

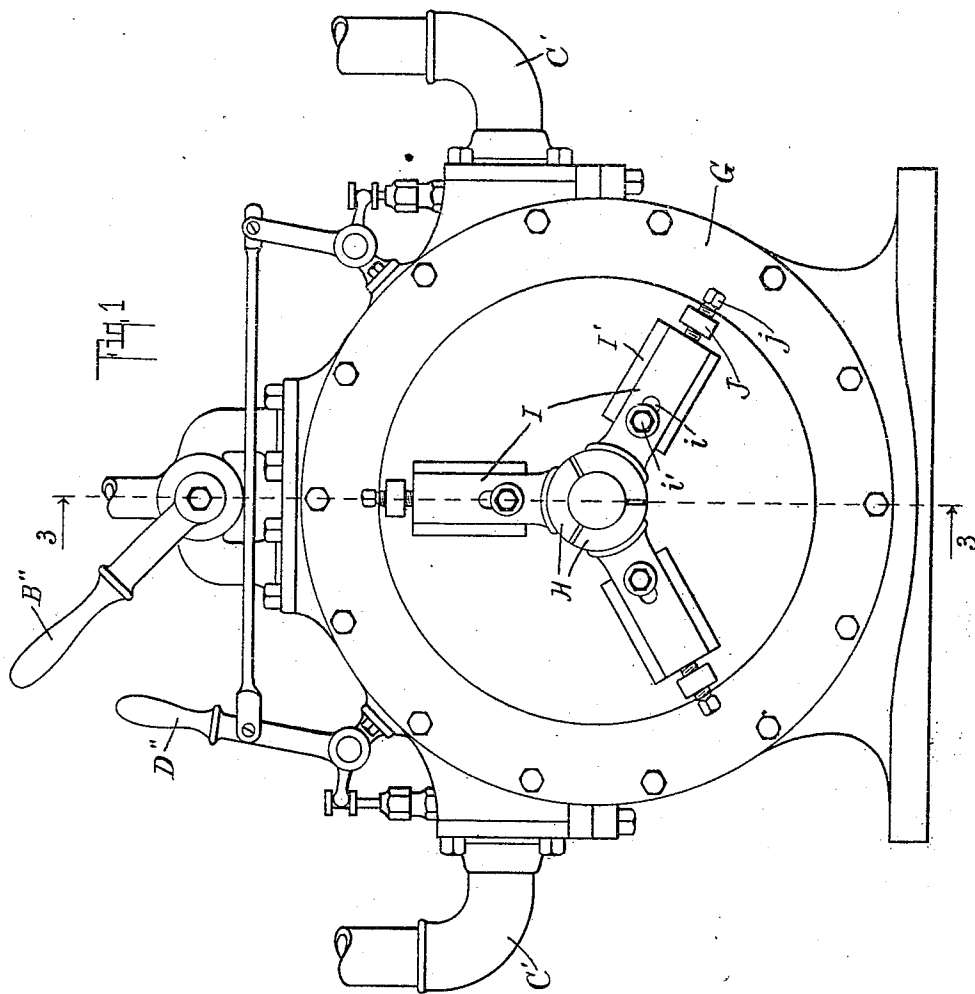
No. 825,374.

PATENTED JULY 10, 1906.

C. A. BLACK.
ROTARY ENGINE.

APPLICATION FILED APR. 13, 1906.

3 SHEETS—SHEET 1.



Witnesses

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Clara A. Sabin.

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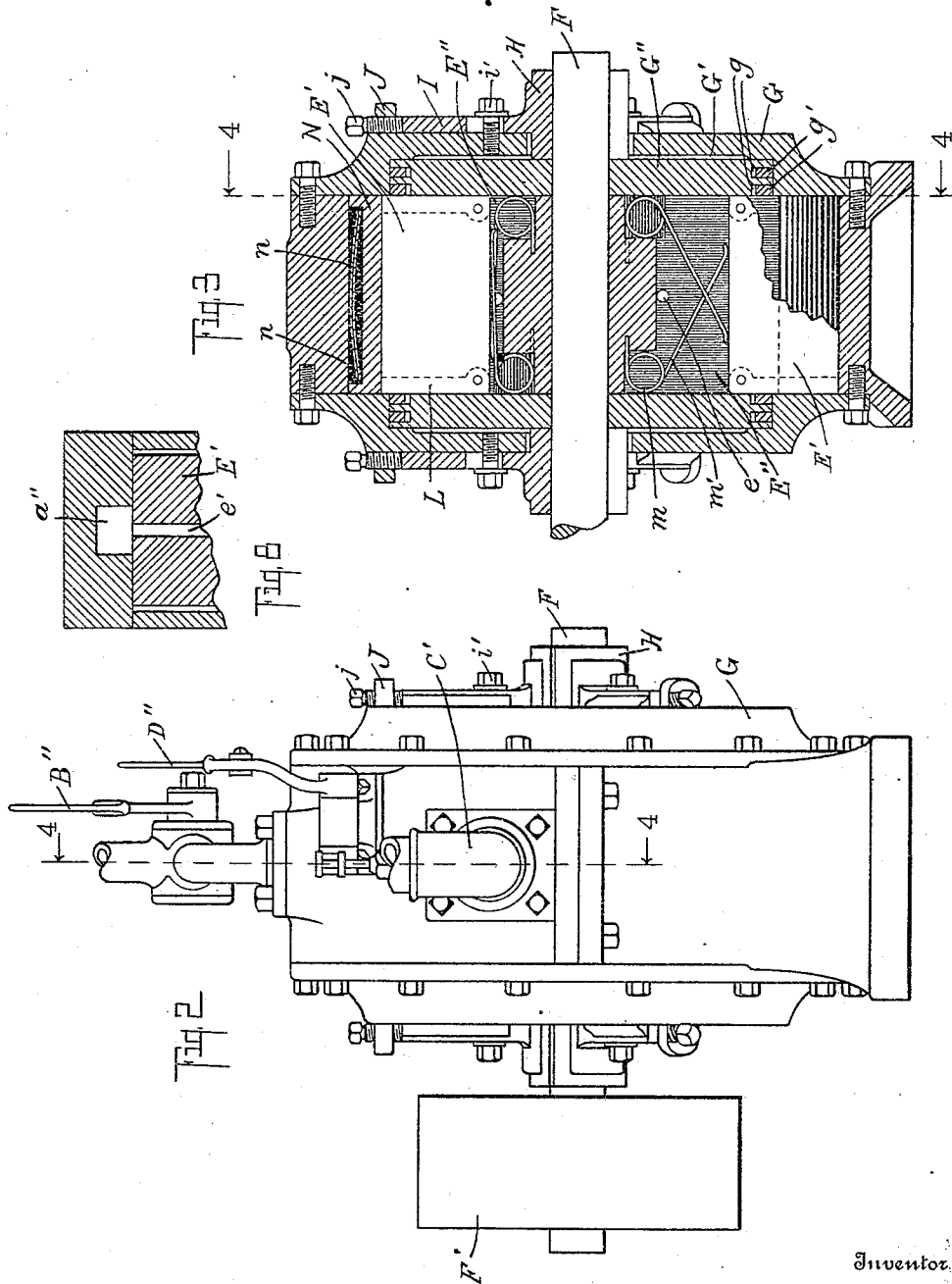
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Witnesses

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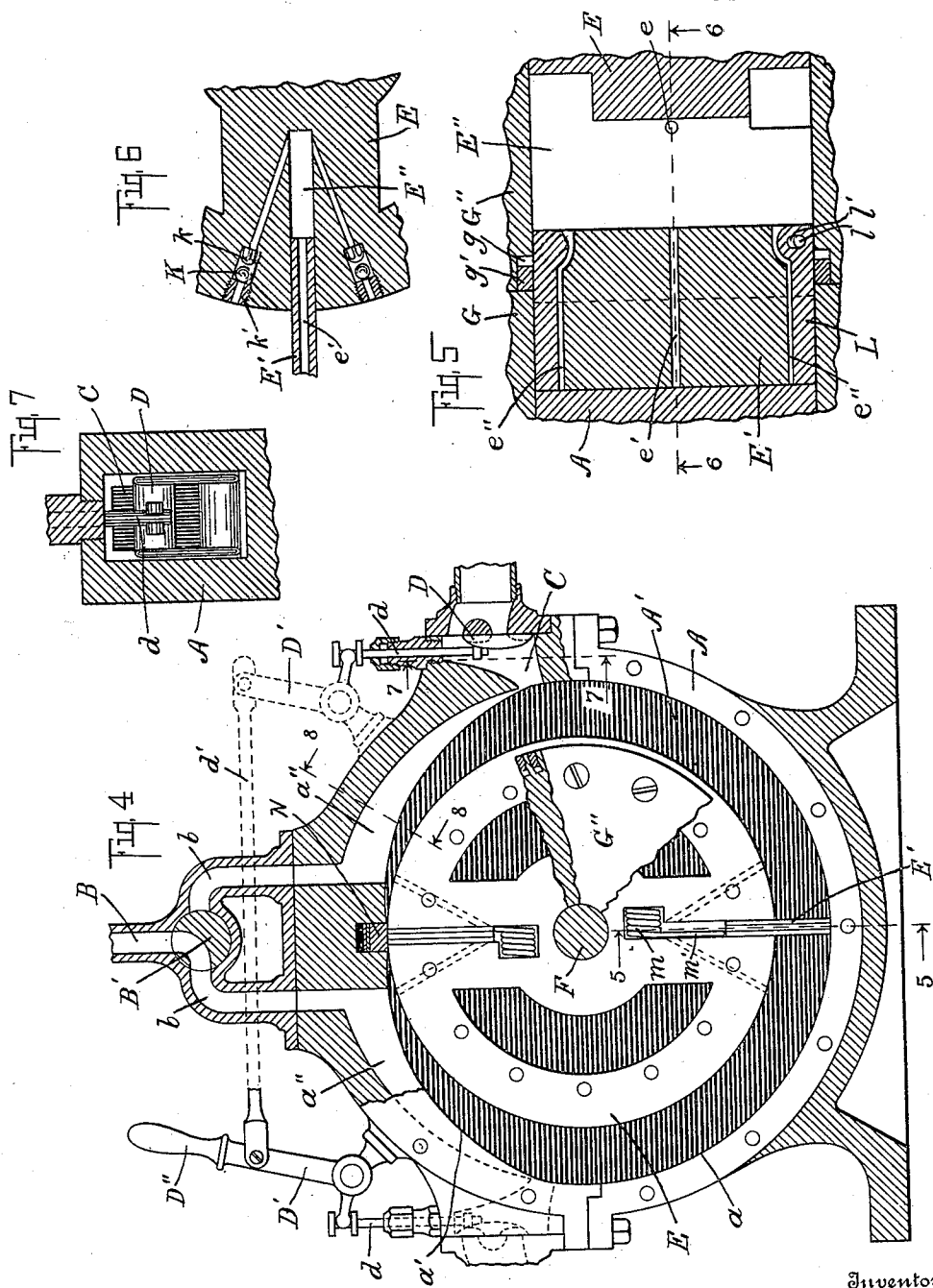
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3 SHEETS—SHEET 3.



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UNITED STATES PATENT OFFICE.

CORNELIUS A. BLACK, OF CONSTANTINE, MICHIGAN, ASSIGNOR OF ONE-THIRD TO WALLACE N. HARVEY, OF CONSTANTINE, MICHIGAN.

ROTARY ENGINE.

No. 825,374.

Specification of Letters Patent.

Patented July 10, 1906.

Application filed April 13, 1906. Serial No. 311,483.

To all whom it may concern:

Be it known that I, CORNELIUS A. BLACK, a citizen of the United States, residing at Constantine, in the county of St. Joseph and State of Michigan, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

This invention relates to improvements in rotary engines.

The objects of this invention are, first, to provide a rotary engine by which a very high speed or power may be attained; second, to provide an improved rotary engine in which the friction of the parts in operation is reduced to a minimum; third, to provide an improved rotary engine in which but a minimum of power is consumed in the operation of the engine; fourth, to provide an improved rotary engine which may be operated in either direction and which may be quickly reversed and, further, one having no dead-center—that is, it may be started in either direction, with the piston standing in any position; fifth, to provide an improved rotary engine which is exhausted, so that there is no cushion action against the piston-heads; sixth, to provide an improved rotary engine in which the movable piston-heads are held in position while under pressure by steam; seventh, to provide in a rotary engine an improved adjustable shaft-bearing, and, eighth, to provide an improved rotary engine which is simple in structure, economical to produce, and one which is very durable in use and not likely to get out of repair.

Further objects and objects relating to structural details will definitely appear from the detailed description to follow.

I accomplish the objects of my invention by the devices and means described in the following specification.

The invention is clearly defined and pointed out in the claims.

A structure embodying the features of my invention is clearly illustrated in the accompanying drawings, forming a part of this specification, in which—

Figure 1 is an end elevation of my improved rotary engine, the steam and exhaust pipes being shown broken away. Fig. 2 is a vertical central section taken on a line corresponding to line 3 3 of Fig. 1. Fig. 3 is a detail vertical section taken on a line corresponding to line 3 3 of Fig. 1, portions being

broken away to show the structural details. Fig. 4 is a vertical section taken on a line corresponding to line 4 4 of Fig. 2. Fig. 5 is an enlarged detail section showing the structure and arrangement of the piston and piston-heads or blades, taken on a line corresponding to line 5 5 of Fig. 4. Fig. 6 is a detail sectional view taken on a line corresponding to line 6 6 of Fig. 5. Fig. 7 is an enlarged detail section of one of the exhaust-valves, taken on a line corresponding to line 7 7 of Fig. 4; and Fig. 8 is an enlarged detail section, showing structural details of the cylinder, taken on a line corresponding to line 8 8 of Fig. 4.

In the drawings the sectional views are taken looking in the direction of the little arrows at the ends of the section-lines, and similar letters of reference refer to similar parts throughout the several views.

Referring to the drawings, the cylinder A is provided with a piston-chamber A'. The lower portion of this chamber *a* is in the form of a true circle, and the upper portion *a'* is in the form of an ellipse. Steam is admitted to the cylinder from the pipe B through the ports *b b*. These ports open into the cylinder-chamber at each side of the packing N, which is arranged centrally of the elliptical portion of the cylinder-chamber. The valve B' is so arranged as to control the delivery to either of the ports *b*, as desired.

The exhaust-ports C are located at or adjacent to the points where the cylindrical and elliptical portions of the cylinder-chamber meet or merge, as clearly appears in Fig. 4. In the walls of the cylinder are groove-like passages *a''*, which extend from the inlet-ports *b* to the exhaust-ports C. These passages are gradually diminished in size as they approach the exhaust-ports. The purpose of these passages will appear as the description proceeds. The exhaust-ports C are controlled by the slide-valves D. These valves are provided with upwardly-projecting stems *d*, which I preferably connect so that when one is opened the other is closed. This connection preferably consists of the bent pivoted levers D', which are connected by the link *d'*, one arm of the levers D' being arranged to engage the valve-stems and the other being connected by the link. One of the levers D' is provided with a suitable handle, as D''. (See Figs. 1 and 4.)

The valve B' is provided with a suitable handle, as B''.

Delivery-pipes, as C', are preferably provided for the exhaust-ports.

5 The piston E, which is cylindrical in form, is mounted upon the shaft F. This shaft is carried by suitable bearings, mounted upon the cylinder-heads G. The shaft-bearings are preferably made up of sections H, which
10 sections are mounted on adjustable supports I. The supports I are arranged in radial ways or guides I' on the cylinder-heads and are secured by means of the bolts i', which are arranged through suitable longitudinal
15 slots i, which are in the supports. For adjusting these supports I provide set-screws j, which are arranged through the projecting ears J on the cylinder-heads, the inner ends of the screws engaging the ends of the supports. By this means the bearings can be
20 adjusted to take up wear and also to properly center the shaft. The shaft F is centered in the cylinder relative to the circular portion A' thereof. The parts are so proportioned
25 that the piston contacts with the elliptical portion of the cylinder at the central point thereof, as clearly appears in Fig. 4. At this point I arrange the packing N. This packing is arranged in a suitable groove N' in the
30 cylinder-wall, extending from side to side thereof. The packing N is held yieldingly against the periphery of the piston by means of the spring n, arranged in the groove behind the same. (See Fig. 3.)

35 The piston-heads E' are slidably arranged in the radial slot-like chambers E'' in the piston. These piston-heads are held yieldingly outward by means of the springs m, which are arranged in the chambers E'' behind the
40 same. These springs are preferably coiled springs, with arm-like extensions m' arranged to engage the piston-heads, as illustrated in Fig. 3, it being intended that the flexing of the spring shall occur mainly in the coils. By this form of spring the tension thereof is not
45 materially affected whether the piston-heads be in their inner or outer position. It is intended that the tension of these springs shall be sufficient only to hold the piston-heads in their outer position. When the heads or
50 blades are under steam-pressure, they are packed or held outward by the steam. To accomplish this, I provide the cylinder with passages e, which extend from the periphery thereof to the inner end of the piston-head
55 chambers E'', there being two passages e for each chamber. These passages e are provided with check-valves, consisting, preferably, of the balls K, which are held in chambers
60 formed at the outer ends of the passages by perforated plugs k', the balls seating outwardly against these plugs. At the inner end of these chambers are cages k, which prevent the balls from seating inwardly. When
65 a piston-head is in position to take steam, the

steam passes through the passages e to the chamber E'' behind the piston-head, thereby holding the same in position. To exhaust these chambers E'', passages e'' are formed longitudinally through the piston-heads. (See 70 Figs. 5, 6, and 8.) It is evident that during that portion of the movement of the piston-head over the elliptical portion of the chamber the pressure in the chamber E'' and that in the cylinder acting upon the blade is equal. 75 While the piston-blade is under full steam-pressure it is passing through the circular portion of the cylinder, so that it maintains its fixed position—that is, it is not necessary for the head to shift either in or out while 80 under full steam-pressure. As soon as the blade or piston-head passes the exhaust-port the passages e' open into the passage a'' on the exhausting side of the cylinder, so that the chamber E'' is exhausted therethrough. 85 The passage a'' also allows the steam which may be in the front of the piston to pass to the rear thereof to the exhaust-port, thereby preventing cushioning of the piston-heads. By this arrangement of parts the piston- 90 heads are, as stated, held in a fixed position while under the full pressure of steam. As soon, however, as a blade has passed the exhaust-port the blades are held in position only by the springs m, which, as stated, are 95 only of sufficient tension to hold them normally out.

To effectively pack my improved piston, I provide packing-disks G'', which are secured to each end thereof. The cylinder-heads G 100 are provided with suitable chambers G' to receive these packing-disks. The packing-disks G are provided with peripheral grooves g, adapted to receive the packing-rings g'. I thus provide an effective packing with comparatively little friction. I also preferably 105 provide the ends of the blades or piston-heads E' with packings, which consist of strips of metal L, arranged in suitable grooves e'', formed therefor in the edges of the heads. 110 These packing-strips L are secured at their inner ends by suitable pins l', which are arranged through slots l therein. This allows the packing-strips to shift. The inner ends of the grooves e'' open into the chamber E'', 115 so that when this chamber is under steam-pressure the strips are held in their outer position. As soon as the chamber G is exhausted the pressure on the strips is released, so that the friction is reduced to a minimum. 120

As I have heretofore stated, no shifting of the piston-heads or blades is required while moving through the circular portion of the cylinder, during which period the blades are being acted upon by the steam. This reduces the friction and wear upon the parts to 125 a minimum, and also the blades being held in position by the steam-pressure during this period, it is only necessary to provide springs of sufficient tension to hold them in 130

position for starting the engine, so that the friction upon the blades during the period in which they are shifted is only the minimum amount. Also by my improved arrangement of packings I reduce the friction very materially.

It is immaterial in starting my improved rotary engine what the position of the piston-heads may be, as one or the other is always in position to be acted upon by the steam from either inlet-port. My improved engine may be driven in either direction desired merely by means of adjusting the inlet and exhaust valves. By means of my adjustable bearing the shaft may be accurately adjusted and the wear upon the bearings taken up. Further advantages will readily appear to those skilled in the art to which my invention relates.

I have illustrated and described my improved rotary engine in detail in the form preferred by me on account of its structural simplicity and economy in manufacture. I am aware, however, that it is capable of considerable variation in structural details without departing from my 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 of a cylinder having a circular portion and an elliptical portion; a pair of inlet-ports; a packing-strip arranged between the said inlet-ports; a spring for holding said strip yieldingly in position; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in the elliptical portion of said cylinder extending from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; heads for said cylinder having circular chambers therein; disk-like packing-plates having peripheral grooves therein secured to said piston, said packing-plates being arranged in said chambers in said cylinder-heads; packing-rings arranged in said grooves; piston-heads having longitudinal passages therethrough and longitudinal grooves in their edges, slidably arranged in said chambers in said piston; packing-strips arranged in said grooves in said piston-heads having transverse slots therein; pins arranged in said slots for holding said packing-strips adjustably in position; and coiled springs having oppositely-arranged arms like extensions arranged to engage the inner ends of said piston-heads, all coacting for the purpose specified.

2. In a rotary engine, the combination of a

cylinder having a circular portion and an elliptical portion; a pair of inlet-ports; a packing-strip arranged between the said inlet-ports; a spring for holding said strip yieldingly in position; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in the elliptical portion of said cylinder extending from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of said piston to the inner ends of piston-head chambers; check-valves for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; piston-heads having longitudinal passages therethrough and longitudinal grooves in their edges, slidably arranged in said chambers in said piston; packing-strips arranged in said grooves in said piston-heads having transverse slots therein; pins arranged in said slots for holding said packing-strips adjustably in position; and coiled springs having oppositely-arranged arms like extensions arranged to engage the inner ends of said piston-heads, all coacting for the purpose specified.

3. In a rotary engine, the combination of a cylinder having a circular portion and an elliptical portion; a pair of inlet-ports; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in the elliptical portion of said cylinder extending from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; heads for said cylinder having circular chambers therein; disk-like packing-plates having peripheral grooves therein secured to said piston, said packing-plates being arranged in said chambers in said cylinder-heads; packing-rings arranged in said grooves; piston-heads having longitudinal grooves in their edges, slidably arranged in said chambers in said piston; packing-strips arranged in said grooves in said piston-heads having transverse slots therein; pins arranged in said slots for holding said packing-strips adjustably in position; and coiled springs having oppositely-arranged arms like extensions arranged to engage the inner ends of said piston-heads; all coacting for the purpose specified.

4. In a rotary engine, the combination of a cylinder having a circular portion and an elliptical portion; a pair of inlet-ports; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in the elliptical

tical portion of said cylinder extending from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; piston-heads having longitudinal passages therethrough, and longitudinal grooves in their edges, slidably arranged in said chambers in said piston; packing-strips arranged in said grooves in said piston-heads having transverse slots therein; pins arranged in said slots for holding said packing-strips adjustably in position; and coiled springs having oppositely-arranged arms like extensions arranged to engage the inner ends of said piston-heads, all coacting for the purpose specified.

5. In a rotary engine, the combination of a cylinder having a circular portion and an elliptical portion; a pair of inlet-ports; a packing-strip arranged between said inlet-ports; a spring for holding said strip yieldingly in position; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in the elliptical portion of said cylinder extending from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; heads for said cylinder having circular chambers therein; disk-like packing-plates having peripheral grooves therein secured to said piston, said packing-plates being arranged in said chambers in said cylinder-heads; packing-rings arranged in said grooves; piston-heads having longitudinal passages therethrough slidably arranged in said chambers in said piston; and coiled springs having oppositely-arranged arm-like extensions arranged to engage the inner ends of said piston-heads, all coacting for the purpose specified.

6. In a rotary engine, the combination of a cylinder having a circular portion and an elliptical portion; a pair of inlet-ports; a packing-strip arranged between the said inlet-ports; a spring for holding said strip yieldingly in position; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in the elliptical portion of said cylinder extending from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; a shaft for said piston, centered rela-

tive to the circular portion of said cylinder; piston-heads having longitudinal passages therethrough slidably arranged in said chambers in said piston; and coiled springs having oppositely-arranged arm-like extensions arranged to engage the inner ends of said piston-heads; all coacting for the purpose specified.

7. In a rotary engine, the combination of a cylinder having a circular portion and an elliptical portion; a pair of inlet-ports; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in the elliptical portion of said cylinder extending from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; heads for said cylinder having circular chambers therein; disk-like packing-plates having peripheral grooves therein secured to said piston, said packing-plates being arranged in said chambers in said cylinder-heads; packing-rings arranged in said grooves; piston-heads having longitudinal passages therethrough slidably arranged in said chambers in said piston; and coiled springs having oppositely-arranged arm-like extensions arranged to engage the inner ends of said piston-heads, all coacting for the purpose specified.

8. In a rotary engine, the combination of a cylinder having a circular portion and an elliptical portion; a pair of inlet-ports; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in the elliptical portion of said cylinder extending from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; piston-heads having longitudinal passages therethrough slidably arranged in said chambers in said piston; and coiled springs having oppositely-arranged arm-like extensions arranged to engage the inner ends of said piston-heads, all coacting for the purpose specified.

9. In a rotary engine, the combination of a cylinder having a circular portion and an elliptical portion; a pair of inlet-ports; a packing-strip arranged between the said inlet-ports; a spring for holding said strip yieldingly in position; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinders; groove-like passages in the elliptical portion

of said cylinder extending from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; heads for said cylinder having circular chambers therein; disk-like packing-plates having peripheral grooves therein secured to said piston, said packing-plates being arranged in said chambers in said cylinder-heads; packing-rings arranged in said grooves; piston-heads having longitudinal passages therethrough and longitudinal grooves in their edges, slidably arranged in said chambers in said piston; packing-strips arranged in said grooves in said piston-heads having transverse slots therein; pins arranged in said slots for holding said packing-strips adjustably in position; all coacting for the purpose specified.

10. In a rotary engine, the combination of a cylinder having a circular portion and an elliptical portion; a pair of inlet-ports; a packing-strip arranged between the said inlet-ports; a spring for holding the said strip yieldingly in position; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in the elliptical portion of said cylinder extending from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; piston-heads having longitudinal passages therethrough and longitudinal grooves in their edges, slidably arranged in said chambers in said piston; packing-strips arranged in said grooves in said piston-heads having transverse slots therein; pins arranged in said slots for holding said packing-strips adjustably in position; all coacting for the purpose specified.

11. In a rotary engine, the combination of a cylinder having a circular portion and an elliptical portion; a pair of inlet-ports; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in the elliptical portion of said cylinder extending from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of the said piston to the inner ends of said piston-head chambers; check-valves for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; heads for said cylinder having circular chambers therein; disk-

like packing-plates having peripheral grooves therein secured to said piston, said packing-plates being arranged in said chambers in said cylinder-heads; piston-heads having longitudinal passages therethrough and longitudinal grooves in their edges, slidably arranged in said chambers in said piston; packing-strips arranged in said grooves in said piston-heads having transverse slots therein; and pins arranged in said slots for holding said packing-strips adjustably in position, all coacting for the purpose specified.

12. In a rotary engine, the combination of a cylinder having a circular portion and an elliptical portion; a pair of inlet-ports; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in the elliptical portion of said cylinder extending from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; piston-heads having longitudinal passages therethrough and longitudinal grooves in their edges, slidably arranged in said chambers in said piston; packing-strips arranged in said grooves in said piston-heads having transverse slots therein; and pins arranged in said slots for holding said packing-strips adjustably in position, all coacting for the purpose specified.

13. In a rotary engine, the combination of a cylinder having a circular portion and an elliptical portion; a pair of inlet-ports; a packing-strip arranged between the said inlet-ports; a spring for holding said strip yieldingly in position; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in the elliptical portion of said cylinder extending from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; heads for said cylinder having circular chambers therein; disk-like packing-plates having peripheral grooves therein secured to said piston, said packing-plates being arranged in said chambers in said cylinder-heads; packing-rings arranged in said grooves; piston-heads having longitudinal passages therethrough slidably arranged in said chambers in said piston; all coacting for the purpose specified.

14. In a rotary engine, the combination of a cylinder having a circular portion and an elliptical portion; a pair of inlet-ports; a packing-strip arranged between the said inlet-

ports; a spring for holding said strip yieldingly in position; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinders; 5 groove-like passages in the elliptical portion, said cylinder extending from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of 10 said piston to the inner ends of said piston-head chambers; check-valves for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; piston-heads having longitudinal passages 15 therethrough slidably arranged in said chambers in said piston, all coacting for the purpose specified.

15. In a rotary engine, the combination of a cylinder having a circular portion and an 20 elliptical portion; a pair of inlet-ports; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in the elliptical portion of said cylinder extending 25 from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check- 30 valves for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; heads for said cylinder having circular chambers therein; disk-like packing-plates having peripheral grooves therein 35 secured to said piston, said packing-plates being arranged in said chambers in said cylinder-heads; packing-rings arranged in said grooves; piston-heads having longitudinal passages therethrough slidably arranged in 40 said chambers in said piston, all coacting for the purpose specified.

16. In a rotary engine, the combination of a cylinder having a circular portion and an 45 elliptical portion; a pair of inlet-ports; exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in the elliptical portion of said cylinder extending 50 from the inlet-ports to the exhaust-ports; a circular piston having opposite radial piston-head chambers therein; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves 55 for said passages; a shaft for said piston, centered relative to the circular portion of said cylinder; heads and piston-heads having longitudinal passages therethrough slidably arranged in said chambers in said piston, all co- 60 acting for the purpose specified.

17. In a rotary engine the combination of a cylinder having a circular portion and an 65 elliptical portion; a circular piston having opposite radial piston-head chambers therein, centered in the cylinder-chamber relative to the circular portion thereof and contacting

with the cylinder-wall at the center of the elliptical portion thereof; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check- 70 valves for said passages; an inlet-port at each side of the point of contact of said piston and cylinder-wall; a pair of exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; 75 groove-like passages in said cylinder extending from the inlet-ports to the exhaust-ports; piston-heads having longitudinal passages therethrough slidably arranged in said chamber in said piston; and springs for holding 80 said piston-heads yieldingly outward, for the purpose specified.

18. In a rotary engine, the combination of a cylinder having a circular portion and an 85 elliptical portion; a circular piston having opposite radial piston-head chambers therein; centered in the cylinder-chamber relative to the circular portion thereof and contacting with the cylinder-wall at the center of the 90 elliptical portion thereof; an inlet-port at each side of the point of contact of said piston and cylinder-wall; a pair of exhaust-ports located adjacent to the meeting-points of the circular and elliptical portions of said cylinder; 95 groove-like passages on said cylinder extending from the inlet-ports to the exhaust-ports; piston-heads having longitudinal passages therethrough slidably arranged in said chamber in said piston; and springs for holding 100 said piston-heads yieldingly outward, for the purpose specified.

19. In a rotary engine, the combination of a cylinder having a circular portion and an 105 elliptical portion; a circular piston having opposite radial piston-head chambers therein, centered in the cylinder-chamber relative to the circular portion thereof and contacting 110 with the cylinder-wall at the center of the elliptical portion thereof; an inlet-port at each side of the point of contact of said piston and cylinder-wall; a pair of exhaust-ports located 115 adjacent to the meeting-points of the circular and elliptical portions of said cylinder; groove-like passages in said cylinder extending from the inlet-ports to the exhaust-ports; piston-heads slidably arranged in said 120 chamber in said piston; and springs for holding said piston-heads yieldingly outward, for the purpose specified.

20. In a rotary engine, the combination of a cylinder; a circular piston having opposite 125 radial piston-head chambers therein, arranged to contact with the cylinder-wall at one point; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said 130 passages; an inlet-port at each side of the point of contact of said piston and cylinder-wall; a pair of oppositely-arranged exhaust-ports for said cylinder; groove-like passages in said cylinder extending from the inlet-ports 135

to the exhaust-ports; piston-heads having longitudinal passages therethrough and longitudinal grooves in their edges, slidably arranged in said chamber in said piston; packing-strips arranged in said grooves in said piston-heads having transverse slots therein; pins arranged in said slots for holding said packing-strips adjustably in position; and coiled springs having oppositely-arranged arm-like extensions arranged to engage the inner ends of said piston-heads, for the purpose specified.

21. In a rotary engine, the combination of a cylinder; a circular piston having opposite radial piston-head chambers therein, arranged to contact with the cylinder-wall at one point; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; an inlet-port at each side of the point of contact of said piston and cylinder-wall; a pair of oppositely-arranged exhaust-ports for said cylinder; groove-like passages in said cylinder extending from the inlet-ports to the exhaust-ports; piston-heads having longitudinal passages therethrough and longitudinal grooves in their edges, slidably arranged in said chamber in said piston; packing-strips arranged in said grooves in said piston-heads having transverse slots therein; pins arranged in said slots for holding said packing-strips adjustably in position; for the purpose specified.

22. In a rotary engine, the combination of a cylinder; a circular piston having opposite radial piston-head chambers therein, arranged to contact with the cylinder-wall at one point; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; an inlet-port at each side of the point of contact of said piston and cylinder-wall; a pair of oppositely-arranged exhaust-ports for said cylinder; groove-like passages in said cylinder extending from the inlet-ports to the exhaust-ports; piston-heads having longitudinal passages therethrough and longitudinal grooves in their edges, slidably arranged in said chambers in said piston; packing-strips arranged in said grooves in said piston-heads; and coiled springs having oppositely-arranged arm-like extensions arranged to engage the inner ends of said piston-heads, for the purpose specified.

23. In a rotary engine, the combination of a cylinder; a circular piston having opposite radial piston-head chambers therein, arranged to contact with the cylinder-wall at one point; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; an inlet-port at each side of the point of contact of said piston and cylinder-wall; a pair of oppositely-arranged exhaust-ports for said cylinder; groove-like passages

in said cylinder extending from the inlet-ports to the exhaust-ports; piston-heads having longitudinal passages therethrough; and longitudinal grooves in their edges, slidably arranged in said chamber in said piston; packing-strips arranged in said grooves in said piston-heads; for the purpose specified.

24. In a rotary engine, the combination of a cylinder; a circular piston having opposite radial piston-head chambers therein, arranged to contact with the cylinder-wall at one point; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; an inlet-port at each side of the point of contact of said piston and cylinder-wall; a pair of oppositely-arranged exhaust-ports for said cylinder; groove-like passages in said cylinder extending from the inlet-ports to the exhaust-ports; piston-heads having longitudinal passages therethrough slidably arranged in said chamber in said piston; and coiled springs having oppositely-arranged arm-like extensions arranged to engage the inner ends of said piston-heads, for the purpose specified.

25. In a rotary engine, the combination of a cylinder; a circular piston having opposite radial piston-head chambers therein, arranged to contact with the cylinder-wall at one point; passages leading from the periphery of said piston to the inner ends of said piston-head chambers; check-valves for said passages; an inlet-port at each side of the point of contact of said piston and cylinder-wall; a pair of oppositely-arranged exhaust-ports for said cylinder; groove-like passages in said cylinder extending from the inlet-ports to the exhaust-ports; piston-heads having longitudinal passages therethrough slidably arranged in said chamber in said piston; for the purpose specified.

26. In a rotary engine, the combination of a cylinder; a circular piston having opposite radial piston-head chambers therein, arranged to contact with the cylinder-wall at one point; an inlet-port at each side of the point of contact of said piston and cylinder-wall; a pair of oppositely-arranged exhaust-ports for said cylinder; groove-like passages in said cylinder; extending from the inlet-ports to the exhaust-ports; and piston-heads slidably arranged in said chambers in said piston, for the purpose specified.

27. In a rotary engine, the combination of a cylinder; cylinder-heads; a piston; a shaft for said piston; bearings for said piston-shaft made up of sections; supports for said bearing-sections having longitudinal slots therein; radial guides on said cylinder-heads for said supports; set-screws arranged in said slots for adjustably securing said supports in position in said guides; ears projecting from said cylinder-heads at the ends of said supports; and set-screws arranged through said

ears to engage said supports, for the purpose specified.

28. In a rotary engine, the combination of
a cylinder; cylinder-heads; a piston; a shaft
5 for said piston; bearings for said piston-shaft
made up of sections; supports for said bearing-
sections having longitudinal slots there-
in; radial guides on said cylinder-heads for
said supports; set-screws arranged in said
10 slots for adjustably securing said supports in
position in said guides; and set-screws arranged
through said ears to engage said supports,
for the purpose specified.

29. In a rotary engine, the combination of

a cylinder; a circular piston having piston- 15
head chambers therein; piston-heads slidably
arranged in said chambers in said piston; and
coiled springs having oppositely-arranged
arm-like extensions arranged to engage the
inner ends of said piston-heads, for the pur- 20
pose specified.

In witness whereof I have hereunto set my
hand and seal in the presence of two wit-
nesses.

CORNELIUS A. BLACK. [L. s.]

Witnesses:

GEO. A. HELPICH,

DON H. KING.