No. 652,317. Patented June 26, 1900.

J. KNOWLES.

ROTARY ENGINE.

(Application filed Dec. 19, 1899.)

(No Model.) 3 Sheets—Sheet 1.

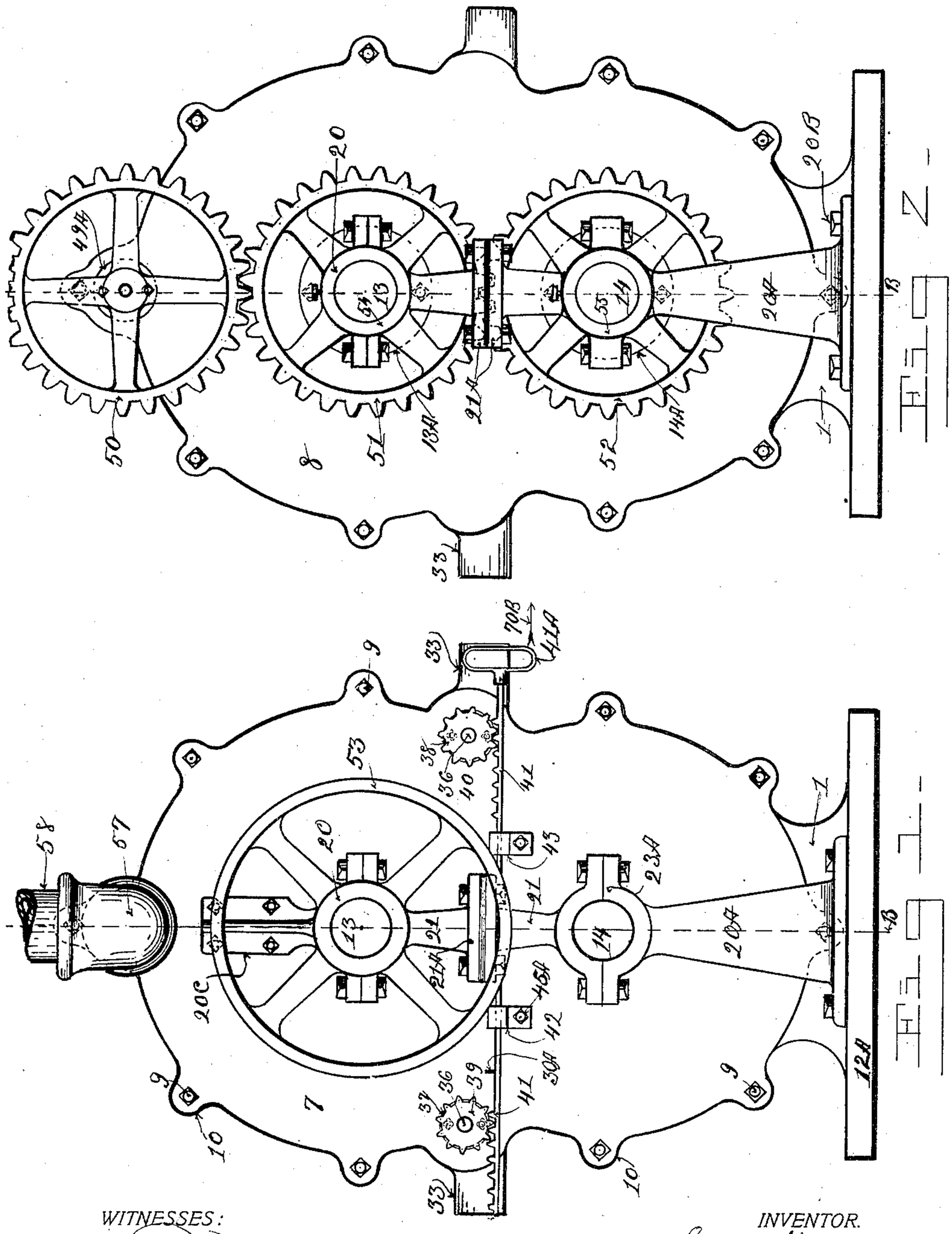

FIG. 1.

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Claude. A. Dunn.

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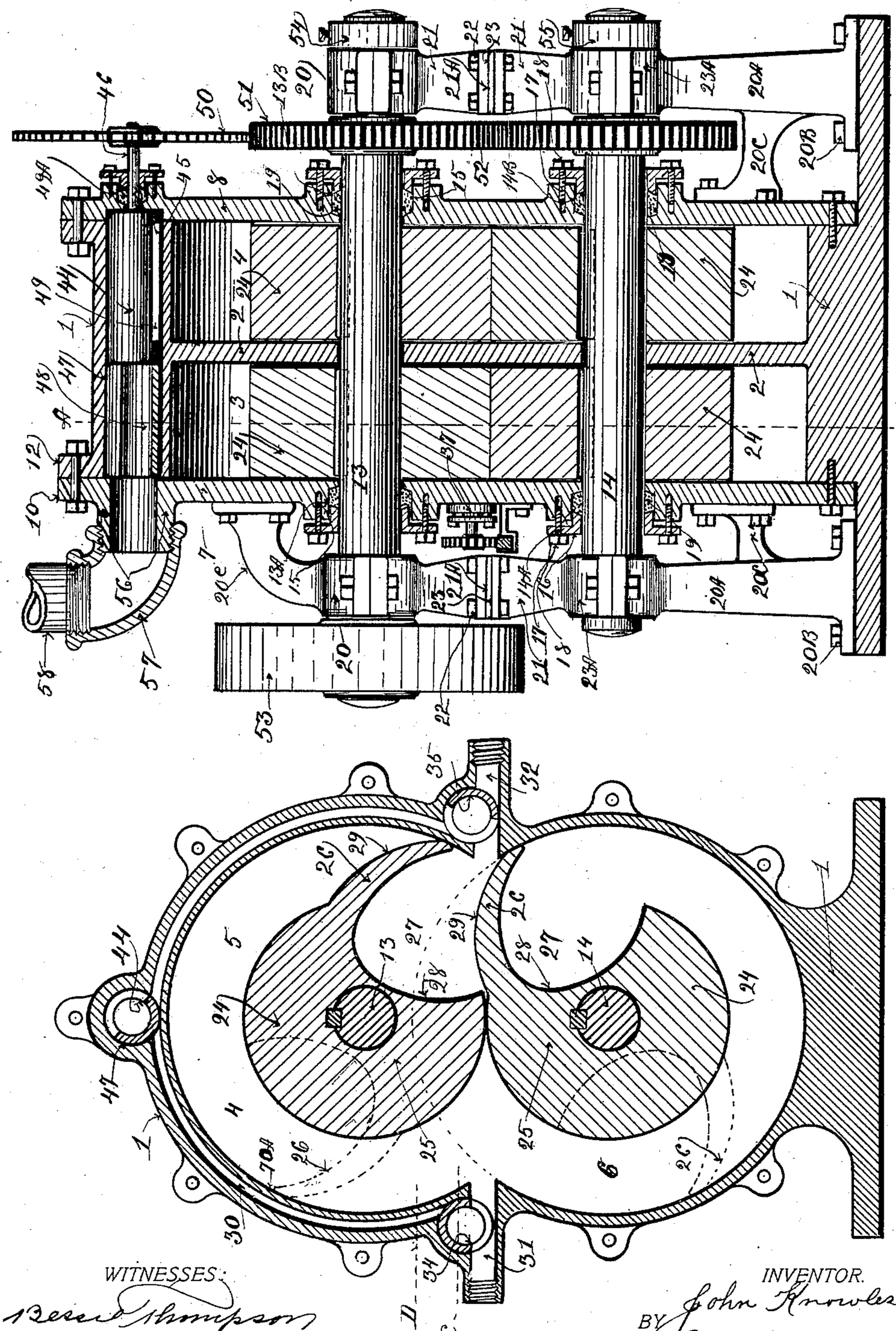

FIG. 4.

FIG. 5.

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(No Model.) 3 Sheets—Sheet 3.

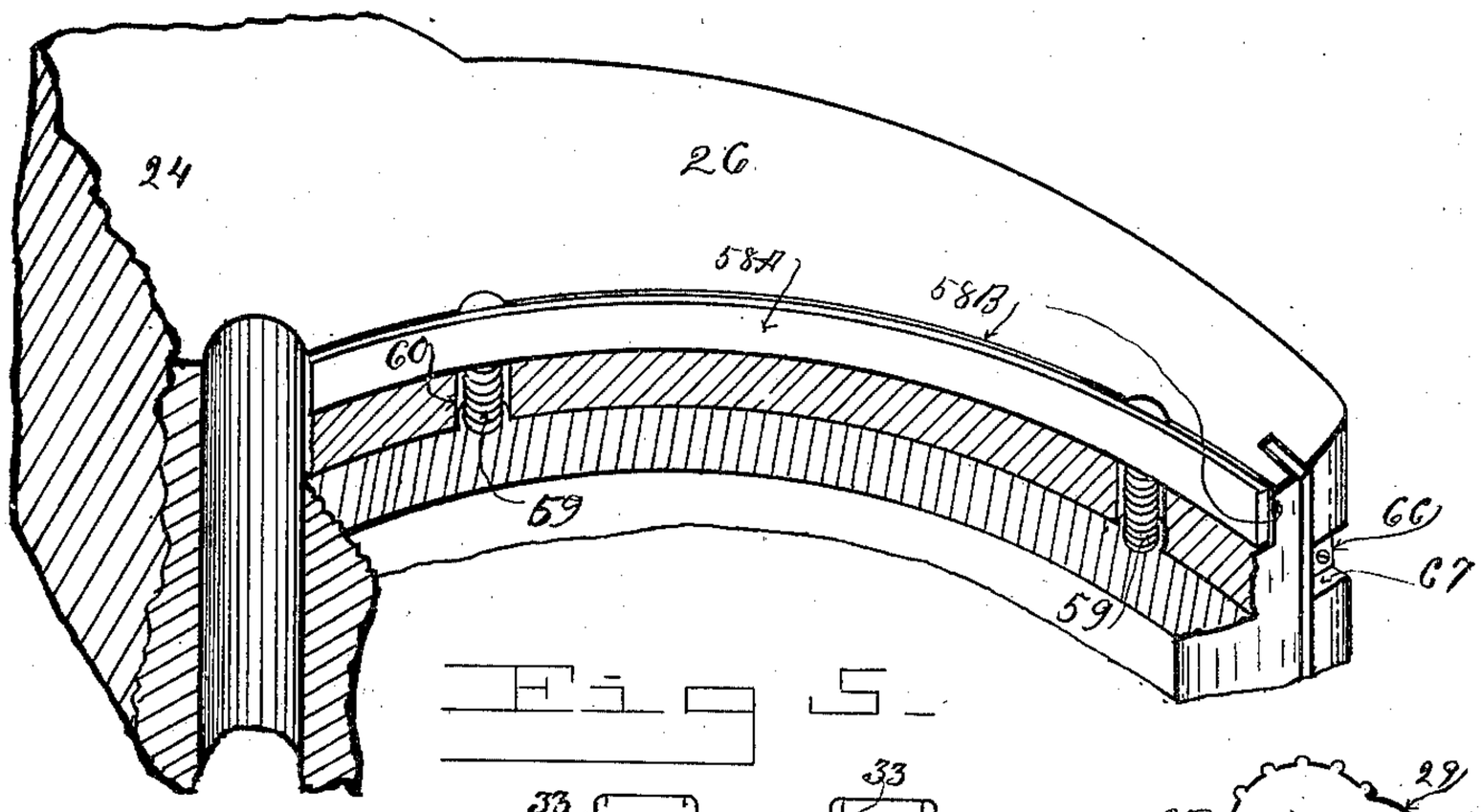

Fig. 5.

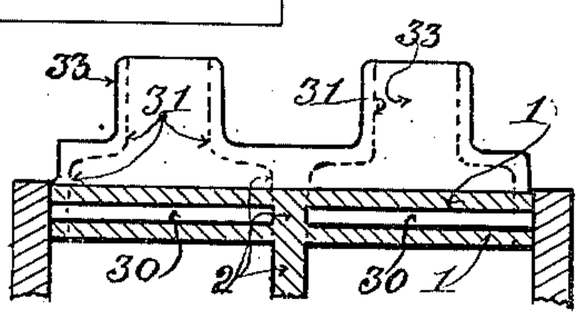

Fig. 11.

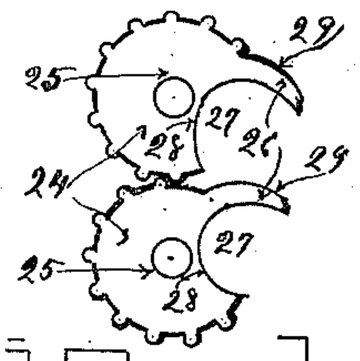

Fig. 12.

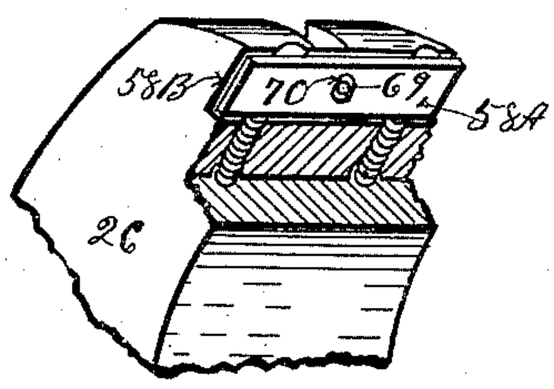

Fig. 6.

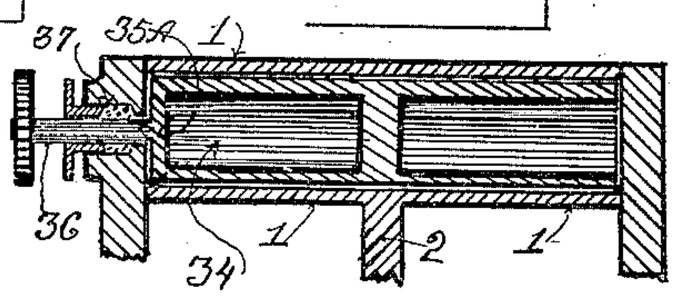

Fig. 7.

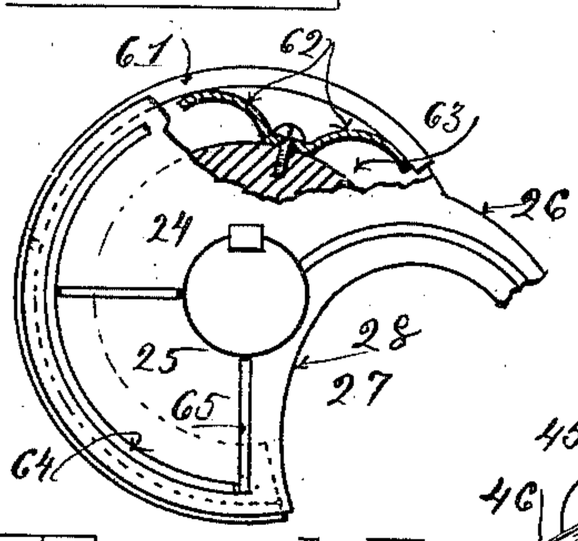

Fig. 10.

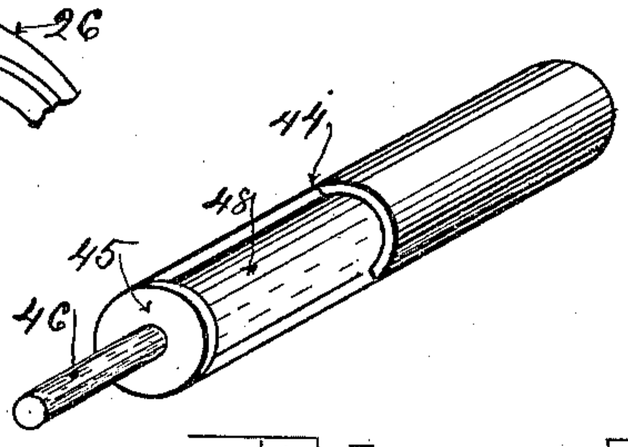

Fig. 9.

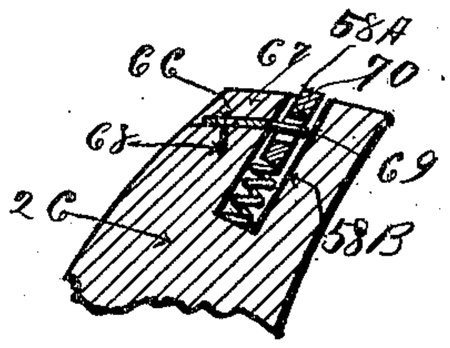

Fig. 8.

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UNITED STATES PATENT OFFICE.

JOHN KNOWLES, OF DENVER, COLORADO.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 652,317, dated June 26, 1900.

Application filed December 19, 1899. Serial No. 740,901. (No model.)

To all whom it may concern:

Be it known that I, JOHN KNOWLES, a citizen of the United States of America, residing at Denver, in the county of Arapahoe and State of Colorado, have invented certain new and useful Improvements in Rotary Engines; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the figures of reference marked thereon, which form a part of this specification.

My invention relates to improvements in rotary engines; and the objects of my invention are, first, to provide a rotary engine having two or more cylinders and two pistons in each cylinder arranged to be rotated in opposite directions by steam and arranged in frictional contact with one another throughout a portion of their circumference, and, second, to provide a compact, simple, and durable rotary double engine. I attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation of my improved rotary engine. Fig. 2 is a side elevation of the opposite side of the engine from that shown in Fig. 1. Fig. 3 is a cross-section of Fig. 4 on line A. Fig. 4 is a vertical sectional view on line B of Figs. 1 and 2 with certain parts shown in elevation. Fig. 5 is a fragmentary view of one of the pistons, showing the application of a packing-strip to the side of the piston. Fig. 6 is a fragmentary view of the end of the pistons' arms, showing the application of a packing-strip to the end of the arm of the piston where it bears against the internal periphery of the cylinder. Fig. 7 is a plan view of the exhaust-valves on line C of Fig. 3. Fig. 8 is a perspective view of the steam-inlet valve. Fig. 9 is a sectional fragmentary view of the end of the arms of the pistons and the packing-strip. Fig. 10 is a fragmentary side elevation of one of the pistons, showing a portion broken away and one arrangement of packing-strips for the sides, face, and arm of the pistons. Fig. 11 is a fragmentary cross-section of the cylinder, showing the steam-inlet ports on line D of Fig. 3 and also showing a plan view of exhaust-ports. Fig. 12 illustrates a modification of the pistons.

Similar letters of reference refer to similar parts throughout the several views.

Referring to the drawings, the numeral 1 designates the casing. It is divided by a partition 2 into two independent cylinders 3 and 4. Each cylinder is also divided into two semicircular parts 5 and 6, the centers of which are placed in vertical alinement. The cylinders on each side of the central partition 2 are the same in size and arrangement. Cylinder-heads 7 and 8 are secured to opposite sides of the cylinder-casing by bolts 9, that pass through lugs 10 and 12, formed on the heads and cylinder at suitable intervals apart to register opposite each other. The cylinder-head 7 I term the "front" head and the head 8 the "rear" cylinder-head. A base 12^A is cast integral with the casing. Through the center of each cylinder I journal shafts 13 and 14. These shafts extend through the central partition and through both cylinder-heads, which are provided with stuffing-boxes 13^A and 13^B and 14^A and 14^B. These stuffing-boxes consist of the hollow hubs 15, into which glands 16 fit slidably. The glands are adjustably secured to the hubs by the studs 17 and nuts 18. Suitable packing 19 is placed in the stuffing-boxes to prevent leakage of the steam. The shafts 13 and 14 are journaled in boxes 20 and 23^A, respectively, which have an arm member 20^A, that extends to the base, to which they are secured by bolts 20^B. Bracket portions 20^C extend from the arm to the cylinder-heads and are bolted to them. The lower and upper boxes are illustrated connected together by an arm 21, which is divided into two parts that are clamped together at 21^A by bolts 22. Several thin pieces 23 of any suitable material, such as paper, may be placed between the clamped parts of the arm, which will permit a little vertical adjustment of the shafts toward one another to compensate for wear of the engaging surfaces of the pistons, as will be further described hereinafter.

Upon the shafts on each side of the partition I secure pistons 24. These pistons comprise a semicircular disk portion 25, which is considerably smaller in diameter than the diameter of the cylinders, and an arched arm

portion 26, that projects from the disk portion and extends to the inner periphery of the cylinders. The pistons on opposite sides of the partitions are arranged with their arms standing diametrically opposite to each other, as shown in Fig. 3.

The diameters of the disk portions of the pistons are equal and their peripheries meet and bear and roll upon each other through about one-half of their diameters. The disks are cut away under each arm portion, and a recess 27 is formed of a curvature and of just sufficient size to allow the arm of each piston-disk to rotate around its own axis in the recess of the coöperating piston when the arm of each piston passes into the plane or orbit of the coöperating piston, each arm folding into the recess of the other and rolling around the curve 28, which is formed to register with the outside periphery 29 of the arms. There are thus two pairs of pistons in the double cylinder, and two pistons are required in each cylinder to make an operative rotary engine. In the peripheral edge of the upper half of these cylinders a steam-inlet port 30 is formed, which is divided by a partition similar to the cylinders. This inlet-port extends in a semicircle to near the horizontal center of the intersection of the two portions of each cylinder, where the peripheries of the two pistons meet. At this point the steam-inlet port intersects the exhaust-ports 31 and 32, which extend outward to the atmosphere through tubular projecting portions 33, that are threaded to receive pipes to lead the exhaust-steam away from the engine. These exhaust-ports also open into the cylinder.

At the point of intersection of the ends of the steam-inlet port and the exhaust-port valves 34 and 35 are placed. These valves rest in circular chambers bored out in the casing of the cylinders. The valves are alike and extend across both cylinders, as shown in Fig. 7. They consist of round hollow members, with about one-half of their shell cut away. One of their ends may be open; but the opposite end is closed by a disk portion 35^A, from which a valve-stem 36 extends. These stems pass through stuffing-boxes 37 and 38, formed in the adjacent cylinder-head and extend beyond it. Upon the ends of the stems gears 39 and 40 are secured. These gears mesh into a toothed bar 41, which extends from one gear to the other. (See Fig. 1.) The bar is slidably supported in boxes 42 and 43, which are secured to the adjacent cylinder-head by bolts 45^A. The gear-teeth of the bar are arranged to mesh with those of the gears and are placed to turn both gears in the same direction and in unison, and as the gears are of the same diameter the valves are rotated the same amount of their circumference. These exhaust-valves are, however, set opposite to one another, so that one is always closed and the other is always open to the exhaust-ports and steam-inlet ports, as shown in Fig. 3, in which the valve 34 and exhaust-port 31 are open and the steam-inlet port 30 is closed at that end by this valve, and the valve 35 and exhaust-port 32 are closed and the steam-inlet port 30 is open. On one end of the toothed bar a handle 41^A is placed, by which an operator may slide it through its boxes and reverse the positions of the valves. A stop-pin 30^A is placed in the bar to define the movement of the bar and of the valves, which should be about two-fifths of their revolution, this amount of movement being sufficient to reverse the ports.

In the steam-inlet port, preferably at the top of the cylinder-casing, a steam-inlet valve 44 is placed. This valve is also a hollow tubular valve open at one end and having a disk 45 and stem 46 at the opposite end. It is seated to rotate in a chamber 47, which is bored out in the casing. This valve is, however, arranged with opposite ports 48 and 49, as shown in Figs. 4 and 8, which are arranged to admit steam to the opposite cylinders of the engine in alternate order, one port being closed to the admittance of steam to one cylinder and the other being open in alternate order as the valve rotates.

The valve-stem 46 extends through a stuffing-box 49^A, and at its end a gear 50 is secured. This gear meshes with a gear 51, secured to the shaft 13 of the pistons of the upper portion of the cylinders, and the gear 51 meshes into a gear 52, secured to the shaft 14 of the pistons of the lower portions of the cylinders. These three gears are of equal diameters; but the valve-gear may be much lighter. The gears on the shafts hold the pistons in operative rotative relation and prevent any movement or creeping of one over the other. Should any movement take place, the pistons would collide with each other and lock themselves against rotative movement. These gears also assist in driving each shaft from the piston movement of the other. Upon the opposite end of the upper shaft a belt fly-wheel 53 is secured. Collars 54 and 55 are secured to the ends of the shafts adjacent to the gears. The cylinder-head 7 contains a tubular projection 56, which registers opposite the upper end of the steam-inlet valve. The end of this projection is threaded, and an elbow 57 is threaded to it. A pipe 58 also leads from the elbow to a source of steam-supply.

All the pistons should be packed on all sides to prevent steam passing them to the exhaust-ports, and while the form of the pistons is such that the circular packing-rings in common use for packing circular pistons cannot be used with them, yet there are many piston-packings in use that can be adapted to them. Consequently my invention contemplates the use of any suitable packing for the opposing surfaces of the pistons and the cylinders. I illustrate, however, in Figs. 5, 6, 9, and 10 a simple packing which comprises a thin strip 58^A, fitted loosely in a groove 58^B. Under the strip, at its opposite ends, expansive springs 59 are placed in holes 60 to press the

strips resiliently outward against the adjacent surface of the cylinder. These strips can be arranged around the arms and disks of the piston and transversely across the end of the piston, as shown in Figs. 5, 6, and 9. A segment 61 of a ring can also be placed in the periphery of the disk circumferentially, as shown in Fig. 10, and springs 62 may be arranged at suitable intervals apart in a circumferential groove 63, this being a common method of packing pistons and permits the two pistons to be packed on their contacting rolling surfaces. A segment of a ring 64 can also be inserted in the sides of the pistons and arranged with flat or coiled springs, as shown in Figs. 5, 6, 9, and 10, to press outward. Radial packing-strips 65 may also be arranged in the sides of the pistons in a similar manner. When strips are used transversely across the periphery of the piston, as shown in Figs. 5, 6, and 9, some means must be employed for securing them against displacement when they leave their own surrounding portion of the cylinder and pass through the orbit of the adjacent piston. I accomplish this by securing a clip 66 in a recess 67 by a screw 68. From the end of the clip a pin 69 projects through a slot 70 in the strip, which is enough longer than the pin to allow the packing-strip operative movement.

The operation is as follows: The steam flows through the steam-pipe and elbow into the inside of the hollow valve, one or the other part of which is always more or less open, and flows through the part that is open into the inlet-port 30 to the valve 35, through which it flows into the cylinder between the arms of the pistons and by its expansive power forces them in opposite directions, the upper piston moving up and the lower piston moving down. As the steam-inlet valve makes a complete revolution in the same time as the pistons through the medium of the gears and as the valve-ports occupy about one-half of the diameter of the valve, they are preferably arranged in relation to the inlet-port to cut off the steam at about one-half of their revolution, and consequently the pistions are moved by direct pressure about one-half of their revolution and are moved by the expansive forces of the steam the balance or about one-fifth of their revolution. Valves can, however, be provided that will cut off at a greater or less portion of the pistons' circumferential movements by increasing or diminishing the circumferential area of the valve inlet-ports. Both pistons work expansively from the cut-off point 70^A until they reach the ends of their surrounding peripheral casing, when each passes into the orbit of the other, their respective arms folding into and swinging around in the recess under the arm of the opposite piston. The steam then exhausts out through the valve 34, which is open, and the exhaust-port 31, the opposite port 32 being closed by the valve 35. The peripheries of the disk portions of the pistons should bear and roll on each other, and if their faces are formed smooth, true, and even, or if they are fluted or toothed, as shown in Fig. 12, the packing shown in Fig. 10 may not be necessary to prevent steam from passing between them. The two shafts are made vertically adjustable by the removable packing between their divided arms, especially in order to allow the upper shaft to be lowered slightly from time to time or to be clamped tight enough to draw the shaft slightly down as the peripheries of the pistons wear by removing a very thin layer of the packing between the joint of these arms. As the pistons and inlet-port valves of one cylinder are arranged diametrically opposite those of the opposite cylinder, one pair or set of pistons commences to receive steam at about the time the steam is cut off from the other set. The engine can be instantly reversed to run in the opposite direction by grasping the handle of the toothed bar and pulling it out in the direction of the arrow 70^B in Fig. 1, which partially rotates the valves about two-fifths of a revolution and closes the valve 35 and opens valve 34 to the exhaust and at the same time closes the steam-inlet port at the valve 34 side of the cylinder and opens it at the valve 35 side. The gears being also reversed by this movement reverse the direction of the steam-inlet valve. The piston-shafts can be made long enough to place two or more single or double cylinders on them side by side, thus enabling large horse-power to be obtained in a small amount of space.

My improved engine is very compact and simple and can be placed and set in any desired position, as the base can be placed at either end or side.

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

1. The combination with divided, double cylinders and removable cylinder-heads, of the shafts through said cylinders, pistons adapted to rotate in rolling contact with each other, inlet-ports leading into opposite sides of said cylinders, the rotating steam-inlet valve having oppositely-arranged ports, each of which is arranged to register with the steam-inlet port of one of said cylinders, the exhaust-ports arranged at the opposite entrances of said inlet-port into said cylinder, the tubular exhaust-valves rotatively seated at the intersection of steam inlet and exhaust ports, the valve-stem on said exhaust-valves, the gears on said valve-stems, and a toothed bar slidably supported in mesh with the gears of said exhaust-valves, and means for moving said bar manually to reverse said exhaust-valves and for defining their rotative movement, and means including gears of equal diameter for rotating said pistons and said steam-inlet valves at equal speeds and in operative, rotative unison, substantially as described.

2. The combination with the casing, the double divided cylinders, the cylinder-heads, the rolling pistons, the shafts supporting said pistons, the journal-boxes for supporting said shafts, the gears secured to said shafts, the belt fly-wheel and the stuffing-boxes surrounding said shafts, with the semicircular-shaped steam-inlet port arranged to deliver steam at substantially the horizontal center of the rolling contact of said pistons and at diametrically-opposite sides of said cylinder, an exhaust-port in each cylinder in line with said horizontal rolling center of said pistons at opposite sides of said cylinders intersecting the cylinder-entrances of said steam-inlet ports, a round, hollow exhaust-valve rotatively journaled at the intersection of each of said steam inlet and exhaust ports, and extending across both cylinders and having a port-opening through its shell of about one-half of its diameter and arranged and adapted to close the steam-inlet port on one side of said cylinder and open the adjacent exhaust-port, and to open the steam-inlet port on the opposite side of said cylinder and close the adjacent exhaust-port, and means including gears and a toothed rack arranged to connect said valves together for manually reversing the position of the valves, substantially as described.

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

JOHN KNOWLES.

Witnesses:
BESSIE THOMPSON,
CLAUDE A. DUNN.