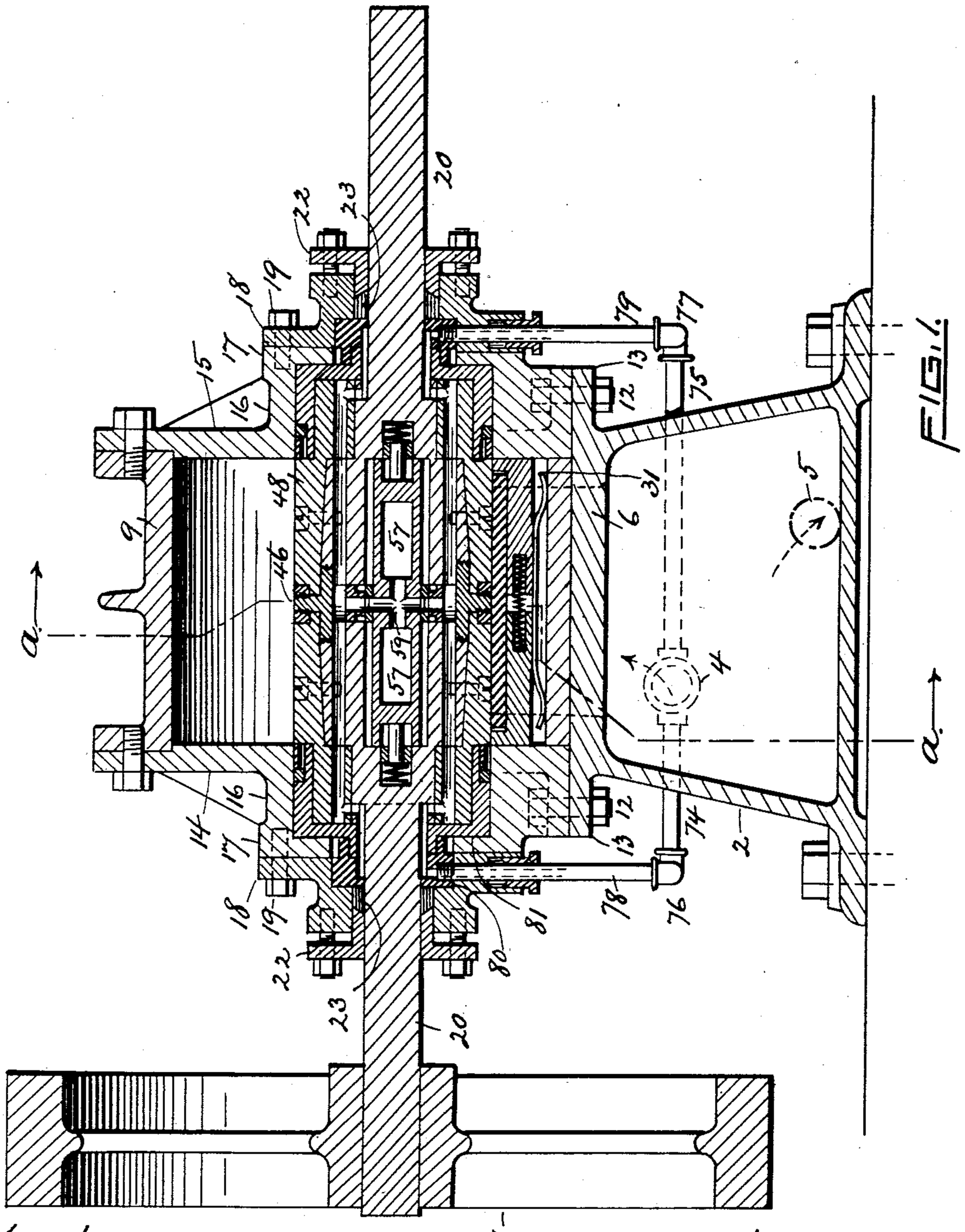
No. 751,584. PATENTED FEB. 9, 1904.

F. J. WATERS.

ROTARY ENGINE.

APPLICATION FILED NOV. 7, 1903.

NO MODEL. 3 SHEETS—SHEET 1.



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NO MODEL. 3 SHEETS—SHEET 2.

FIG. 3.

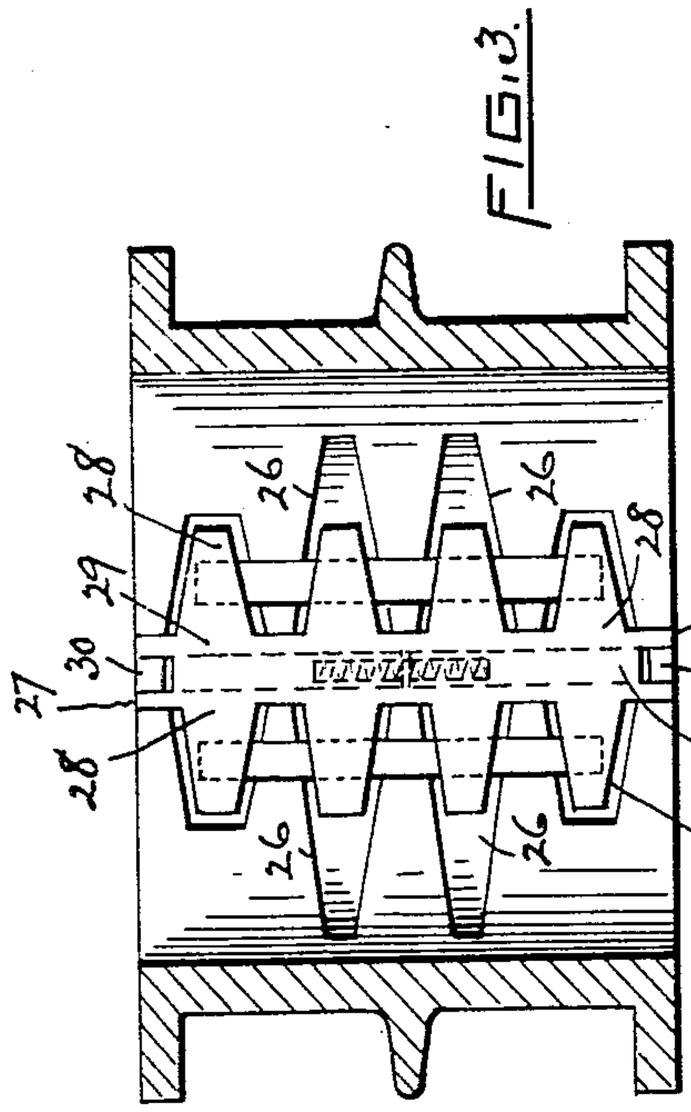


FIG. 4.

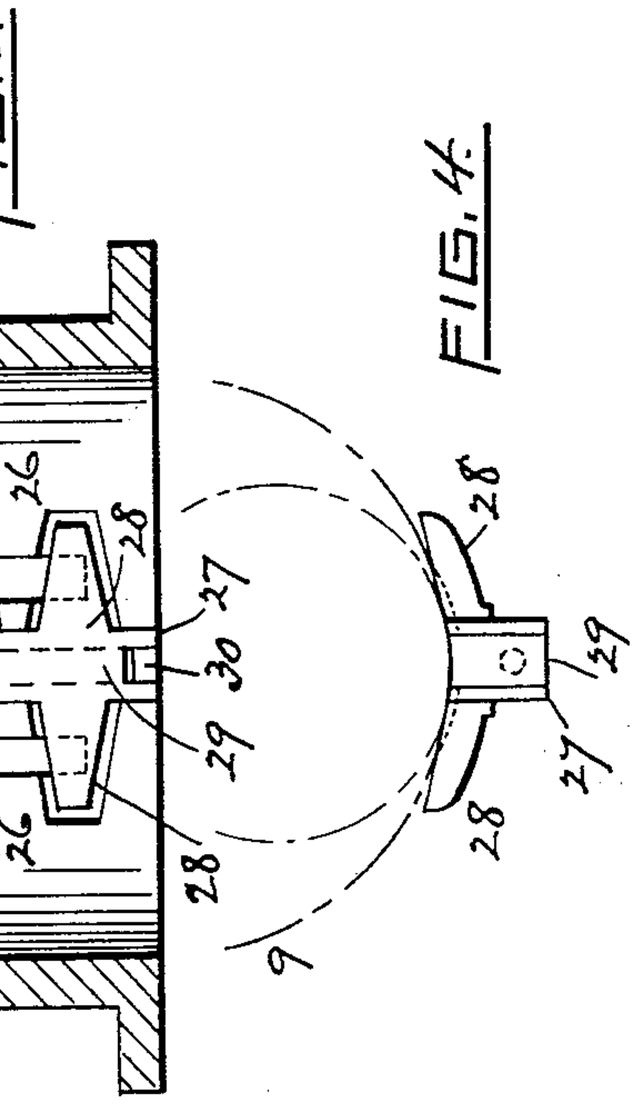


FIG. 5.

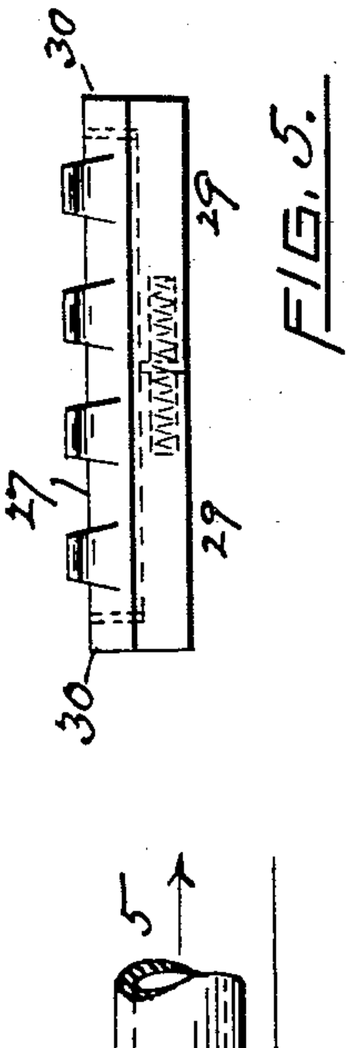
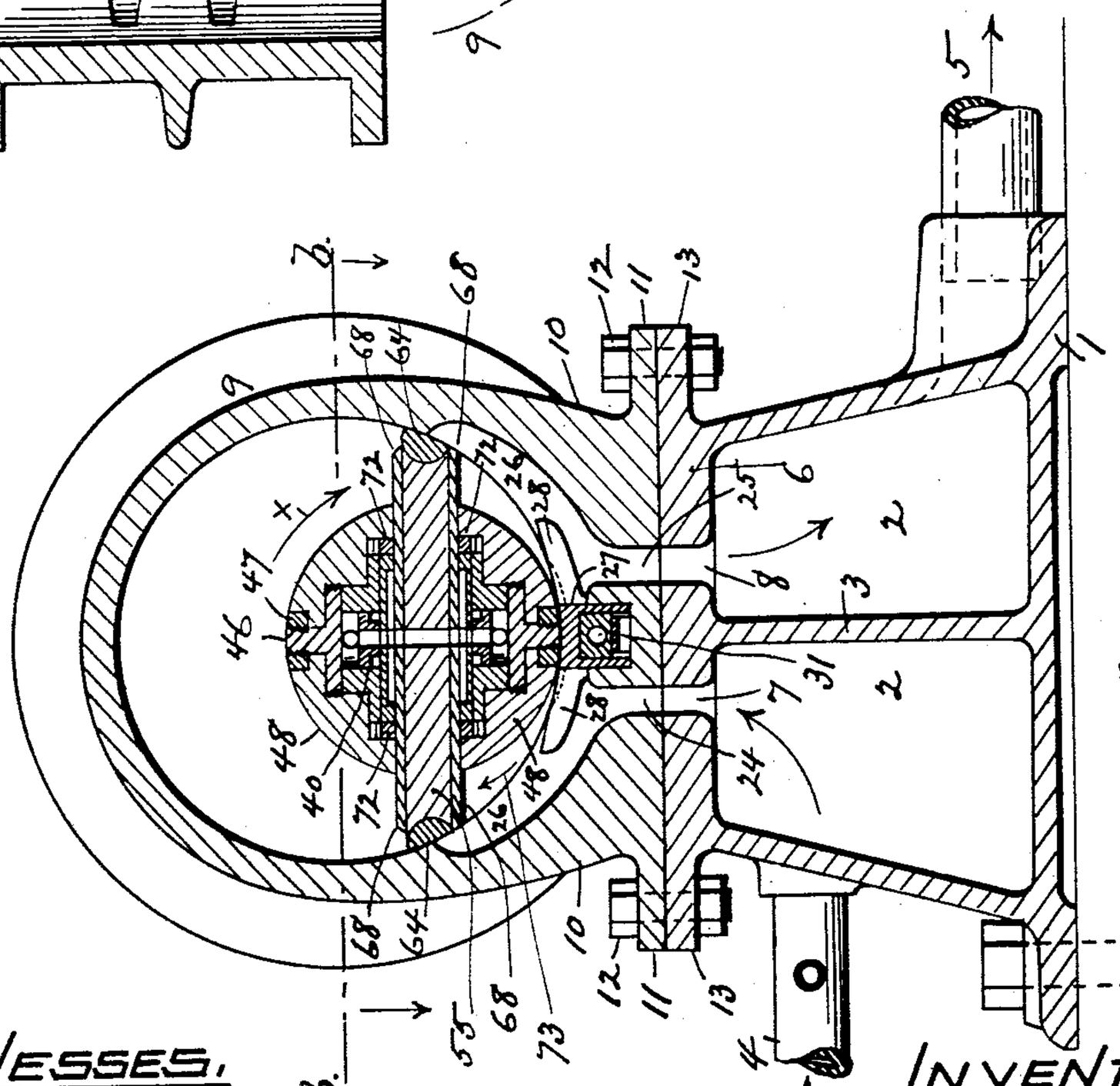


FIG. 2.



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No. 751,584. PATENTED FEB. 9, 1904.

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ROTARY ENGINE.

APPLICATION FILED NOV. 7, 1903.

NO MODEL. 3 SHEETS—SHEET 3.

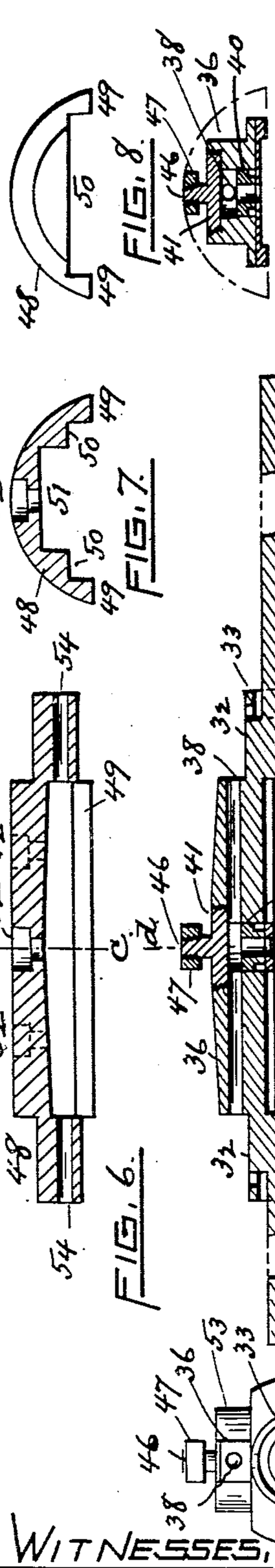

FIG. 8.

FIG. 11.

FIG. 15.

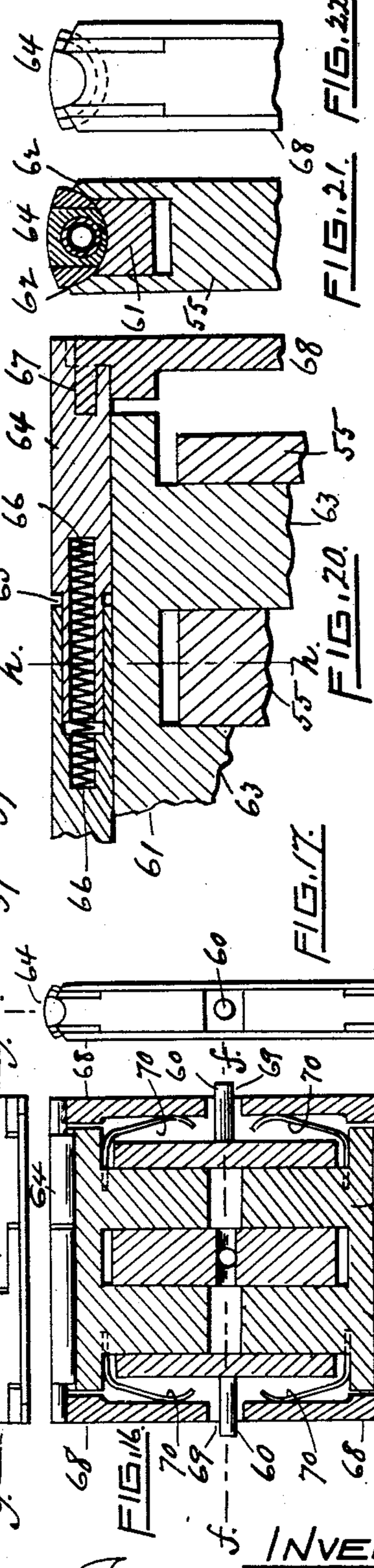

FIG. 21.

FIG. 22.

FIG. 20.

FIG. 7.

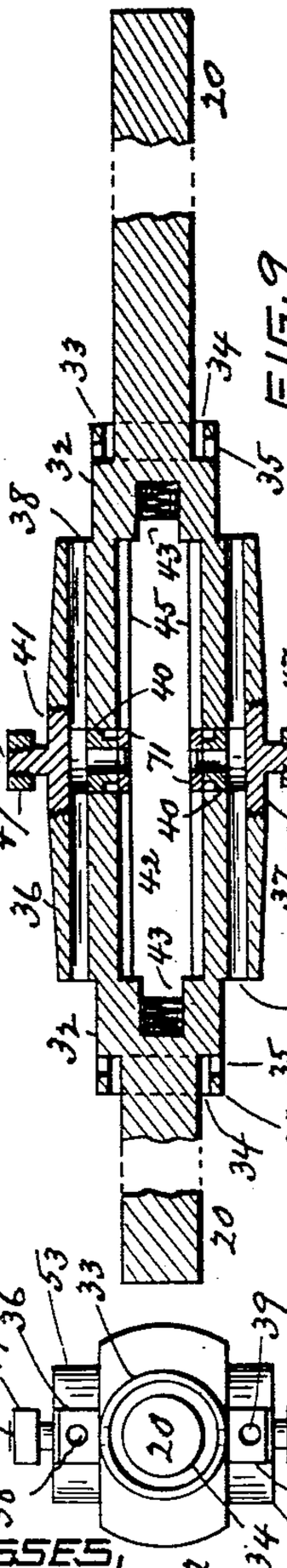

FIG. 9.

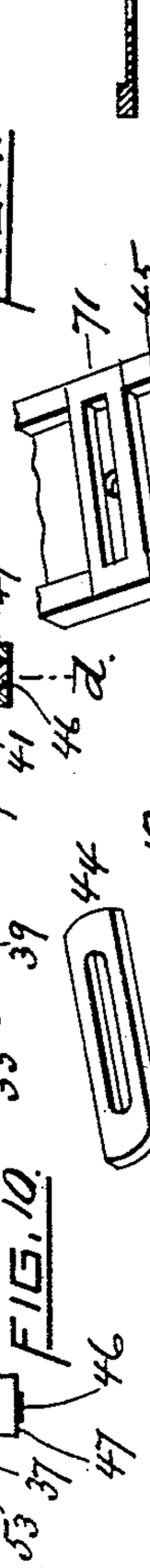

FIG. 13.

FIG. 14.

FIG. 10.

FIG. 18.

FIG. 12.

FIG. 16.

FIG. 17.

FIG. 19.

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No. 751,584. Patented February 9, 1904.

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.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 751,584, dated February 9, 1904.

Application filed November 7, 1903. Serial No. 180,210. (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 Rotary Steam-Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

Like numerals indicate like parts.

Figure 1 is a central longitudinal section of a steam rotary engine provided with my invention. Fig. 2 is a sectional view of the same as seen on line *a a* of Fig. 1. Fig. 3 is a plan view of the bottom of the cylinder and of the keeper constituting a part of my invention as seen on line *b b* of Fig. 2. Fig. 4 is an end elevation of said keeper. Fig. 5 is a side elevation of the same. Fig. 6 is a central longitudinal section of one of the detachable sides of the piston-hub constituting a part of my invention. Fig. 7 is a sectional view of the same as seen on line *c c* of Fig. 6. Fig. 8 is an end elevation of the same. Fig. 9 is a vertical longitudinal section of the piston-hub and shaft. Fig. 10 is an end elevation of the same. Fig. 11 is a sectional view of the same as seen on line *d d* of Fig. 9. Fig. 12 is a perspective view of one of the slotted pieces or bearings used in connection with the piston-hub. Fig. 13 is a perspective view of one of the shoes in position and the adjacent portion of the piston-hub. Fig. 14 is a central longitudinal section of said shoe. Fig. 15 is a perspective view of a piston or packing used in connection with said shoe. Fig. 16 is a sectional view of the piston-hub and expansion-piston blades as seen on line *e e* of Fig. 17. Fig. 17 is an end elevation of the expansion-piston blades with the packing-bars on the outer ends thereof. Fig. 18 is a top plan of one of said packing-bars. Fig. 19 is a sectional view as seen on line *f f* of Fig. 16. Fig. 20 is an enlarged view of said packing-bar and adjacent parts as seen on line *g g* of Fig. 18. Fig. 21 is a sectional view as seen on line *h h* of Fig. 20. Fig. 22 is an end elevation of the parts shown in Fig. 21.

My invention relates to steam rotary engines, and especially to the piston and piston-hub thereof and to the keeper in the bottom of the cylinder with which said piston and piston-hub (being mounted eccentrically in said cylinder) are in contact.

My invention consists in the novel construction and combination of the several parts hereinafter described, and specifically set forth in the claims.

My invention is an improvement on certain portions of the steam rotary engine described in Letters Patent of the United States, No. 733,777, granted to me, and dated July 14, 1903. I will here very briefly describe such parts of said rotary engine as are related to the piston, piston-hub, cylinder, and keeper which constitute my present invention.

In the drawings 1 represents the base, and 2 the steam-chest. The chest 2 is divided into two compartments by a partition 3. The steam-inlet pipe is shown at 4 and the steam outlet or exhaust pipe is shown at 5.

The steam-chest 2 is covered by the table or plate 6, having the ports 7 and 8. The cylinder 9 has a base 10 with flanges 11. Bolts 12 pass through the flanges 11 and also through the flanges 13 of the plate 6. The cylinder 9 has the heads 14 15. Each cylinder-head has the integral concentric tube or sleeve 16 and the circular flange 17. A stuffiing-box 18 is fastened to the flange 17 by bolts 19. The main shaft 20 extends through the cylinder 9 eccentrically, as shown, and the fly-wheel 21 is mounted on said shaft. A gland 22, bolted to the stuffing-box 18, compresses a packing 23 in the well-known manner.

In the base 10 of the cylinder 9 are the ports 24 25, which are continuous with the ports 7 and 8, respectively. The ports 24 25

have branch ports 26, and in the upper portion of said ports 24 25 and in the branches 26 thereof is the keeper 27.

The keeper 27 has a series of integral arms 28 on opposite sides thereof. The arms 28 taper outwardly on their sides so as to extend loosely into the branch ports 26, as seen in Figs. 2 and 3, and said arms are slightly curved, as seen in Figs. 2 and 4. The branch ports 26 are considerably wider than the arms 28, and so there is a sufficient steam-space around said arms respectively. The two central branch ports, as seen in Fig. 3, are much longer than the arms 28 which extend in them respectively, and said two central branch ports extend, as seen in Fig. 2, up to the horizontal diameter of the piston-hub. The lower portion of the keeper 27 is a rib, having straight parallel sides and a longitudinal channel or groove in the bottom. In this longitudinal groove are loosely mounted the two bars 29, rectangular in cross-section, each of which has a central longitudinal socket in its inner end. A spiral spring in the said sockets of these two bars serves to keep them normally apart. At the outer end of each of said bars 29 is an upward projection 30 shutting over the outer adjacent end of the keeper 27 in grooves of the latter, as seen in Figs. 3 and 5. The radius of the curvature of the upper surface of the arms 28 is greater than the radius of the curvature of the interior surface of the cylinder 9, as illustrated by dotted lines in Fig. 4. The lower part of the keeper 27 is mounted loosely in a channel or groove in the central part of the base of the cylinder 9 and rests upon a bow-spring 31, as seen in Figs. 1 and 2. As shown in dotted lines in Figs. 2 and 4, the lower surface of the cylinder 9 is concaved longitudinally at and near the intersection of the branch ports 26.

Integral with the main shaft 20 at the center thereof is an enlargement which constitutes the piston-hub, and the same is shown at 32 in Figs. 9 and 10. It has two annular flanges 33, leaving an annular groove 34 at each end of the hub. The two opposite edges of the piston-hub 32 are convex and of the same curvature and concentric with the annular groove 34 and the main shaft 20, as illustrated in Fig. 10. At the bottom of each annular channel 34 is a passage or port 35.

On opposite sides of the piston-hub are two longitudinal ribs 36 37, as seen in Figs. 9, 10, and 11. Each of these ribs has a longitudinal bore through it, as seen at 38 and 39, and also has a transverse circular aperture through each side thereof. (Shown in Fig. 9.) In these two circular apertures are mounted circular packings or pistons 40. Each rib 36 37 has a screw-threaded circular aperture through it transversely for the reception of a circular screw-threaded plug 41. This piston-hub 32 has an oblong rectangular aperture 42, as seen in Figs. 9 and 11. Said hub also has two transverse grooves 43 in which, respectively, are seated the slotted pieces or bearings 44. At the closed ends of said grooves 43, respectively, are circular sockets, Fig. 9, for the reception of spiral springs, Figs. 1 and 9. On the opposite sides of the aperture 42 the piston-hub has the parallel flanges 45, as seen in Figs. 9 and 11. The plug 41 has a screw-threaded stem 46, on the end of which is engaged the check-nut 47.

In Figs. 6, 7, and 8 is shown a side piece 48, having the flanges 49, plane adjacent surfaces 50, and a central longitudinal groove 51. The side piece 48 has in it countersunk holes 52, and screws pass through said holes into screw-holes tapped therefor in the ribs 36 37. There are two of these side pieces 48, which are put on the opposite plane sides of the piston-hub 32. These side pieces 48 are convex on their outer surfaces and the curvatures are of the same radius as indicated by the dotted lines in Fig. 11.

A circular boss 53 on each side of the hub 32 surrounds the plug or disk 41, which is screwed into a central aperture of said boss 53. The position of said bosses 53 is indicated in Fig. 9 by dotted lines.

In the side pieces 48 are the longitudinal bores 54, which when the side pieces are secured to the hub 32 are continuous with the bores 38 39 thereof, respectively.

The piston-case 55, Figs. 19, 20, 21, is slidably mounted in the aperture 42 of the piston-hub. Its parts are thus described: It has on each edge the parallel flanges 56 and is made with two straight apertures or ways 57, rectangular crosswise, as seen in Fig. 19. It also has a central partition 58 between said apertures 57, and the same is provided with cross-shaped steam passage-ways 59. On each side of the piston-case 55 and between the flanges 56 56 thereof a cylindrical stud or projection 60 extends outwardly at a right angle, as seen in Figs. 16, 17, and 19. The ends of the studs or projections 60 enter into the slots of the pieces 44 on each side, as seen in Fig. 1, which slotted pieces 44 serve as bearings for said studs 60.

There are two piston-blades 61, the outer end of which projects between the parallel flanges 62 of the piston-case 55, Fig. 21. Each piston-blade 61 has two parallel projections 63, Fig. 20, rectangular in cross-section and of a size to fit loosely in the aperture 57 57 of the piston-case 55. The inner ends of said projections 63 of the two piston-blades 61 do not come into abutment the one with the other, but are separated, as seen in Fig. 16. The outer edge of each piston-blade 61 has a seat, which is curved crosswise in the true arc of a circle in which seat is mounted an oscillating packing-bar 64, the same being made in two parts, one part with a mortise and the

other part with a tongue 65, Fig. 18, loosely fitting in said mortise. These packing-bars have longitudinal sockets in their adjacent ends, in which a spiral spring 66 is mounted. At the outer end of each packing-bar it has a groove or channel 67 in the arc of a circle. Two side packing-plates 68 form the side edges of the piston comprising these several parts. They each have a central transverse aperture 69, through which the studs 60 project, as seen in Fig. 16, and they each have at both ends a concentric annular flange and a concentric annular groove, by which they engage with the concentric annular groove and concentric annular flange, respectively, at the ends of the packing-bars 64, as illustrated in Fig. 20. Springs 70 have their inner ends secured in the piston-blades 61 and their bent outer ends freely press against the inner surfaces of the side packing-plates 68, as seen in Fig. 16.

Across the inner surfaces of the piston-hub 32, just above the circular packings 40, are the slotted shoes 71, and against these shoes the piston-case 55 slides. As seen in Fig. 2, there are four packing bars or strips 72, of which two are on each side of the piston-case 55 and bear against the same. There are two of said packing bars or strips 72 at each end of the piston-hub 32. Said packing bars or strips 72 are pressed by bow-springs, as indicated (but not numbered) in Fig. 2, which are inserted in the spaces between said bars or strips 72 and the inner surfaces of the side pieces 48, respectively. These packing bars or strips have a steam-tight contact with the piston-case 55, which slides between them.

From the inlet-pipe 4 are branch pipes 74 75, which are connected, respectively, by the elbows 76 77 with the pipes 78 79. The flange of the stuffing-box 18 is radially bored, as seen in Fig. 1, for the passage of the pipe 78 (or 79). The pipe 78 enters at its upper end into a radial bore in the flange of a collar 80. The steam is discharged from the upper end of the pipe 78 into an annular space, plainly shown (but not numbered) in Fig. 1, between said collar 80 and the main shaft 20, and thence flows into a contiguous annular passage between a port-sleeve 81, and thence through two steam-passages (seen in Fig. 1) in the piston-hub side pieces, and thence through the ports 35 and the ports registering therewith in the side pieces 48, thence through the bores 54 of the side pieces 48, thence through the bores 38 39 in the ribs 36 37, thence through the circular packings 40, thence into the space between the inner ends of the piston-blades 61 61, and so spread said piston-blades apart. In like manner the pipe 79 on the opposite end of the engine conducts steam between the inner ends of the piston-blades, as seen in Fig. 1.

Having thus described the several parts of my invention, I will now explain its operation.

The steam is admitted at boiler-pressure through the pipe 4 into the steam-chest 2 and thence passes through the ports 7 and 24 and the branch ports 26 into the cylinder 9 and rotates the piston therein. The steam in passing into the cylinder 9, as just stated, is prevented from passing to the right by the keeper 27, as seen in Fig. 2, because said keeper is forced up into contact with the piston-hub 37 38 48 48 by means of the spring 31 beneath the keeper. Therefore the steam, having passed through the port 24, moves, as indicated by the arrow 73 in Fig. 2, and impinges against that one of the packing-plates 68 (seen in Fig. 2) in the lower left-hand portion of the cylinder, and so causes the piston-hub 32 and the main shaft 20, with which it is integral, to move in the direction indicated by the arrow x in Fig. 2. As the steam passes between the inner ends of the piston-blades 61 61 it causes said blades to press their respective packing-bars 64 64 outwardly against the inner surface of the cylinder 9 and as the transverse convex curvature of the packing 64 64 is such as to exactly fit the transverse concave curvature of the cylinder it is seen that said packing-bars oscillate in the longitudinal concave seats made for them in the outer edge of the piston-blades 61 61. These packing-bars 64 are of a sufficient width to exceed the width of the entrance of the exhaust-port, as seen in Fig. 2. As soon as the exhaust-port has been uncovered by the passage of the packing-bar 64 to a position beneath it and as long as said exhaust-port remains so uncovered the exhaust-steam passes into and through said exhaust-port into the port 8 of the plate 6 and thence through the chamber 2 and outlet-pipe 5 into the outer air. The steam leaves the cylinder through the interstices between the arms 28 of the keeper 27. In Fig. 4 it is seen that the curvature of the upper surface of the arms 28 of the keeper 27 is on a larger radius than that of the curvature of the cylinder 9, (represented in said figure by dotted lines.) The result of this construction is that said keeper and its arms are out of the way of the rapidly-rotating piston, and the piston thus does not encounter any obstruction at that place, and consequently there is no noise. The spiral springs 66, Fig. 20, cause the longitudinal spreading apart of the packing-bars 64 to prevent the steam from passing by the ends of the piston-blades. The circular packings 40, Figs. 9, 11, press the shoes 71 against the piston-case 55. The spiral spring between the bars 29 of the keeper, Fig. 5, serves to prevent leakage of steam between the ends of the keeper and the cylinder. The springs 70, Fig. 16, are for the purpose of keeping the side packing-plates 68 in steam-tight con-

tact with the ends of the cylinder. The oscillation of the packing-bars 64 and the fact that their edge has a curvature exactly fitting the curvature of the inner surface of the cylinder 9 enable them to maintain a steam contact with the inner surface of the cylinder in whatever position they may be in said cylinder, as is apparent by an examination of Fig. 2.

It is evident that in this engine there is no "dead-center" and that the steam-pressure is always applied to the piston at a right angle and that there is no variation in the angle of steam-pressure on the piston. For these reasons this engine is especially useful for and adapted to the propulsion of automobile vehicles and steam-launches, while for millwork or similar uses it is equally useful and may be compounded merely by duplication and applying the power of several engines to the same main shaft.

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

1. In a steam-engine, the combination of a tubular cylinder having an inlet-port and an outlet-port and also having a base provided with a longitudinal groove, a bow-spring in the bottom of said groove, a packing-bar resting on said spring, a keeper having a rib with a groove therein in which said packing-bar is received, and a rotatable piston having reciprocating piston-blades mounted therein, whose outer edges are in contact with the upper surface of said keeper when passing the same, substantially as described.

2. In a steam-engine, the combination of a cylinder, a rotatable piston of less diameter than said cylinder and mounted therein eccentrically thereto, a base constituting a part of said cylinder provided with a longitudinal groove and with an inlet-port and with a series of branch ports communicating with said inlet-port and a keeper having a longitudinal rib adapted to fit loosely in said longitudinal groove and also having a series of arms projecting laterally therefrom into said branch ports, which keeper and the lateral arms thereof are concaved on their upper surfaces with a curvature of a radius greater than the radius of the curvature of said cylinder, substantially as specified.

3. In a steam-engine, the combination of a cylinder, a rotatable piston of less diameter than said cylinder and mounted therein eccentrically thereto, a base constituting a part of said cylinder provided with a longitudinal groove and with an inlet-port and with a series of branch ports communicating with said inlet-port, a keeper having a longitudinal rib grooved in its lower side and adapted to fit loosely in said longitudinal groove and also having a series of arms projecting laterally into said branch ports, which keeper and the lateral arms thereof are concaved on their upper surface with a curvature whose radius is greater than the radius of the curvature of said cylinder, a packing-bar mounted in the groove of the rib of the keeper made in two parts, a spring adapted to spread said parts lengthwise, and a spring in the first-named groove adapted to press said bar upwardly, substantially as described.

4. In a rotary steam-engine, the combination of a tubular cylinder having a base provided with inlet and outlet ports, branch ports opening laterally out of the first-mentioned ports, a keeper located in said base between the said inlet and outlet ports and having lateral arms extending into said branch ports respectively, substantially as described.

5. In a rotary steam-engine, the combination of a tubular cylinder having a base provided with inlet and outlet ports, a main shaft rotatably mounted in said cylinder but eccentrically thereto, a piston-hub upon said shaft, piston-blades slidably mounted in said piston-hub, branch ports opening laterally out of said inlet and outlet ports of which branch ports some extend up to a line in continuation of the horizontal diameter of said shaft and hub, a keeper located in said base between the said inlet and outlet ports and provided with lateral arms which extend into the branch ports respectively, substantially as specified.

6. In a steam-engine, the combination of a tubular cylinder, a main shaft extending through said cylinder but mounted eccentrically therein, a piston-hub constituting a part of said main shaft and provided with a central rectangular aperture and with two longitudinal bores and with two transverse circular apertures, a piston-case slidably mounted in the rectangular aperture of the piston-hub, two piston-blades mounted slidably in said piston-case and provided with packing-bars on their outer edges which bars are adapted to contact with the inner surface of said cylinder, two circular pistons mounted in the transverse circular apertures of the piston-hub and communicating with the longitudinal bores thereof respectively, two slotted bearing-plates or shoes inserted between said piston-hub and piston-case and adapted to be pressed against the latter by steam passing through said circular pistons respectively, a partition in said piston-case having steam-passages arranged to receive steam from said circular pistons and to conduct the same to the space between the inner ends of said piston-blades, a steam-pipe connected with a steam-supply, a stuffing-box having a radial bore through which said steam-pipe passes, a collar surrounding the main shaft and having a radial bore into which the end of said steam-pipe is inserted and also having a concentric annular steam-space, a port-sleeve adjacent to said collar and having a concentric annular steam-space continuous with the annular steam-space of said collar and also having two steam-pas-

sages which communicate with the two longitudinal bores of the piston-hub, substantially as specified.

7. In a steam-engine, the combination of a main shaft, a piston-hub constituting a part of said shaft, a piston-case slidably mounted in said piston-hub having two opposite closed ends, two piston-blades slidably mounted in said piston-case and steam-passages adapted and arranged to conduct steam from a source of supply to the interior of the piston-case between the inner ends of the piston-blades, substantially as specified.

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

FRANK J. WATERS.

Witnesses:
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WARREN R. PERCE.