(No Model.) 4 Sheets—Sheet 1.

F. M. MACKEY.

ROTARY ENGINE.

No. 525,559. Patented Sept. 4, 1894.

FIG. 1.

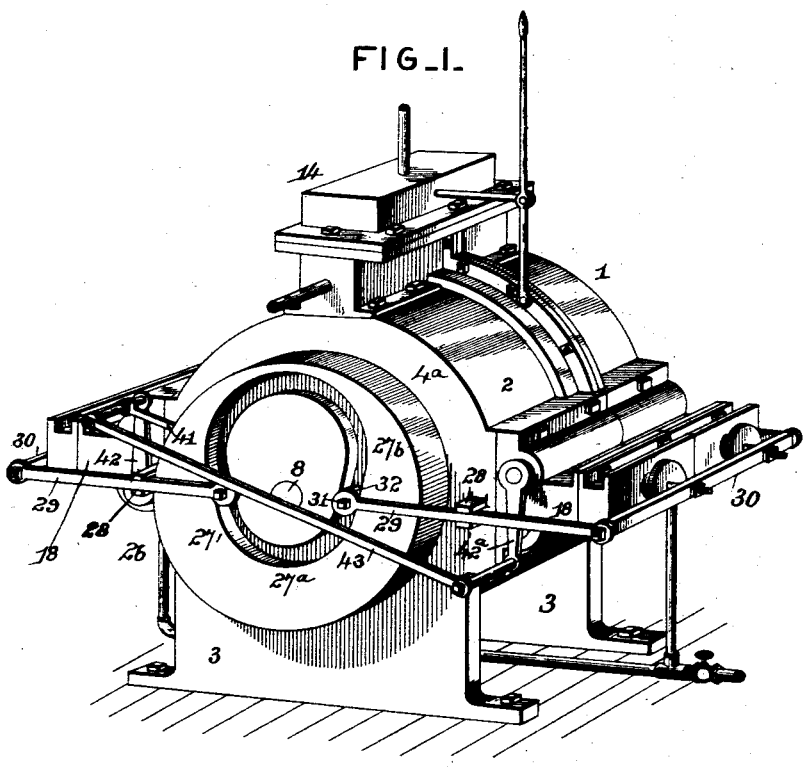
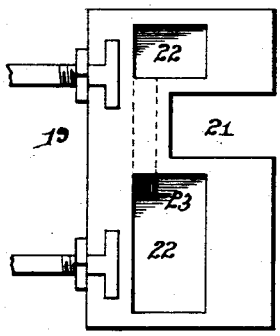


FIG. 7.



Witnesses

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C. E. Wright.

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(No Model.)

4 Sheets—Sheet 2.

F. M. MACKEY.

ROTARY ENGINE.

No. 525,559. Patented Sept. 4, 1894.

FIG. 2.

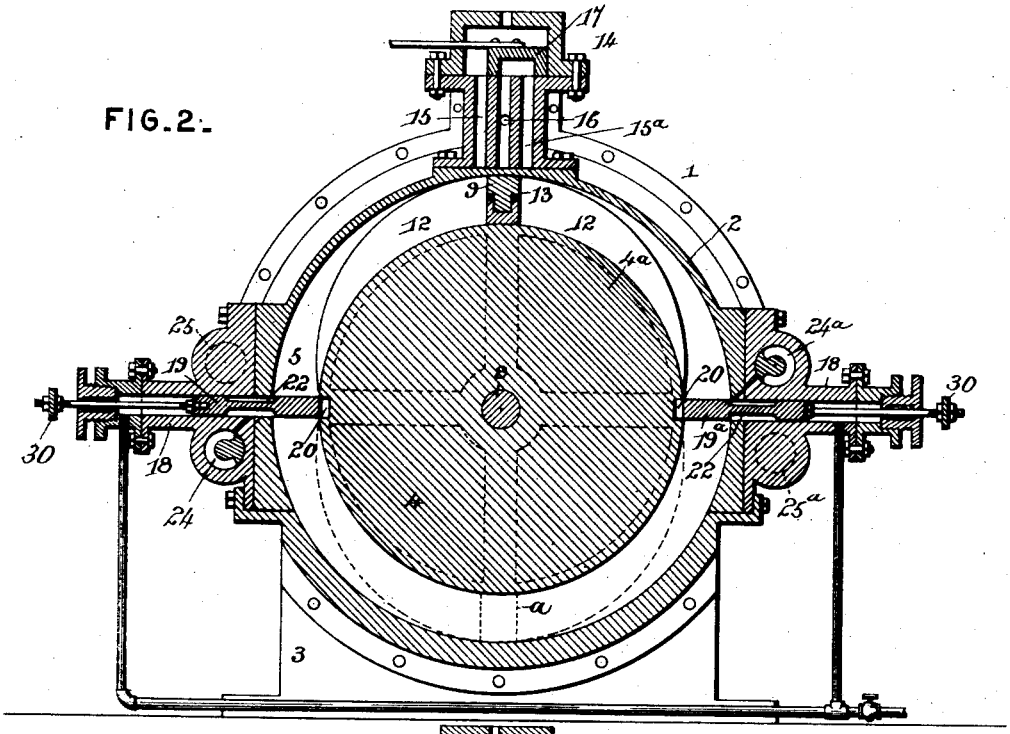
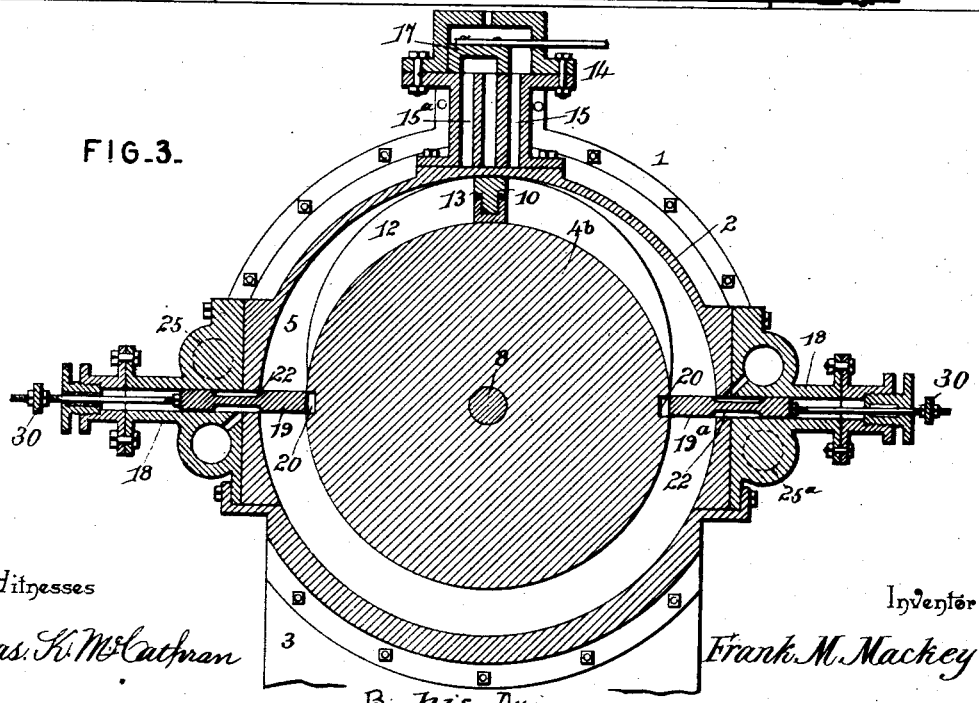


FIG. 3.



Witnesses

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F. M. MACKEY.

ROTARY ENGINE.

No. 525,559. Patented Sept. 4, 1894.

FIG. 4.

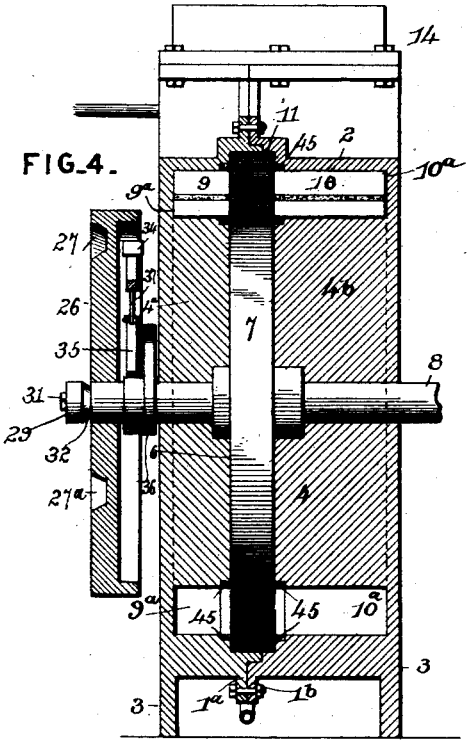


FIG. 6.

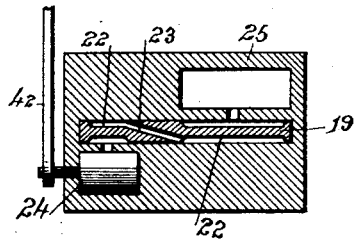


FIG. 9.

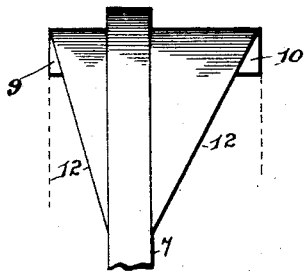
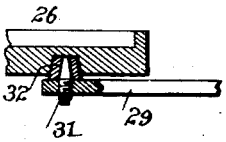


FIG. 10.



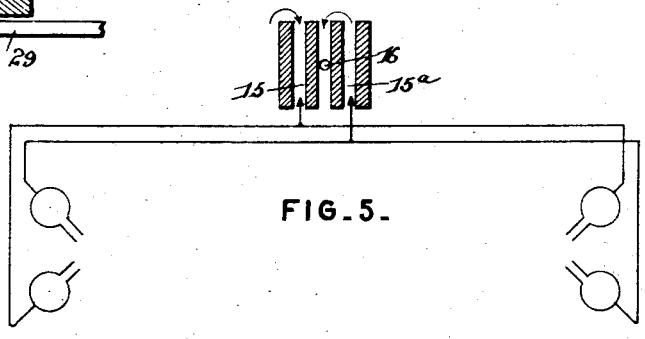


FIG. 5.

Witnesses

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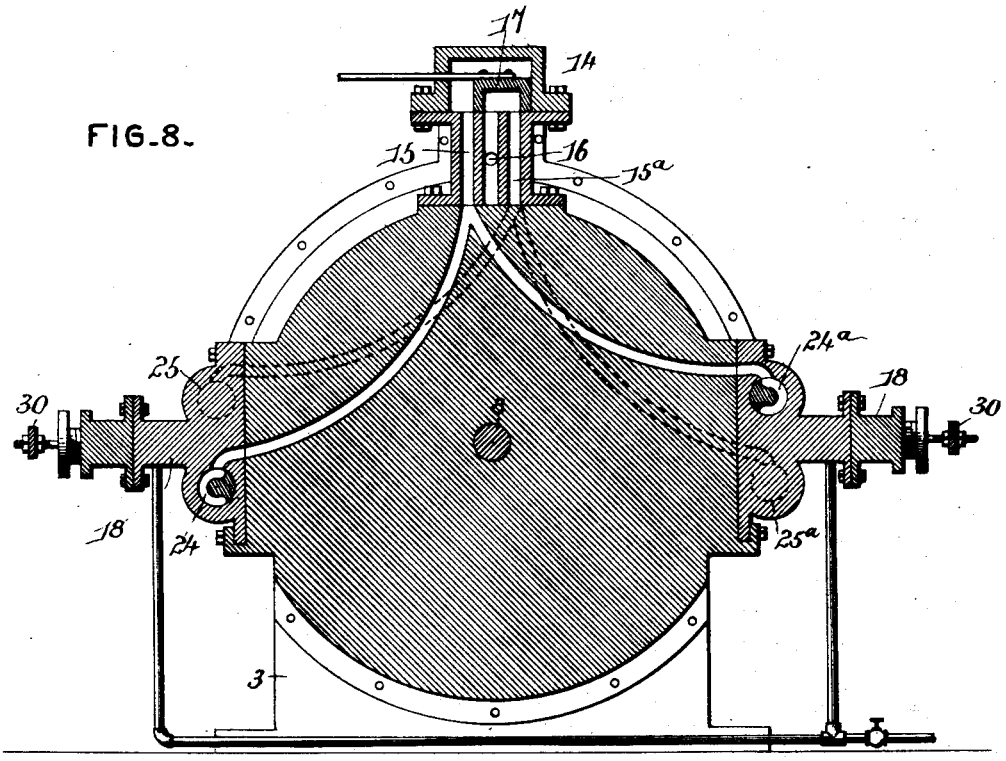
(No Model.) 4 Sheets—Sheet 4.

F. M. MACKEY.

ROTARY ENGINE.

No. 525,559. Patented Sept. 4, 1894.

FIG. 8.



Inventor
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Witnesses
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C. E. Doyle.

By his Attorneys.
C. A. Snow & Co.

UNITED STATES PATENT OFFICE.

FRANK M. MACKEY, OF WILLIAMSPORT, PENNSYLVANIA, ASSIGNOR OF FOUR-FIFTHS TO CHARLES C. GIBSON AND DANIEL F. RING, OF SAME PLACE.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 525,559, dated September 4, 1894.

Application filed May 17, 1893. Renewed April 27, 1894. Serial No. 509,275. (No model.)

To all whom it may concern:

Be it known that I, FRANK M. MACKEY, a citizen of the United States, residing at Williamsport, in the county of Lycoming and State of Pennsylvania, have invented a new and useful Rotary Engine, of which the following is a specification.

My invention relates to a rotary engine or motor designed to utilize either steam or compressed air as a motive force.

The objects in view are to provide means whereby a continuous and uniform pressure may be applied to one side of the rotating piston, said piston being arranged to expose the same area and to have a constant leverage upon the shaft at all points of its revolution; to provide high and low pressure cylinders, the former of which exhausts into the latter, and to so arrange the cut-off devices that a certain percentage of the live steam is always retained in rear of the piston after each cut off as an aid to the succeeding stroke; and to provide automatic operating connections between the shaft and the reciprocating and oscillating valves to maintain an accurate co-operation of the parts.

Further objects and advantages of my invention will appear in the following description, and the novel features thereof will be particularly pointed out in the appended claims.

In the drawings—Figure 1 is a perspective view of a rotary engine embodying my invention. Fig. 2 is a vertical sectional view at a right angle to the shaft and taken through the high pressure cylinder. Fig. 3 is a similar view taken through the low pressure cylinder. Fig. 4 is a vertical sectional view taken axially. Fig. 5 is a diagram of the steam inlet and exhaust passages, the oscillating valves or cut-offs and the steam passages connecting such parts. Fig. 6 is a detail transverse section parallel with the axis of the shaft and taken through the cut-offs, to show the position of the duct by which the exhaust steam of the high pressure cylinder is conveyed to the low pressure cylinder. Fig. 7 is a detail view of one of the reciprocating valves. Fig. 8 is a vertical section, showing the inlet and exhaust passage; those connecting with the high pressure cylinder being in full and those connecting with the low pressure cylinder in dotted lines. Fig. 9 is a detail view, partly broken away, of the disk and seat for the piston. Fig. 10 is a detail section of cam-disk, connecting bar, and means for compensating for wear.

Similar numerals and letters of reference indicate corresponding parts in all the figures of the drawings.

1 represents the casing of an engine having the cylindrical sides 2 and the heads 3, and within this casing is arranged a cylindrical core 4, between which and the interior surface of the casing is an annular chamber 5 in which operates the pistons, to be hereinafter described. This core is divided to form two independent sections 4^a and 4^b which are carried, respectively, by the heads of the casing and are separated at their inner ends to provide a space 6 to receive a disk 7. This disk is fixed firmly to the rotary shaft 8 and is designed to rotate between the opposing inner ends of the core.

9 and 10 represent the piston heads which are carried by the rotary disk 7 and operate, respectively, in the high pressure cylinder 9^a and the low pressure cylinder 10^a into which the annular space 5 is divided by the disk 7. The periphery of the disk 7 fits into a channel 11 in the side of the casing whereby such disk breaks joint with the surface of the casing.

It will be seen that the casing is formed in separable sections 1^a and 1^b which are jointed opposite the periphery of the disk 7.

The disk is provided at its periphery with strengthening ribs 12 which are divided centrally to form a seat 13 for the transversely-disposed piston, the ends of which project over the surfaces of the sections of the core and fill or fit snugly in the annular space to form the piston heads 9 and 10. Being fitted loosely in its seat this piston is capable of automatic adjustment to accommodate the wearing of the surfaces with which it contacts and also the wearing of the shaft. If the piston were fixed permanently to the periphery of the disk the wearing of the shaft would cause the wings of the piston which form the piston heads, as I have for convenience termed them, to bear against the surfaces of the core sec

tions. The ends of the ribs in which is formed the seat 13 are tapered, as shown clearly in the sectional views, Figs. 2 and 3.

14 represents a valve casing of the ordinary or any approved construction having the similar inlet passages 15 and 15ª and the intermediate exhaust passage 16. Above these passages is arranged a slide throttle-valve 17 which, in the construction shown in the drawings, is designed to be operated by hand to reverse the engine or cut off the supply of steam, but which may be operated in any approved manner.

Located at the sides of the casing in suitable horizontal guide-ways 18 are the reciprocating valves 19 and 19ª which are adapted to fit at their inner edges into seats 20 in the opposite sides of the core 4 and are of sufficient width to extend from one head of the casing to the other whereby they cover or close both high and low pressure cylinders. These reciprocating valves are provided with notches 21 to receive the periphery of the disk 7 when they are extended across the cylinders or are in their operative positions.

The reciprocating valves are provided in their upper and lower sides with chambers 22, as shown clearly in the transverse sectional views, Figs. 2 and 3, the chamber in the upper side which communicates with the high pressure cylinder being connected by means of an inclined communicating duct 23 with the chamber on the lower side which communicates with the low pressure cylinder, the object of this construction being to enable the high pressure cylinder to exhaust, through the chamber 22 upon the upper side, the communicating duct 23 and the lower chamber upon the other side, into the low pressure cylinder.

Arranged, respectively, above and below the plane of the reciprocating valves 19 and 19ª are the oscillating or cut-off valves 24 and 24ª, the cut-off 24 being arranged below the valve 19 and the cut-off 24ª above the valve 19ª such valves, when open, communicating through suitable passages, respectively, with the high pressure chamber of valve 19 and the high pressure chamber of the valve 19ª.

25 and 25ª designate outlets which communicate, respectively, with the low pressure chamber upon the upper side of the valve 19 and the low pressure chamber upon the lower side of the valve 19ª.

From this description it will be apparent that when the reciprocating valves are in the positions shown in Figs. 2 and 3, in their operative positions, the portion of the low pressure cylinder above the valve 19 and between such valve and the piston head communicates with the outlet 25 and is in position to exhaust therethrough, the corresponding portion of the high pressure cylinder communicates through the duct 23 with the portion of the low pressure cylinder which is below the valve 19, and the cut-off or oscillating valve is in communication with the portion of the high pressure cylinder which is below the reciprocating valve, or would be if open. Furthermore, if open, the cut-off 24ª would communicate directly with the portion of the high pressure cylinder which is above the valve 19ª, the portion of the high pressure cylinder which is below the valve 19ª is in connection with the portion of the low pressure cylinder above said valve through the communicating duct 23, and the portion of the low pressure cylinder below said valve is in communication with the exhaust or outlet 25ª. Thus, it will be seen that with the reciprocating valves in their operative positions the portion of the high pressure cylinder ahead of the piston is in direct communication with the corresponding portion of the low pressure cylinder for the reason that the communicating duct 23, in the valve 19, allows the pressure of the steam in the high pressure cylinder to pass to the low pressure cylinder below the valve 19 and thence through the communicating duct in the valve 19ª to the portion of the low pressure cylinder above the latter valve and hence in rear of the piston in the low pressure cylinder. Furthermore, it will be observed by reference to Figs. 2 and 3 that both of the reciprocating valves are in their operative positions and both of the oscillating valves or cut-offs are closed, this being the arrangement of the parts when the piston is in the position shown in the said figures, or at the top of the cylinder. As, however, said piston approaches the valve 19 the latter will recede into its guide-way until completely removed from the interior of the cylinder to allow the piston to pass, the cut-off 24 remaining closed during this retraction of the reciprocating valve 19. But as said valve 19 recedes the cut-off 24ª opens and allows the steam to enter the high pressure cylinder to actuate the piston, and such pressure is maintained until after the piston has passed the valve 19 and has reached a point indicated by dotted lines *a* in Fig. 2. At this point the valve 19 opens or assumes its operative position thus confining between such valve and the rear side of the piston a volume of live steam which corresponds with one-third of the quantity in the cylinder at the time such valve is projected into the cylinder.

It will be seen that the valve 24ª has been feeding the steam and that the distance between the valve 19 and the rear side of the piston is precisely one-third of the space which is included between the valve 19ª and such rear side of the piston. Thus, after the opening of the valve 19 and the cut-off of the portion of live steam between such valve and the piston, the oscillating valve 24 is opened to admit steam, as above, into the high pressure cylinder, and simultaneous therewith the valve 24ª is cut off or closed. Subsequent to the closing of the valve 24ª the reciprocating valve 19ª recedes into its guide-way, as described in connection with the valve 19, to

allow the piston to pass, the latter, meanwhile, being driven by the steam admitted through the valve 24.

Having thus described the main features of the cylinder of my improved engine or motor, and the valves which co-operate with the piston, and having described the relative movements of such parts it remains to describe means for accomplishing this co-action between the parts of the device.

Fixed to the shaft 8, adjacent to one of the heads of the casing, is a disk 26 provided upon one side, which I have for convenience in the drawings shown as the outer side, with a cam groove 27 having one portion 27^a which is concentric with the shaft and having an opposite portion 27^b which is eccentric with the shaft.

Mounted in suitable guides 28 upon the heads of the casing are the connecting bars 29, which are connected at their outer ends to the stems 30 of the reciprocating valves and are provided at their inner ends with fixed pins 31 bearing anti-friction sleeves 32 which operate in the said cam-groove 27, maintaining their positions at opposite sides of such groove, or upon opposite sides of the shaft.

The pin 31 is tapered toward its inner end and the sleeve 32 is correspondingly tapered interiorly and exteriorly, the former to fit the taper of the pin and the latter to fit a corresponding bevel in the sides of the cam-groove 27. The object of this construction is to enable the parts to be adjusted to take up lost motion by simply setting the pin 31 farther inward or toward the disk.

It will be noted that the wear will be upon the exterior of the sleeve and the sides of the groove 27 and also upon the contacting surfaces of the pin 31 and sleeve 32, and hence by moving the pin inwardly, as described, the wear upon all of said surfaces may be adjusted by one movement.

The construction of the means for operating the reciprocating valves, as will be readily understood, causes such valves to be operated alternately, each operation involving the retraction of a valve sufficiently to allow the piston to pass and then the reprojection of such valve into its operative position. Furthermore, the shape of the cam groove is such as to cause one valve to remain entirely at rest during one-half of the stroke of the piston or during the retraction and reprojection of the other valve. Such arrangement of parts avoids the necessity of providing for an extended movement of the reciprocating valves as in those cases where a continuous motion of the valves is produced.

Suitable packing rings 45 are provided in the casing to bear against opposite sides of the disk 7.

Reference to the drawings will show that the low pressure cylinder is greater in sectional area than the high pressure cylinder, and, therefore, that the low pressure piston head is correspondingly larger than the high pressure piston head. In practice I prefer to construct the low pressure cylinder with twice the sectional area of the high pressure cylinder, as shown in the drawings.

From the above description it will be observed that the construction of the parts, as of the members comprising the casing, &c., is such as to enable the same to be interchanged, their construction being identical, and, therefore, the cost of manufacture is correspondingly reduced.

My improved engine may, by increasing the sizes of the ports, be used as a pump, and, therefore, while I have shown it adapted for use as an engine I desire to be understood as not limiting myself to any particular use.

Various changes in the form, proportion, and minor details of construction may be resorted to without departing from the spirit or sacrificing any of the advantages of my invention.

Having described my invention, what I claim is—

1. A rotary engine having high and low pressure cylinders, the former exhausting into the latter, rotary piston valves, arranged in the casing and slidably mounted to retreat into cavities formed therein and operating connections between the pistons and said valves, substantially as specified.

2. A rotary engine having high and low pressure cylinders, an intermediate rotary disk, provided with a transverse seat, a piston loosely fitted in said seat to slide transversely of the disk and extending laterally to form heads which fit respectively in said cylinders, valves, and operating connections therefor, substantially as specified.

3. A rotary engine having contiguous parallel high and low pressure cylinders, of different sectional areas, a rotary disk interposed between and separating said cylinders, and provided with a transverse peripheral seat, a piston slidably fitted in said seat and consisting of a bar which extends laterally beyond the side surfaces of the disk to form opposite piston heads of different areas, and laterally and radially adjustable by contact with the walls of said cylinders, valves, and operating connections therefor, substantially as specified.

4. A rotary engine having contiguous annular cylinders, a rotary piston mounted therein, oppositely-disposed, radially-slidable reciprocating valves, mounted and adapted to be received in guide-ways, in the casing and each arranged to close both cylinders simultaneously cut-offs, and operating connections for said parts, substantially as specified.

5. A rotary engine having high and low pressure cylinders, a rotary piston, having piston heads operating respectively in such cylinders, reciprocating valves arranged to normally close the cylinders at diametrically opposite points, and provided with ducts whereby the high pressure cylinder exhausts into the low pressure cylinder, cut-offs, and

operating connections between the cut-offs and valves and the piston, substantially as specified.

6. A rotary engine having high and low pressure cylinders, a piston having heads operating in such cylinders, reciprocating valves adapted to divide the interior of the cylinders and provided with communicating ducts connecting the portion of the high pressure cylinder in front of the piston with the low pressure cylinder in rear of the piston, cut-offs, and operating connections between the cut-offs and valves and the piston, substantially as specified.

7. A rotary engine having high and low pressure cylinders, reciprocating valves provided with communicating ducts, a piston having piston-heads operating in such cylinders, a cam device operatively connected to the piston, independent connections between such cam and the reciprocating valves, opposite portions of such cam being respectively concentric and eccentric with the piston, cut-offs, and means for operating the same, substantially as specified.

8. A rotary engine having high and low pressure cylinders, a rotary piston, reciprocating valves, a rotary disk operatively connected to the piston and provided with a cam-groove having beveled sides, connecting bars connected to said valves to reciprocate parallel with said disk and carrying tapered pins, tapered sleeves rotatably mounted upon such pins and fitting in the cam-groove, cut-offs, and operating connections therefor, substantially as specified.

9. In a rotary engine, the combination of the casing, a concentric core separated from the side walls of the casing and formed in sections separated at their inner ends, a shaft, a disk fixed to the shaft, operating between the contiguous ends of the core-sections and fitting at its periphery in a channel in the side wall of the casing, a piston loosely fitted in a transverse peripheral seat in said disk, valves, and operating connections therefor, substantially as specified.

10. In a rotary engine, the combination of a casing, contiguous cylinders formed therein, a rotary disk interposed between such cylinders, tapered ribs provided with a central seat, a piston fitted in such seat, valves, and operating connections, substantially as specified.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

FRANK M. MACKEY.

Witnesses:
M. S. CROWNOVER,
AMOS WRIGHT.