of the blades is offset from the outer end so as to form a guiding extension 40 which is received in a space 41 between the two guiding blocks 42 which project from the inner face of the rotor. It will be understood that the extension 40 of the blade has free and sliding movement between guiding blocks 42, so that the blade is perfectly free to move radially in the source of its travel.

To the inner ends of each of the blades 38 and 39 is attached an eccentric strap or ring, these being respectively designated by the numerals 45 and 46. The ring 46 is attached to the blade 38 and the ring 45 to the blade 39, and the rings are precisely similar to each other, except that the ring 46 is less in diameter than the other ring 45 and fits therein. The inner ring 46 is provided with a pawl 46^a engaging in a recess 45^a in the ring 45, and thus both of the rings will rotate as one in either direction and yet be separably removable when desired, it being only necessary to disengage the pawl 46^a from this recess to disengage the rings from each other. Rigidly attached to but formed in part with the pillow block 7 and projecting from the inside face thereof into the interior of the rotor, is a fixed hollow hub 47 which is eccentric to the shaft 25. This hub forms practically an eccentric with which the rings 45 and 46 co-act, the rings 45 and 46 being placed within the hollow eccentric formed by the hub 47. In order to permit the easy removal and adjustment of the rings 45 and 46, this eccentric is preferably formed in two parts or sections 47 and 47^a, these two parts or sections being formed with mating flanges at their ends and connected together by screws or in any other suitable manner, so that the covering part 47 may be easily removed from 47^a. The interior face of the eccentric is annularly recessed, as at 47^b to receive an annular flange 45^b on the ring 45. The ring 45 is thus locked in place until the removable section 47^a is removed. The outer face of the inner ring 46 and the inner face of the outer ring are slightly beveled, as shown in Fig. 2, so that the inner ring cannot move outward unless the outer ring is removed. This eccentric extends downward and hence it will be seen that the blades 38 and 39 will be drawn inward as each moves upward toward the abutment 50, and will be then gradually projected outward as it moves downward on the other side away from the abutment 50.

The shaft 25 passes through the ring 46 and is eccentrically set with relation to the rings and the eccentric. The inner ends of the rings 45 and 46 are not in the same

plane with the inside faces of the piston blades and hence the blades are connected to the rings by inwardly projecting ears 48. It will be plain that upon a rotation of the rotor upon the eccentric 47, the blades will be drawn inward and then forced outward, this inward movement of each of the blades occurring at a certain point before it reaches the abutment 50 and the outward movement occurring after the blades have moved beyond this abutment.

At its uppermost portion, the rotor casing A, on its inside face, is provided with the abutment 50 which is cast on or otherwise attached to the inside face of the upper section of the rotor casing. This abutment 50 forms the means whereby the steam is admitted to the casing and exhausted therefrom. The abutment at its ends is beveled, as at 51, and an inlet passage 52 extends inward through the shell of the casing A and through to one beveled end face of the abutment, while an exhaust passage 53 also extends through the shell and opens upon the opposed beveled face of the abutment. This abutment is rounded on its lower face so as to fit the channel 31. Thus, steam which is admitted through the passage 52 or inlet port of the rotor, will pass entirely around the channel of the rotor and will pass out through the exhaust port or passage 53. In order to provide means for preventing any possible leakage of steam through the abutment or past the same, even at the time when the piston blade is passing the abutment, we provide the packing strip or plate 54 which is carried in a recess 55 in the middle of the abutment and in the wall of the casing. This packing plate is rounded on its lower edge to fit the channel, and its upper end is reduced, as at 56, and passes upward to the exterior of the casing. A coil spring 57 surrounds the reduced end 56 and acts normally to force the packing strip downward. The resiliency of the spring can be so adjusted as to force the packing plate inward to a greater or less degree. The recess 57 is closed by a plate 57^a through which the reduced end 56 of the abutment projects. The edge of the packing plate should fit the channel in the rotor with sufficient tightness to prevent any passage of steam from one side of the abutment to the other, even when the piston blades are passing the abutment, but at the same time it should interfere as little as possible with the free rotation of the rotor.

In order to provide for a proper movement of the blades permitting them to pass the abutment 50 and to contact with the walls of the casing as soon as possible after they have passed the abutment, a peculiar eccentric relation exists between the rotor casing and the eccentric which moves the

blades. This relation is shown in Fig. 3. It will be seen from this figure that the inner face of the steam channel formed in the casings A or B, is not a true circle concentric to the shaft 25, but that it is ellipsoidal, having a major diameter longer than its minor diameter by the depth of the abutment 50. The lower portion of this ellipse, from the points $z-z'$, is concentric with the eccentric 47, and hence, the ends of the blades will contact with the inner face of the steam channel or cylinder, as it may be called, from one point z to the other point z' around the lower half of the casing. From the point z' , however, to the abutment 50, the blades will be gradually retracted by the eccentric 47 and will take a path indicated by the dotted lines z , this path being concentric to the eccentric 47. The blades will therefore be fully retracted at the point where they meet the abutment 50, and from there to the point z will gradually be projected until at the point z they will come in full contact with the face of the steam channel. Hence, the steam admission is so regulated that it occurs at the time that the blade is brought in contact with the face of the channel at the point z or z' , depending upon the direction of motion of the rotor. As soon as the blade has reached the point z , steam will enter through the inlet passage 52 between the piston blade and the end of the abutment, and the blade will be forced forward in its rotation until such time as it reaches and passes the outlet opening 53. When this occurs, the steam behind the blade will be exhausted, this steam being in turn forced out of the piston space by the next following blade. While we have shown two blades upon the rotor, we wish it understood that we may use as many blades as desired, two being shown merely for illustrative purposes.

In order to suitably pack the rotor and prevent the escape of steam at the junction of the rotor with the incasing cylinder, we bevel each face of the rotor, as at 58, and place within the rotor casing on each side thereof the packing rings 59, as shown in Figs. 2 and 9. Each packing ring, as shown particularly in Fig. 9, has a beveled inner face fitting the beveled edge 58 of the rotor. The packing is held from any rotation with the rotor by any suitable means attaching it to the adjacent covering plates or the casing.

As before stated, our invention comprehends the provision of a high pressure cylinder from which the exhaust steam shall be carried to a low pressure cylinder. The steam space formed by the channels A^x and 31 in the low pressure cylinder and rotor is of larger area than the like steam space in the rotor and casing A, so as to provide for the expansion of the steam in passing from the high pressure to the low pressure cylinder.

der. The high pressure cylinder A has the two ports or passages 52 and 53. The low pressure cylinder also has two ports corresponding to the ports 52 and 53. Each of the ports 52 and 53 are provided with the upstanding pipe connections 52' and 53', while the two ports of the cylinder B have the upstanding pipe connections 72' and 73', which lead to a valve chest 75. This valve chest consists of a cylindrical casing closed at its ends, one of the ends, however, being provided with a stuffing box 76 for the passage of the spindle 77 of a rotary valve which is designated generically 80. Formed in one piece with the cylindrical valve chest 75 are the opposed longitudinally extending chambers 78 and 79, these chambers forming conducting passages leading from the forward end of the valve chest to the rear end thereof, or in other words, forming by-passes. The ends of the chamber 78 is connected to the inlet pipe 52' and 72' of the casings A and B. Each of the chambers is divided at its middle by a septum into two parts or chambers 81 and 82. These chambers on each side of the valve chest communicate with the interior thereof by the ports 83 and 84. The valve chest itself has an inlet opening at 85 from which a pipe 86 passes to any suitable source of steam or motor fluid supply. This inlet opening is at one end of the valve chest, while an outlet or exhaust opening 87 is located at the other end of the valve chest and connects with an exhaust pipe 88 which leads therefrom to any suitable location. The valve 80 is cylindrical in cross section. It is provided with a head 90 at each end which fits the bore of the valve chest. The middle of the valve is provided with an outstanding flange or wall 91 which contacts with the valve chest at the middle thereof and intermediate between the inlet and exhaust ports of the valve chest which lead to the chambers 81, 83, 82 and 84. The valve is thus divided into two parts *a* and *b*, the part *a* acting as the valve for cutting off and admitting steam to the casing A, while the part *b* admits and cuts off the steam to the casing B. The valve is cut away on each side in the form of a segment of a cylinder so that the valve practically forms a two-way valve, permitting, when the valve is in one position, the inlet of steam at the inlet opening 85 to the chest, and the inlet of steam through the port into the chamber 81, from whence it will pass by the pipe 52 to the inlet port of the casing. The exhaust steam from the casing A will pass up the outlet pipe 53' into the opposite side chamber 79 of the valve chest. From this chamber, it will pass through the port into the valve chest, and from thence will pass through a diagonal passage 89 cut through the middle wall 91 of the valve and into the compartment *b* therein. From

thence, it will pass by the port into the chamber 83, thence by the pipe 72' to the inlet port of the cylinder casing B, thence around the rotor, out through the outlet port of the cylinder casing, up through the pipe 72', into the chamber 84, from said chamber into the rear end of the valve chest and out through the exhaust port 80 to the exhaust 87.

It will be seen that if the valve 80 were not oscillated within the chamber, the steam would be delivered against the blades during nearly the whole of every revolution and until the blade has passed the abutment. There would be therefore no means of cutting off the steam, and the steam would not act expansively. It is therefore necessary to provide some means of oscillating the valve 80 so that it will open the port leading to the inlet of the rotor casings, and after a proper time cut off these inlet openings or cut off the main inlet to the valve chest, though preferably the former is the case, as this permits the valve chest to be used as a reservoir for steam. For the purpose of oscillating the valve 80, we provide the end of the stem 77 with the transverse arm 100. One end of this arm is pivotally connected to a link 101 which is bent outward and then extends downward over the end of the shaft 25, the link being slotted or bifurcated, as at 102, for this purpose so as to fit over the shaft. The other extremity of the arm 100 is also provided with a pivoted link 103 which extends almost directly downward and is likewise slotted at its end, as at 104, to fit around the shaft. The lower ends of these links are spaced sufficiently far apart to accommodate between them a double cam 105. This cam, on one lateral half of its periphery, is formed with the cam projections 106 and on the other half with the alternately placed cam projections 107. Each of the links is provided with the inwardly projecting pintles 108 upon which are pivoted the rollers 109 adapted to contact with the cam projections on that particular side of the cam when the links are so moved as to bring one or the other of the rollers against the face of the cam. This cam is fast upon the shaft 25 and as it rotates, the link whose roller is in contact with its face, will be reciprocated. In order to draw the rollers on the links into contact with the faces of the cam, we prolong one of the links, as at 110. This passes through the bifurcated end of a lever 111 which is pivoted upon a support 112 so as to be held in any desired adjustment thereon. The extension 110 of the link 101 is surrounded on either side of the lever 111 by coil springs 113, 114. These elastically hold the link in engagement with the lever 111. Thus, the link will move up or down with the lever, as the lever is actuated, but the springs 114 will

hold the roller of the link 101 in contact with its cam face, while the spring 113 will hold the roller of the link 103 in contact with this face of the cam so that when the cam projections have passed, the rollers will drop into the space between the projections. Thus, when either of the links is drawn downward, the valve spindle will be rotatably reciprocated, thus oscillating the valve.

The purpose of the two sets of links and the two sets of cam faces is of course in order to provide for a reversal of the engine, whereby the steam may be reversely directed to the course of travel previously stated. In this case, the former outlet ports become the inlet ports, and vice versa. This is secured by operating the lever 111 so as to force one of the links out of engaging position with the cam, and force the other link into such engaging position. This rocks the arm 100 and turns the valve within the valve chest so that it connects, in one position, the inlet port with the port which was before the outlet port of the valve or of that particular chamber, and what was before the inlet port, now becomes the outlet port therefore, this reversal of the valve of course acting, as just stated, to direct the motive fluid through the engine in a reverse direction to that previously described, as far as regards the individual rotor. Of course the motive fluid passes first to the high pressure cylinder and then to the low pressure cylinder, and no reversal in this instance takes place.

It may sometimes happen that the rotor will stop upon the cut-off, and if this is the case, it would be practically impossible to start the engine without turning the rotor past the abutment. Under these circumstances, provision must be made for directing the motive fluid into the other side of the rotor casing so as to force the blades past the abutment. It is for this purpose that we provide a cylindrical valve chest 120 which has the port 121 communicating with the inlet end of the valve chest 75 and with the opposed outlet ports 122 which lead by passages 123 to conductor passages 78 and 79 respectively. Mounted within the chamber 120, is the rotatable two-way valve 124 which, in one position connects the inlet passage 121 with the end of the outlet 123, and in the other position connects it with the other of the outlet ports.

The operation of our invention will be obvious from what has gone before. Steam entering the valve chest is directed into the high pressure rotor casing upon the inlet side thereof, and after a blade has passed the inlet port. The steam forced into this space between the periphery of the rotor and the inner face of the rotor casing, will act against the piston blade to rotate the rotor. After it has rotated a sufficient distance, the valve gear will cut off the flow of steam to

the rotor, and the steam will thenceforth act expansively until it has reached the outlet port. Upon reaching the outlet port, the steam will be forced outward and into the forward portion of the valve chest, and will be carried through the valve and into the lateral passage. From thence, it will pass into the inlet side of the rotor casing B. In this casing, it will act expansively and under low pressure upon the blades, in precisely the same manner that it acted in the former case, and will travel around until it reaches an exhaust port, from which it will be forced off and carried out through the exhaust pipe. The period of cut-off may of course be varied by varying the stroke of the arm 100 or of the cam motion which operates said arm. We do not wish to be limited to any particular manner of oscillating the valve or of changing the amount of cut-off of said valve. When it is desired to reverse the engine, it is only necessary to move the lever 111 so as to throw the other link into engagement with the cam, and thus turn the valve 80 from one position to a diametrically opposite position, as before described.

Having thus described the invention, what is claimed as new is:—

1. In a rotary engine, a rotor casing, a rotor shaft, a rotor on the shaft disposed within the casing, radially movable blades on the rotor, an annular eccentric on the inner face of the rotor casing made in sections, and a plurality of rings fitting one within the other and disposed within said annular eccentric, means for engaging said rings with each other for movement together, and connections from each radially movable blade to one of said rings.

2. In a rotary engine, an outer casing, an abutment on the interior face of the casing, a rotor shaft extending through the casing, a rotor on the shaft, a radially shiftable blade mounted on the rotor and projecting toward the inner face of the rotor casing, guides on the rotor in which said blade moves, a fixed annular eccentric surrounding the shaft and extending toward the rotor, and a ring disposed within the eccentric and connected to said blade.

3. In a rotary engine, an outer casing having a channel formed in its inner face, an abutment projecting into said channel, a rotor shaft passing through the casing, a rotor open on one end and mounted on the shaft and having a slot in its periphery, said rotor having a channel extending around its circumference complementary to the channel in the casing, a radially shiftable blade mounted within the rotor and extending out through the slotted periphery thereof, a fixed annular sectional eccentric surrounding the shaft and projecting into the hollow interior of the rotor, a ring dis-

posed within the eccentric to which said blade is connected, guides on the interior of the rotor for guiding said blade in its radial movement, and means for admitting steam to the channel on one side of the abutment and exhausting the steam from the channel on the other side thereof.

4. A rotary engine including a high pressure casing and a low pressure casing, a shaft passing through both of said casings, rotors mounted on said shaft and located one in each of the casings, said rotors being channeled upon their periphery, radially movable blades carried by each rotor and extending into the channel, a fixed eccentric located adjacent to each rotor, connections between the eccentrics and blades whereby the latter may be readily moved upon the rotation of the rotor, an abutment located in each casing and extending down into the channel of the rotor, each of said abutments having an inlet port located on one end thereof and an outlet port on the other, a valve casing extending transversely over the two casings, a rotatable cylindrical valve mounted in the valve casing, said valve being solid at its middle and cut away on each side of the middle solid portion, a steam inlet pipe leading into the upper portion of the valve casing, opposed longitudinally extending conducting pipes mounted parallel to the main valve casing and having openings in their sides leading into the main valve casing on each side of the centrally solid portion of the valve, a septum crossing said conducting pipes in the middle thereof and dividing the pipes in two portions, and pipes leading from each end of the conducting pipes to the ports on each end of the abutments in the high and low pressure casings.

5. In a rotary engine, a rotor comprising a disk-like body having a laterally projecting peripheral annular flange extending at right angles to the face of the rotor, said flange being slotted transversely, a shaft on which the rotor is mounted, radially movable blades carried within the rotor and extending out through said slots in the flange, a casing surrounding the rotor, a fixed eccentric surrounding the shaft but non-rotatable therewith and projecting through the open side of the rotor, means for operatively engaging the fixed eccentric with the blades to

shift the latter radially as the rotor rotates, and removable plates closing the side of the casing and embracing the base of the fixed eccentric.

6. In a rotary engine, a rotor comprising a disk-like body having a laterally projecting peripheral flange, said rotor being open on one side, said flange being slotted at a plurality of points, the outer face of the flange forming the periphery of the rotor being channeled, a shaft on which the rotor is mounted, radially movable blades carried within the rotor and extending out through the slots in the flange, a casing surrounding the rotor and formed with an abutment extending down into the channeled face of the rotor, said abutment being provided with ports opening on one side thereof, a fixed annular eccentric surrounding the shaft of the rotor but non-rotatable therewith and projecting into the hollow interior of the rotor, rotatable members operatively engaging with the eccentric and shifted radially by said eccentric, said members being operatively attached to the blades, and removable plates closing the side of the casing with which the edge of the peripheral flange of the rotor contacts, said plates when closed embracing the fixed eccentric.

7. In a rotary engine, a rotor comprising a disk-like body having a laterally projecting peripheral flange, said rotor being open on one side, said flange being slotted at a plurality of points, a shaft on which the rotor is mounted, radially movable blades carried within the rotor and extending out through the slots in said flange, a casing surrounding the rotor and provided with an abutment formed with inlet ports on each side thereof, a fixed annular eccentric surrounding the shaft and projecting into the hollow interior of the rotor, a plurality of rings disposed one within another and located within the annular eccentric and shiftable thereby, said rings each being connected with a corresponding blade on the rotor.

In testimony whereof we affix our signatures in presence of two witnesses.

OLOF STAFF. [L. S.]

WILLIAM LARSON. [L. S.]

Witnesses:

H. H. MOHR,

R. J. BROWN.