(No Model.)

5 Sheets—Sheet 1.

L. J. WING.

ROTARY ENGINE.

No. 259,964.

Patented June 20, 1882

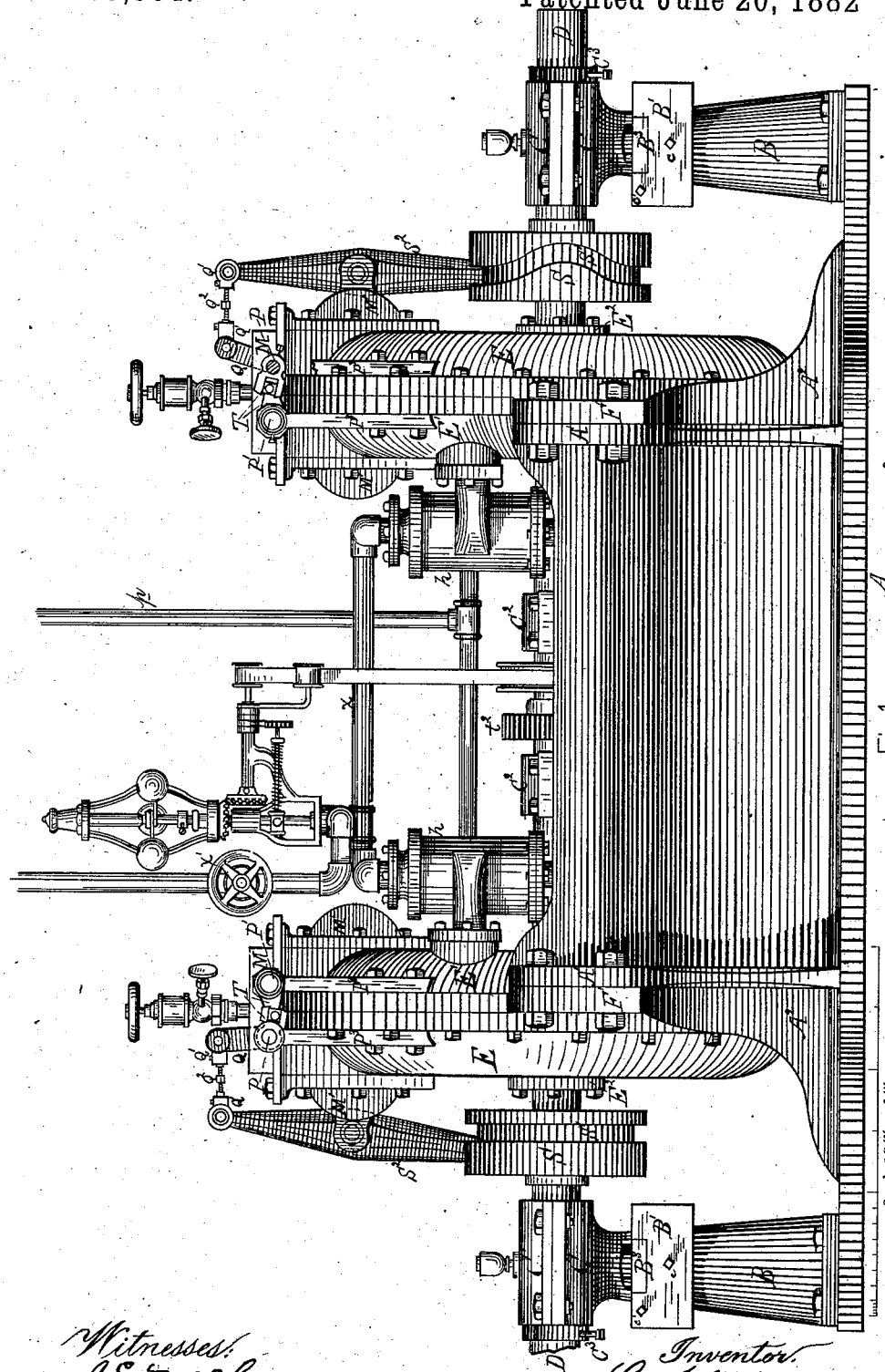

Fig. 1.

Witnesses:
J. E. McLean
Arthur E. Perkins.

Inventor.
L. J. Wing

(No Model.) 5 Sheets—Sheet 2.

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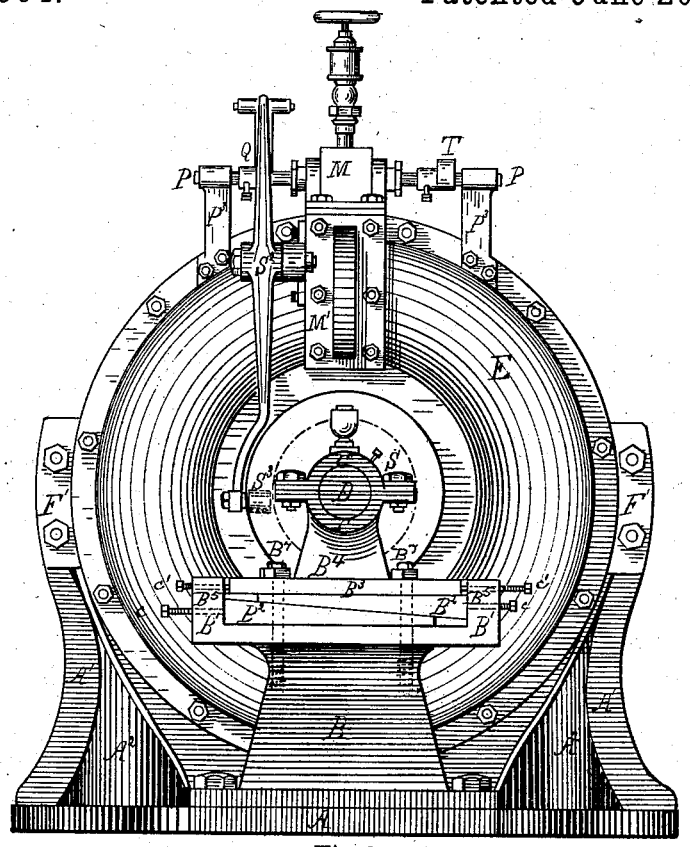

Fig. 2.

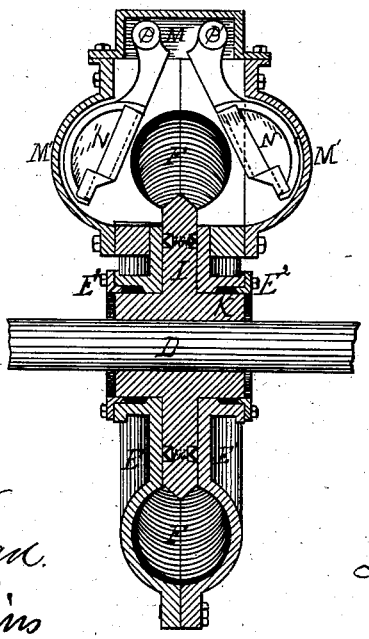

Fig. 3.

Witnesses:
J. E. McLean.
Arthur E. Perkins

Inventor:
L. J. Wing

(No Model.) 5 Sheets—Sheet 3.

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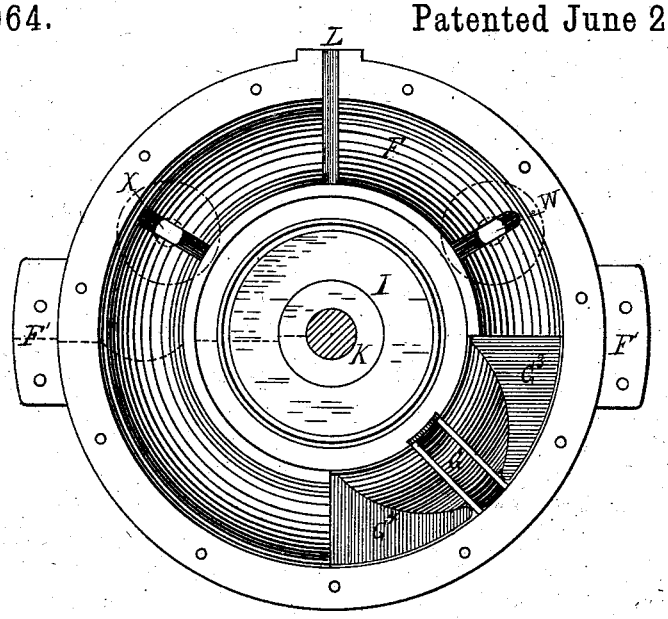

Fig. 4.

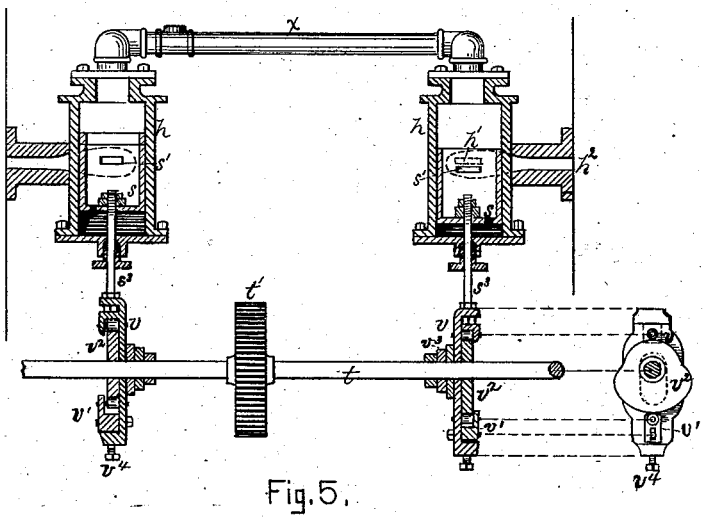

Fig. 5.

Witnesses:
J. E. McLean
Arthur E. Perkins.

Inventor:
L. J. Wing

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L. J. WING.

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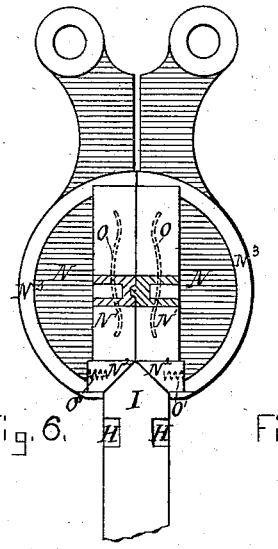

Fig. 6.

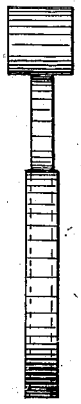

Fig. 7.

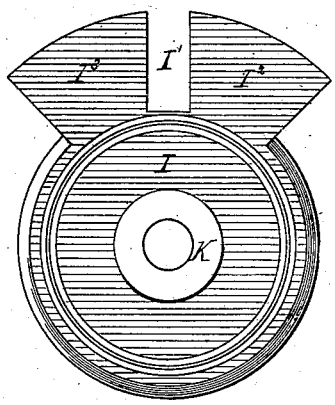

Fig. 8.

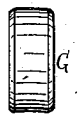

Fig. 9.

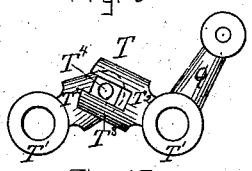

Fig. 13.

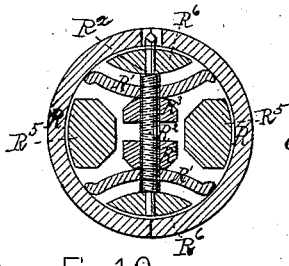

Fig. 10.

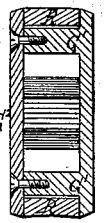

Fig. 11.

Fig. 12.

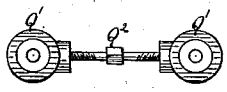

Fig. 15.

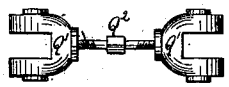

Fig. 14.

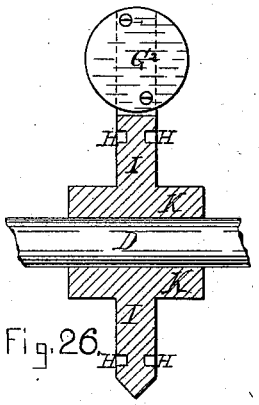

Fig. 26.

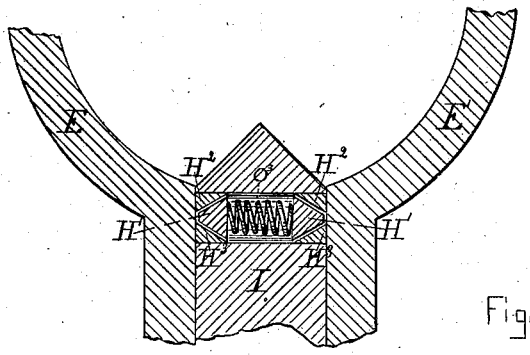

Fig. 25.

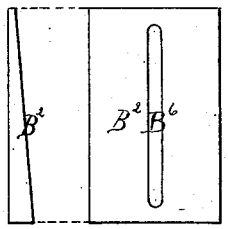

Fig. 17. Fig. 16.

WITNESSES:
J. E. M Lean
Arthur E. Perkins

L. J. Wing
INVENTOR.

(No Model.) 5 Sheets—Sheet 5.

L. J. WING.

ROTARY ENGINE.

No. 259,964. Patented June 20, 1882.

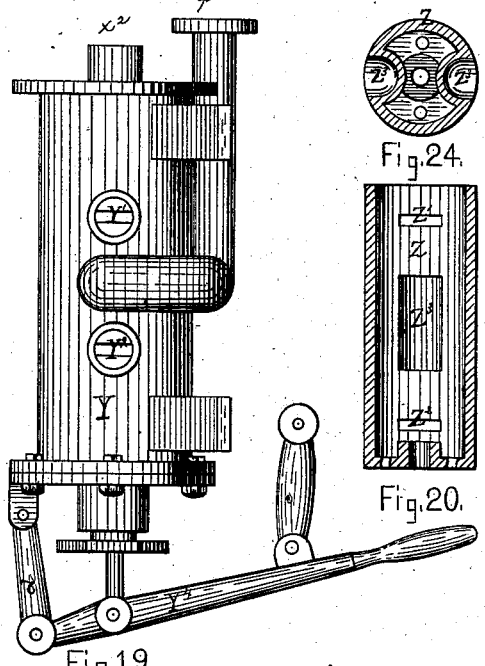

Fig. 19.

Fig. 24.

Fig. 20.

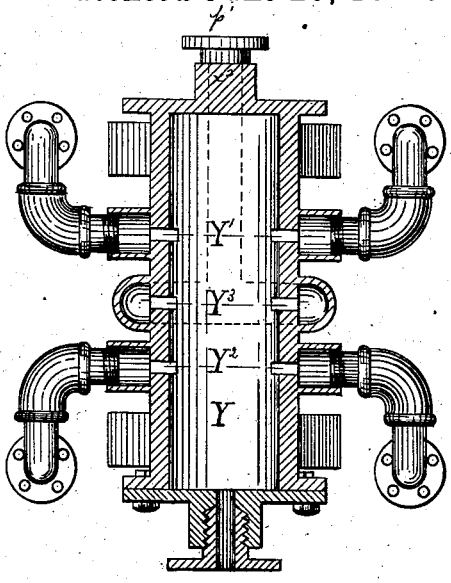

Fig. 21.

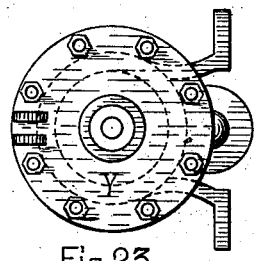

Fig. 23.

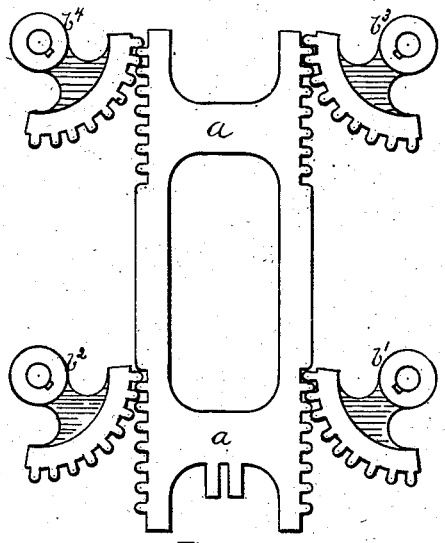

Fig. 22.

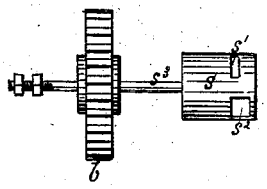

Fig. 18.

L. J. Wing
INVENTOR.

WITNESSES:
J. E. McLean.
Arthur C. Perkins.

UNITED STATES PATENT OFFICE.

LEANDER J. WING, OF BOSTON, MASSACHUSETTS.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 259,964, dated June 20, 1882.

Application filed June 10, 1880. (No model.)

To all whom it may concern:

Be it known that I, LEANDER J. WING, of Boston, in the county of Suffolk and Commonwealth of Massachusetts, have invented certain new and useful Improvements in Rotary Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use it, reference being had to the accompanying drawings, which form part of this specification.

A very desirable object to be accomplished in the construction of a thoroughly practical rotary engine is to so construct the movable abutment, when such is used, as to render the movement by which it is operated easy, and at the same time allow it to be done rapidly. To this needs to be added the quality of durability in its movable parts, and due regard must be had to its compensating qualities. To accomplish this object I have constructed a double swinging abutment, an enlarged view of which is seen in Figs. 6 and 7. By the use of this style of abutment it will be readily seen that the movement necessary to operate it is very slight, at the same time very easy, and, being operated when there is no steam-pressure upon it, is susceptible of very rapid movement. It is evident that by properly enlarging the diameter of the circle described by the annular steam-chamber three very desirable advantages are secured—namely, a swiftly-moving piston, a slowly-revolving main shaft, and greater leverage between the piston and main shaft, by which the power of the engine is proportionately increased.

Figure 1 is a front elevation of my engine. Fig. 2 is an end view of the same. Fig. 3 is a vertical section on a line drawn through the pockets M′ M′ of Fig. 1. Fig. 4 is a view in side elevation of the inner face section, E′, of the annular steam-chamber F, showing the annular grooves forming one-half of the annular steam-chamber, the ports of ingress and egress, rotating disk I, piston G, and piston-extensions G^3 G^3. Fig. 5 is a view in vertical section of the valve-cylinder *h* and piston-valve *s*, with cam *v*, taken on a line with the valve-rod *s*. Fig. 6 is an enlarged side view of the abutment. Fig. 7 is an enlarged edge view of the same. Fig. 8 is a side view of the rotating disk, showing the slot I′ between the segments I^2 and I^3, together with the beveled periphery and hub K. Fig. 9 is a side view of the piston. Fig. 10 is an enlarged plan view of the same after the cap G^2 is removed. Fig. 11 is an enlarged vertical sectional view of the piston, the right-and-left-hand screw R^2 not being shown. Fig. 12 is a plan view of the spring R′. Fig. 13 is an enlarged representation of the device for moving the abutment-shafts in opposite directions. Figs. 14 and 15 are enlarged views of the adjustable connecting-rod connecting the lever S^2 and crank Q. Fig. 16 is a plan view of the slotted wedge B^2. Fig. 17 is an edge view of the same. Fig. 18 is a side view of the valve *s* and segmental gear *b*. Fig. 19 is a view in side elevation of the reversing-valve cylinder Y. Fig. 20 is a vertical sectional view of the reversing piston-valve Z. Fig. 21 is a vertical section of Fig. 19, the steam-pipes being shown in side elevation. Fig. 22 is a plan view of the sliding gear-plate *a* and segmental gears b' b^2 b^3 b^4. Fig. 23 shows an end view of Fig. 19. Fig. 24 is a transverse section of the reversing piston-valve Z. Fig. 25 is an enlarged detached view, in section, of the packing-rings on the disk. Fig. 26 is a view in vertical section of the disk I, piston G, main shaft D, and slots H H.

A represents the bed of my improved engine, having two upright projections, A′ A′, to the outer sides of which are secured the inner sections, E′ E′, of the annular steam-chambers F F. The bed A is also provided with the stays or braces A^2 A^2 to impart additional strength and stiffness thereto.

To the opposite ends of the bed A are secured, by bolts or in any other desired manner, the standards B B, each having an elongated bracket or support, B′, formed in its upper end.

The main shaft D is journaled in its opposite ends in journal-bearings C, the lower halves of which bearings are purposely cast solid with the standards B^4, which latter is constructed with a foot, B^3, the latter being of less length than the space between the end flanges, B^5, of the bracket B′ on the upper end of standard B. Foot B^3 rests upon the wedge B^2, the inclined surface of which rests upon the inclined surface of under wedge B^2,

the latter being supported upon the upper surface of the bracket or support B. The wedges B^2 B^2 are formed with elongated slots B^6, through which are inserted the bolts B^7, which serve to secure the standard B^4 against displacement.

The journal-bearings C C may be vertically adjusted to compensate for wear and bring the shaft in proper alignment by means of the set-screws *c c*, which are inserted through the end flanges B^5 B^5 of the bracket or support B'. By regulating the adjustment of these set-screws, the inner ends of which engage with the opposite ends of the wedges B^2 B^2, the latter are moved endwise, and by means of their inclined faces serve to raise or lower the bearings C C, as may be desired.

The bearings C C are laterally adjusted by means of the set-screws *c' c'*, which are also inserted through the flanges B^5 B^5, and engage with the opposite ends of the foot B^3 and serve to retain it in any desired lateral adjustment. Thus it will be observed that the bearings C C of the main shaft may be brought on proper alignment and readily adjusted, either vertically or laterally, to compensate for wear, by varying the adjustment of the set-screws *c c* and *c' c'*.

E and E' represent the half-sections of the annular steam-chamber, each being formed with a groove extending entirely around, so that when the two parts are joined together they will form an annular steam-chamber, in which revolves the piston G, which is connected with and revolves the main shaft D by means of the rotating disk I. The disk I is fitted between the two sections E and E' of the annular steam-chamber, F, which sections are cut away to receive the disk.

Near the outer edge of each half of the annular steam-chamber is an abutment-chamber, L, extending slightly below the inside circle described by the annular steam-chamber and upward through the flange of sections E and E', also being as wide as these sections. In this abutment-chamber L the double abutment N slides or swings.

At a point of about one sixth (more or less) of the circumference of the annular steam-chamber from either side of the abutment-chamber L, in sections E' E' of the annular steam-chamber F, are placed the ports W and X for ingress and egress of steam.

At right angles with the abutment-chamber L, on either side of sections E' E', are the ears F' F', by which the sections E' E' are bolted to the upright projections A' A' of the bed A.

At the bottom of the annular steam-chamber F, opposite the abutment-chamber, is a petcock (not shown) to discharge water of condensation. To the opposite side of the abutment-chamber L, on sections E and E' of the annular steam-chamber F, are bolted the pockets M' M', into which the double abutment N swings while the piston G is passing. At the top of the abutment-chamber L and pockets M' M' is bolted the cap M, in which cap are arranged the abutment-shafts P and P', they passing through stuffing-boxes arranged on each side of the cap M, also supported by bearings P^3 P^3, secured to the flanges of sections E and E' on each side of the cap M.

The double swinging abutment at its top is secured by its hub to the shafts P and P'. The lower part of the abutment covering the annular steam-chamber is made thin, and the inside edges are overlapped by the packing-sections N' N', which on one edge are grooved for the purpose, and on the other edge they are either tongued or grooved, so that when the abutment is shut and these sections N' N' are pressed together by means of springs O O, situated between the bottom of the slot and the thin edge of the abutment, there may be secured a steam-tight joint between the contiguous surfaces of sections N' N'. The beveled sections N^2 N^2 also overlap the lower section of the abutment N, and are provided with springs O' O' behind them for the purpose of pressing them against the beveled periphery of the disk I, so that while forming a steam-tight joint they may take up any wear on the beveled periphery of the disk I resulting from the pressure of the spring-pressed packing-sections N^2 N^2 exerted thereon.

Just outside of that portion of the abutment which covers the annular steam-chamber each side of the abutment is provided with ribs N^3 N^3, of proper thickness to snugly fit within the abutment-chamber and freely slide therein. When closed, and steam is admitted to the annular steam-chamber, these abutments are pressed against the sides of the abutment-chamber L, so as to form a steam-tight joint. To avoid any tendency to leak, these abutments may be made of steel, and that section to which the hub is attached may be made thin, so as to become flexible under the steam-pressure.

The rotating disk I is secured to the main shaft D by means of the hub K. That portion of the disk I extending from the hub K outward is fitted between the two sections E and E' of the annular steam-chamber F. For two-thirds or three-fourths of the circumference of the disk the periphery thereof is beveled from its outer edge to the center, (shown enlarged in Fig. 25,) thereby forming a beveled wearing-surface on the periphery of the disk which will exceed the thickness of the disk in any desired proportion, as I do not restrict myself to any particular angle to which the periphery should be beveled, the essential feature of construction being that the circle described by the abutment shall be such as to cause the inclined face of the abutment to fit snugly the beveled periphery of the disk. This bevel of the periphery of the disk I is for the purpose of furnishing suitable means for forming a tight joint between the disk I and the sections N^2 N^2 of the abutment N when they are pressed against it, also to assist in taking

up the wear between the sections N^2 N^2 and the disk I.

In that part of the disk where the periphery is not beveled are two segments, I^2 and I^3, which, when the disk is in position, extend nearly through the annular steam-chamber. Between these segments I^2 and I^3 is a slot, I′, which is sufficiently wide to admit the piston G. This slot I′ is sufficiently deep to allow the piston G to have a radial movement when the engine is in operation to adapt it to any variation in the distance between the shaft and annular steam-chamber resulting from the displacement of the shaft or other cause.

Near the periphery of the disk I, on opposite sides thereof, are formed the annular grooves H H, (see enlarged Figs. 6 and 25,) extending entirely around the disk I, each of which serves the purpose of containing the three triangular-shaped packing-rings H′ H^2 H^3, which are situated as follows: H′ is a V-shaped ring, and is placed in the bottom of the groove like an inverted V. On the outer side of the groove is placed the ring H^2, while on the opposite side is the ring H^3.

Springs O^3 are seated at opposite ends upon the inner faces of the rings H′ H′, and operate to force them outwardly and cause their beveled faces to press the rings H^2 and H^3 snugly against the sides of the annular groove H and their outer faces against the inner surfaces of the sections E and E′, and thereby insure a steam-tight joint, which will automatically compensate for any wear. Thus steam is prevented from passing in force between the disk I and sections E and E′ of the annular steam-chamber, inside the said rings. To avoid any spray of steam that might pass through before these parts are sufficiently worn to become tight, a stuffing-box is arranged around the hub K of the disk I, the gland E^2 of which is shown in Fig. 1.

To the two segments I^2 I^3 of the disk I are secured, on either side of the disk I, the piston-extensions G^3 and G^4, Fig. 4. At the point of contact between these two piston-extensions and the piston G, these extensions form a circle; but at the end remotest from the piston they run down to a sharp edge, and are in form a templet of the movement of the double abutment as related to the piston while passing the abutment, and they are designed to lessen the clearance of the engine, but may also be utilized to act as cams when required. These piston-extensions are smaller in diameter than the piston, and allow of the admission of steam to the annular steam-chamber as soon as the piston has passed the port of ingress.

The piston G is composed of two sections, G′ being the main section, and G^2 the cap. G′ is constructed with a flange extending around the same, having four projections, as shown in Figs. 10 and 11, one on each side, R^5 R^5, and one each at top and bottom, R^6 R^6, to which is secured the cap G^2, between which and the flange of section G′ is formed a recess to receive the cut metal packing-ring R, which is ground to fit between the flanges, and is of sufficient width so that in passing the abutment-chamber L one side of the ring shall always overlap the edges of the abutment-chamber L, and thus avoid any concussion and allow it to rotate smoothly in the annular steam-chamber F.

The packing R is concave on that side nearest the shaft and convex on the opposite side, thus becoming the segment of a circle adapted to fill the annular steam-chamber; and this metal ring R is cut at the top or bottom, or both, to allow it to expand to take up the wear between the annular steam-chamber and itself.

The appliance for expanding this ring is as follows: Between the top and side projections, R^6 and R^5, and bottom and side projections, R^6 and R^5, of the piston G is a space, in which are inserted the bent springs R′ R′, Fig. 12, with a hole in their centers. The ends of these springs R′ R′ are placed against the inner surface of the ring R, and by means of a right-and-left-hand screw, R^2, passing through the hole in the spring R′, and having shoulders to keep it in place between the top and bottom projections, R^6 R^6, of piston G, two nuts, R^3 R^3, are moved in opposite directions against these springs R′, and thus the pressure of the cut-metal ring R against the annular steam-chamber may be increased or decreased at pleasure.

To the top of the screw R^2, which projects into a hole in the ring R, is fitted a socket-wrench, which can be applied when the piston is in proper position by removing the cap M; but it can be so arranged as to be adjusted by removing the pocket M′, if preferred. During the passage of the piston around that part of the annular steam-chamber occupied by the double abutment the two sections of the abutment are caused to swing outwardly in opposite directions by means of a double arm device, (shown in Fig. 13,) which consists of an arm, T^2, on which is a hub, T′, which is secured to the abutment-shafts P and P′. One arm is made sufficiently wide to contain a slot, in which moves the slide T^3.

Through the slide T^3 passes a pin, T^4, which connects it with the other arm, to which the pin T^4 is rigidly fixed. Hence by the action of the cam S upon the roller S^3, fitted to the slot S′, the lever S^2 operating through the connecting-rod formed by yokes Q′ Q′ and right-and-left-hand screw Q^2 upon the arm Q and abutment-shafts P and P′, the abutment is caused to open, and that at the proper time, during the revolution of the main shaft D.

Steam is admitted into the ports W or X, according to the direction in which the shaft D is to revolve, by means of the piston-valve *s*, connected with each annular steam-chamber, which valve is caused to slide in the cylinder *h* by means of the cam *v*, operated by the action of the gear t^2 on the main shaft D, revolving gear *t*′ on the cam-shaft *t*. The piston-valve *s* is constructed with two ports, *s*′ *s*′,

of equal size, and directly opposite each other, and corresponding in size and position with the two ports h' h' of the cylinder h, so that when the ports s' s' are exactly over the ports h' h' there will be an equal and simultaneous passage of steam from each side of the valve s into the ports h' h' through the passage h^2 and into the ports W or X of the annular steam-chamber.

At the top of the cylinder h is an opening for the passage of steam from the supply-pipe x into the cylinder h. Steam is thus admitted to or cut off from the annular steam-chamber by the action of the cam v, connected with the valve s by valve-rod s^3.

The cam-plate is composed of a slotted plate, v, on each end of which are projections, the upper projection being for the purpose of connecting the cam v with the valve-rod s^3, and the lower projection is to contain a set-screw, v^4, with which to adjust the sliding section v', containing the lower friction-roller, the upper friction-roller being stationary. The cam v^2 is secured to the cam-shaft t through its long hub, on which is a collar, v^3, which, by a set-screw, is secured to the hub close to the cam-plate v, thus avoiding any side motion.

The adjustable friction-roller serves to take up any wear of the cam v^2 at pleasure.

The engine shown in Fig. 1 is only designed to run in one direction. Steam entering the cylinder h through the supply-pipe x and throttle-valve x' passes through the port s' of the valve s, thence through port h' of cylinder h and passage h^2 into the annular steam-chamber F through the port W, Fig. 4, forcing the piston G and disk I around the annular steam-chamber until the piston G passes the port X, acting as an exhaust, when the steam behind the piston, somewhat expanded by being cut off at half-stroke, is exhausted out of port X and escapes through the exhaust-pipe p; but when it is desired to constitute the engine shown in Fig. 1 a reversing-engine, it is necessary to connect with it the reversing-valve cylinder Y, Figs. 19 and 21, in which slides the reversing piston-valve Z, Figs. 20 and 24, the sliding gear-plate a and segmental gears b' b^2 b^3 b^4, the lever Y^4, and connecting-rods d and e. In the cylinder Y, Fig. 21, there are three ports on each side directly opposite—namely, Y' Y^2 Y^3. The ports Y' and Y^2 correspond with the ports Z' and Z^2 of the reversing piston-valve Z, but so situated that the port at one end of the valve Z must be closed when the port at the other end is open. In the center of the valve Z, and on either side, is a concave recess, Z^3, of such length that when the port Z' is directly over the port Y' the concave recess Z^3 will cover the ports Y^2 and Y^3 of the cylinder Y, and thus form a continuous passage of steam from the annular steam-chamber F through the ports W W, passages h^2 h^2, ports h' h' and s^2 s^2, and through connecting-pipes into concave recesses through ports Y' Y' and Y^3 Y^3 to the exhaust-passage p'. It will be remembered that while the exhaust-steam is being thus disposed of live steam is being admitted through ports Z' and Y' and connecting-passages into the corresponding cylinders h, connected with the ports X X of the annular steam-chamber F, and at each half-revolution of the main shaft is let on and cut off by means of the cam v operating the piston-valve s. To reverse the action of the steam and the motion of the engine the lever Y^4 of the cylinder Y is pushed in until the ports Z^2 Z^2 of the valve Z are directly opposite the ports Y^2 Y^2 of cylinder Y. This movement, by reason of the action of the connecting-rod e upon the sliding gear-plate a, partly revolves the segmental gears b' b^2 b^3 b^4, through which the valve rod s^3 is allowed to slide upon a feather in such a manner that when the segmental gears are partly revolved the valve-rod s^3 and the valve s will also partly revolve; but this action does not impede or interfere with the sliding of the valve s in the cylinder h, Fig. 5, through the action of the cam v. The valves operated upon by the segmental gears b' and b^2 will be in such position that their ports s' s' will be directly opposite ports h' h' of the cylinder h, while the valves partly revolved by the action of segmental gears b^3 and b^4 will be in such position that the wide ports s^2 s^2 of valve s, Fig. 18, will be directly opposite ports h' h' of cylinder h, and by reason of the width of the ports s^2 s^2 will form a constantly-open passage from the annular steam-chamber into the cylinder h, it being understood that the ports s^2 s^2 are of sufficient width to cover the ports h' h' of the cylinder h and also the lift of the cam v.

In that part of the sliding piston-valve s and also the reversing-valve Z to which the rod is attached there are openings to admit of the steam passing through the head (see Figs. 20 and 24) to equalize the steam-pressure and form a perfect balance.

An automatic cut-off may be arranged in connection with valve s and cylinder h by dispensing with the use of the cam v and substituting in its place an eccentric and a long valve-rod, connecting at the bottom with a dash-pot and near the valve s with a tripping device operated by a suitable governor applied to the main or valve shaft.

In place of the triangular rings used in the grooves H H on disk I, flat rings may be used as follows: In place of ring H put a flat ring which shall just fill the groove and move in it. Between this and the cut double outer ring which is to take the place of rings H^2 and H^3 insert several layers of thin felting or other flexible material, care being taken that the cuts in the two outer rings shall not be opposite each other. The action of the spring O^3 upon the inner ring and flexible packing causes the outer rings to perform the same functions as rings H^2 and H^3 in former device.

I am aware that rotary engines have been invented wherein the rotary disk is construct-

ed with a curved or rounded periphery. I make no claim to such construction, as in such form of disk it is impossible to take up for the wear between the periphery of the rotary disk and the wearing-faces of the abutment. In my invention the periphery of the rotary disk is constructed with two flat faces, with which engage correspondingly-flattened faces on the sectional abutment, whereby the wear is compensated for and an accurate steam-tight joint secured.

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

1. In a rotary engine, the combination, with an annular steam-chamber, of a rotary disk having a beveled periphery, forming two flat wearing-faces inclined toward each other, which extend only partly through said annular steam-chamber, substantially as shown and described, and for the purposes herein set forth.

2. In a rotary engine, the combination, with an annular steam-chamber, of a rotary disk having a beveled periphery, forming two flat wearing-faces inclined toward each other, which extend only partly through the annular steam-chamber, said disk being furnished with steam packing-rings located between its beveled periphery and the shaft to which it is secured, substantially as shown and described, and for the purposes herein set forth.

3. In a rotary engine, the combination, with an annular steam-chamber, of a rotary disk having a beveled periphery, forming two flat wearing-faces inclined toward each other, which extend only partly through said annular steam-chamber, and a radially-adjustable piston, substantially as shown and described, and for the purposes herein set forth.

4. In a rotary engine, the combination, with an annular steam-chamber and rotary disk provided with two flat wearing-faces on the periphery, of a sectional abutment constructed and adapted to fit said wearing-faces on the periphery of the disk and to open and move outwardly from opposite sides of a piston connected with said disk, substantially as shown and described, and for the purposes herein set forth.

5. In a rotary engine, the combination, with an annular steam-chamber and rotary disk having two flat wearing-faces on its periphery, of a sectional abutment constructed to fit said wearing-faces on the periphery of the disk, and mechanism for imparting simultaneous movement to said sections and move them in opposite directions away from a piston connected with said rotary disk, substantially as shown and described, and for the purposes herein set forth.

6. In a rotary engine, the combination, with an annular steam-chamber and rotary disk having a piston connected therewith, of a sectional swinging abutment, the adjacent edges of said abutment being furnished with compensating slides to form a steam-tight joint, substantially as shown and described, and for the purposes herein set forth.

7. In a rotary engine, the combination, with an annular steam-chamber and rotary disk having a radially-movable piston connected therewith, of a two-part swinging abutment, the sections of which are adapted to move outwardly from said piston when the latter passes the abutment, substantially as shown and described, and for the purposes herein set forth.

8. In a rotary engine, the combination, with an annular steam-chamber and rotary disk having a beveled periphery, of a sectional abutment provided with spring-pressed packing-sections, which fit steam-tight against said beveled periphery, substantially as shown and described, and for the purposes herein set forth.

9. In a rotary engine, the combination, with an annular steam-chamber and rotary disk having a beveled periphery, of a sectional swinging abutment the sections of which are adapted to move toward and away from each other, such sections provided with spring-pressed packing-sections to pack the joint between the two sections and between the abutment and beveled periphery of the rotary disk, substantially as shown and described, and for the purposes herein set forth.

10. In a rotary engine, the combination, with an annular steam-chamber having an abutment-chamber formed therein, of a sectional swinging abutment having ribs formed on its rear edges, said ribs snugly fitting within the walls of the abutment-chamber, substantially as shown and described, and for the purposes herein set forth.

11. In a rotary engine, the combination, with the half-sections of the annular steam-chamber, of the sectional swinging abutment and abutment-pockets secured at opposite sides of the abutment-chamber, substantially as shown and described, and for the purposes herein set forth.

12. In a rotary engine, the combination, with the half-sections of the annular steam-chamber, of abutment-pockets secured to opposite sides of the abutment-chamber and a cap located over said abutment-chamber, substantially as shown and described, and for the purposes herein set forth.

13. In a rotary engine, the combination, with the annular steam-chamber and rotary disk, of sectional swinging abutments attached to rock-shafts, cams on the main shaft, and suitable devices between the cams and rock-shafts for actuating the latter and imparting a swinging movement to the two sections of the abutment, substantially as shown and described, and for the purposes herein set forth.

14. In a rotary engine, the combination, with the annular steam-chamber, rotary disk, and sectional swinging abutment, of cams attached to the main shaft, pivoted levers provided with anti-friction rollers which engage in the cam-grooves, and jointed arm for transmitting motion from the pivoted levers to the rock-shafts

to which the abutments are attached, substantially as shown and described, and for the purposes herein set forth.

15. In a rotary engine, the combination, with the main shaft, of standards for supporting the same, said standards formed in two parts, the upper portion constituting the lower half of the shaft-bearing and provided with outwardly-projecting ears or flanges for the removable attachment of the cap of the journal-box, and secured to the lower section of the standard in a manner to prevent any longitudinal displacement, the upper portion of the standard made both vertically and laterally adjustable, substantially as shown and described, and for the purposes herein set forth.

16. The standards formed of upper and lower sections, the latter provided at its lower end with a perforated supporting-flange and at its upper end with a supporting-bracket, and wedges interposed between said sections of the standard, and set-screws for varying the adjustment of said wedges, and thereby raising or lowering the upper section of the standard, substantially as shown and described, and for the purposes herein set forth.

17. The combination, with the upper and lower sections of the main shaft standards, of wedges provided with elongated slots, bolts inserted through said slots for securing said sections together, and set-screws for varying the adjustment of said wedges, substantially as shown and described, and for the purposes herein set forth.

18. In a rotary engine, the combination, with the rotary disk, of a radially-movable piston provided with a split packing-ring, a right-and-left-hand screw, springs, and nuts for adjusting the packing-ring, substantially as shown and described, and for the purposes herein set forth.

19. In a rotary engine, the combination, with the rotary disk, of a radially-movable piston provided with a split packing-ring, and screw-shaft extending partly through the packing-ring for expanding said ring, substantially as shown and described, and for the purposes herein set forth.

20. In a rotary engine, the combination, with an annular steam-chamber and sectional swinging abutment, of a rotary disk provided with a radially-moving piston and tapering piston-extensions on opposite sides of said piston, substantially as shown and described, and for the purposes herein set forth.

21. In a rotary engine, the combination, with the reversing-valve, of the rack-plate, segmental gears, and rotary valves, the latter having narrow and wide ports on opposite sides thereof, substantially as shown and described, and for the purposes herein set forth.

22. In a rotary engine, the combination, with the balanced reversing-valve Z, having the ports Z' Z^2 and intermediate recess, Z^3, of the cylinder provided with ports Y', Y^2, and Y^3, substantially as shown and described, and for the purposes herein set forth.

In testimony that I claim the foregoing I have hereunto set my hand this 9th day of June, A. D. 1880, in the presence of two subscribing witnesses.

LEANDER J. WING.

Witnesses:
JAS. H. LANGE,
GEO. D. SEYMOUR.