No. 626,216. Patented June 6, 1899.

J. BODAM.

ROTARY ENGINE.

(Application filed July 15, 1898.)

(No Model.) 4 Sheets—Sheet 1.

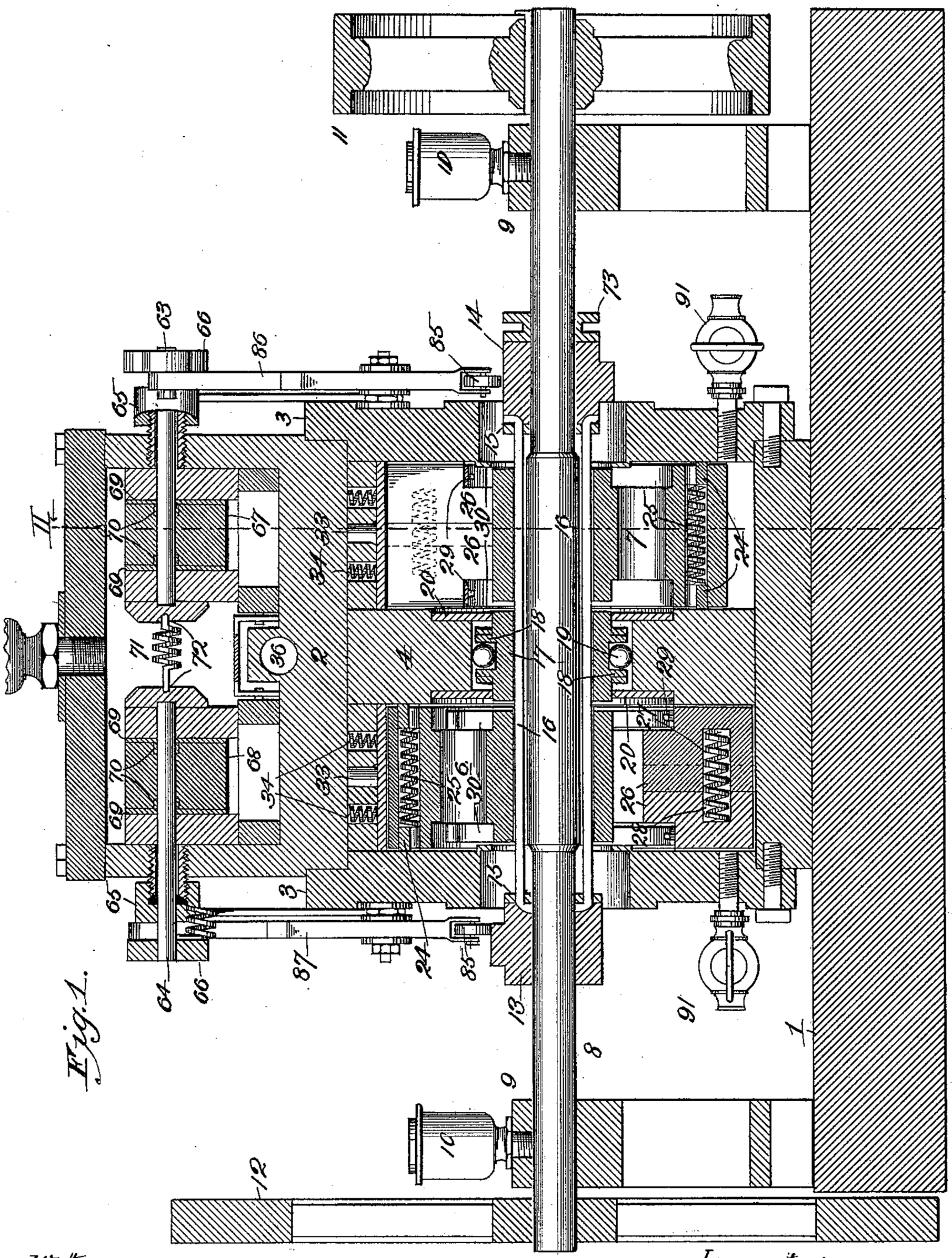

Fig. 1.

Witnesses:
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(No Model.) 4 Sheets—Sheet 2.

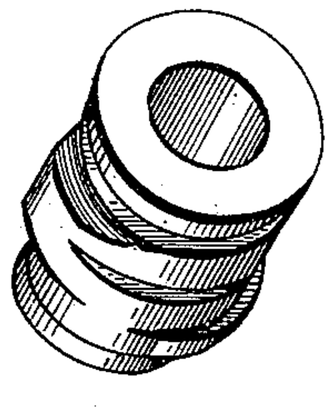

Fig. 9.

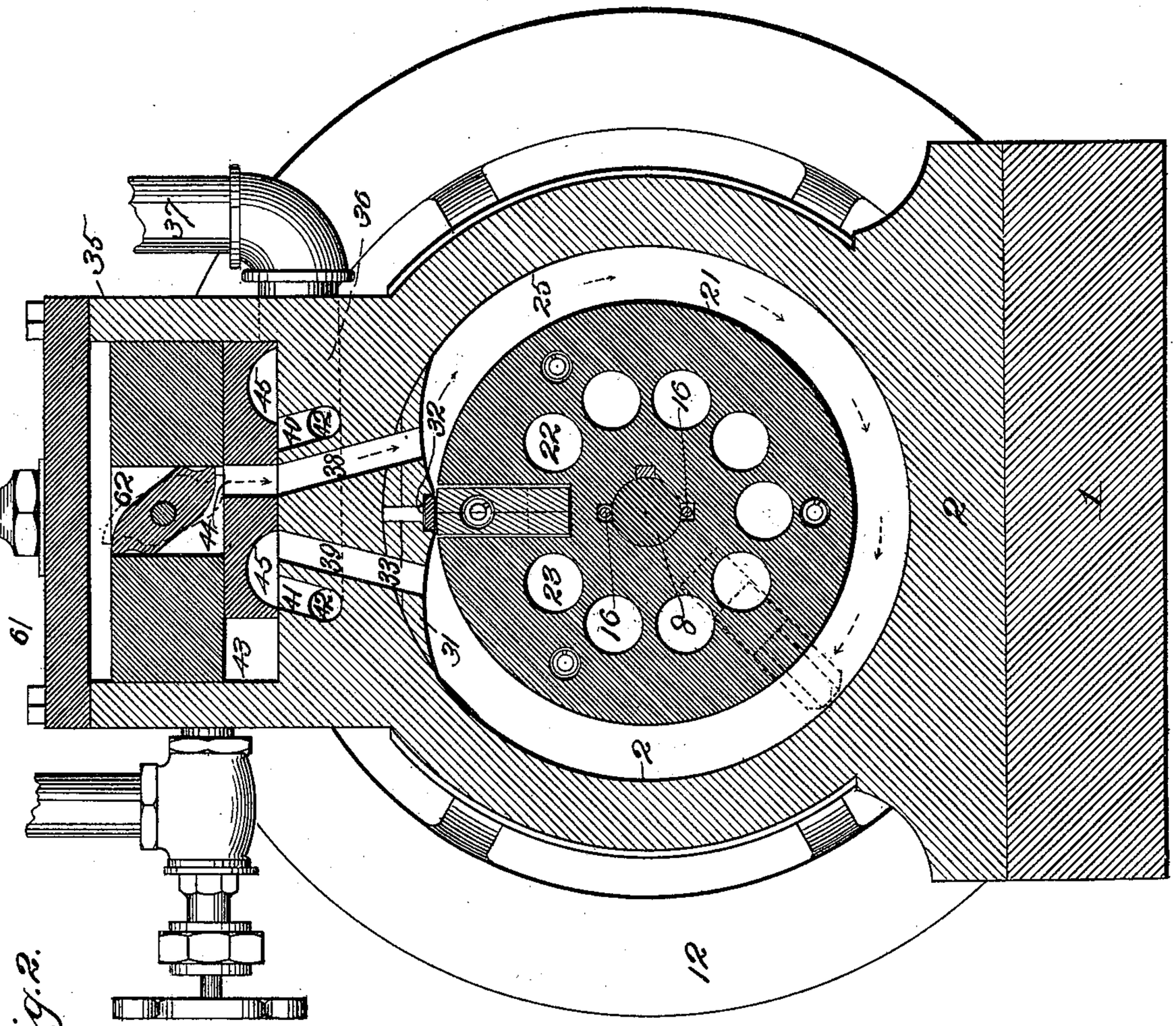

Fig. 2.

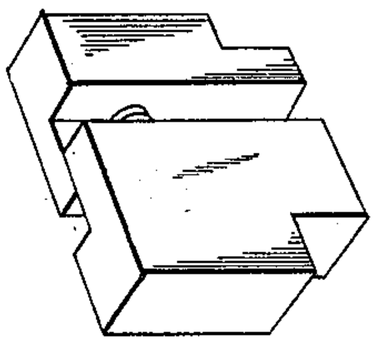

Fig. 10.

Witnesses:

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(No Model.) 4 Sheets—Sheet 3.

Fig. 3.

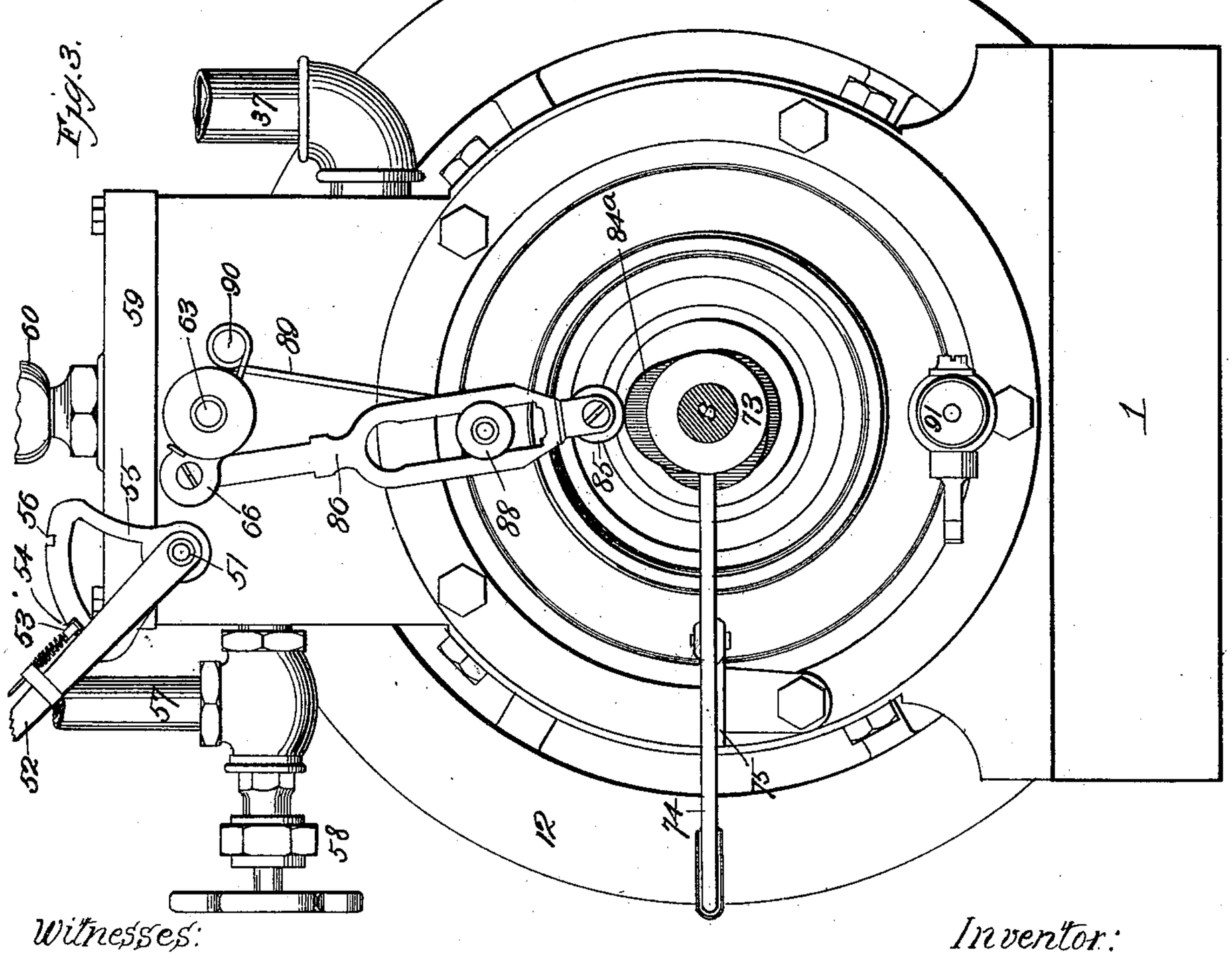


Fig. 11.

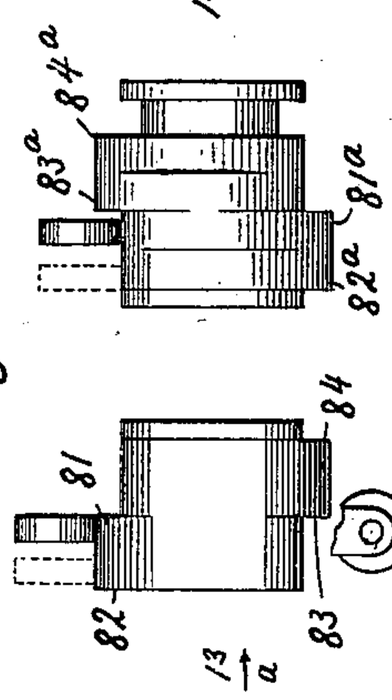


Fig. 12.

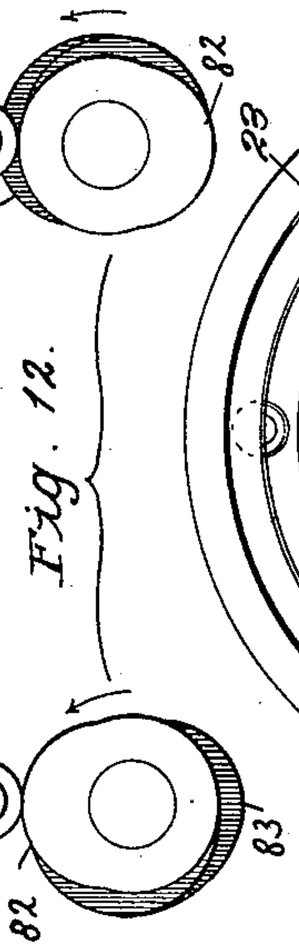
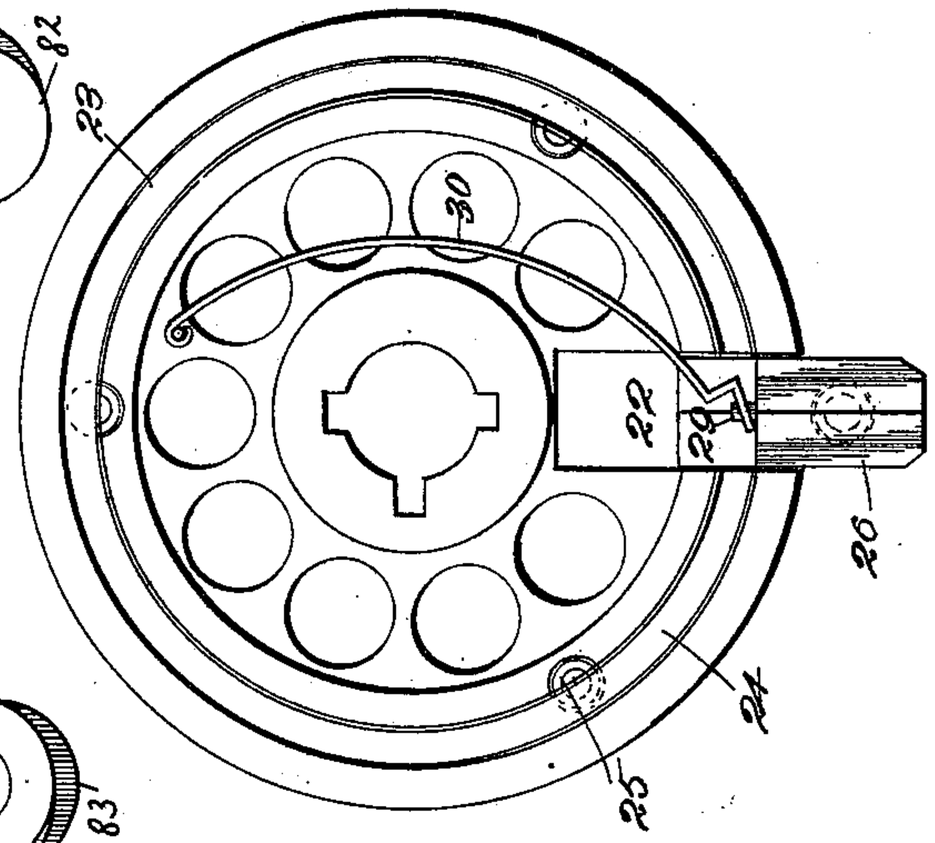


Fig. 4.



Witnesses:

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(Application filed July 15, 1898.)

(No Model.) 4 Sheets—Sheet 4.

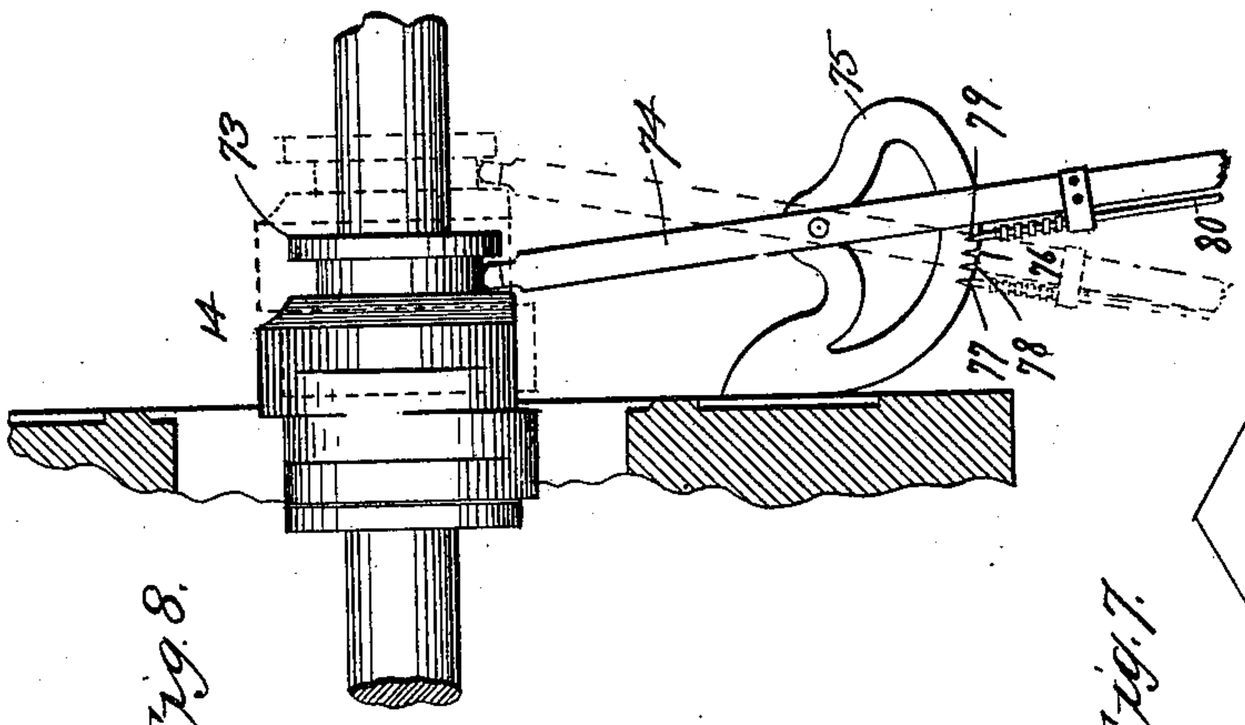

Fig. 8.

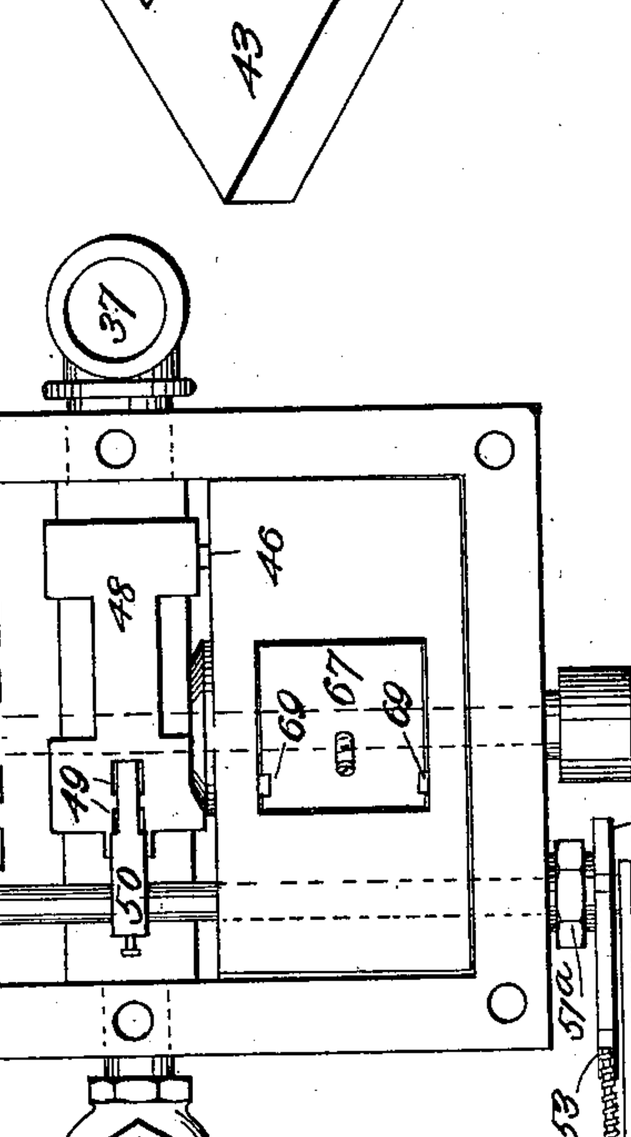

Fig. 7.

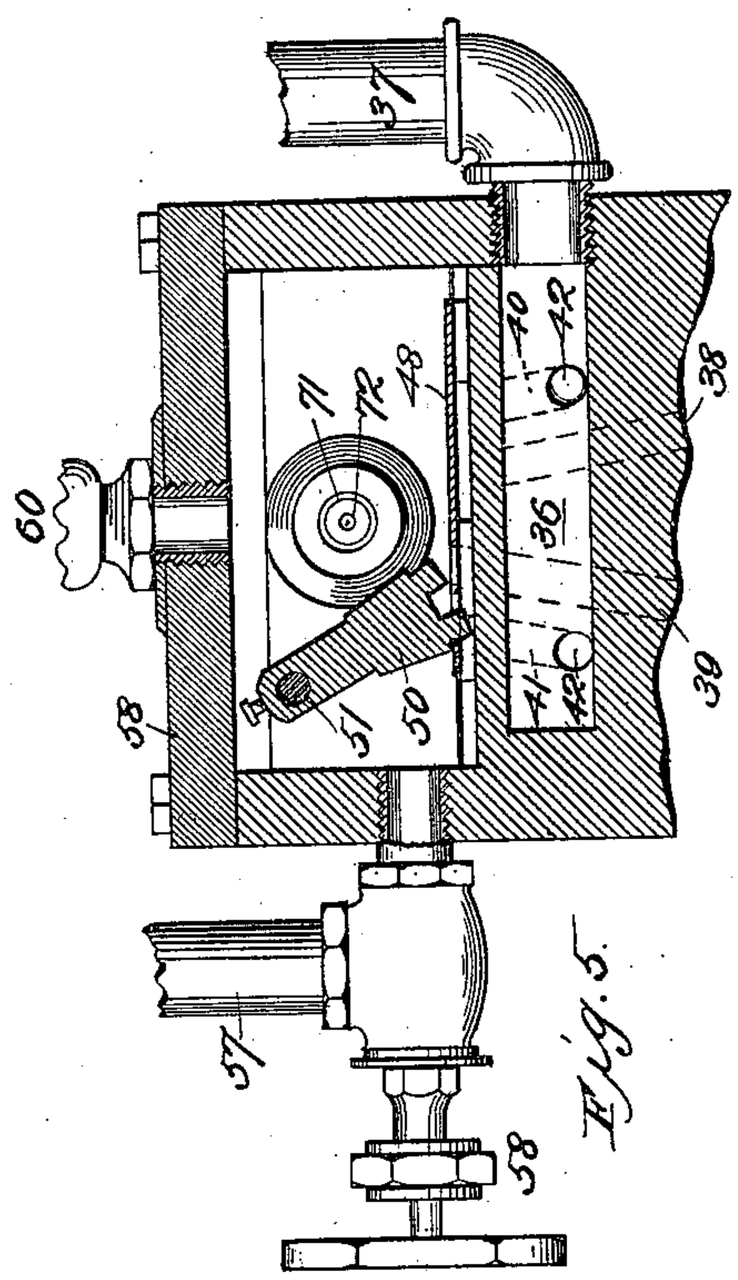

Fig. 5.

Fig. 6.

Witnesses:

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Inventor:

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UNITED STATES PATENT OFFICE.

JOHN BODAM, OF McFALL, MISSOURI.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 626,216, dated June 6, 1899.

Application filed July 15, 1898. Serial No. 685,990. (No model.)

To all whom it may concern:

Be it known that I, JOHN BODAM, of McFall, Gentry county, Missouri, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

My invention relates to rotary engines; and my objects are to produce an engine of this character provided with a pair of rotary pistons mounted on the same shaft, but in independent chambers or subcylinders set at one hundred and eighty degrees to each other in order to obviate all chance of the machine stopping on a "dead-center," to produce a rotary engine wherein the volume of steam may be varied in order to permit the engine to work with more or less expansion, as desired, and to produce a rotary engine provided with oscillatory balanced valves, and thereby reduce friction to the minimum.

Other objects of the invention will hereinafter appear and be pointed out in appended claims; and in order that the invention may be fully understood I will proceed to describe it with reference to the accompanying drawings, in which—

Figure 1 represents a vertical longitudinal section taken through the center of the engine. Fig. 2 represents a transverse section of the same, taken on the dotted line II of Fig. 1. Fig. 3 is an end view with the shaft shown in section. Fig. 4 is a face view of one of the rotary pistons. Fig. 5 is a vertical central transverse section of the upper part of the engine. Fig. 6 is a top plan view of the upper part of the engine with the cap-plate of the steam-chest omitted. Fig. 7 is a perspective view, enlarged, of the reversing-valve mechanism. Fig. 8 is a view illustrating one of the adjustable cam-collars for regulating the volume of steam permitted to enter the cylinder. Fig. 9 is a perspective view of one of said collars detached. Fig. 10 is a perspective view of one of the spring-actuated wings of the rotary pistons. Fig. 11 is a side view of the cam-collars detached, but in their proper positions with relation to each other. Fig. 12 is an end view of each of said cams as viewed in a direction opposite to the point of view of Fig. 3.

In the said drawings, 1 designates the engine-base, of any suitable form or material. 2 designates the cylinder, secured upon said base in any suitable or preferred manner and provided with the customary circular heads 3, bolted thereto. It is also provided with a central partition 4 in order to provide the two like piston-chambers or subcylinders 6 and 7, and said partition and cylinder-heads are provided with centrally-arranged openings, through which extends axially of the cylinder the shaft 8, journaled in suitable bearings 9, provided with oil-cups 10, and said shaft carries at its opposite ends the belt-wheel 11 and fly or balance wheel 12. Keyed to slide, but not to rotate, upon said shaft and arranged at opposite sides of the cylinder are collars 13 and 14, which will be hereinafter more particularly described, and secured reliably to said collars, by means of the plates 15, are rods 16. 17 designates a collar keyed by said rods upon the shaft in the opening of partition 4 and provided with a peripheral annular groove formed by the upwardly-projecting parallel flanges 18, and fitting in said groove and bearing against its base and the wall of said opening are a series of bearing-balls 19 in order that the shaft may rotate within the engine with the minimum degree of friction. Said collar is limited as to lateral movement by means of the rings 20, secured in receses formed in opposite sides of the partition in order that said rings shall not project into the piston-chamber or subcylinders 6 and 7. (See Fig. 1.) A slight lateral pull or movement of the ball-bearing collar is unobjectionable, and as it rotates with the same speed and in the same direction as the rotary pistons 20 no friction would be created, even if the collar should come in contact with either of said pistons. As shown, however, such contact does not take place.

The pistons 21 are in duplicate and are constructed as follows: Each piston is formed with a radial passage 22, extending from its periphery a suitable distance, and at opposite sides with concentric grooves 23, intersected by said passage, and mounted in said grooves are spring packing-rings 24, which are forced apart and against the side walls of the chamber or subcylinder by means of the expansive springs 25, fitting in passages bored through the piston. The wing of the piston fits snugly

in the passage 22 and is formed substantially L-shaped, with its head or widest portion disposed outward and its stem projecting radially inward of the piston. Said wing is of the expansive type—that is to say, consists of two sections lap-jointed together (see Fig. 10) and provided with opposite cavities 27, wherein are seated the opposite ends of an expansive spring 28, which presses the sides of the wing against the opposite sides of the chamber or subcylinder. As this wing occupies a position between the ends of the spring-rings 24, it is obvious that steam entering the chamber outward of said rings will be unable to pass farther inward, and consequently cannot pass from one piston-chamber or subcylinder to the other. At opposite sides of the stem of said wing each section thereof is provided with an inwardly-projecting pin 29, and engaging the same and bearing against the inner side of the ring are the free ends of the springs 30, secured at their opposite ends to the piston, as shown most clearly in Fig. 4, these springs tending to advance the wing radially at all times, so as to make a steam-tight joint between its outer surface or edge and the circular wall of the chamber or subcylinder in order that steam introduced in rear of the wing and between the same and the abutment 31 of the chamber or subcylinder will exert its full power upon said wing, and therefore rotate the piston at exceedingly high speed.

The abutment 31 of each chamber or subcylinder is arranged vertically over its axis and slopes at the same curve or angle from each side toward its center in order that the engine may rotate in one direction or the other with equal facility. Said abutment partitions the space between the periphery of the partition and the surrounding wall of the chamber or subcylinder, (see Fig. 2;) but in order to prevent any possibility of steam leaking back between said abutment and the piston it is provided with a recess in its apex and with, by preference, three holes above and communicating with said recess. A wear-plate 32 fits snugly in said recess and is provided with a stem 33, fitting snugly in said central hole, in order that the springs 34, fitting in the flanking-holes and bearing down upon said plate, shall press the latter straight downward at all times. If this guide-stem were not employed in order to prevent any tilting action of the plate, due to an unequal pressure thereon, it is probable that the joint between said plate and the cylinder or its wing, as the case may be, would be imperfect, as will be readily understood.

In practice the pistons are arranged relatively, so that the wing of one shall project at an angle of one hundred and eighty degrees to the other in order to render it impossible for the engine to stop on a dead-center.

Superposed with relation to the cylinder and by preference cast integral with the same is the steam-chest 35, provided with a transverse passage 36, communicating with the exhaust-pipe 37.

At opposite sides of the longitudinal center of the box and at each side of the exhaust-port passage 36 are a pair of downwardly-diverging passages 38 and 39, opening into each chamber or subcylinder through its abutment 31 at opposite sides of the wear-compensating plate 32 and communicating at their upper ends with the steam-chest. At the outer sides of said passages are the cavities 40 41, connected by the holes 42 with the common exhaust-port passage 36, hereinbefore described. When the passage 38 performs the function of an inlet-port, the passage 39 serves as an outlet-port, and vice versa, as will be hereinafter more fully explained.

43 designates a pair of slide-valves, each provided with a central passage 44 and with cavities 45 in its under side, said cavities being of such size and arrangement that when the passage 45, for instance, connects passages 39 and 41 the other passage 45 will be to one side of passages 38 and 40, and at the same time the central passage 44 connects with passage 38. These slide-valves 43 are provided with pins 46, projecting inward from their side edges and engaging apertures in the depending flanges 47 of an I-shaped plate 48, which plate is provided along its longitudinal center with a plurality of openings 49, with one or the other of which a cog-segment 50 engages, said cog-segment being adjustably mounted upon a short shaft 51, journaled in one end of the steam-chest and in a packing-box 51^a to prevent the leakage of steam therefrom. The lever 52, mounted upon the outer end of said shaft, is provided with the customary spring-actuated dog 53 to engage the notch 54 of sector 55, supported externally of the steam-chest, or the notch 56 of the sector, accordingly as the pistons are rotating in one direction or the other. The manipulation of the lever slides the plate 48, and consequently said valves, from one side of the steam-chest to the other—that is to say, slides them from the position illustrated in Fig. 2 to the opposite side of the steam-chest in order to place ports 38 and 40 in communication with one of the cavities 45 and at the same instant cause port 44 to register with port 39, thus cutting off ports 39 and 41 from connection with each other. The reverse operation of said lever of course restores said valves to their original position or to the position shown in Fig. 2.

57 designates the steam-supply pipe, provided with a controlling-valve 58 and communicating with the steam-chest above the valve-shifting plate 48.

59 designates a cap-plate or cover for the steam-chest, and 60 an oil-cup mounted thereon in order to lubricate the valve-shifting plate 48 and the pistons.

In order to provide for and regulate the introduction of steam to the piston-chambers or subcylinders, I provide a mechanism con-

structed as follows: 61 designates similar stationary valve-blocks, fitted in the steam-chest at opposite sides of the valve-shifting plate 48 and resting upon the slide-valves 43. Said blocks are each provided with a central opening 62, in width about equal to the distance between the outer sides of the ports 38 and 39, in order that said opening may communicate with either of said ports, accordingly as the slide-valve 43 below registers with the one or the other, the central passage 44 of the slide-valve being always in communication with said opening 62. Shafts 63 and 64 extend centrally through said openings in alinement with each other and parallel with the main shaft 8. They are journaled in said blocks and, projecting outward through the packing-boxes 65, mounted upon the steam-chest, are provided with crank-arms 66 at their outer ends. Similar valves 67 and 68 are rigidly mounted upon said shafts 63 and 64, respectively, and are adapted through the instrumentality of parts actuated by collars 13 and 14, as hereinafter explained, to rock back and forth at proper times and by simultaneous contact with the opposite sides of openings 62 of the valve-blocks cut off the entrance of steam to the pistons. In order to provide a steam-tight joint between the sides of said valves, which are of the "balanced" type, in order to work with the minimum of friction, they are provided in said sides with grooves, in which are seated wear-strips 69, and interposed, preferably, between said strips and the valves are the cushions 70, which tend to press said strips laterally outward and compensate for wear by keeping them in frictional contact with the opposing walls of openings 62 at all times, as will be readily understood.

In order to prevent the valve-blocks from having end movement toward each other and yet provide for their easy and quick removal, if necessary, I interpose a stiff expansive spring 71 between them, said spring preferably having its opposite ends seated in sockets 72 in the opposing surfaces of the blocks, as shown in Fig. 1.

Referring now to the collars 13 and 14, it will be noticed that they are of the cam type and of similar construction, with the exception that the collar 14 is provided with a grooved extension 73, engaged by the lever 74, pivoted upon a sector 75, secured to the engine and provided with a series of equidistant notches 76 77 78 79, the notches 76 and 78 being arranged between the notches 77 and 79. Said lever also carries the usual spring-actuated dog 80, which, by engagement with one or another of said notches, regulates the volume of steam admitted to the cylinder and the length of time which such supply continues to be admitted, as will be presently explained.

The cam-collars 13 and 14 are secured upon the shaft at an angle of one hundred and eighty degrees, and one is adapted to work in conjunction with one piston and the other with the companion piston.

The cam 13 is provided with four cam-surfaces—viz., 81 82 83 84, 81 and 83 being arranged diametrically opposite each other and extending about half-way around the collar in order that steam may be admitted to the cylinder while the piston is traveling half the revolution and then be cut off, as hereinafter explained, so that the remaining half-revolution of the piston may be accomplished by the expansion of the steam admitted during the first half-revolution, one of these cams serving to cause the admission of steam when the piston is rotating in one direction and the other when the engine is reversed. The cams 82 and 84 of said collar are also located at diametrically opposite points and extend about one-quarter way around the collar and are adapted, accordingly as the engine runs in one direction or the other, to admit steam while the piston is traveling one-fourth of a revolution and then permit it to be cut off, in order that the remaining three-quarters revolution shall be under the expansion of the steam admitted during the first quarter-revolution. The collar 14 is also provided with four similar cam-surfaces 81^a 82^a 83^a 84^a. These surfaces are arranged with the same relation to each other as the cam-surfaces of collar 13, but owing to the fact that the collar 14 is secured upon the shaft at an angle of one hundred and eighty degrees to the collar 13 the companion surfaces 81 81^a 82 82^a, &c., are at diametrically opposite sides of the shaft 8, and consequently at the instant steam is cut off from one chamber or subcylinder it is admitted to the other chamber or subcylinder. Therefore it is obvious that the steam is acting on one piston or the other as long as the engine is in operation. In order to explain this operation more clearly, attention is directed especially to Figs. 11 and 12, where the collars are arranged in proper relation to each other.

85 designates rollers, which engage the cam-collars and are mounted in the lower ends of the slotted links 86 and 87, pivoted to the crank-arms 66, hereinbefore described. (See Figs. 1 and 3.) Said links are guided upon the antifriction-rollers 88, mounted upon pins projecting from the cylinder-heads, and are held depressed with a yielding pressure by means of springs 89, mounted upon the pins 90, and bearing at their upper and lower ends, respectively, upon crank-arms 66 and the pins upon which guide-rollers 88 are journaled.

The water accumulating in the piston-chambers by condensation is drained off through the drain-cocks 91.

Supposing, now, that the lever 74 occupies the position shown in Fig. 8, with the dog engaging notch 79, it is obvious that the collars are moved to the left upon the shaft as far as possible, and that in consequence the link-rollers 85 are engaged with said collars in the plane of the collars 84 and 84^a, respectively, so that as the shaft revolves said cams for one-quarter of each revolution raise said links,

and thereby oscillate the valves 67 and 68 from the position indicated in full lines to that in dotted lines, Fig. 2, and thereby admit steam to the cylinders by way of the openings 62, passages 44 of slide-valves, and ports 38, and that the exhaust-steam at this time escapes by way of ports 39, slide-valve cavities 45, communicating therewith, passages 41, and holes 42 into the common exhaust-passage 36, whence it escapes through the exhaust-pipe 37 in the customary manner. Owing to the fact that the valves are alternately held open for only one-quarter revolution it is obvious that the first quarter-revolution of each piston is under direct steam-pressure and the following three-quarters revolution is under expansion.

To reverse the operation of the engine and still obtain three-quarters expansion, the lever 52 is manipulated to shift the slide-valve and cause the steam to enter the subcylinder by way of passages 39 instead of passages 38.

To cause the engine to reverse without waste of steam, it is necessary to shift the cam-collars from the position described—viz., that shown in full lines, Fig. 8—to the position shown in dotted lines, same figure, with dog 80 engaging notch 77 of the sector 75. This operation of course is accomplished while the engine is in motion and causes the mutual engagement of the rollers 85 with the quarter-cams 82 and 82ª.

If it be desired to run the engine with half direct pressure and half expansion, the lever 74 is shifted so as to cause dog 80 to engage notch 76, and consequently place the rollers 85 in engagement with half-cams 81 81ª. To reverse the operation of the engine and still maintain the same direct and expansive pressure, said lever is manipulated to cause the rollers 85 to engage the half-cam surfaces 83 83ª, as will be readily understood.

From the above description it will be apparent that I have produced a rotary engine embodying the features of advantage enumerated as desirable in the statement of invention, and it is to be understood that I reserve the right to make such changes as do not involve a departure from the spirit and scope of the same.

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

1. A rotary engine, provided with a piston-chamber, having an abutment with sloping approaches and ports at opposite sides of its apex, a steam-chest, provided with supply and exhaust ports, a slide-valve therein, provided with a passage communicating with the supply-port and with cavities connecting the other port with the exhaust-port of the steam-chest, a shaft extending through said piston-chamber, a rotary piston thereon provided with a radially-extending wing, a block upon said valve provided with an opening always registering with the supply-port of the valve, a balanced valve arranged to oscillate in said opening and by contact with its opposite sides cut off the passage of steam therethrough, means to operate said slide-valve, a cam-collar upon the engine-shaft, and instrumentalities actuated by said cam-collar for oscillating said balanced valve, substantially as described.

2. A rotary engine, provided with two piston-chambers, each having an abutment with sloping approaches and ports at opposite sides of its apex, a steam-chest provided with supply and exhaust ports, slide-valves therein, provided with passages communicating with certain of said ports, and with cavities connecting the other ports with the exhaust-ports of the engine, a shaft extending through said chambers, rotary pistons thereon, and provided with radially-extending wings set at an angle to each other, a slide-plate connecting said valves, and provided with openings, a lever-carrying shaft journaled in the steam-chest and provided with a cog-segment engaging the openings of said plate, and means to secure said lever and connecting slide-plate, at their required point of adjustment, substantially as described.

3. A rotary engine, provided with two piston-chambers, each provided with an abutment having sloping approaches and ports at opposite sides of its apex, a steam-chest, provided with supply and exhaust ports, slide-valves therein, provided with passages communicating with certain of said ports, and with cavities connecting the other ports with the exhaust-port of the engine, a shaft extending through said chambers, rotary pistons thereon and provided with radially-projecting wings set at an angle to each other, a slide-plate connecting said valves and provided with openings, a lever-carrying shaft journaled in the steam-chest and provided with a cog-segment engaging the openings of said plate, a sector, and a spring-actuated dog carried by the lever and adapted to engage said sector and hold the slide-valves in one position or the other, substantially as described.

4. A rotary engine, provided with two piston-chambers, each provided with an abutment having sloping approaches and ports at opposite sides of its apex, a steam-chest, provided with supply and exhaust ports, slide-valves therein, provided with passages communicating with certain of said ports, and with cavities connecting the other ports with the exhaust-port of the engine, a shaft extending through said chambers, rotary pistons thereon and provided with radially-projecting wings set at an angle to each other, blocks mounted in the steam-chest and upon the slide-valves and provided with openings communicating with the passages of said valves, and balanced valves located in said openings and adapted to permit or prevent steam passing therethrough, substantially as described.

5. A rotary engine, provided with two piston-chambers, each provided with an abut-

ment having sloping approaches and ports at opposite sides of its apex, a steam-chest, provided with supply and exhaust ports, slide-valves therein, provided with passages communicating with certain of said ports, and with cavities connecting the other ports with the exhaust-port of the engine, a shaft extending through said chambers, rotary pistons thereon and provided with radially-projecting wings set at an angle to each other, blocks mounted in the steam-chest and upon the slide-valves and provided with openings communicating with the passages of said valves, balanced valves located in said openings, collars provided with cam-surfaces mounted upon the shaft, and instrumentalities operated by said cams to oscillate said balanced valves, substantially as and for the purpose set forth.

6. A rotary engine, provided with two piston-chambers, each provided with an abutment having sloping approaches and ports at opposite sides of its apex, a steam-chest, provided with supply and exhaust ports, slide-valves therein, provided with passages communicating with certain of said ports, and with cavities connecting the other ports with the exhaust-port of the engine, a shaft extending through said chambers, rotary pistons thereon and provided with radially-projecting wings set at an angle to each other, blocks mounted in the steam-chest and upon the slide-valves and provided with openings communicating with the passages of said valves, balanced valves located in said openings, collars mounted upon said shaft and provided with a pair of cam-surfaces extending about one-quarter way around the collar, and a pair of cam-surfaces extending about half-way around the collar, instrumentalities connected to said balanced valves, and means to adjust said collars and thereby cause the corresponding cam-surfaces to actuate said valves through said instrumentalities, substantially as described.

7. A rotary engine, provided with two piston-chambers, each provided with an abutment having sloping approaches and ports at opposite sides of its apex, a steam-chest, provided with supply and exhaust ports, slide-valves therein, provided with passages communicating with certain of said ports, and with cavities connecting the other ports with the exhaust-port of the engine, a shaft extending through said chambers, rotary pistons thereon and provided with radially-projecting wings set at an angle to each other, blocks mounted in the steam-chest and upon the slide-valves and provided with openings communicating with the passages of said valves, shafts journaled in said blocks, a spring forcing said blocks apart, shafts journaled in the steam-chest and said blocks, balanced valves mounted thereon in the openings of said blocks, spring-depressed crank-arms upon said shafts, slotted links suitably guided pivoted to said arms and provided with rollers at their lower ends, cam-collars rotating with but adapted to slide upon the shaft, each collar being provided with two one-quarter and two one-half cams; one quarter and one half cam being arranged diametrically opposite each other, tie-rods connecting said cam-collars, a lever for shifting them longitudinally on the shaft, so as to cause the desired cams to engage the rollers of said links, a sector, and a spring-actuated dog carried by said lever and engaging said sector, substantially as described.

8. In a rotary engine, a circular piston provided with a radial notch, a T-shaped wing seated therein, consisting of a pair of sections 26, lap-jointed together and provided with opposing cavities 27, and with pins 29, projecting inward at opposite sides of the stem of the wing, springs 28 seated in said opposing cavities and exerting outward pressure upon said sections, and springs 30, secured to the pistons and having their opposite ends engaging said pins and pressing outward upon the wing, substantially as described.

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

JOHN BODAM.

Witnesses:
B. W. KNIGHT,
JOSHUA BRADLEY.