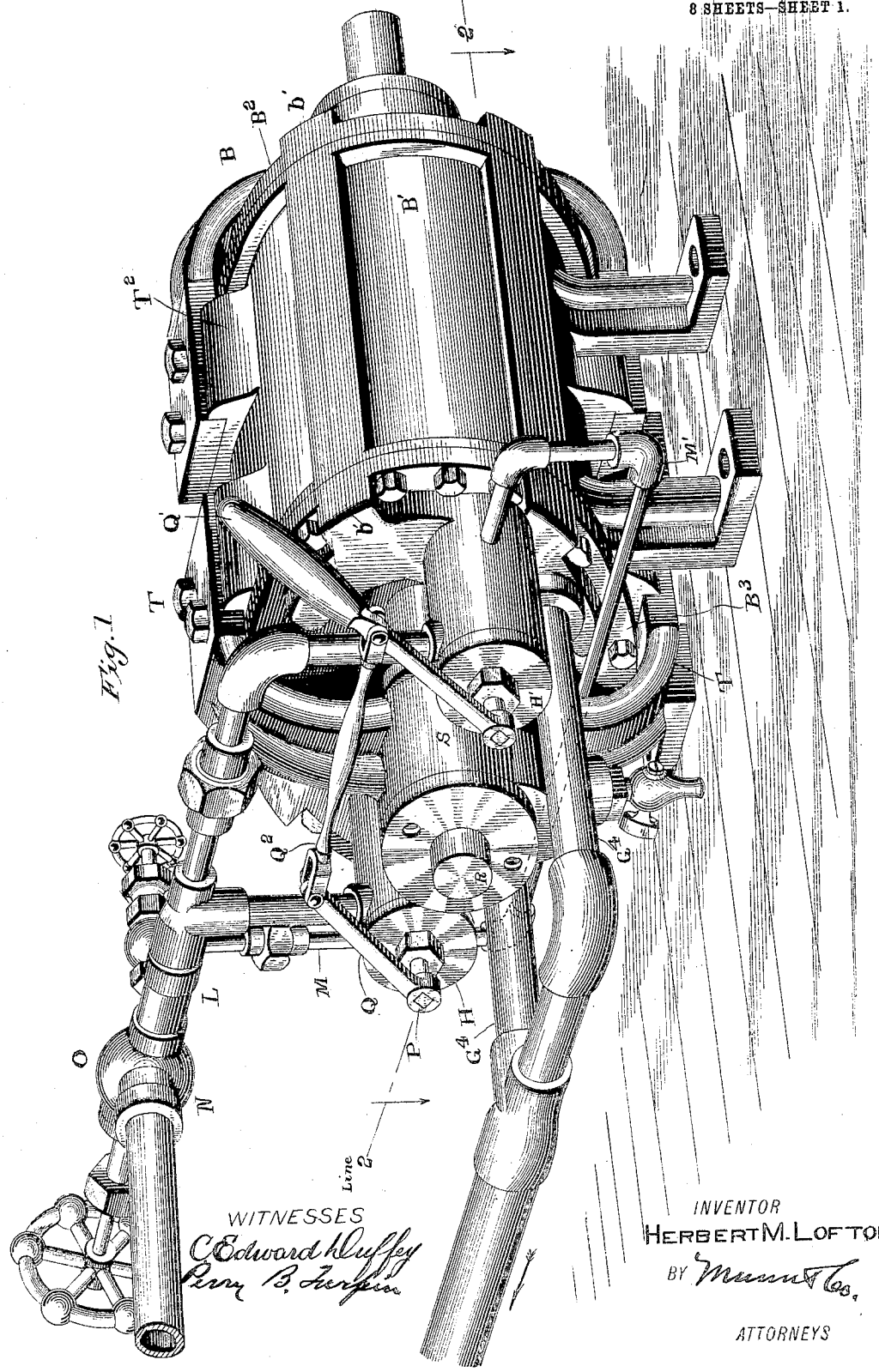
No. 804,746. PATENTED NOV. 14, 1905.

H. M. LOFTON.

ROTARY ENGINE.

APPLICATION FILED MAY 24, 1905.

8 SHEETS—SHEET 1.



WITNESSES

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No. 804,746. PATENTED NOV. 14, 1905.

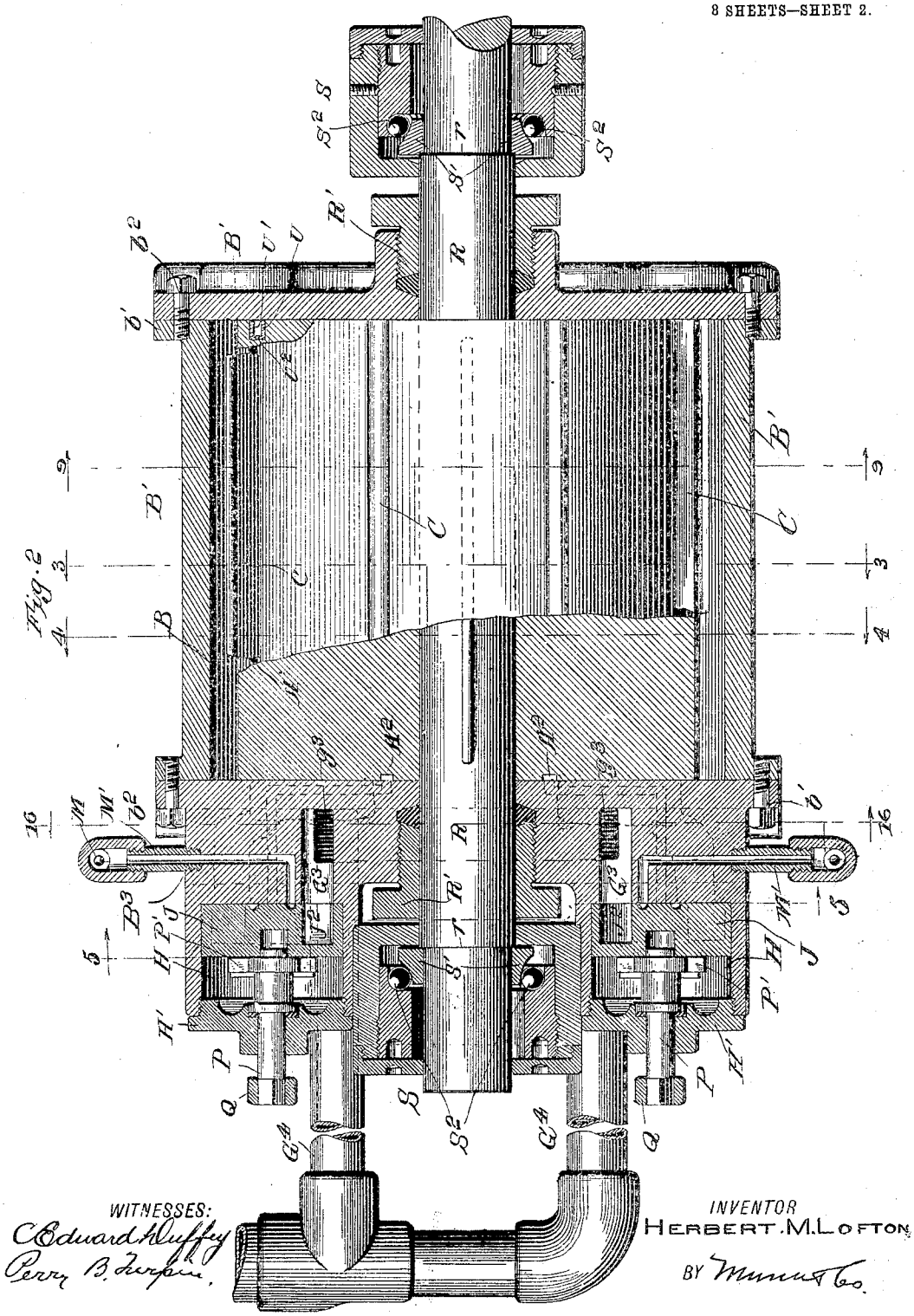
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8 SHEETS—SHEET 2.

Fig. 2



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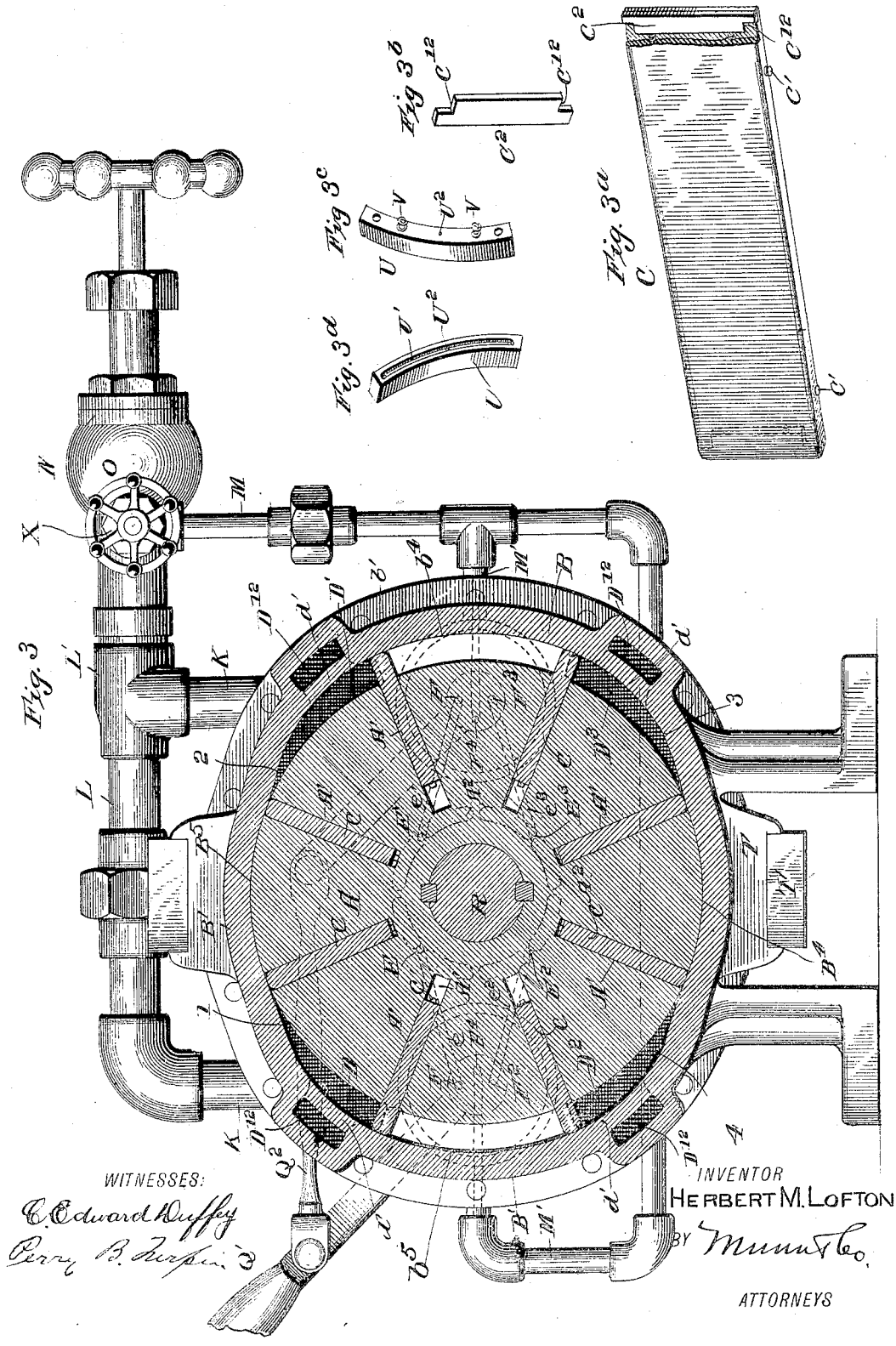
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8 SHEETS—SHEET 3.



WITNESSES:

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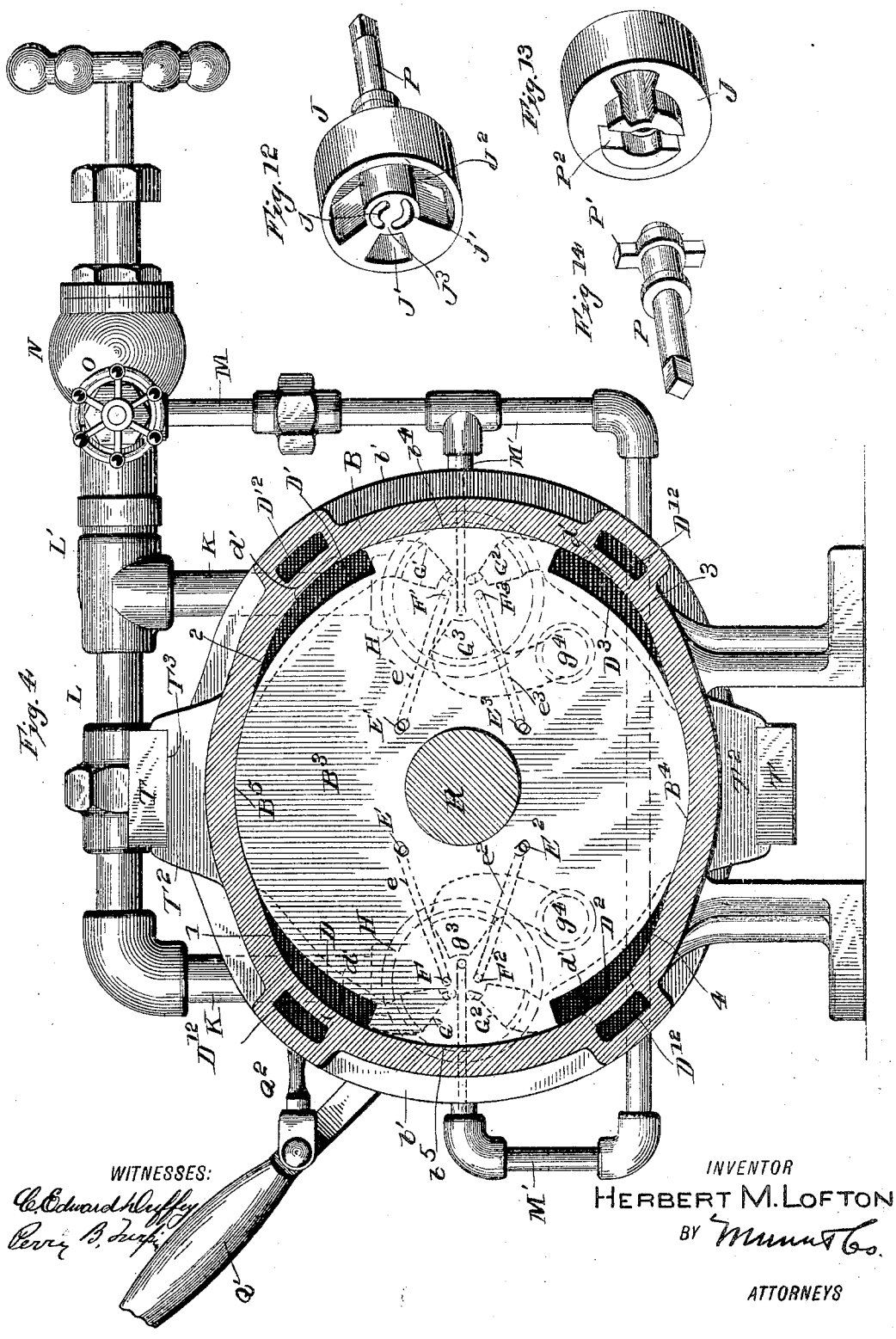
No. 804,746. PATENTED NOV. 14, 1905.

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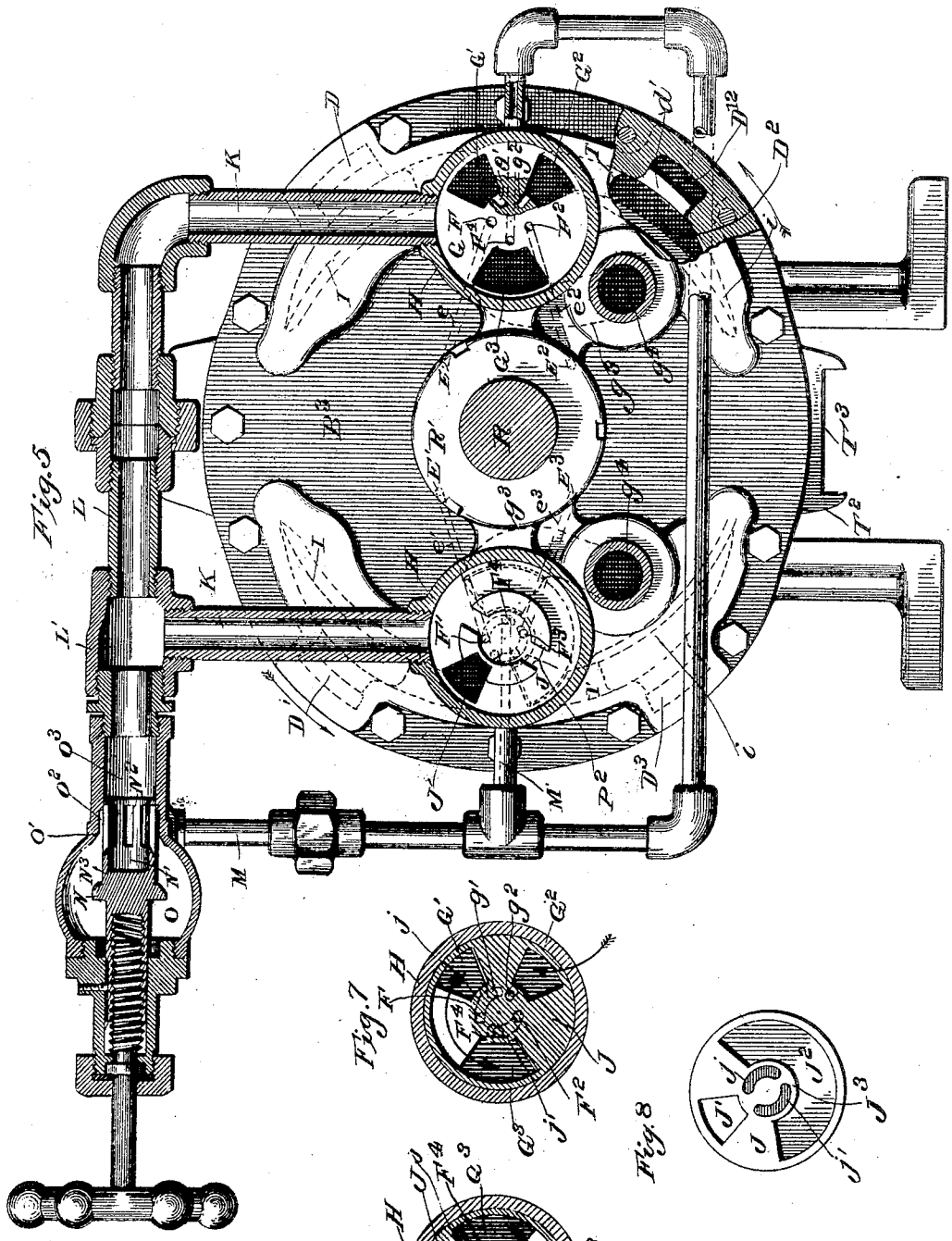


Fig. 5

Fig. 7

Fig. 8

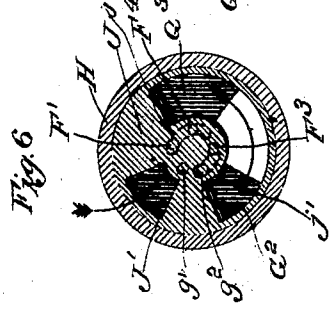


Fig. 6

WITNESSES:

C. Edward Duffey

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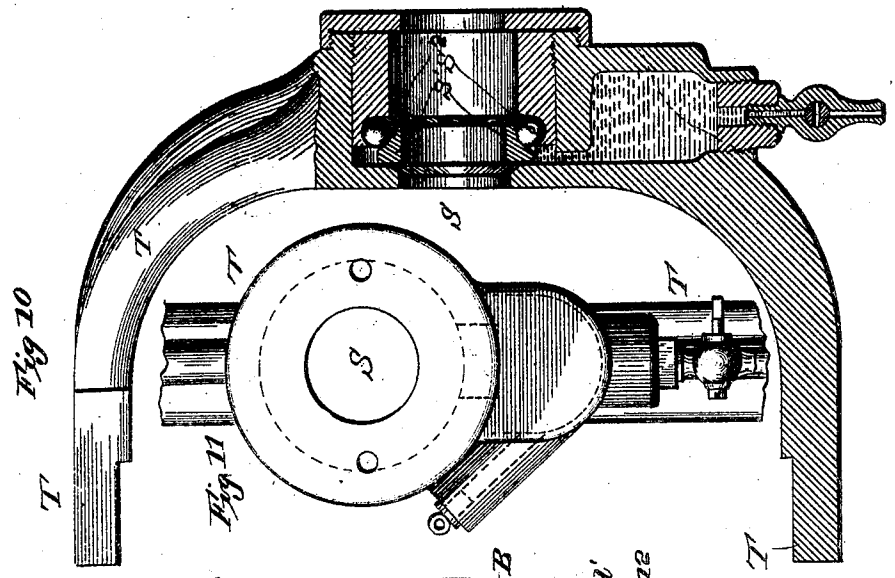
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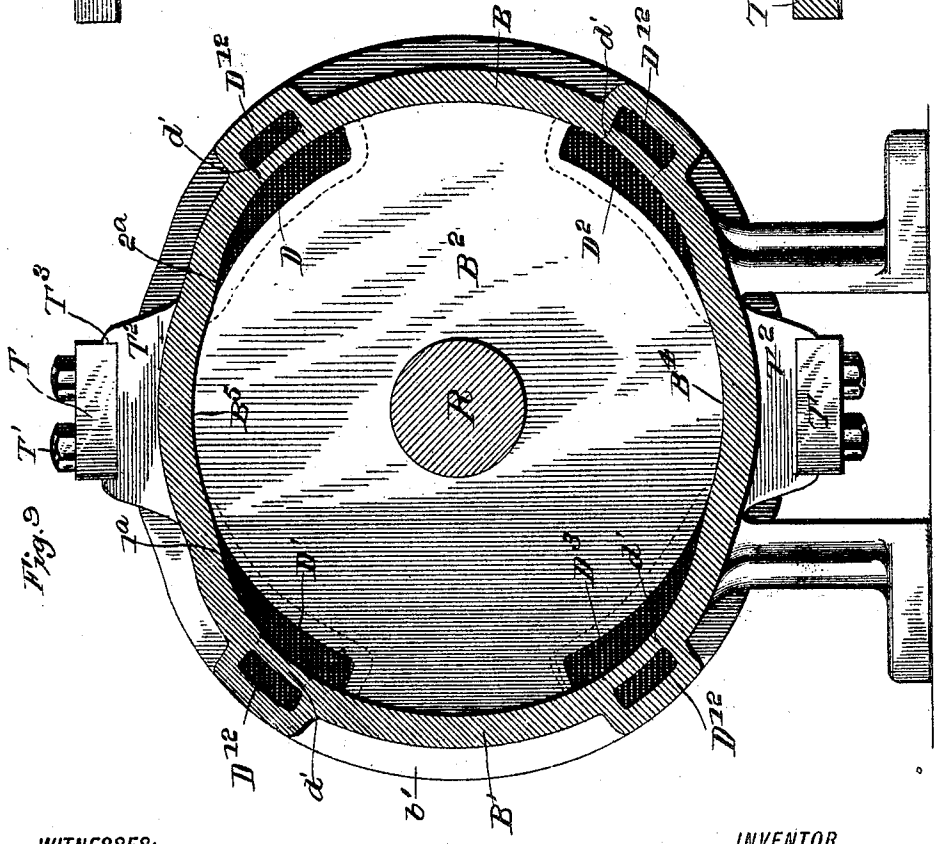
H. M. LOFTON.

ROTARY ENGINE.

APPLICATION FILED MAY 24, 1905.

8 SHEETS—SHEET 6.





WITNESSES:

C. Edward Kluffy

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No. 804,746. PATENTED NOV. 14, 1905.

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8 SHEETS—SHEET 7.

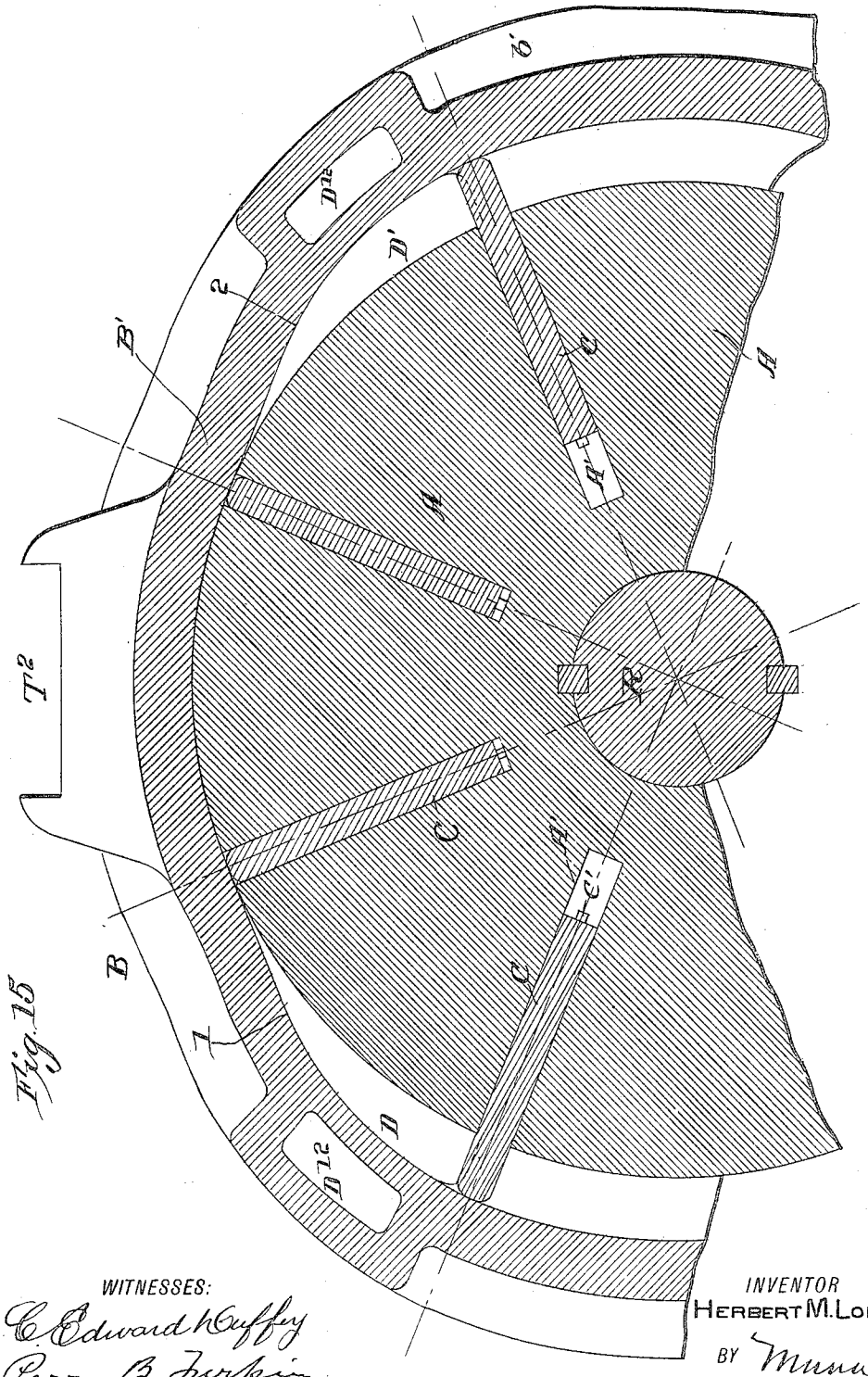


Fig. 15

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No. 804,746. PATENTED NOV. 14, 1905.

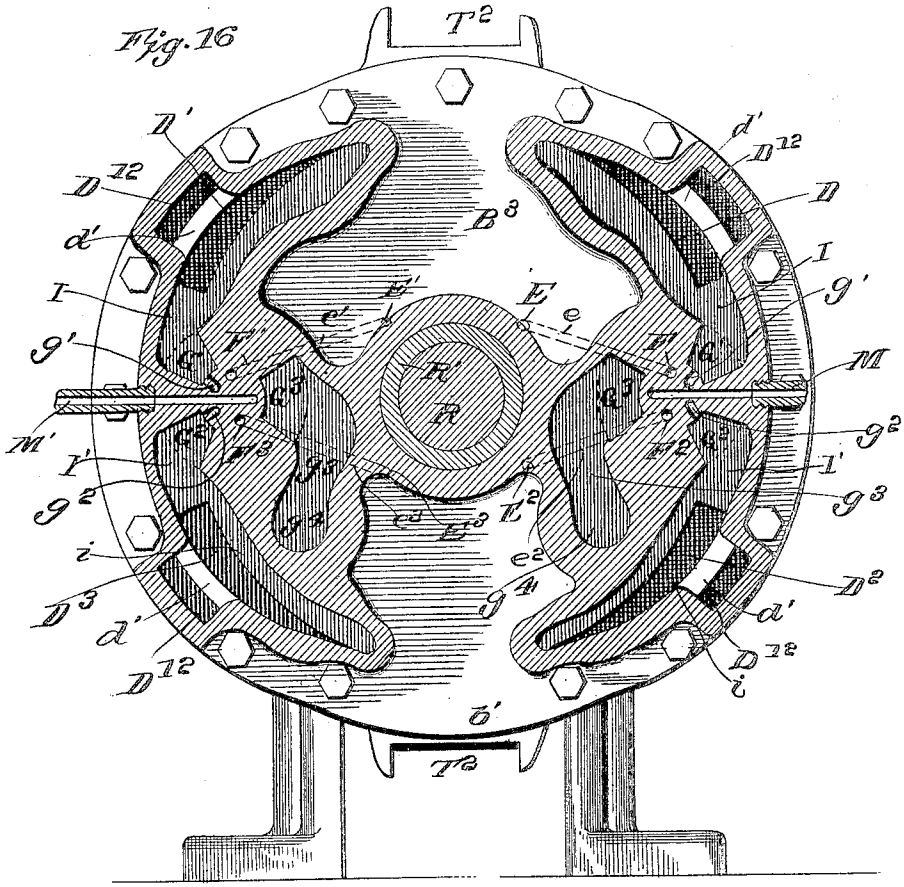
H. M. LOFTON.

ROTARY ENGINE.

APPLICATION FILED MAY 24, 1905.

8 SHEETS—SHEET 8.

Fig. 16



WITNESSES:

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UNITED STATES PATENT OFFICE.

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ROTARY ENGINE.

No. 804,746. Specification of Letters Patent. Patented Nov. 14, 1905.

Application filed May 24, 1905. Serial No. 262,056.

To all whom it may concern:

Be it known that I, HERBERT M. LOFTON, a citizen of the United States, and a resident of Atlanta, in the county of Fulton and State of Georgia, have made certain new and useful Improvements in Rotary Engines, of which the following is a specification.

This invention is an improvement in rotary engines; and the invention consists in certain novel constructions and combinations of parts, as will be hereinafter described and claimed.

In the drawings, Figure 1 is a perspective view of an engine embodying my invention. Fig. 2 is a horizontal section thereof on about line 2 2 of Fig. 1. Fig. 3 is a vertical cross-section on about line 3 3 of Fig. 2. Fig. 3^a is a detail perspective view, partly broken in section, of one of the blades. Fig. 3^b is a detail perspective view of the packing-strip for the ends of said blades. Figs. 3^c and 3^d are detail views illustrating the packing device for the ends of the piston. Fig. 4 is a cross-sectional view drawn through the casing and looking toward the front head thereof. Fig. 5 is a vertical cross-section on about line 5 5 of Fig. 2. Figs. 6 and 7 are detail cross-sections of the valve-chests and valves, showing the latter in position for causing the engine to revolve in the direction indicated by arrows in Fig. 5. Fig. 8 is a detail elevation of the inner side of the valve. Fig. 9 is a cross-sectional view of the casing looking toward the rear head thereof. Fig. 10 is a detail side view, partly in section, of one of the yokes. Fig. 11 is an end elevation of one of the yokes, partly broken away. Fig. 12 is a detail perspective view of the inner side of the valve. Fig. 13 is a detail perspective view, partly broken away, of the outer side of the valve. Fig. 14 is a detail perspective view of the valve-stem. Fig. 15 is a detail enlarged view showing the connection between the eccentric leading-up portion with the larger and smaller concentric portions and the piston fitting such concentric portions, and Fig. 16 is a vertical cross-section on about line 16 16 of Fig. 2.

The engine comprises a circular piston A and a casing B, in which said piston operates. The casing comprises the rim or body portion B′, the rear head B^2, and the front head B^3, (see Fig. 2,) the rim being suitably flanged at b' and bolted at b^2 in connection with the opposite heads.

The piston A is provided with radial slots A′, opening at its rim and within which operate the blades C. These blades are provided at their inner ends with pins or projections C′, (see Figs. 3 and 3^a,) which by abutment with the inner walls of the slots A′ prevent the blades from moving in so far as to entirely close the inner ends of said recesses, and so prevent the steam from passing into the inner ends of the recesses to press the blades outwardly. The blades C are also provided at their ends with packing-strips C^2, which may preferably be spring-pressed, as shown in Fig. 3^a, and so operate to provide a better fit of the blades within the casing. At their outer edges the blades are preferably curved in cross-section to better operate in connection with the rim of the casing, as will be understood from Fig. 3 of the drawings. At its end next the front head of the casing the piston is provided (see Fig. 2) with a circular series of recesses A^2, which communicate at their middle portions with the inner ends of their respective blade-recesses A′ and communicate steam to said recesses or slots A′ and form passages for the feed of steam to and the exhaust of steam from said slots in the operation of the engine, as presently described. These recesses A^2, as shown in Fig. 3, are comparatively close together at their adjacent ends, so that the steam-passages F to F^3 may communicate with both of two adjacent recesses A^2, as will be best understood from Fig. 3 of the drawings.

The casing has its rim portion formed internally of a special construction, having the two opposite circular concentric segments B^4 and B^5, which conform to and closely fit the piston, so the latter can turn in said opposite concentric portions, the spaces between the ends of the concentric piston fitting portions on opposite sides of the piston, constituting steam-spaces and having their walls formed with intermediate circular concentric portions b^4 and b^5 of greater diameter than the piston-fitting segments B^4 and B^5, concentric therewith, and having curved eccentric portions 1, 2, 3, and 4, connecting said larger concentric portions with the smaller piston-fitting concentric portions, ports D′, D^2, D^3, and D^4 being provided for the admission of live steam and for the discharge of exhaust-steam between the junctions of the smaller concentric portions and the larger concentric portions

with the intermediate eccentric or leading-up portions, as will be more fully described. As shown, the intermediate leading-up portions 1, 2, 3, and 4 are of a special construction, especially at their connection with the smaller concentric portions B^4 and B^5, in order to avoid any hammering such as might result from the passage of the blades past an abrupt joint formed by the juncture of the eccentric leading-up portions 1 to 4 and the concentric portions B^4 and B^5. In securing an easy-running of the engine and avoiding all hammering or pounding of the blades at such point I have found it desirable to unite the concentric portions and the leading-up or intermediate portions by a gradual curve, and in securing this, as best shown in Figs. 9 and 15, I merge the smaller concentric piston-fitting portions and the eccentric leading-up portions by means of slight compound or reverse curves simulating the line of beauty—that is, the smaller concentric portion is enlarged gradually after passing its one-eighth portion of the circle—thus allowing the radial movements of the blades in passing over the juncture of these two portions to be very gradual. In this condition the curvature of the eccentric portion would assume the shape of the letter **S** to a very slight degree, the reverse curve in same being adjacent to the smaller concentric portion. While this change may appear slight when illustrated in a drawing on the reduced scale necessarily employed in this presentation of the invention, I have found in actual practice that the change is of great importance in securing a smooth easy operation of the engine free of all pounding and similar noises, and it therefore constitutes an important feature of the present invention.

Ordinarily I prefer to employ eight blades in connection with my improved piston, and in such instance I divide the rim of the casing into eighths, comprising the two similar concentric portions fitting the piston, the two larger concentric portions constituting the steam-spaces, and the four intermediate leading-up portions, as illustrated in the drawings. I also find it desirable to admit steam at both ends of the piston in order to avoid any unequal pressure on opposite ends of the piston-blades during their travel outward and inward in traversing the intermediate or leading-up portions of the rim. I provide for the pressure of steam, whether feed or exhaust, on both sides of said blades during such travel. This is preferably effected by providing the engine at the ends of its casing with ports D, preferably formed in the heads, connected together by means of ducts D^{12}, formed in the rim of the casing and extending from end to end thereof and communicating at d' with the ports D to D^3, formed in the heads of the casing, and these ports D to D^3 extend in register with the leading-up portions of the casing from end to end of said leading-up portions and are open from end to end, as shown, and preferably conform in shape to the space between the piston and the rim of the casing and between the ends of the leading-up portion of the cylinder. By this means I am able to balance the pressure against the blades while they are traveling from end to end of the leading-up portion, and thus avoid any undue pressure against one side of the blades, which would have a tendency to press the blades against the sides of their respective slots so tightly that excessive pressure would be necessary to force them out or in to conform to the cylinder or casing. I prefer to make the ports D open from end to end, as thereby I increase the port area and also insure an equalization of steam-pressure on both sides of the blades during their in-and-out movement, thus balancing them perfectly. In the construction shown I provide four ports D to D^3, inclusive, and these ports are arranged opposite their respective eccentric or leading-up portions and extend throughout their lengths uninterruptedly in open communication with their respective leading-up portions of the casing. I also employ in this construction four ports E, E′, E^2, and E^3, opening through the front head of the casing for delivering steam to and exhausting steam from the blade-slots in the piston, these ports being in a circle concentric with and equal to that of the circular series of channels A^2 in the end of the piston and delivering steam to or exhausting it from the blade-slots, according to the position of the valves controlling the ports E to E^3. These ports E to E^3 communicate, through passages e, e', e^2, and e^3, with ports F, F′, F^2, and F^3, as best shown in Fig. 5 of the drawings, such ports being provided in the bottom plates G of the valve-chests H. The feed-ports F^4 for operating the piston-blades open through the bottom or valve-seat plates G between their respective ports F F^2 and F′ F^3 and may be communicated with either of the said ports by means of the channels j j' in the inner faces of the reversing-valves presently described. These seat-plates G are provided with steam-ports G′ and G^2 and with an exhaust-port G^3, the latter communicating with channels g^3, leading to outlets g^4, communicating with pipe connections G^4, through which the exhaust discharges. It will be noted that the exhaust-channels g^3 and connections are duplicated at the opposite sides of the casing for the proper operation of the engine. In both instances the exhaust-ports G^3 are arranged at the sides of their seat-plates adjacent to the center of the piston, or, in other words, at the inner side of the said seat-plates, while the steam-ports G′ and G^2 are arranged at the outer side of said seat-plates. The seat-plate G is also provided adjacent to the ports F and F′ with ports g', communicating with the adjacent steam-ports G′, and adjacent to the ports F^2 and F^3 with ports g^2,

communicating with the adjacent steam-ports G^2 for the purpose of delivering the exhaust from beneath the piston-blades to the ports G′ and G^2 when either of the latter are communicated with the exhaust-channels g^3 in the manner presently described. In the operation of the engine in exhausting, the steam from beneath the blades is exhausted through the main steam-ports G′ and G^2 when either of the latter are communicated with the exhaust-discharge openings.

Referring to Figs. 3 and 5, it will be understood that the upper steam-ports G′ communicate, through channels I, with the upper ports discharging at the ends of the casing to the upper eccentric connecting portions thereof, while the lower ports G^2 communicate, through channels I′, with the lower inlet-ports to the engine, said channels I and I′ being formed in the front and back heads of the casing and connected together by ducts, as will be understood from Figs. 1, 9, and 5 of the drawings. In driving the engine in one direction—say that indicated by the arrow in Fig. 5—the valve in the left chest H should be adjusted to feed steam through the port G′ of said chest to the upper channel I at the left, and the valve in the chest at the right should be adjusted to deliver steam to the lower port G^2 of said chest, so it will pass to the lower channel *i* at the right side of the engine, and these positions should be reversed in order to reverse the engine. This will be better understood from the description of the valve which I will now make. The reversing-valves J are alike and are provided with the feed-port J′, which may be registered with either of the ports G′ and G^2, and this valve is provided in its inner face with the exhaust-chamber J^2, which is so formed that it may be set to establish communication between the steam-port G′ and the exhaust G^3 when the feed-port J′ registers with the steam-port G^2, or such exhaust-chamber J^2 will communicate the ports G^3 and G^2 when the feed-port J′ is in register with the steam-port G′. It will be noticed that the valve J is cylindrical and may be rocked within its chest in order to bring the feed-port J′ into register with either of the steam-ports G′ and G^2 or to blank the valve by bringing its port J′ opposite a solid portion of the seat-plate G. The valve J is also provided at its inner side with a central portion J^3, in which is formed the two separated segmental grooves or chambers *j* and *j*″, which operate to conduct the steam to and discharge it from the space beneath the blades. It will be noticed, with the understanding that the reversing-valves and ports are alike at both the right and left in Fig. 5, and, referring to Figs. 3, 5, and 8, that when the steam-port J′ is registered with the steam-port G′ at the left in Fig. 5 the groove *j*″ will connect the ports F′ and F^4, so that steam will pass through the port F^4 into the groove *j*″ and thence through the port F′ and the channel *e*′ to the space beneath the blades in position at the opposite ends of the eccentric portion at the left upper side of Fig. 5 and the right upper side of the piston, as shown in Fig. 3, in such manner as to force and hold the said blades out against the rim of the casing until the blades are ready to recede. At the same time the groove *j* at the left in Fig. 5 communicates the ports F^3 and g^2 and permits the steam below the piston-blades at the opposite ends of the eccentric leading-up portions at the lower left-hand side of Fig. 5 to exhaust through the port F^3 and groove *j* and port g^2 into the steam-port G^2, which is communicated at such time through the channel J^2 with the main exhaust-port G^3. In the meantime the port *g*′ adjacent to the steam-port G′ is blanked by the solid portion of the inner face of the valve between the grooves *j* and *j*′ at one end of the latter, the reverse of this operation being secured when the steam-port J′ is communicated with the steam-port G^2.

The steam-chests H are closed at their outer ends by heads H′ and steam is supplied to said chests between said heads and the outer faces of the reversing-valves through branch pipes K, leading from the main steam-pipe L, a pipe M leading from the main steam-pipe and being provided with the branches M′ for conducting steam to the ports F^4 for actuating the piston-blades. It is desirable in starting the engine to admit steam first to the chamber beneath the blades of the piston in order to force said blades out before the steam for operating the engine is admitted to the casing. To this end I provide a throttle-valve N, operating in a casing O, which latter is provided at O′ with a seat for the valve N and with an annular recess O^2, concentric with the seat O′ and forming a chamber from which leads the pipe M in the form of a branch outlet, the main outlet L′ to the pipe L being at the opposite end of a cylindrical portion O^3 of the casing opposite the annular recess O^2. The throttle-valve N fits the seat O′, and at the outer side of said valve I provide a projecting cylindrical portion N′, which fits a cylindrical portion O^3 of the casing, is of less diameter than the annular recess O^2 of the casing, and is provided with openings N^2, through which the steam passes to the main steam-pipe L when the valve is adjusted to the position shown in Fig. 5. It will be noticed, however, that the valve is provided with an imperforate cylindrical portion N^3, between the valve N and the openings N^2, and when the valve N is unseated the steam will pass to the branch outlet leading to the pipe M before the openings N^2 are uncovered, so that I am able by the same throttle-valve to control the passage of steam to the inner sides of the blades of the piston before the steam for operating the engine is fed to the steam-ports G′ or G^2.

It will be noticed that in feeding the steam to and exhausting it from the spaces beneath the piston-blades the steam-passages e to e^3 open at their inner ends by means of ports E to E^3 with the circular series of recesses A^2 in the ends of the piston and communicating with the spaces beneath the piston-blades, as before described.

In operating the reversing-valves J, I prefer to employ stems P, keyed, by means of lugs P′, operating in slots P^2 of the valves, to the said valves and projecting through the heads H′ of the valve-chest H and receiving the crank-arms Q, one of which is extended at Q′ to form a handle, and said arms Q being connected by a link Q^2 so they may be operated as desired, it being understood that these valves are in practice so set that when the valve at the left (see Fig. 5) registers with the upper steam-port G′ the valve at the right will be registered with the lower steam-port G^2, and vice versa. These valves J are used in the construction of a reversible engine; but where it is not necessary to reverse the engine, as in some forms of stationary engines, the reversing feature may be omitted and fixed feed and exhaust steam ports be provided in connection with the engine, as will be readily understood by those skilled in the art.

The piston is keyed upon the shaft R, which extends through suitable stuffing-boxes R′ in the heads of the casing and is journaled in bearings S. As shown, the shaft R is provided with outwardly-facing shoulders r, which abut cones S′, forming parts of the bearings S and moving against balls S^2. These bearings S are supported in yokes T, whose ends are bolted at T′ to the rim of the casing, the latter being preferably provided with saddles T^2, recessed in their outer faces at T^3 to receive the yokes T, as will be understood from Figs. 1 and 9 of the drawings. By this construction I am able to resist any end thrust or tendency on the part of the shaft R and support the same entirely from the rim of the casing, thus relieving the heads from all such strain, as will be readily understood.

The distance between the adjacent ends of the two steam-ports in the heads of the casing, at the same side thereof—say at the right or left in Fig. 3—is slightly greater than the distance between the middle portions of two adjacent blades, so that the rearmost blade will pass the live-steam port in the operation before the immediately-preceding blade will reach its exhaust-port in order to prevent the steam from blowing through from the live-steam port to the exhaust-port.

In constructing the packing-strips C^2 at the ends of blades C, I prefer to make said blades with shoulders C^{12} near their opposite ends and facing toward said ends in such manner as to prevent the packing-strip C^2 from working in or out in the operation of the engine and to secure the said strips firmly in the desired relation with the blades.

In Figs. 3^c and 3^d I show packing-boxes for the end of the piston. These are ordinarily employed at one end only of the piston (see Fig. 2) and are curved concentrically with the piston and are seated in curved grooves formed in the end of the piston and comprise the curved strips U, which are actuated outwardly by the springs V bearing beneath them and are provided in their outer sides with the chamber U′, extending longitudinally and communicating through a port U^2 with the space beneath the said packing-boxes (see Figs. 3^c and 3^d) in such manner as to permit steam to circulate beneath the packing-boxes U and equalize pressure in case any steam should leak at any time beneath the said boxes. I provide these boxes in series extending around the piston and located, preferably, between the adjacent blades, as will be understood from Figs. 3^c and 3^d.

In Fig. 3 I show at X a valve which may be used to control the passage of steam to operate the blades. This valve is not necessary and may be omitted, if desired.

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

1. A rotary engine comprising a piston circular in cross-section and provided with radial slots and with blades operating therein and with a circular series of end grooves communicating with their respective blade-slots, the casing having its rim formed with opposite concentric segments conforming to and fitting the piston for a portion of its circumference, and with an operating-section between the said concentric sections, said operating-section having an intermediate portion concentric with those fitting the piston and curved eccentric portions connecting said intermediate concentric portion with the concentric portions fitting the piston and merging by gradual reverse or compound curves with said smaller concentric portions fitting the piston, the casing-heads provided opposite the said eccentric connecting-sections with ports extending uninterruptedly or in open communication with the rim and approximately throughout the length of said eccentric sections and also having its rim portion provided with a duct or channel connecting the opposite ports, one of said heads being provided with steam-chests having seat-plates provided with ports communicating with their respective ports in the heads of the casing and with ports communicating with the circular series of grooves in the ends of the piston and reversing-valves operating in said chests and suitably ported to coöperate with the ports therein, substantially as and for the purpose set forth.

2. The combination of a piston having eight radially-moving blades, the casing having its

rim provided with opposite concentric portions fitting the piston circumferentially for a length equal to the distance apart of the centers of any two adjacent blades, and with opposite concentric operating-sections between the said piston fitting concentric sections, said concentric operating-sections being of a circumferential length equal to the distance apart of the centers of any two adjacent blades at the time the said two adjacent blades have their greatest outward radial movements, and having four curved eccentric sections connecting said intermediate operating-sections with the concentric sections fitting the piston, the said eccentric sections merging with the piston-fitting sections by gradual compound or reverse curves, the said eccentric sections being of a circumferential length equal to the distance apart of the center of any two adjacent blades at the time the said blades may be covering this portion of the casing, the casing being provided with heads at each end, the said heads having ports opening opposite the eccentric sections, the said ports being of a circumferential length equal to the circumferential length of the said eccentric sections, and the rim of the casing being provided with ducts connecting the opposite ports in each head.

3. The combination of a piston and the casing having its rim provided with a concentric portion and with an eccentric portion leading to said concentric portion and provided with a steam-port opening opposite the eccentric portion and extending uninterruptedly approximately throughout the length of said eccentric portion, the eccentric and concentric portions of the rim at their juncture being united by gradual compound or reverse curves simulating the line of beauty whereby to avoid pounding and the like and secure an easy running of the engine, substantially as set forth.

4. The combination in a rotary engine of the casing, the piston and its blades, the casing-head, the said head being provided with circular valve-chambers with flat seats, steam-passages leading from the valve-seats to the inner sides of the casing-heads for admitting steam for driving the engine and exhausting steam therefrom, smaller steam-passages leading from the valve-seats to the inner sides of the casing-head for admitting steam to the inner sides of the blades and exhausting steam therefrom, of a circular rotative valve fitting neatly in the valve-chamber and seated flat on the valve-seat in the casing-head, the said valve being provided with a steam-port opening longitudinally through same for admitting steam to the steam-passages for operating the engine and provided on its under side with a circular segmental cavity so arranged that when the valve is rotated the cavity will overlap the exhaust-passage from the engine allowing the exhaust-steam to pass out the exhaust-pipe in accordance with the direction in which the engine is revolving the circular rotative valve also being provided at its under flat side with circular segmental channels or grooves so arranged that live steam will be admitted to the inner sides of the blades for forcing them out and exhausting steam from the inner sides of the blades while they are receding in accordance with the direction in which the engine is revolving.

5. The combination of the piston and the casing having its rim provided with concentric and eccentric portions and having steam-ports opening opposite the eccentric portion and a duct or channel extending along the casing and connecting the steam-ports at the opposite ends thereof.

6. The combination of the piston, circular in cross-section, the casing having its rim provided with opposite concentric portions fitting the circular piston and provided between said concentric portions with larger concentric portions and with eccentric portions connecting the larger and smaller concentric portions and merging with the latter on gradual reverse or compound curves, the heads fitting the opposite ends of the rim and provided opposite the eccentric portions thereof with ports, the rim being provided with ducts or channels connecting the respective ports at the opposite ends of the casing, substantially as set forth.

7. The combination of the circular piston provided with radial slots and blades operating therein, the casing having its rim formed with opposite concentric portions conforming to and fitting the piston for a portion of its circumference and with operating-sections between the said concentric sections and with eccentric portions connecting said intermediate concentric portions with the concentric portions fitting the piston, the heads of the casing being provided opposite the eccentric portions with steam-ports extending approximately throughout the length of the eccentric portions and being uninterrupted or in open communication from end to end, whereby the blades will be balanced during their outward and inward movements during the time they are passing over said eccentric sections, the rim of the casing being provided with ducts or channels connecting the opposite steam-ports of the heads, substantially as set forth.

8. The combination of the piston having the blade-slots and the blades operating in said slots, the piston being provided at its end with segmental channels or grooves, one each of said channels or grooves being opposite the blade-slots and in open communication therewith, of the casing and casing-head, the casing-head being provided with ports opening concentrically on a line with the said channels or grooves whereby the piston in revolving will bring the channels or grooves in register with the said ports, the casing-head also being provided with a valve or

valves for admitting steam to and exhausting steam from the said ports whereby the piston in revolving will bring the channel or grooves in register with the said ports allowing live steam to be admitted to the inner sides of the blades while they are moving radially outward and exhausting the steam from the inner sides of the blades just at the point where they are ready to move radially inward.

9. In a rotary engine a piston-blade provided at its end or ends with a packing-strip recessed in the end of the blade and provided near its ends with shoulders facing toward said ends and adapted to abut the blade and prevent the longitudinal displacement of the strip substantially as described.

10. The combination with the piston recessed in its end, of the curved packing-box conformed to and fitting in said recess and having its outer side chambered and provided with a port leading from said chamber to the inner side of the packing-box for the passage of steam, substantially as set forth.

11. An engine comprising a casing, a piston having blades, the casing being provided with ports and channels for conducting steam for driving the engine and for actuating the blades and for exhausting such steam, and a valve provided with means for controlling the passage of steam to drive the engine and to operate the blades and the exhaust of said steam substantially as set forth.

12. The combination in an engine with the casing, the piston and its blades, of a valve having means for controlling the feed and exhaust passage of steam to drive the engine and to operate the blades.

13. The combination in an engine of the casing, the piston and its blades, the valve-seat having ports for the feed and exhaust of steam to operate the engine and to actuate the blades and a valve fitting said seat and ported to cooperate therewith in feeding and exhausting the steam to and from the engine and for operating the blades, substantially as set forth.

14. The combination in an engine with the casing, the piston and its blades, of the valve-seat having ports and passages communicating the same with the blade-slots of the piston and provided with ports for feeding steam to and exhausting it from the engine and with ports communicating with the exhaust-ports and a valve having ports controlling the latter ports and also ported and chambered to coöperate with the feed and exhaust ports of the valve-seat substantially as and for the purposes set forth.

15. The combination with the casing, the piston having the blade-slots and the blades operating therein, the valve-seat having a port and a passage connecting the same with the blade-slot, a feed-port adapted to be communicated with said slot-port and a feed-port and an exhaust-port for steam for driving the engine and the valve fitted to said seat and ported and chambered for the feed and exhaust of steam to and from the engine and provided in its under side with a chamber to communicate the slot-port and its feed-port and with means for controlling the exhaust of steam from the slot-port, substantially as for the purposes set forth.

16. The combination of the casing, the piston having its slots and the blades therein, the valve-seat having the exhaust-port and the pair of feed-ports for the passage of steam to and the exhaust thereof from the engine, passages being provided for the steam between said seat and the operating parts of the engine and ports for supplying steam to the under side of the blades during the time they are moving outwardly and exhausting it from the slots of the piston while the blades are receding, and connecting-ports between the seat-plate and the main feed-ports for the engine, and the valve fitted to said seat and having a feed-port and an exhaust-chamber for controlling the feed and exhaust of steam for operating and reversing the engine and provided in its inner side with chambers for controlling the feed and exhaust of steam to and from the blade-slots of the piston, substantially as set forth.

17. The combination of the casing having the rim provided with longitudinal ducts or channels and the heads having ports for admitting and exhausting steam to the casing and communicating with said ducts or channels, one of said heads being provided with valve-chests and with seat-plates ported for the feed and exhaust of steam, the valves operating in said chests and ported and chambered to coöperate with the seat-plates and connections between said valves whereby they may be operated jointly substantially as set forth.

18. The combination of the piston circular in cross-section and provided with radial slots and with blades operating therein, the casing having its rim formed with opposite concentric segments conformed to and fitting the piston for a portion of its circumference and with opposite operating-sections between the said concentric sections, said operating-sections consisting of intermediate portions concentric with those fitting the piston and curved eccentric portions connecting said intermediate concentric portions with the concentric portions fitting the piston, the heads at the ends of said rim, one of said heads being provided opposite the larger concentric portions of the rim with valve-chests and with ports and passages for feeding steam to operate the engine and to actuate the piston-blades and for the exhaust of steam from the engine and from said blades, and the valves operating in said chests and ported and chambered to coöperate in feeding and exhausting the steam to and from the engine and the blades, substantially as set forth.

19. A rotary engine comprising the piston, the casing having a rim portion and the opposite heads, the shaft connected with the piston and extending through and beyond the heads and the yokes connected at their ends with the rim portion of the casing and provided at their middles with bearings for the piston-shaft, substantially as set forth.

20. An engine having a seat-plate provided with a main feed-port and a main exhaust-port and having a piston provided with slots and with blades operating therein and having passages for conducting the steam to and from the inner ends of the blade-slots and ports communicating with said passages and opening through the seat-plate and the valve fitted to said seat-plate and having a feed-port and an exhaust-chamber and provided in its inner side with chambers coöperating with the ports for feeding and exhausting steam to and from the blade-slots, during the outward and inward movements of the blades, substantially as set forth.

21. In an engine the combination of the casing and the piston provided with radial blade-slots and in its end with a circular series of recesses communicating at their middle portions with the inner ends of their respective blade-recesses and arranged comparatively close together at their adjacent ends, the casing being provided with ports communicating with said recesses, substantially as set forth.

22. The combination in an engine with the piston and its blades, of the casing having its head provided on opposite sides of the center of the piston with valve-chests having seat-plates provided with steam-ports and with an exhaust-port, the exhaust-ports of the opposite chests being arranged at the sides of their seats adjacent to the center of the piston and the steam-ports being arranged at the outer sides of said seats, the valves operating in said chests and connections between the valves whereby they may be operated in unison, substantially as set forth.

23. The combination of the piston circular in cross-section, the casing having its rim provided with concentric portions fitting the circular piston and provided between said concentric portions with larger concentric portions and with eccentric portions connecting the larger and smaller concentric portions and merging with the latter, the heads fitting the opposite ends of the rim and provided opposite the eccentric portions thereof with ports, the ends of said ports on opposite sides of the larger concentric portions being slightly farther apart than the distance between the sections or any two adjacent blades, whereby steam may not blow directly through from feed to exhaust ports.

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