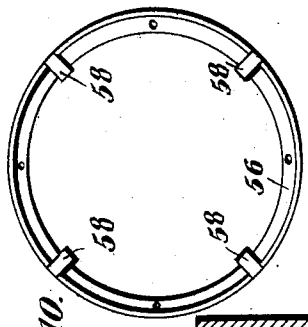
No. 832,848. PATENTED OCT. 9, 1906.

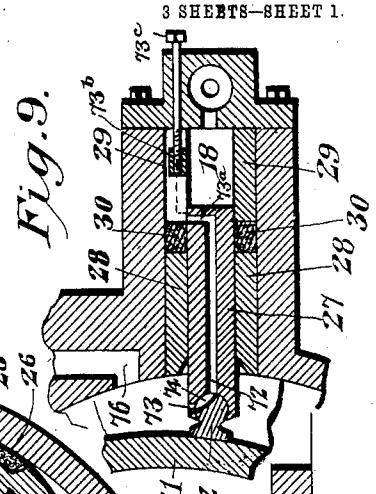
T. CROSTON.

ROTARY ENGINE.

APPLICATION FILED OCT. 10, 1904. RENEWED AUG. 30, 1905.

3 SHEETS—SHEET 1.





Witnesses
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3 SHEETS—SHEET 2.

Fig. 12.

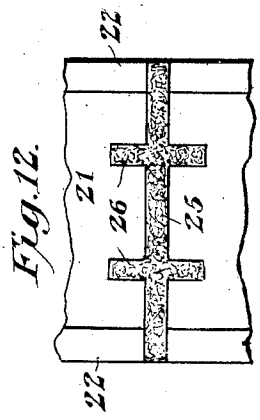

Fig. 2.

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3 SHEETS—SHEET 3.

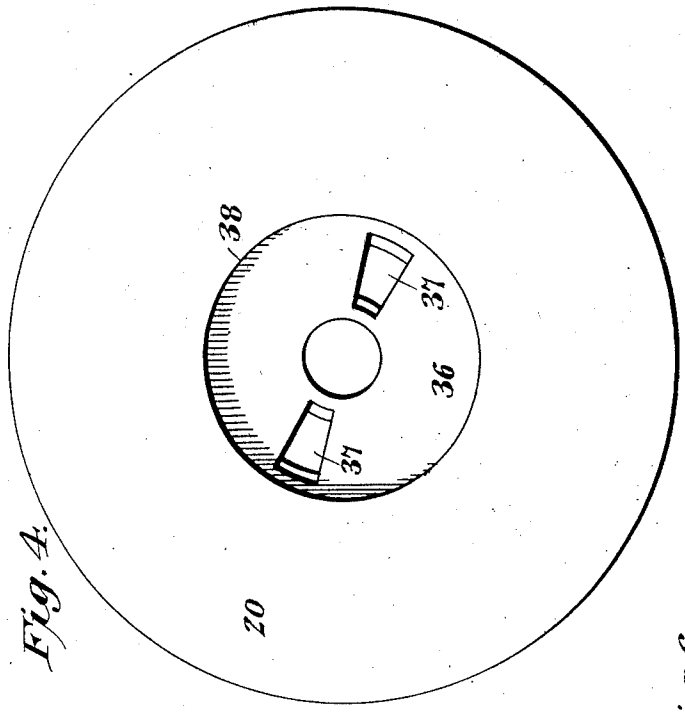

Fig. 4.

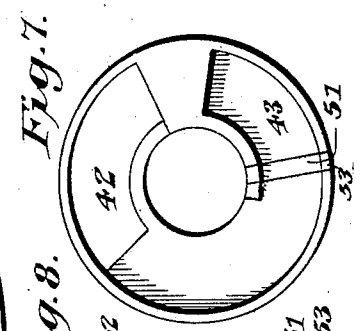

Fig. 7.

Fig. 8.

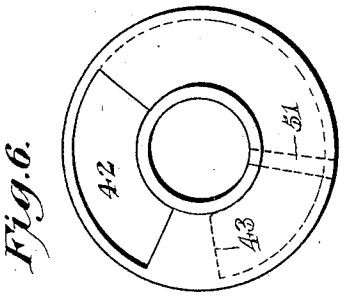

Fig. 6.

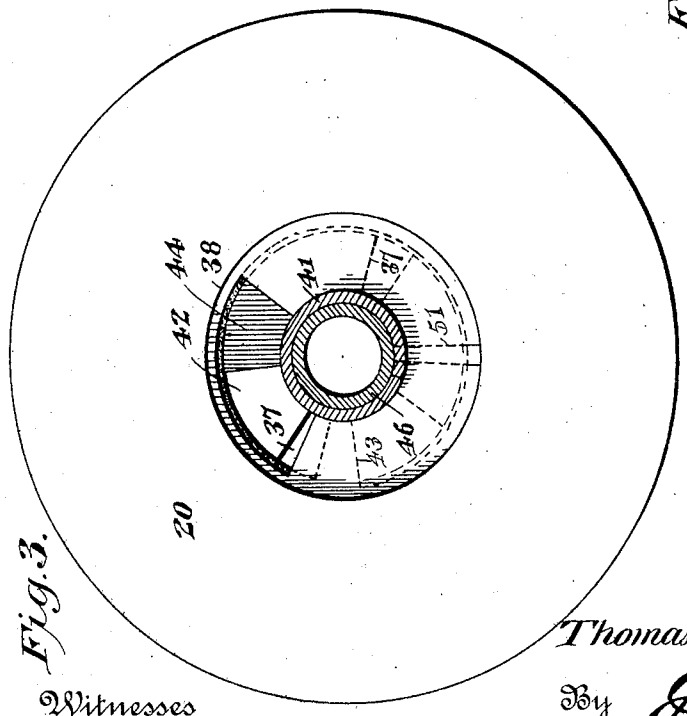

Fig. 3.

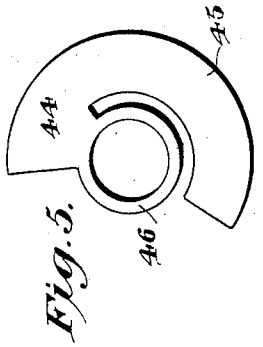

Fig. 5.

Witnesses

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UNITED STATES PATENT OFFICE.

THOMAS CROSTON, OF HOQUIAM, WASHINGTON.

ROTARY ENGINE.

No. 832,848. Specification of Letters Patent. Patented Oct. 9, 1906.

Application filed October 10, 1904. Renewed August 30, 1905. Serial No. 276,479.

To all whom it may concern:

Be it known that I, THOMAS CROSTON, a citizen of the United States, residing at Hoquiam, in the county of Chehalis and State of Washington, have invented a new and useful Rotary Engine, of which the following is a specification.

This invention relates to that type of engines wherein a rotary piston is employed; and the object is to provide a comparatively simple structure having but few movable parts or elements, which parts or elements are so constructed that their coöperating portions wear so as to always maintain steam or motive-fluid tight joints, the structure being efficient and securing the advantages of steam expansion with the consequent reduction in the amount of steam necessary for operation.

The preferred embodiment of the invention is illustrated in the accompanying drawings, wherein—

Figure 1 is a vertical sectional view through the engine. Fig. 2 is a horizontal sectional view taken on an irregular line. Fig. 3 is a view in elevation of the piston, showing the controlling means for the motive-fluid supply. Fig. 4 is a similar view of said piston with the valve mechanism removed. Fig. 5 is a side elevation of the valve. Fig. 6 is a view in elevation of one side of the valve-seat plate. Fig. 7 is a view in elevation of the opposite side of said plate. Fig. 8 is a vertical sectional view therethrough, showing the packing-stirrup. Fig. 9 is a detail sectional view through one of the abutments, showing the valve open to permit the exhaust of the motive fluid. Fig. 10 is a view in elevation of one section of one of the packing-rings. Fig. 11 is a detail sectional view showing a slightly-modified form of packing for the piston. Fig. 12 is a detail view of one end of the piston, showing the packing thereof in elevation.

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

In the embodiment illustrated a cylinder 12 is employed, carried by a base 13 and having a circular bore 14 therein, the ends of said bore being closed by heads 15 and 16. The cylinder is provided on diametrically opposite sides with projections 17, within which are formed pockets 18, opening into the circular bore. A shaft 19, journaled in any suitable manner, extends centrally through the bore of the cylinder and constitutes the driving-shaft of the engine. On this shaft is mounted a piston 20, the main body of which is elliptical in form, as shown in Fig. 1, the elliptical surface 21 being located between circular flanges 22. It will be observed by reference to Fig. 2 that the piston terminates short of the heads 15 and 16, leaving steam-spaces 23, which are in communication between openings 24, formed in the piston. The flanges 22 fit snugly within the bore of the cylinder, and the opposite ends of the elliptical body likewise bear against the annular wall of the bore, being provided with packing comprising transverse strips 25, provided with cross-fingers 26, the length of which is sufficient to bridge the pockets 18. This form of packing may, however, be changed, and as an example of this attention is invited to Fig. 11, wherein a portion of a piston 20^a is shown located within a cylinder 12^a, the packing between the piston and cylinder being in the form of a yielding element 25^a, secured at one edge to the piston and located in a seat 26^a, the outer portion being in engagement with the cylinder-wall.

Coöperating with the piston are reciprocatory abutments 27, which are slidably mounted in the pockets 18 between bed-plates or blocks 28, secured in the front or inner portion of the pockets, and glands 29, located in the rear portions of said pockets and conforming to the cross-sectional shape of the same and of the abutments, packing 30 being arranged between the plates and glands. As illustrated in Fig. 2, the width of the abutments is the same as the width of the elliptical portion of the piston, and said abutments coöperate only with the same. Arranged in the pockets on opposite sides of said abutments are other abutments 31, which bear against the peripheries of the flanges 22, the packing 30 being extended in rear of said abutments 31 and in front of the glands 29. The inner ends of the abutments 27 carry foot-valves 32, that bear against the elliptical surface of the piston, said foot-valves being supported on the abutments so that they may oscillate.

Motive fluid, such as steam, is introduced into one of the spaces 23 through the head 15 by means of a supply-pipe 33, and this motive fluid is properly introduced into the

engine by the following means: The piston is provided with an annular channel 34, having diametrically opposite branches 35 leading therefrom and terminating in discharge-openings located contiguous to and just in rear of the ends of the piston, as illustrated in Fig. 1. The channel 34 is covered by a cap-plate 36, provided with diametrically opposite ports 37. The cap-plate 36 is located in a recess 38, formed in the side of the piston having the annular channel 34, and also located in this recess is a valve-seat plate 39, held against rotation with the piston by means of a bracket 40, that is attached to a collar 41, forming a part of the seat-plate. As illustrated in Figs. 3, 6, and 7, the valve-seat plate has a port 42 of considerable length, with which the ports 37 of the cap-plate 36 are adapted to successively aline during the rotation of the piston. This valve-seat plate, furthermore, has in one side a recessed seat 43, in which is mounted an oscillating valve 44 in the form of a plate having a wing 45. The valve 44 is carried by a sleeve 46, which is loosely journaled upon the drive-shaft 19 and is located within the collar 41 of the seat-plate. To the outer end of the sleeve 46 is attached a curved rack 47, with which meshes a pinion 48, carried by the inner end of a shaft 49, journaled in and projecting from the adjacent head 15. The outer end of the shaft 49 carries suitable means for operating the same, which means in the present instance is shown in the form of a lever 50, though any other suitable mechanism may be employed, if desired. It will thus be clear that by swinging the lever 50 the valve 44 will be turned so as to vary the size of the port 42 of the valve-seat plate. In order to prevent leakage between said seat-plate and the valve, a packing-stirrup 51 is preferably employed, seated in a slot formed in the seat-plate and pressed outwardly by a spring 52 against one side of the wing 45 of the valve. The outer side of the stirrup is in the form of an outstanding lug 53, bearing against the outer edge of the wing 45 and urged thereagainst by the outturned end of the spring 52. This structure is particularly shown in Fig. 5. Other suitable packing is employed between the joints to prevent leakage.

In order to prevent the passage of steam about the peripheral flanges of the piston, packing-rings are employed, which are located in the spaces 23, and consist of sections comprising bands 55 and 56, these rings being connected by bolts 57. One of the rings is cut away and beveled outwardly, as shown in Fig. 10. The inner side thereof bears against the side of the piston. In order to prevent this side cutting into the piston, abutments 58 are located at suitable intervals, which abutments also bear against the piston-face. The other ring constitutes a follower and is provided with a flange 59, overlying the first-mentioned ring, which ring is preferably beveled, as shown in Fig. 2, and between the beveled portion and the flange 59 is located packing including a thin metallic band 60. It will be evident that when the bolts 57 are screwed down the rings will be moved toward each other and the packing thus forced outwardly against the annular face of the piston-bore 14. Leakage about the shaft to the exterior of the cylinder is prevented by suitable steam-checks or packing-boxes consisting of a ring 61, having a recess for packing 61^a and a gland-ring 61^b, that causes the packing to press against the shaft, thereby effecting the rotation of the boxes with the shaft. The rings are connected by bolts 61^c, and the outer faces of the gland-rings 61^b are held against the inner faces of the adjacent cylinder-heads or end walls.

The means for maintaining the abutments in coaction with the piston is constructed as follows: The head 16 of the cylinder is provided with a chamber 62, and from the same lead channels 63, that have offset discharge-orifices 64, communicating with the rear ends of the pockets 18. The chamber 62 is in communication with the spaces 23, so that steam or motive fluid has free access thereto, and consequently may find its way through the channel 63 to the pockets. This communication is controlled, however, by a cut-off disk 65, adjustably secured to the shaft 19 and located within the chamber 62, said disk having diametrically opposite ports 66, that move into and out of alinement with the inlets of the channel 63 as the shaft rotates. Controlling the discharge-orifices 64 are plunger-valves 67, slidably mounted in sockets 68 and movable across the orifices 64. These plunger-valves have stems 69, borne against by springs 70, that urge the valves across the orifices, the tension of the springs being varied by adjusting-screws 71. The exhaust from the pockets 18 is permitted through channels 72, formed longitudinally through the abutments, each terminating at one end in a rearwardly-extending orifice 73 and at the other end in an offset orifice 73^a. These exhaust-channels are controlled at their inner ends by the foot-valves 32, which are provided with recesses 74, movable into and out of alinement with the orifices 63 and channels 72 as the valves are oscillated by the piston. This will be clear by referring to Figs. 1 and 9. The outer orifices 73 are arranged to be closed when the abutments are in their outer position by block-valves 73^b, secured and made adjustable by screws 73^c. In order to prohibit the escape of steam around the abutments, the same are provided at their opposite edges with packing 75, substantially T-shaped in formation, which packing extends across the joints between the abutments and foot-valves 32 and

is engaged with the latter, as indicated in Figs. 1 and 2. The exhaust from the engine is permitted through channels 76, opening into exhaust-ports 77.

The operation of the herein-disclosed engine may be briefly outlined as follows: The steam or other motive fluid being admitted through the supply-pipe 33 to the space 23 will pass into the port 42 of the valve inlet-plate, and when one of the ports 37 of the cap-plate of the piston alines therewith said motive fluid will enter the channel 34, the amount so entering and the length of time being controlled by varying the length of the port 42 by means of the valve 44, as will be evident. The fluid is, however, admitted just after the ends of the piston pass the abutments, which abutments will be in their outer positions, as shown in Fig. 1. The steam escaping through the branches 35 will not only balance the piston, but force the same around in the direction of the arrow. While in this position the ports 66 of the cut-off plate 65 are alined with the inlets of the channel 63, so that the motive fluid will find its way through said channel and pressing back the plunger-valves 67 will enter the pockets 18, thus forcing the abutments inwardly. In this position, as shown in Fig. 1, the foot-valves close the inlets from behind the abutments. As the piston continues its rotation the port 37 of the piston-cap will move out of alinement with the port 42 of the valve-seat plate, and the supply of steam will therefore be cut off. Consequently the steam within the cylinder will expand, and this force of expansion is employed for driving the piston until the ends of the same pass the exhaust-ports 76, whereupon the steam confined within the cylinder will escape. Prior to this, however, and just after the cylinder has completed a half-revolution, so that the abutments will move outwardly, the foot-valves 32 will swing, as shown in Fig. 9, thereby bringing the recesses 74 so that the exhaust-channels 72 and orifices 73 are in communication. The steam confined behind the abutments will consequently escape, permitting said abutments to move outwardly, and the steam finally finding a passage through the exhaust-ports 77. However, just before the abutments reach their outward limits of movement the passage-ways 73 are cut off by the blocks 73^b, and the steam still located behind the said abutments acts as cushions for the same. Prior to this, however, the cut-off disk 65 has moved so that the ports 66 are out of alinement with the channels 63, and no more steam will be supplied thereto. When this supply has ceased, the plunger-valve 67 will move inwardly to close the orifices 64. As soon as the ends of the piston have again passed the abutments the next port of the piston-cap is brought into alinement with the port 42 of the valve-seat plate and steam is again supplied to both ends of the piston with a repetition of the action above described.

From the foregoing it is thought that the construction, operation, and many advantages of the herein-described invention will be apparent to those skilled in the art without further description, and it will be understood that various changes in the size, shape, proportion, and minor details of construction may be resorted to without departing from the spirit or sacrificing any of the advantages of the invention.

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

1. In a rotary engine, the combination with a cylinder having a circular bore, of a rotary piston located therein and comprising a substantially elliptical body having circular flanges, movable abutments mounted on the cylinder and coacting with the elliptical body between the flanges, said body having supply-ports that communicate and open into the cylinder in rear of the ends of the body, and means for intermittently supplying steam simultaneously to said ports after the same have passed the abutments.

2. In a rotary engine, the combination with a cylinder having a circular bore, of a rotary piston located therein and comprising a substantially elliptical body having circular flanges at its ends, movable abutments mounted on the cylinder and coacting with the body between the flanges, said body having an annular supply-channel, and ports leading therefrom that open into the cylinder in rear of the ends of the body, said ports being of substantially the width of the body between the flanges, and means for supplying steam to the channel.

3. In a rotary engine, the combination with a cylinder having a circular bore, of a rotary piston located therein and comprising a substantially elliptical body having circular flanges at its ends that fit within the bore, movable abutments mounted in the cylinder and coacting with the elliptical body between the flanges, said body having an inclosed annular supply-channel provided with an inlet-port that opens at one side of the piston, and valve mechanism mounted on the cylinder and having a variable supply-port into and out of alinement with which the inlet-port of the channel moves during the rotation of the piston.

4. In a rotary engine, the combination with a cylinder, of a piston mounted therein and having wing portions, movable abutments coacting with the piston, said piston having a motive-fluid-supply channel provided with branches leading to and opening in rear of the wing portions, said channel being covered and having an inlet-port, and valve mechanism mounted on the cylinder

for supplying motive fluid to the channel, said mechanism including a variable port into and out of alinement with which the inlet-port of the channel moves during the rotation of the piston.

5. In a rotary engine, the combination with a cylinder, of an elliptical piston rotatably mounted therein, movable abutments coöperating with the piston, said piston having an annular fluid-supply channel provided with outwardly-extending branches leading to points in rear of the ends of said piston, a cap-plate covering the annular channel and having spaced ports, and means for supplying motive fluid to the channel including a valved port with which the ports of the cap-plate successively aline.

6. In a rotary engine, the combination with a cylinder, of a piston rotatably mounted therein and having an annular motive-fluid-supply channel provided with a covering having an inlet at one side of the piston, a valve-seat member mounted on the cylinder and having a port past which the inlet of the channel-covering moves, and a cut-off valve movably mounted on the member for varying the size of the port.

7. In a rotary engine, the combination with a cylinder, of a piston rotatably mounted therein and having a motive-fluid-supply channel, a cap covering the channel and provided with an inlet at one side of the piston, a stationary valve-seat mounted in the cylinder and having a port past which the inlet of the channel moves, a valve controlling the port, and means located exteriorly of the cylinder and connected to the valve for moving the same.

8. In a rotary engine, the combination with a cylinder, of a piston rotatably mounted therein and having a motive-fluid-supply channel provided with an inlet at one side of the piston, a stationary valve-seat plate having a port past which the inlet of the channel moves, said plate furthermore having a circular seat in one side, and a cut-off valve rotatably mounted on the plate and having a wing located in the circular seat, said plate varying the size of the port.

9. In a rotary engine, the combination with a cylinder, of a piston rotatably mounted therein and having a motive-fluid-supply channel provided with an inlet at one side of the piston, a valve-seat plate having an inlet-port past which the inlet of the channel moves, a cut-off valve coöperating with the inner side of the valve-seat plate and having a sleeve projecting therethrough, a circular rack carried by the outer end of the sleeve, a shaft projecting through the cylinder and having a pinion at its inner end that engages the rack, and means connected to the exterior of the shaft for operating the same.

10. In a rotary engine, the combination with a cylinder, of a shaft extending across the cylinder, a piston rotatably mounted in the cylinder and having a motive-fluid-supply channel provided with an inlet-port at one side of the piston, said side of the piston being provided with an annular recess, a valve-seat plate located in the recess and secured to the cylinder against rotation, said plate having a port past which the inlet of the piston-channel moves and being furthermore provided in its inner side with a circular seat, a collar carried by the valve-seat plate and surrounding the shaft in spaced relation thereto, a sleeve rotatably mounted on the shaft and arranged within the collar, a valve carried by the inner end of the sleeve and located in the circular seat, said valve being movable across the port upon the movement of the sleeve, and means connected to the outer end of the sleeve for moving the same.

11. In a rotary engine, the combination with a cylinder, of a rotary piston located therein, said piston having a fluid-motive-supply channel provided with an inlet at one side, a valve-seat plate having a port and coöperating with the channel, said plate having a seat, a valve located in the seat and movable over the port to vary the size of the same, and a packing-stirrup carried by the seat-plate and having an outwardly-spring-pressed portion bearing against the side of the valve, and an inwardly-spring-pressed lug bearing against the edge of the valve.

12. In a rotary engine, the combination with a cylinder, of an elliptical piston rotatably mounted therein and having an annular motive-fluid-supply channel provided with diametrically opposite branches leading to discharge-outlets that are located directly in rear of the ends of the piston, movable abutments coöperating with the piston, a cap-plate carried by the piston and covering the channel, said plate having diametrically opposite inlet-ports, a valve-seat plate secured to the cylinder and having a port past which the ports of the cap-plate move, a valve movably mounted on the plate for varying the size of the port thereof, and means for moving the valve.

13. In a rotary engine, the combination with a cylinder having a pocket, of an elliptical piston mounted in the cylinder and having flanges, a movable abutment located in the pocket and bearing against the piston between the flanges, and other abutments located in the pocket on opposite sides of the movable abutment and having their inner ends bearing against the flanges.

14. In a rotary engine, the combination with a circular bore, of an elliptical piston movable therein and having circular peripheral flanges, movable abutments mounted in the cylinder and bearing against the piston between the flanges, other abutments mounted in the cylinder on opposite sides of the movable abutments and bearing against

the peripheries of the flanges, and packing-rings bearing against the outer sides of the piston.

15. In a rotary engine, the combination with a cylinder having a circular bore and diametrically opposite pockets, of an elliptical piston rotatably mounted in the cylinder and having circular flanges, abutments slidably mounted in the pockets of the cylinder and bearing against the piston between the flanges, other abutments located in the pockets and bearing against the peripheries of the flanges, and means for introducing steam into the cylinder through the piston between the abutments and the ends of the piston.

16. In a rotary engine, the combination with a cylinder, of a rotary piston located therein, a movable abutment coacting with the piston, means for introducing motive fluid into the cylinder and behind the abutment, means for automatically cutting off the supply of fluid to the abutment at intervals, and means carried by the piston for periodically permitting the exhaust from behind the abutment.

17. In a rotary engine, the combination with a cylinder, of a rotary piston located therein, a movable abutment coacting with the piston, a motive-fluid channel leading from the cylinder to a point in rear of the piston, a cut-off device revoluble with the piston for cutting off the channel from the cylinder, and means separate from said revoluble device and controlled by the position of the piston to permit the exhaust from behind the abutment.

18. In a rotary engine, the combination with a cylinder having a pocket, of a rotary piston located in the cylinder, a movable abutment mounted in the pocket and coacting with the piston, said cylinder having a motive-fluid-supply channel leading to the rear of the pocket, a shaft-support for the piston, and a disk carried by the support and having ports that aline with the channel.

19. In a rotary engine, the combination with a cylinder having a plurality of pockets and channels leading from one side of the cylinder to the rear portions of the pockets, of a shaft extending across the cylinder, a piston revolubly mounted in the cylinder and carried by the shaft, and a cut-off disk mounted on the shaft and having ports that are moved into and out of alinement with the inlets of the channels.

20. In a rotary engine, the combination with a cylinder having diametrically opposite pockets, a chamber in one side and channels leading from the chamber to the rear portions of the pockets, of a shaft extending through the cylinder and chamber, a rotary piston mounted on the shaft, slidable abutments mounted in the pockets and coacting with the piston, and a cut-off disk carried by the shaft and having ports that are movable into and out of alinement with the inlets of the channels.

21. In a rotary engine, the combination with a cylinder, of a rotary piston journaled therein, a movable abutment coacting with the piston, a motive-fluid-supply channel leading to the rear of the abutment, and a plunger-valve located in the channel.

22. In a rotary engine, the combination with a cylinder, of a rotary piston journaled therein, a movable abutment coacting with the piston, a motive-fluid-supply channel leading to the rear of the abutment, and a spring-pressed plunger-valve located in the channel.

23. In a rotary engine, the combination with a cylinder having pockets, of a rotary piston mounted in the cylinder, sliding abutments located in the pockets and coacting with the piston, said cylinder having channels provided with discharge-orifices opening into the rear portions of the pockets, plunger-valves movable across the discharge-orifices and located within the channels, springs bearing against the plunger-valves, and means for varying the tension of the springs.

24. In a rotary engine, the combination with a cylinder, of a rotary piston located therein, an abutment coacting with the piston, an exhaust from the cylinder, means for directing motive fluid behind the abutment, an exhaust for the motive fluid behind the abutment leading to the cylinder, and a valve for cutting off the exhaust between the cylinder and the space in rear of the abutment.

25. In a rotary engine, the combination with a cylinder, of a rotary piston located therein, an abutment coacting with the piston, means for directing motive fluid behind the abutment, an exhaust for said motive fluid, said exhaust being located in the abutment, and means for closing the channel of the abutment to prevent the exhaust therethrough.

26. In a rotary engine, the combination with a cylinder, of a rotatable piston located therein, a movable abutment coacting with the piston, means for directing motive fluid behind the abutment, said abutment having an exhaust-channel communicating with the space in rear of the abutment, and a valve controlling the channel and operated by the piston, said valve automatically cutting off the space in rear of the abutment from the nozzle.

27. In a rotary engine, the combination with a cylinder, of a rotatable piston located therein, a movable abutment coacting with the piston, means for directing motive fluid behind the abutment, said abutment having an exhaust-channel, and a foot-valve for closing and opening the channel between the ends of the abutment, said valve being car-

ried by the abutment and bearing against the piston.

28. In a rotary engine, the combination with a cylinder, of a rotary elliptical piston mounted therein, a sliding abutment coöperating with the piston, means for supplying motive fluid behind the abutment, said abutment having an exhaust passage-way therethrough, and an oscillating foot-valve mounted on the inner end of the abutment and bearing against the piston, said valve controlling the exhaust.

29. In a rotary engine, the combination with a cylinder, of a rotary elliptical piston located therein, oppositely-arranged sliding abutments, means for intermittently supplying motive fluid behind the abutments to urge the same into engagement with the piston, said abutments being provided with longitudinally-disposed exhaust-channels, and oscillatory foot-valves carried by the inner ends of the abutments and bearing against the pistons, said valves controlling the exhaust-channels of the abutments and being oscillated by the piston.

30. In a rotary engine, the combination with a cylinder having diametrically opposite pockets, of a shaft extending across the cylinder, an elliptical piston carried by the shaft, said piston having an annular channel and discharge-branches opening contiguous to the ends of the piston, means for intermittently supplying motive fluid to the channel, reciprocatory abutments coacting with the piston and mounted in the pockets, said cylinder having a chamber at one end and channels leading therefrom to the rear portions of the pockets, a cut-off disk carried by the shaft and controlling the supply of motive fluid from the pockets through the channels, the abutments having longitudinally-disposed exhaust-channels, and oscillatory foot-valves mounted on the inner ends of the abutments and bearing against the elliptical surface of the piston, said foot-valves controlling the exhaust-channels and being operated by the piston.

31. In a rotary engine, the combination with a cylinder having heads, of a rotary piston located in the cylinder and terminating short of one of the heads, means for introducing motive-fluid supply through the head and into the space between the same and the piston, and a packing-ring arranged at the periphery of the piston in said space and comprising sections that are movable toward and from each other.

32. In a rotary engine, the combination with a cylinder having heads, of a rotary piston located in the cylinder and terminating short of the heads, said piston having openings therethrough allowing communication between the spaces between the piston and heads, means for introducing motive-fluid supply into one of such spaces, and packing-rings located in the spaces and bearing against the sides of the piston, said rings consisting of sections adjustably secured together and having interposed packing.

33. In a rotary engine, the combination with a cylinder, of a rotary piston located therein, a movable abutment coacting with the piston, means for directing motive fluid behind the abutment, said abutment having an exhaust-channel provided with a port, said port being movable with the abutment, and stationary means past which the port moves for closing and opening said port.

34. In a rotary engine, the combination with a cylinder having a pocket, of a rotary piston located in the cylinder, a reciprocatory abutment sliding in the pocket, means directing motive fluid to the pocket behind the abutment, said abutment having a longitudinally-disposed exhaust-channel provided with an offset port in its rear end communicating with the rear portion of the pocket, and a valve located in the rear portion of the pocket and arranged to close the port when the abutment is moving outwardly.

35. In a rotary engine, the combination with a cylinder, of a rotary piston located therein, an abutment coacting with the piston and having a space in rear of the same, an exhaust from the cylinder, means for directing motive fluid to the space behind the abutment, an exhaust for the motive fluid in said space, said exhaust leading to the cylinder, and a valve for cutting off the exhaust between the cylinder and the space in rear of the abutment, said valve being automatically operated to open the exhaust-channel when the cylinder is exhausting.

36. In a rotary engine, the combination with a cylinder, of a piston operating therein, an abutment-block located in the cylinder and coöperating with the piston, and a T-shaped packing for said block.

37. In a rotary engine, the combination with a piston, of an abutment-block, a swinging foot-valve carried by the block and coöperating with the piston, and a substantially T-shaped packing mounted on the abutment-block and including a bar portion connecting with the foot-valve.

38. In a rotary engine, the combination with a cylinder having an abutment-chamber, of a rotary piston operating in the cylinder, an abutment-block located in the abutment-chamber and coöperating with the piston-bed, blocks fastened to the sides of the abutment-chamber, and a gland conforming to the abutment-chamber and block and spaced from the bed-blocks, forming a packing-receiving space.

39. In a rotary engine, the combination with a casing, of a rotary piston located therein, and a piston end packing comprising a ring having its peripheral portion cut out and beveled, a follower-ring coöperating

with said first-mentioned ring, packing interposed between the rings, said packing being given an outward thrust by the beveled surface, and a thin metallic band also interposed between the rings and being pressed thereby outwardly toward the cylinder.

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

THOMAS CROSTON.

Witnesses:
F. F. WILLIAMS,
JOHN CROSTON.