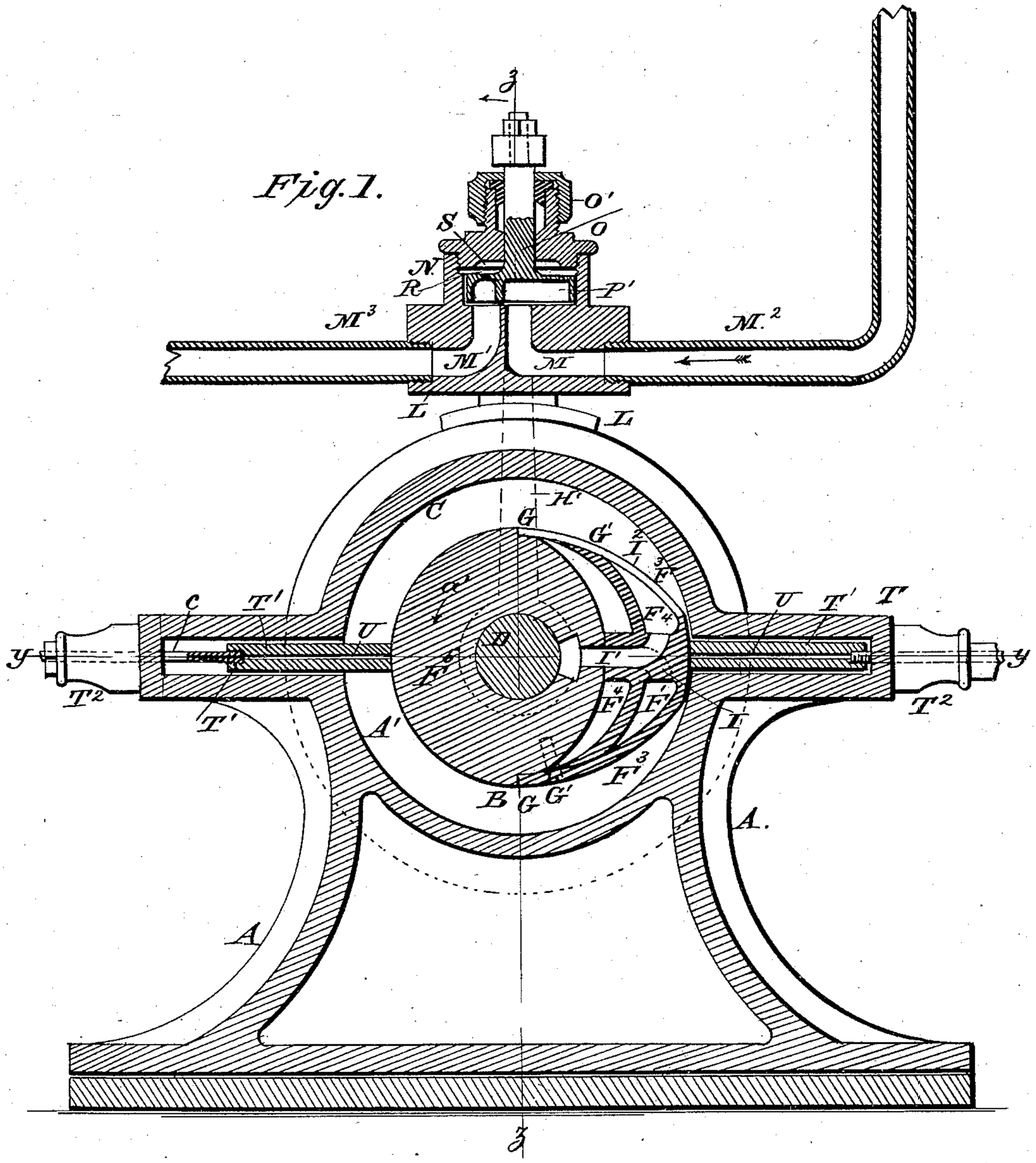
(No Model.) 4 Sheets—Sheet 1.

H. KNEBEL.

ROTARY ENGINE.

No. 371,949. Patented Oct. 25, 1887.

Fig. 1.



WITNESSES:

Fred G. Dieterich

R. B. Surpin.

INVENTOR:

H. Knebel

BY Munn & Co

ATTORNEYS.

(No Model.) 4 Sheets—Sheet 2.

H. KNEBEL.

ROTARY ENGINE.

No. 371,949. Patented Oct. 25, 1887.

Fig. 2.

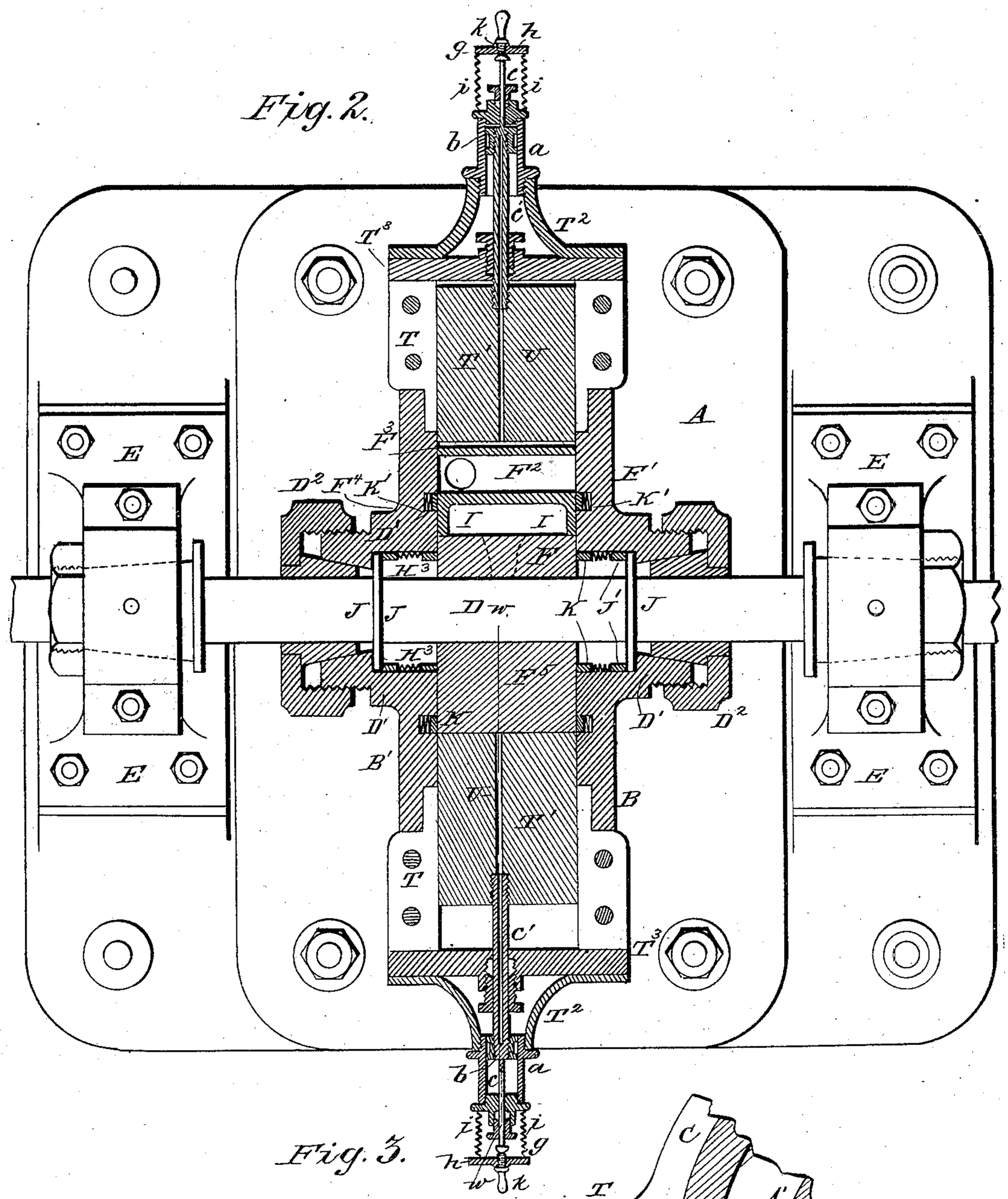


Fig. 3.

WITNESSES:

Fred G. Dieterich

R. B. Dorsey

INVENTOR:

H. Knebel

BY Munn & Co

ATTORNEYS.

(No Model.) 4 Sheets—Sheet 3.

H. KNEBEL.

ROTARY ENGINE.

No. 371,949. Patented Oct. 25, 1887.

Fig. 7.

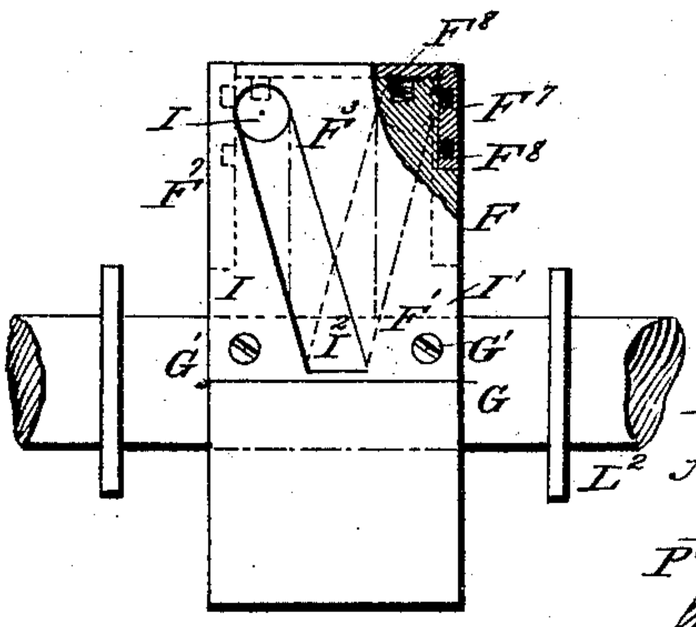


Fig. 4.

Fig. 8.

WITNESSES:

Fred G. Dieterich

P. B. Turpin.

INVENTOR:

H. Knebel

BY Munn & Co

ATTORNEYS.

(No Model.) 4 Sheets—Sheet 4.

H. KNEBEL.

ROTARY ENGINE.

No. 371,949. Patented Oct. 25, 1887.

Fig. 5.

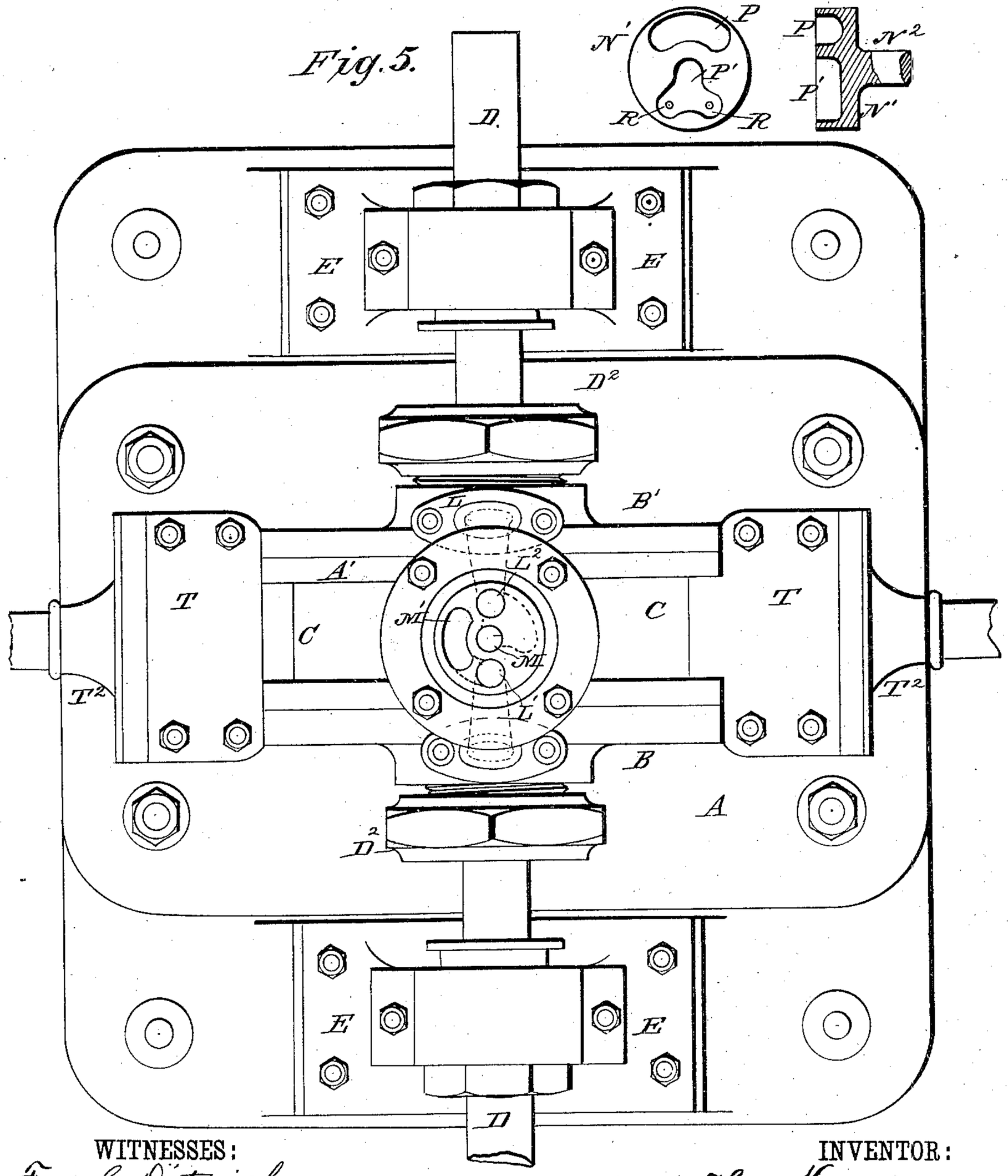


Fig. 6.

Fig. 9.

WITNESSES:
Fred G. Dieterich
P. B. Turpin.

INVENTOR:
H. Knebel
BY Munn & Co
ATTORNEYS.

UNITED STATES PATENT OFFICE.

HERMAN KNEBEL, OF BIRMINGHAM, ALABAMA.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 371,949, dated October 25, 1887.

Application filed November 6, 1886. Serial No. 218,178. (No model.)

To all whom it may concern:

Be it known that I, HERMAN KNEBEL, a citizen of the United States, residing at Birmingham, in the county of Jefferson and State of Alabama, have invented a new and useful Improvement in Rotary Engines, of which the following is a specification.

The object of my invention is to provide a new and improved rotary engine which is simple in construction, easily controlled and reversed, and economical in the consumption of steam.

The invention consists in the construction and combination of parts and details, as hereinafter fully described, and particularly pointed out in the claims.

Reference is to be had to the accompanying drawings, forming a part of this specification, in which similar letters of reference indicate corresponding parts in all the figures.

Figure 1 is a vertical cross-section of my improved engine, taken on about the line *x x*, Fig. 4, the piston being partly turned and parts broken out. Fig. 2 is a sectional plan view on the line *y y*, Fig. 1. Fig. 3 is a sectional elevation on the line *w w*, Fig. 2, showing the steam-acted cut-off blades in detail. Fig. 4 is a sectional elevation on the line *z z*, Fig. 1. Fig. 5 is a plan view, the controlling-valve and its stuffing-box being removed and parts being broken out. Fig. 6 is an inverted plan view of the controlling disk-valve. Fig. 7 is a detail side view of the rotary piston and shaft, parts being broken away. Fig. 8 is an end elevation of the same, the shaft being in section; and Fig. 9 is a sectional view of the valve.

The base or frame A supports the casing A′ of the engine, consisting of the circular head-plates B B′ and the inclosing cylindrical portion C. The main shaft D is mounted to revolve in bearings held in boxes D′, projecting from the opposite head-plates B B′, and on the boxes glands D^2 are placed. The shaft D also revolves in independent bearings held on standards E, arranged adjacent to either head-plate B B′. On the shaft D is secured the body F^5 of the piston F, which body fits closely between the head-plates B B′ of the casing, and thus reduces the steam-space within the same.

One half of the piston-body F^5 is formed on a circle concentric with the cylindrical casing C, and the other half is flattened, made elliptical, or formed on a circle eccentric with its opposite portion, as shown. To the eccentric portion of the piston-body F^5 is attached the casting F′, forming the projecting piston head or wing F^2, extending outward to the cylindrical casing C, and the curved cam-ribs F^3, leading up to the piston head or wing F^2.

In the outer and side edges of the head F^2 are fitted the packing-strips F^6 F^7, respectively, which are pressed outward into contact with the sides and cylindrical portion C of the casing A′ by means of spiral springs F^8, held in suitable recesses in the head. The piston-body F^5 is formed with shoulders G to receive the ends of the casting F′ and prevent it from turning on the body, and the casting is further secured by screws G′, passed into the body. The casting F′ is chambered on its side adjacent to the piston-body at F^4, thus diminishing the weight on that side of the piston and counterbalancing the piston-head.

The head-plates B B′ are formed with the interior steam-channels, H H′, which lead into the annular chambers or recesses H^2 H^3, also formed in the plates B B′ and surrounding the main shaft D.

The recess H^3 is in constant communication with a passage, I′, formed in one side of the piston-body and piston-head F^2 and extending through one face of the latter, the cam-rib F^3, adjacent to that face, being slotted at I^2 to permit free access to the space within the casing A′ at that side of the piston-head. The recess H^2 likewise communicates with a similar passage, I, formed in the opposite side of the piston-body and piston-head F^2 and leading through the opposite face of the piston-head, and a slot, I^2, in the adjacent cam-rib, F^3, into the space within the casing A′ at that side of the piston-head,

A collar, J, surrounds the shaft D within each recess H^2 and H^3, and is held against its seat in the adjacent head-plate by a packing-ring, J′, to effectually prevent escape of steam from the recesses H^2 H^3 through the shaft-bearings into the outer air. Packing-rings K are also placed in recesses H^2 H^3 and rest against the opposite faces of the piston F, and the packing-rings J′ K are held in contact with

their respective bearings by spiral springs interposed between them, as shown. Additional packing-rings, K′, are placed in annular recesses in the head-plates B B′, and are pressed by suitable springs against the opposite faces of the piston-body F^5 and piston-head F^2, thus preventing escape of steam at the sides of the same.

In a casting, L, superposed on the casing A′, are formed the opposite passages L′ L^2, communicating with the channels H H′, respectively, and at right angles to these are formed the steam admission and exhaust passages M M′, respectively connected with suitable steam supply and exhaust pipes, M^2 M^3. The passages L′, L^2, M, and M′ extend upward through the top of the casting L and through the bottom of a cup-shaped valve-box, N, bolted or otherwise secured on the same, as shown in Fig. 4.

In the valve-box N is placed the controlling disk-valve N′, having a vertical stem, N^2, passed through a stuffing-box, O, and gland O′, screwed on the box N, and provided with an operating-handle, N^3.

The disk-valve N′ is formed on its under side with two opposite segmental passages, P P′, which register with and serve to connect adjacent ones of the four openings L′ L^2 M M′ in the bottom of the valve-box N. By means of its handle N^3 the valve N′ may be turned to throttle more or less the steam admission and exhaust openings M M′, or to close them entirely, and the handle is provided with a downwardly-projecting pointer, Q, by the position of which with respect to a suitable scale on the outer surface of the valve-box N the amount of admission-opening may be determined.

The disk-valve N′ is formed with vertical apertures R at either end of the connecting-passage P′, registering with the admission-opening M, through which apertures live steam is admitted to the recess S in the stuffing-box O, above the valve-disk N, so that the valve is held upon its seat.

It will be noticed that the admission-port M in the valve-seat is centrally placed, so as to be in constant communication with the inlet-passage P′ in the valve. The exhaust-port M′ is larger than the admission-port M, to allow of free exhaust and obtain a slight lead for the same.

In horizontal guide-boxes T, projecting from the cylindrical casing C at diametrically opposite points, are mounted to slide the blades T.′ These blades are by preference pressed inward into contact with the piston and piston-head by means of steam. To this end brackets T^2 are attached to the end plate, T^3, of each guide-box T and support a horizontal cylinder, *a*, in which operates a piston, *b*, having a piston-rod, *c*.

The inner part, *c*′, of the piston-rod *c* is tubular, and communicates with the interior of the cylinder *a* by an aperture, *d*, in the piston. (See Fig. 3.) The rod *c* is then passed through a suitable stuffing-box in the end plate, T^3, of the guide-box T and is screwed into the end of a central passage, U, formed longitudinally through the sliding blade T′.

The passage U communicates with the space between the blade T′ and end plate, T^3, by means of an aperture, *e*, in the blade, (see Fig. 3,) and is connected with the slots I^2 in the piston, and hence with the supply and exhaust passages in the same, alternately, as the latter revolves. The outer part of the piston-rod *c* passes through a suitable stuffing-box in the outer head of the cylinder *a* to guide the movement of the piston.

To aid in holding the blade T′ against the rotary piston F, I provide the outer end of the piston-rod *c* with a button, *g*, against which a plate, *h*, is pressed by means of coiled springs *i*, attached to the plate and to the cylinder-head. The plate *h* can be secured to the button *g* by a set-screw, *k*, passed through the plate into the button, as in Fig. 2, or it can be detached from the button and swung one side, as in Fig. 3, to throw the springs *i* out of action.

The operation is as follows: When the valve N′ is turned by its handle to connect the admission-opening M with the passage L′ and the exhaust M′ with the passage L^2, the live steam from the supply-pipe M^2 enters the passages L′ and H and passes thence to the recess H^2 and through the passages I and I^2 in the piston into the space between that side of the piston and the blade T′ at the rear of the same. As the slot or passage I^2 comes into communication with the passage U in the blade T′, part of the live steam passes into the latter and through the bore of the piston-rod *c*′ and the aperture *d* into the cylinder *a*. The steam then drives the piston *b*, and with it the blade T′, inward, and holds the blade in contact with the rotary piston F, the steam passing through the aperture *e* into the box T serving to counterbalance the blade. The blade T′ thus acts as a cylinder-head, and the steam acting on the piston-head F^2 causes it to rotate in the direction of the arrow *a*′, Fig. 1. At the same time, also, the exhaust-steam in the space between the opposite side of the piston-head and the blade T′, in advance of the same, escapes through the passage I′ in the piston into the recess H^3, thence through the passages H′ L^2, valve-passage P, and passage M′ out through the exhaust-pipe M^3. The steam in the opposite auxiliary cylinder, *a*, is also exhausted through the tubular piston-rod *c*′ and the passages U I′ H′ L^2, &c., when the passage U in the corresponding blade is connected with the slot I^2 by the rotation of the piston, whereby the pressure on the face of the blade is removed, thus permitting it to be easily moved inward by the cam-ribs F^3 when struck by the same in their rotation. The size of the cylinders *a*, and their pistons *b* is so proportioned that the pressure of the steam on the latter will hold the blades T′ against the piston F with just enough pressure to prevent leakage

between them. To reverse the engine, the valve N′ is turned so as to connect the openings M and L^2 and M′ and L′, respectively, as indicated in dotted lines in Fig. 5, when the live steam will pass through the passages L^2 and H′, recess H^3, and piston-passage I′ into the space at that side of the piston, so that the latter will be revolved in the reverse direction of the arrow *a′*, Fig. 1, the exhaust taking place through passage I, recess H^2, passages H, L′, P, and M′, and exhaust-pipe M^3. To stop the engine, the valve is turned to bring the opposite blank portions between the passages P and P′ over the admission and exhaust openings M M′ or openings L′ L^2, thereby disconnecting the admission and inlet openings. The engine can thus be quickly controlled and reversed, rotating in either direction with equal facility.

The auxiliary springs *i*, for pressing the blades T′ against the piston F, are used when the steam-pressure is insufficient for that purpose.

Dead-centers are avoided and an exceedingly compact engine is provided, giving great power for the small space occupied.

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

1. In a rotary engine, the combination of the casing, a rotary piston therein and cams or inclines leading up to the head of said piston, an auxiliary cylinder connected with and receiving steam from the interior of the casing, the sliding blade, the auxiliary piston, the spring *i*, support *n*, and screw *k*, connected therewith, substantially as set forth.

2. The combination, with the engine-casing and piston, the steam-pipes, and the steam ducts or channels leading to the casing, of the valve-box having openings connected with said steam pipes and ducts or channels, and the valve supported in said box and having passages P P′, the said valve being rotatable in the box in a plane at right angles to the openings of the steam pipes and ducts thereinto, substantially as set forth.

3. The combination of the piston having steam-passages and provided with spring-pressed plates F^7 and F^8, the engine-casing having chambers H^2 H^3, and the spring-pressed packing-rings K′, all substantially as set forth.

4. The combination, with the engine-casing having the steam-channels H H′ and annular chambers H^2 H^3 in the cylinder-heads, of the shaft D, the piston thereon having opposite steam-passages I I′, registering with the annular chambers H^2 H^3 and opening at either side of the piston-head, a four-way valve connected with the steam-channels H H′, and the steam supply and exhaust pipes, substantially as specified.

5. In a rotary engine, the combination of the casing, the valve-box, the steam-pipes, and the steam ducts or channels, and the valve having the passages P P′, the latter having a portion extended in approximately to the center of motion of the valve, substantially as set forth.

6. In a rotary engine, the combination of the casing, the valve-box, the steam-ducts and steam-pipes opening into said valve-box and through the same side thereof, and the valve supported in said box and having its side facing the pipe-openings into the box provided with passages, all arranged substantially as set forth.

7. In a rotary engine, the combination of the casing, the steam-pressed blades, and the valve-piston having passages I I′, the same being extended to the center line of the piston, whereby to admit the predischarge of steam from behind the cut-off blades as soon as such blades are struck by the piston-head, all arranged substantially as set forth.

8. The combination, with the engine-casing, the main shaft, and the rotary piston, the casing being provided on opposite sides of the piston with steam-chambers surrounding the shaft and communicating with steam-passages in the piston, opening at either side of the piston-head, and with steam channels or ducts connected with the said chambers, of a valve-chamber connected with said ducts and with the exhaust and supply pipes and of a valve for connecting either duct with either of the said pipes, substantially as specified.

9. The combination, with the valve-box N, having openings connected with the steam-pipes M^2 and M^3 and with the steam ducts or channels H H′, leading to opposite sides of the rotary piston, of the valve N′, having opposite passages P P′, registering with the openings in the valve-box and provided with the stem N^2 and handle N^3, substantially as specified.

10. The combination, with the valve-box N, having openings M M′ and L′ L^2, connected, respectively, with the steam supply and exhaust pipes and with the channels H H′, for leading steam to opposite sides of the rotary piston F, of the disk-valve N′, having segmental passages P P′, registering with the openings M M′ and L′ L^2, and steam-hole R, and the stuffing-box O, having recess S, substantially as specified.

11. The combination, in a rotary engine, of the piston, the casing having steam-passages H H′, the disk-valve supported and rotatable in a plane at right angles to the passages H H′, and the steam supply and exhaust pipes, substantially as set forth.

HERMAN KNEBEL.

Witnesses:
SEARS LOVETT,
JOE. C. HAIL.