No. 735,181. PATENTED AUG. 4, 1903.

F. J. WATERS.

REVERSING VALVE FOR ROTARY ENGINES.

APPLICATION FILED JAN. 19, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

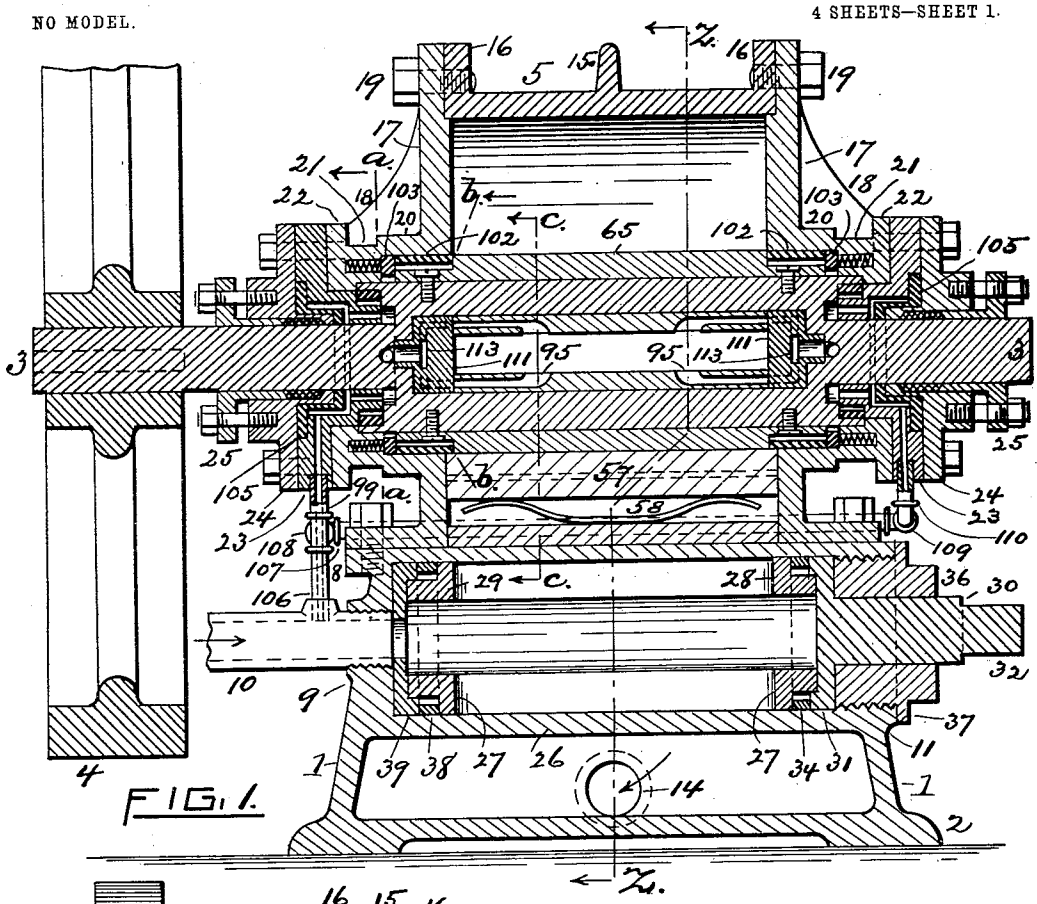


FIG. 1.

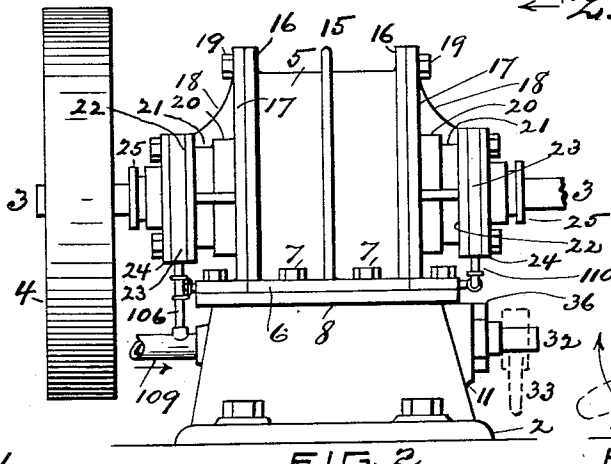


FIG. 2.

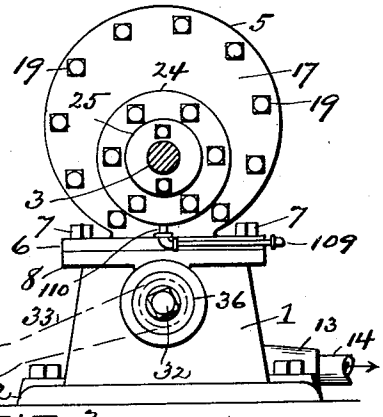


FIG. 3.

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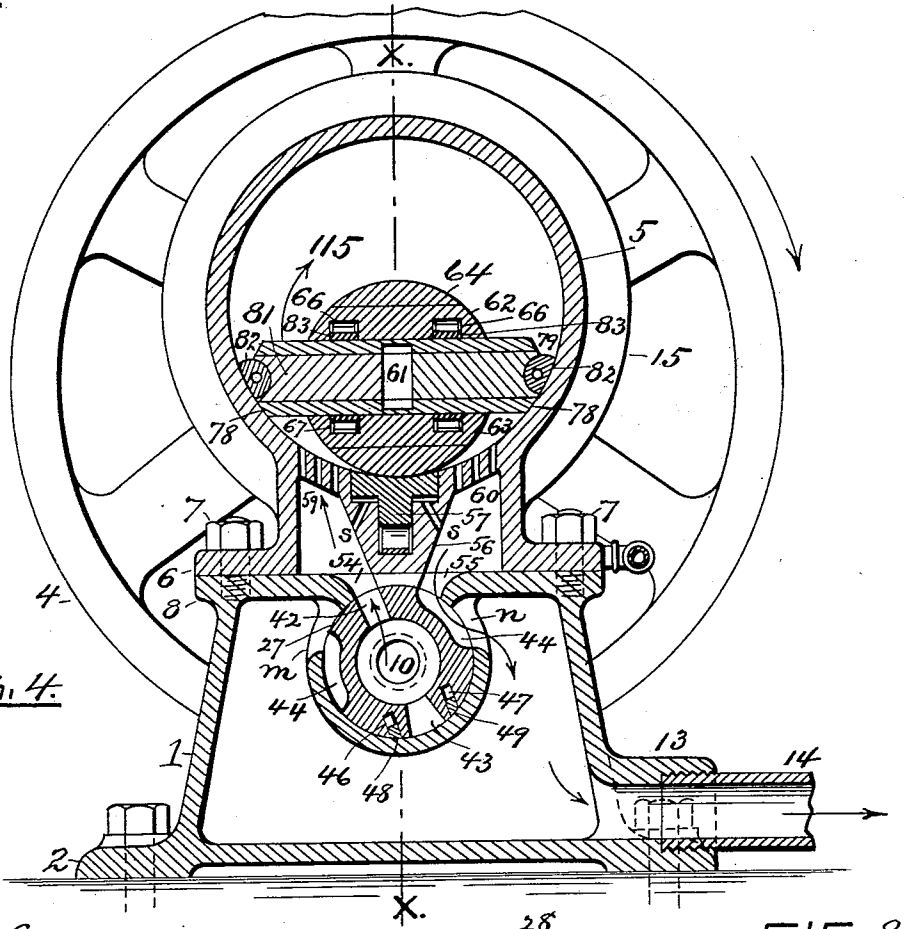


FIG. 4.

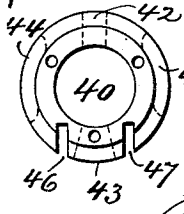


FIG. 6.

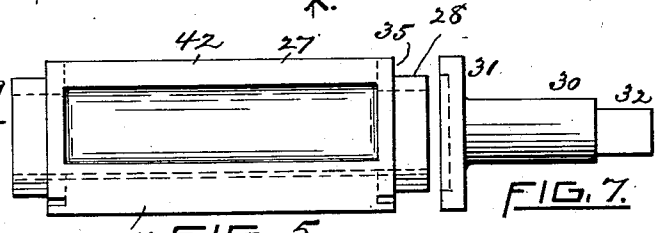


FIG. 5.

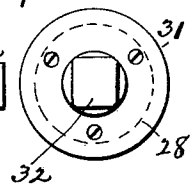


FIG. 7.

FIG. 8.

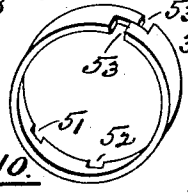


FIG. 10.

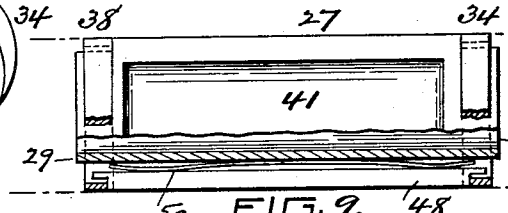


FIG. 9.

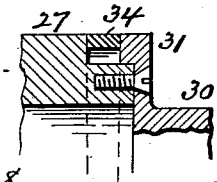


FIG. 11.

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NO MODEL. 4 SHEETS—SHEET 3.

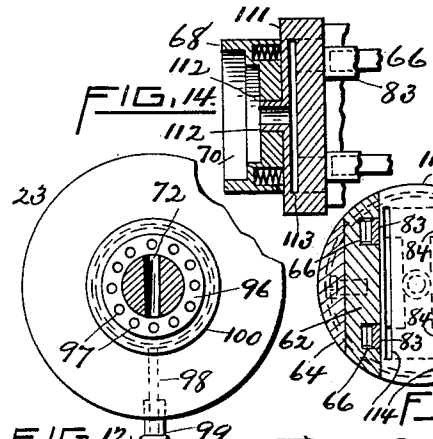


FIG. 14. FIG. 13.

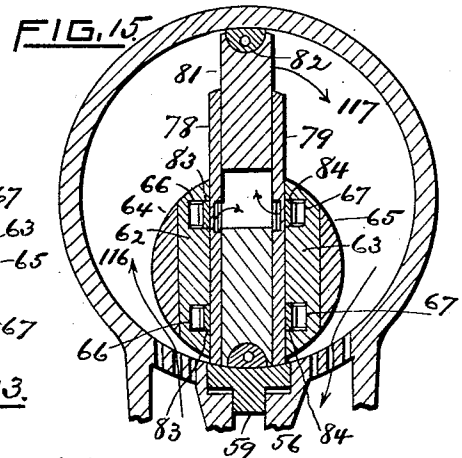


FIG. 15.

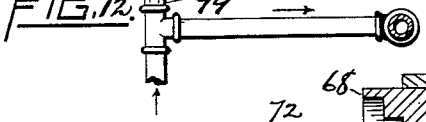


FIG. 12.

FIG. 16.

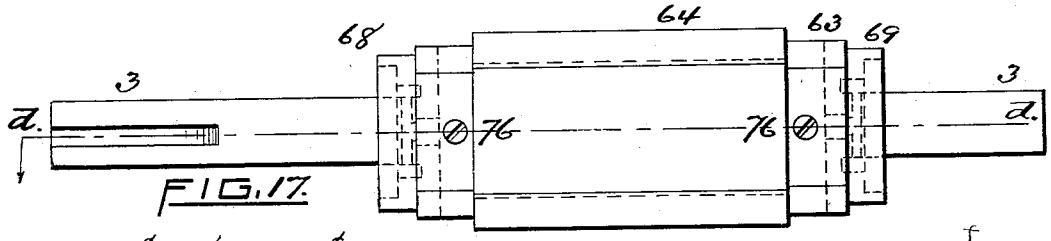


FIG. 17.

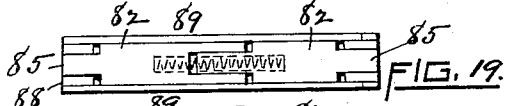


FIG. 19.

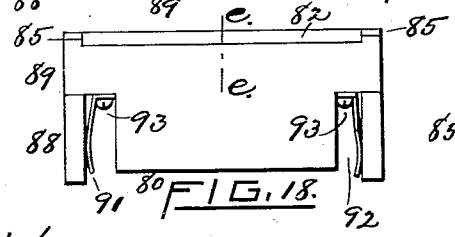


FIG. 18.

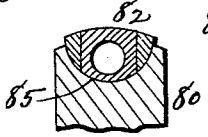


FIG. 20.

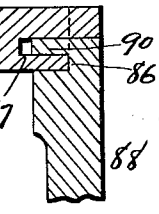


FIG. 21.

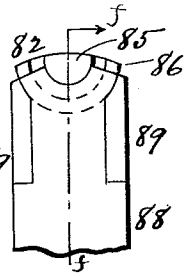


FIG. 22.

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No. 735,181. PATENTED AUG. 4, 1903.

F. J. WATERS.

REVERSING VALVE FOR ROTARY ENGINES.

APPLICATION FILED JAN. 19, 1903.

NO MODEL. 4 SHEETS—SHEET 4.

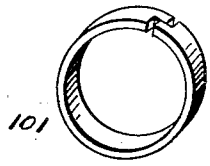


FIG. 23.

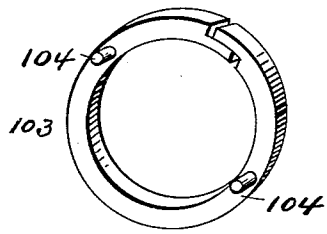


FIG. 24.

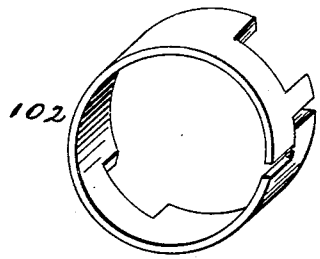


FIG. 25.

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No. 735,181. Patented August 4, 1903.

UNITED STATES PATENT OFFICE.

FRANK J. WATERS, OF PROVIDENCE, RHODE ISLAND, ASSIGNOR OF TWO-THIRDS TO WILLIS A. DREW, FRANK E. FARNHAM, ARTHUR C. FARNHAM, AND ALFRED HARRISON, OF PROVIDENCE, RHODE ISLAND, JAMES GEE, OF CRANSTON, RHODE ISLAND, AND HENRY J. PAGE, OF WARWICK, RHODE ISLAND.

REVERSING-VALVE FOR ROTARY ENGINES.

SPECIFICATION forming part of Letters Patent No. 735,181, dated August 4, 1903.

Application filed January 19, 1903. Serial No. 139,669. (No model.)

To all whom it may concern:

Be it known that I, FRANK J. WATERS, a citizen of the United States, residing at Providence, in the county of Providence and State of Rhode Island, have invented certain new and useful Improvements in Reversing-Valves for Rotary Steam-Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

Like characters indicate like parts.

Figure 1 is a view of my improved rotary steam-engine as seen on line *x x* of Fig. 4. Fig. 2 is a side elevation of the same. Fig. 3 is an end elevation thereof. Fig. 4 is a sectional view of said engine as seen on line *z z* of Fig. 1. Fig. 5 is a side elevation of the balanced reversing-valve. Fig. 6 is an end elevation of the same. Fig. 7 is a side elevation of the trunnion which supports said valves. Fig. 8 is an end elevation of the same. Fig. 9 is a view of said valve, partly in side elevation and partly in central longitudinal section. Fig. 10 is a perspective view of one of the spring-ring packings of said valve. Fig. 11 is a detail view showing in section a part of said valve, the spring-ring packing in position thereon, and the means for securing the trunnion upon the valve. Fig. 12 is a view, partly in elevation and partly in section, on line *a a* of Fig. 1. Fig. 13 is a view, partly in elevation and partly in section, on line *b b* of Fig. 1. Fig. 14 is a central longitudinal section of one of the steam-valves, showing the ports which conduct the steam to the expansion-chamber of the piston. Fig. 15 is a cross-sectional view as seen on line *c c* of Fig. 1. Fig. 16 is a central longitudinal section (on line *d d* of Fig. 17) of the main shaft of my improved engine and the hub diametrically slotted for the reception of the piston-case therein. Fig. 17 is a side elevation of the same. Fig. 18 is a side elevation of one of the piston-blades. Fig. 19 is a top plan of the same. Fig. 20 is an enlarged detail view as seen on line *e e* of Figs. 18 and 19. Fig. 21 is an enlarged detail view of the rocking packing-bar of the piston-blade, together with the means of supporting the same in position, as seen on line *f f* of Fig. 22. Fig. 22 is an enlarged end view of the same. Figs. 23, 24, and 25 are perspective views of three of the spring-ring packings.

My invention relates to reversing-valves for rotary steam-engines; and it consists of the novel construction and combination of the several parts, as hereinafter described and specifically set forth in the claims.

This improved reversing-valve constitutes a part of the rotary steam-engine described and claimed in my application for Letters Patent, Serial No. 126,786, filed October 10, 1902, and allowed December 22, 1902, which rotary steam-engine is shown in the drawings and hereinafter described in order to show the entire circuit of the steam and its work from the time it enters the said reversing-valve until it is discharged therefrom.

In the drawings the exterior parts of the rotary steam-engine to which my improved reversing-valve is applied are shown in Figs. 2 and 3. The base 1 of the engine is an inclosed chamber having a flange 2, by which it is bolted to the floor or other proper support. 3 is the main shaft, on which the fly-wheel 4 is splined, as usual. The cylinder 5 has a base 6, by which it is fastened by bolts 7 to the upper plate or table 8 of the base 1. The base 6 has a boss 9, provided with a screw-threaded circular opening in which the pipe 10 is fitted, which takes steam from the boiler to the engine. On the opposite side the base is made with boss 11, having a large screw-threaded circular aperture in which is fitted a sleeve or tube 12. The base 6 also has a tube or boss 13, provided with a screw-threaded circular aperture in which is fitted the exhaust-pipe 14 to carry away the exhaust-steam from the engine. The cylinder 5 has a central circumferential rib 15 to strengthen and stiffen said cylinder. The cylinder 5 has at each end a circular flange 16, and each end of the cylinder is closed by a head 17, provided with strengthening side ribs 18 and bolted at 19 to the flange 16 of said cylinder. Each cylinder-head 17 has integral therewith the concentric sleeves or

tubes 20 and 21 and the circular flange 22. 23 is a tube or port sleeve, whose purpose I will presently describe, and 24 is a stuffing-box surrounding the main shaft 3 of the engine and provided with the usual packing, which is compressed by a gland 25 in the well-known manner.

In the base or chamber 1 and integral therewith is a valve-seat 26, substantially tubular in form and shown in Figs. 1 and 4. This tubular valve-seat has the two opposite ports *m* and *n*. In this tubular valve-seat is mounted a valve 27, capable of a limited oscillation therein, which valve is shown separately in Figs. 5 and 9. The ends 28 29 of the valve 27 are reduced concentrically in diameter, and on the valve end 28 is fitted and fastened in any suitable manner (preferably by screws, as shown in Fig. 11,) a trunnion 30, whose inner end is diametrically enlarged, as seen at 31, and chambered, as indicated in dotted lines in Fig. 7, so as to receive the end 28 of the valve 27. The outer end 32 of the trunnion 30 is squared in cross-section, as shown in Fig. 8, for the reception of a wrench or lever 33, (see Fig. 3,) by means of which said trunnion 30 can be turned and with it the valve 27, for the purpose hereinafter explained. A split spring-ring packing 34, Fig. 10, surrounds the end 28 of the valve 27 and lies between the annular shoulder 35 of said valve (see Figs. 5 and 9) and the circular flange or head 31 of the trunnion 30. A sleeve 36 has a smooth central bore through which the trunnion 30 passes, and also an exrior screw-thread, as shown in Fig. 1, by which it is engaged with the tubular valve-seat 26, the circular flange 37 of said sleeve lying over the open end of the boss 11 of the base 1, as illustrated in Fig. 1. On the end 29 of the valve 27 is placed a split spring-ring packing 38, and the same is held in position thereon from lateral movement by the washer 39, having a central circular aperture and provided with an annular flange which receives and surrounds the extremity of said end portion 29 of the valve 27, as shown in Fig. 1.

The valve 27 is in general shape cylindrical, having a concentric aperture 40 through its end 29, as shown in Fig. 6, and a concentric chamber 41 extends in the valve 27 longitudinally. The chamber 41 is circular in cross-section, as best seen in Fig. 4. The valve 27 has an upper port 42, extending both longitudinally, as shown in Fig. 5, and radially, as shown in Fig. 4, whose longitudinal sides are parallel, and also a diametrically opposite lower port 43, extending both longitudinally, as shown in Fig. 5, and radially, as shown in Fig. 4. These ports 42 and 43 open into the central chamber 41 of the valve 27. On the sides of the valve 27 are two grooves or depressions 44 and 45, which, with the tubular valve-seat 26, constitute ports or steam-passages, as will be hereinafter explained. The valve 27 has at its bottom two parallel grooves 46 and 47, Figs. 4, 6, and 9, in which, respectively, are packing-bars 48 49 of about the same width as the grooves, so as to move freely therein, but having a thickness from top to bottom less than the depth of said grooves. The outer edge of each packing-bar is flush with the peripheral surface of the valve and curved to correspond therewith, as illustrated in Fig. 4. In the space between the inner edge of the packing-bar and the bottom of the slot is a bow-spring 50, as seen in Fig. 9. The ends of the packing-bars have ears (shown in Fig. 9) which hold the bar in place by projecting within the spring-rings 34 38, said rings being provided with slots 51 52, as seen in Fig. 10, for the reception of the ends of said packing-bar. The spring-ring packing 34 (or 38) is split, as shown at 53, Fig. 10, to afford the requisite elasticity of action.

The table or upper plate 8 of the base or chamber 1 has two ports or passages 54 and 55, of such size and shape and so located that the port 42 of the valve 27 may be moved to register with either one of them, as shown in Fig. 4.

At the bottom of the cylinder 5 is a steam-chest, (see Fig. 4,) and extending longitudinally therein is a block or piece 56, which in cross-section has the shape of a truncated wedge, the lower or smaller edge of which rests upon the central longitudinal portion of the table 8. Said block 56 has on its upper part a longitudinal slot or groove T-shaped in cross-section. The piece or block 57 is a partition dividing the steam-chest beneath the cylinder into two compartments. A packing-strip 57, substantially T-shaped in cross-section, is loosely inserted in the T-shaped slot or groove. The upper surface of the packing-strip 57 is longitudinally concaved to be continuous in curvature with the inner surface of the cylinder 5, and a bow-spring 58 in the bottom of said slot bears up against the lower edge of the packing-strip 57, as seen in Figs. 1 and 4. The bottom of the cylinder 5 has small parallel vertical ports or openings 59 60 through it.

The piston frame or case of my improved engine constitutes practically the hub of the shaft and is separately illustrated in Figs. 13, 16, and 17 and in combination with other parts in Figs. 1, 4, and 15. One portion of this piston-frame is integral with the main shaft 3, as seen in Fig. 16, and is substantially rectangular on two of its opposite faces, but concentrically curved or convexed on its other two opposite faces. It is provided with a central transversely-directed slot 61, rectangular in shape, as seen in Figs. 1, 15, 16, and 29, and also has closed ends. The piston frame or case is composed of several parts, the two fixed guide-plates 62 63, integral with the main shaft 3, and two detachable strips 64 65, substantially segmental in cross-section. These parts of the piston I will now more particularly describe.

The fixed guide-plates 62 63 have longitu-

dinal slots 66 67. (Shown in dotted lines in Figs. 1 and 16 and transversely in solid lines in Figs. 4, 13, and 15.) The guide-plates 62 and 63 have curved edges, as seen in Figs. 4, 13, and 15, continuous in curvature with the convex surfaces of the strips 64 and 65, so that together they form a true circle, as seen in central transverse section, and they have at their ends the annular flanges 68 69 and the concentric annular chambers 70 71. (Best shown in Fig. 16.) A port 72 opens at one end into the chamber 70 and at the other end into the passage 73, and a port 74 opens at one end into the chamber 71 and at the other into the passage 75, as seen in Fig. 16. The strips 64 and 65 are reduced in thickness and curvature at their ends and are secured by screws 76 77 to the fixed guide-plates 62 63. The parts of the piston-frame 62 to 77, inclusive, above described, move with the main shaft 3 in the rotation thereof.

The reciprocating part or piston proper is described as follows: There are two rectangular sliding guide-plates 78 and 79, parallel with each other and connected at their opposite ends by strips, as best seen in Figs. 31 and 32. Between the guide-plates 78 79 are the two pistons or blades 80 and 81, each provided with a packing-strip 82. (Best shown in Figs. 4 and 15.) These parts 78, 79, 80, and 81 have sliding movements in a direction at right angles with the axial line of the main shaft, the plates 78 and 79 sliding between the plates 66 67 and the piston-blades 80 and 81 sliding between the plates 78 and 79. Packing-strips 83 and 84 are located in said slots 66 and 67 and bear against the sliding plates 78 and 79 by the pressure of bow-springs placed behind them in the slots 66 67. The packing-bars 82 have an oscillating motion. They are shown in detail in Figs. 18 to 22, inclusive, and in position on the piston in Figs. 4 and 15. Each packing-bar 82 is made up of two pieces, as seen in Fig. 19, one tongued and the other mortised and both longitudinally bored for the reception of a spiral spring, (shown in dotted lines in Fig. 19,) by which said two parts are expanded or spread apart as far as is allowed by their supporting means. The outer edge of each packing-bar 82 is convexed transversely in a curve corresponding to the curvature of the inner surface of the cylinder 5, Figs. 4 and 15. Each packing-bar 82 has a semicircular trunnion 85 and a semi-annular tongue 86, with a semi-annular groove 87 between said tongue and trunnion. At each end said packing-bar 82 rests by its trunnions 85 in a semicircular socket formed in the outer end of a supporting-bar 88, which is also provided with a semi-annular groove for the reception of the tongue 86 of the packing-bar 82, as shown in Fig. 21. Said supports are loosely mounted by the tenons between two cross-pieces 89, Figs. 19 and 22, and are secured in position by a semi-annular tongue 90, engaging with the groove 87. The cross-pieces 89 support the piston-blade 80. Springs 91 92, secured by screws 93, are fastened to the piston-blade 80 and press against the inner edge of each of the supporting-bars 88 to normally spread apart the lower ends of said supporting-bars, and so to cause the upper ends of said supporting-bars to press inwardly against the packing-bars 82, a space being provided, as shown in Fig. 18, between the outer edges of the piston-blade 80 and the adjacent inner edge of each supporting-bar 88. The supporting-bars 88 are inserted in the slot 61, with their outer edges in sliding contact with the inner faces of the port-blocks 111 111. In the central longitudinal line of each of the sliding plates 78 and 79 are two ports 95 (shown in Fig. 1) and extending from the inner surface of said plates within the same to the opposite edges thereof.

Between the flange 22 of the cylinder-head 17 of the cylinder 5 and the stuffing-box 24 is the tubular sleeve 23, having two concentric bores. (Shown in vertical diametrical section in Fig. 1 and in elevation in Fig. 12 as seen on line *a a* of Fig. 1.) The inner (smaller) end of the sleeve 23 is shown as 96 in Fig. 12 and has a series of small ports 97. As shown at 98 in Figs. 1 and 12, a straight passage-way extends radially from the bottom of said sleeve 23, the outer end of which passage is enlarged to receive the upper end of a steam-pipe 99. The intermediate portion 100 of the sleeve 23, Fig. 12, comes to the inner edge of the annular flange 68 of the fixed piston member, as seen in Fig. 1, said flange 68 being also shown in Figs. 14, 16, and 17. In the annular space of said flange 68 and the sleeve 23 is placed the split spring-ring packing 101. (Shown separately in Fig. 23.) The inner edge of the sleeve 23 closes the outer opening of the chamber 70, (71,) as shown in Fig. 1. A split spring-ring packing 102 (shown separately in Fig. 25) surrounds the fixed portion of the piston and passes over the reduced ends of the strips 64 and 65 and has two diametrically opposite slots, as shown in Fig. 1. A split spring-ring packing 103 (shown separately in Fig. 24) lies in the annular space between the outer edge of the ring-packing 102 and the inner edge of the integral sleeve 20 of the cylinder-head 17, as seen in Fig. 1. The ring-packing 103 has dowels 104 projecting from the outer edge thereof, (see Fig. 24,) and these are loosely engaged in holes in the inner edge of said integral sleeve 20 of the cylinder-head. Other sockets are also made in said inner edge, and in them are placed spiral springs, which press against the outer edge of the ring-packing 103, as seen in Fig. 1.

A sleeve 105 has an outwardly-extending flange on one end and an inwardly-extending flange on the other end, and, as shown in Fig. 1, the outwardly-extending flange lies in an annular recess in the outer side of the sleeve or tube 23 and the inwardly-extending flange extends to and receives the main shaft 3.

This sleeve 105 has a diameter less than the inner diameter of the sleeve 23, and so leaves between said sleeves an annular steam-passage, as seen in Fig. 1.

A steam-pipe 106 opens from the steam-pipe 10, and a pipe 107 is coupled at 108 to the pipe 106 and extends horizontally to the opposite side of the engine, where it is coupled at 109 to a pipe 110, which enters the port through the sleeve 23 on the side of the engine opposite the fly-wheel 4.

In Fig. 14 is shown a port-block 111, having the central tube or short pipe 112, adapted to lie in the bore 73 of the fixed portion of the piston. The block 111 has a vertical port 113, into which the tube 112 opens, as seen in Fig. 14, and from the port 113 at the top and bottom, as indicated in dotted lines in Fig. 13, are horizontal ports, which themselves open into two vertical ports 114. These ports 114, as seen in Fig. 1, open into the ports 95 in the fixed portion of the piston. Each port-block 111 lies in the diametrically opposite slots of the packing-ring 102, Fig. 25.

Through the wedge-shaped block 56 are two ports *s s*, extending diagonally from each outer side to the central longitudinal groove therein.

Having thus specified and described the several parts of my improved rotary engine, I will now explain its operation. Steam from the boiler under pressure passes into and through the pipe 10. A portion of the steam passes from the pipe 10 into the vertical pipe 106 and thence through the pipes 107, 109, and 110, and a portion of the steam passes through the pipe 10 into the central bore or chamber 41 of the oscillating valve 27. By operating the lever 33 the valve 27 is oscillated in its bearings or seat 26, so that its upper port 42 registers with either the port 54 or 55 of the table or plate 8 of the base or chamber 1 of the engine. In further describing the engine I will do so considering the parts to be in the positions indicated in Fig. 4, where the valve-port 42 registers with the port 54. The steam entering in the central chamber 41 of said valve 27 in part flows into the chamber or closed port 43, the purpose of said closed port being to balance the valve, which oscillates on a fixed axial line. The packing-bars 48 and 49, pressed outwardly by the bow-springs 50 50, are kept in sliding friction with the inner surface of the circular valve-seat 26, and so prevent steam leakage from the balancing-valve port 43. The remainder of the steam received in the chamber 41 of the valve 27 passes out through the port 42, through the port 54 into the chamber (shown in Fig. 4) formed by the perpendicular sides and ends of the cylinder-base and the wedge-shaped block 56, and thence passes up through the series of small ports 59 into the cylinder 5. Here the steam (when the piston is in the position shown in Fig. 4) impinges upon the then lower exposed surface of the sliding plate 78 and (as there is no steam-pressure resistance, because there is no steam then passing up through the ports 60) causes the piston and the main shaft, with which a portion of said piston is integral, to rotate, thus revolving the shaft 3 and wheel 4. At the same time the steam which passes from the pipe 10 up through the pipe 106 into the steam-passages shown in Fig. 1 and also the steam which passes from the pipe 106 through the pipes 107, 109, and 110, as shown in Fig. 1, cause the expansion of the piston in the following manner: The steam passing up from the pipe 106 enters the radial port in the sleeve or tube 23 and thence passes into the annular steam-passage between the sleeves 23 and 105, thence through the ports 97, Figs. 1 and 12, into the annular steam passage or chamber 70, Figs. 1 and 14, thence through the port 72, thence through the tube 112, the port 113, the top and bottom ports, Fig. 13, and ports 114 of the port-block 111, and thence through the ports 95 into the expansion-chamber 61 of the piston. The steam from the pipe 106, which passes thence through the pipes 107, 109, and 110, takes a similar course on the opposite side of the engine and also enters said piston expansion-chamber 61. The steam on entering the chamber 61 presses equally against the inner ends of the piston-blades 80 and 81, as indicated by the small arrows in Fig. 15, and so crowds said piston-blades outwardly in opposite directions as far as is allowed by the contact of the packing-bars 82 82 with the inner surface of the cylinder 5. Recurring now to Fig. 4, as the steam passing up through the ports 59 moves the piston-plate 67 in the direction of the arrow 115 the steam in the expansion-chamber 61 forces outwardly the piston 81 continually more and more as the shaft 3 and the piston-frame rotate until the piston 81 reaches the full limit of its movement, when it comes into the position illustrated in Fig. 15. By this time the piston 80, coming around from the position seen in Fig. 4 to that seen in Fig. 15, has been moved inwardly within the chamber 61 by reason of the packing-strip 82 thereof following the curvature of the inner surface of the cylinder 5. As soon as the piston-frame and piston, rotating in the direction indicated by the arrows 115 in Fig. 4 and by the arrows 116 and 117 in Fig. 15, have come to such position that the packing-bar 82 of the piston 80 has passed down beyond the ports 60 the steam then in that part of the cylinder 5 where the arrow 117 is shown in Fig. 15 is enabled to escape through the ports 60, as indicated by the arrow 118 in Fig. 15, and by the continued rotation of the piston-frame and the movement of the piston 81 therein is driven out through the port 55 of the table or plate 8, thence through the side port 45 of the valve 26, thence through the port *n* of the tubular valve-seat 27 into the chamber of the base 1, as indicated by the arrow 118 in Fig. 4, from which it passes, as indicated by the arrow 119,

through the tube 13 and out of the exhaust-pipe 14. The pressure of the bow-spring 58, Figs. 1 and 4, in the wedge-shaped block 56 against the T-shaped packing-strip 57 causes a steam-tight contact of said packing-strip 57 with the parts of the piston or piston-frame which may at any instant of time be adjacent thereto. The packing-bars 83 and 84 are pressed by the bow-springs in the slots 66 67 of the piston guide-plates 78 79, and this pressure prevents any escape of steam from the expansion-chamber 61 of the piston. The ring-packing 101, Fig. 23, which, as before described, lies between the flange 68 of the piston-frame and the inner edge of the sleeve 23, as shown in Fig. 1, prevents any escape of steam at that place from the annular steam passage or chamber 70, Figs. 14, 16, and 17. The packing-rings 102, Fig. 25, and 103, Fig. 24, prevent any escape of steam from the cylinder 5. The packing-rings 34 and 38 prevent the escape of steam from the chamber 41 of the valve 27. The ports *s s* allow the passage of steam to the under surface of the packing-strip 57 in the groove of the block 56, and thus balance the steam-pressure on the upper surface of said packing-strip 57. The oscillation of the packing-bars 82 of the pistons 80 and 81 and the fact that their edge has the same degree of curvature as the inner surface of the cylinder 5 enables them to maintain a steam-tight contact with the inner surfaces of the cylinder 5 in whatever position they may be in said cylinder, as will be apparent by examining Figs. 4 and 15. By moving the lever 33 the valve 26 is oscillated to a position such as to allow the port 42 of said valve to register with the port 55, whereupon the direction of the rotation of the main shaft 3 and the piston is reversed. The sliding movements of the piston, as described, constitute it an expansion-piston. The steam is applied to only one of the two piston-blades at the same time and always at a right angle thereto and by a direct impact. The increasing extent or degree of the projection of the piston-blade which receives this steam-impact affords a regularly-increasing area to receive the steam-pressure, which being applied on an increasing leverage utilizes the power of the steam to the fullest possible extent.

I claim as a novel and useful invention and desire to secure by Letters Patent—

1. The combination of the tubular valve-seat 26 having the ports 54 and 55, the cylindrical rotatable valve 27 having the central chamber 41 and the port 42 registrable with either of the ports 54 and 55, and also having the balancing-chamber 43 and the parallel longitudinal slots 46 and 47, together with the packing-strips 48 and 49 mounted in said slots and having their edges transversely curved to correspond with the curvature of the tubular valve-seat, and the bow-springs 50, 50, all arranged and operating, substantially as set forth.

2. The improved rotary steam-valve herein described, consisting of the cylindrical body portion 27, having the central chamber 41, the balancing-chamber 43, the port 42 and the parallel longitudinal slots 46, 47, the packing-strips 48 and 49 and the springs 50, 50 in said slots, the reduced tubular ends 28, 29, the split spring-ring packings 34, 38 on said ends, respectively, and the trunnion 30 having the cupped flange 31 and secured to the end 28 of said valve, substantially as specified.

In testimony whereof I affix my signature in presence of two witnesses.

FRANK J. WATERS.

Witnesses:
WILLIAM G. BUDLONG,
WARREN R. PERCE.