J. GRINDROD.

ROTARY ENGINE.

APPLICATION FILED AUG. 30, 1907.

994,313.

Patented June 6, 1911.

3 SHEETS—SHEET 1.

Fig. 2.

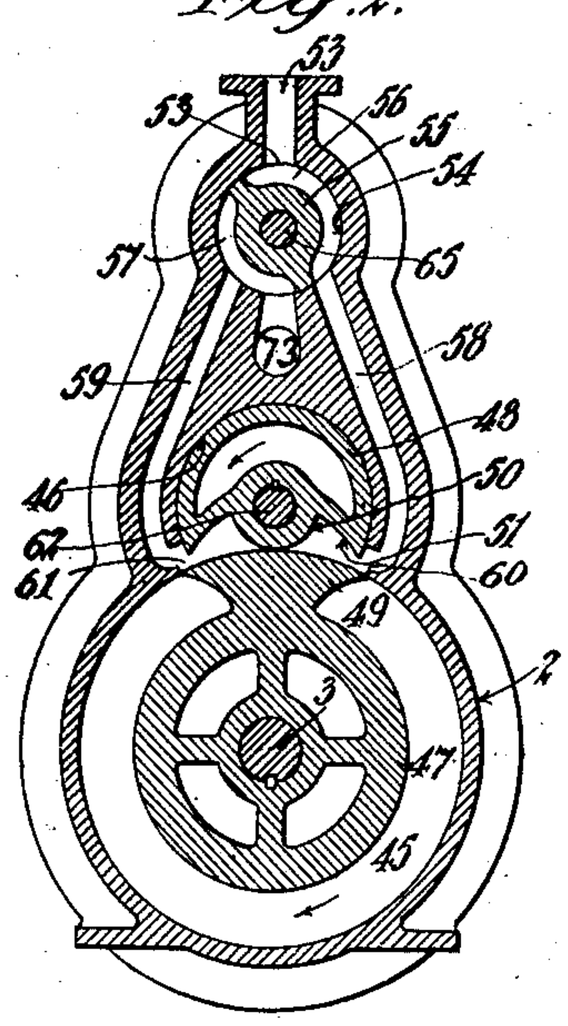


Fig. 1.

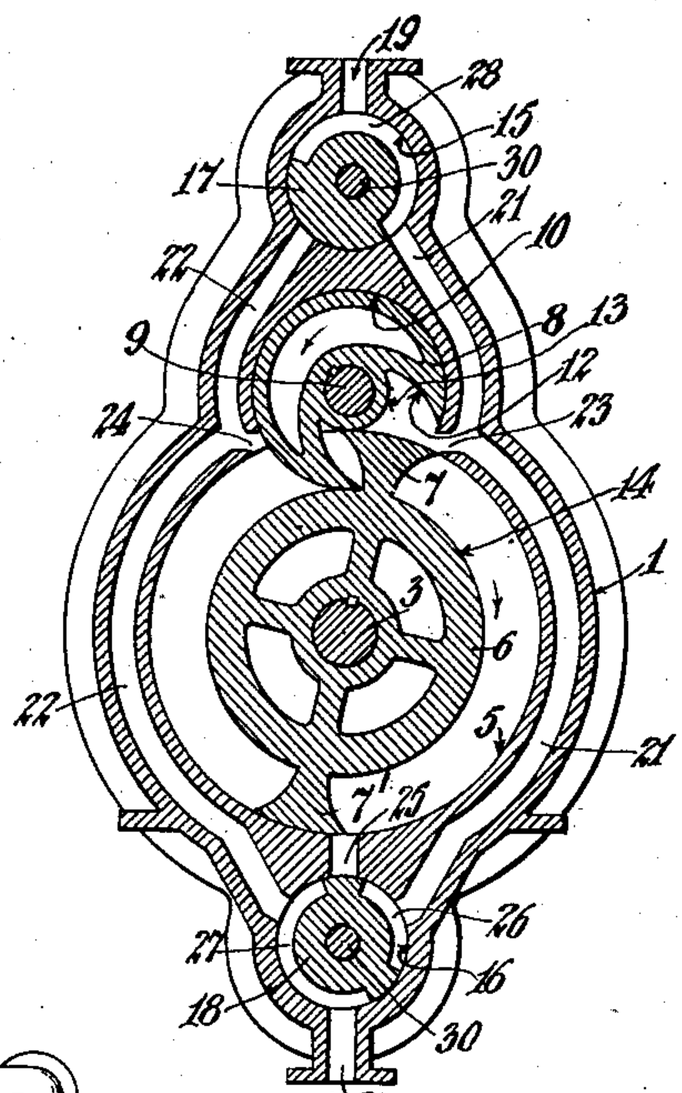
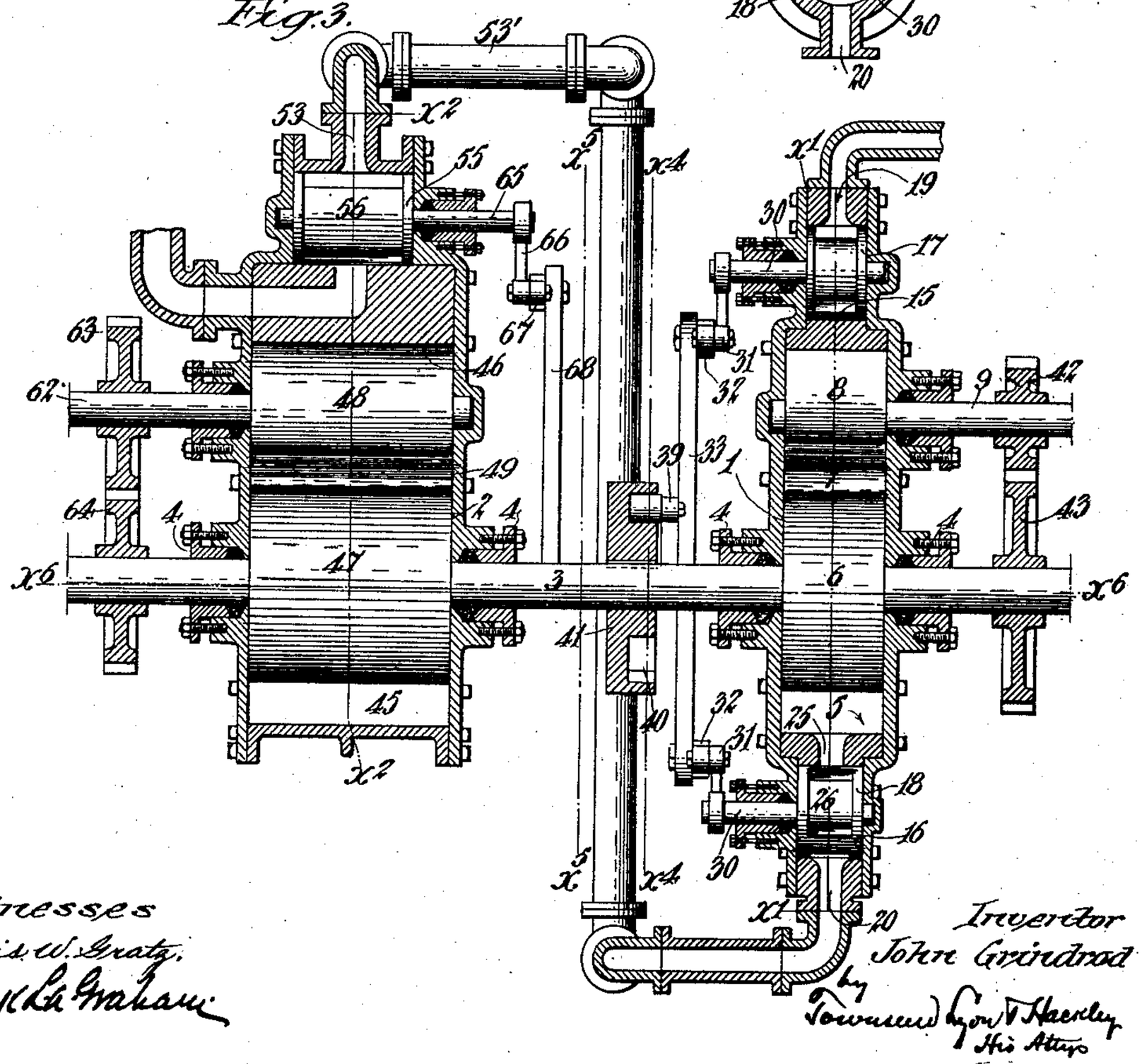


Fig. 3.



Witnesses
Louis W. Gratz.
Frank L. Graham.

Inventor
John Grindrod
by
Townsend Lyon & Hackley
His Attys

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3 SHEETS—SHEET 2.

Fig. 5.

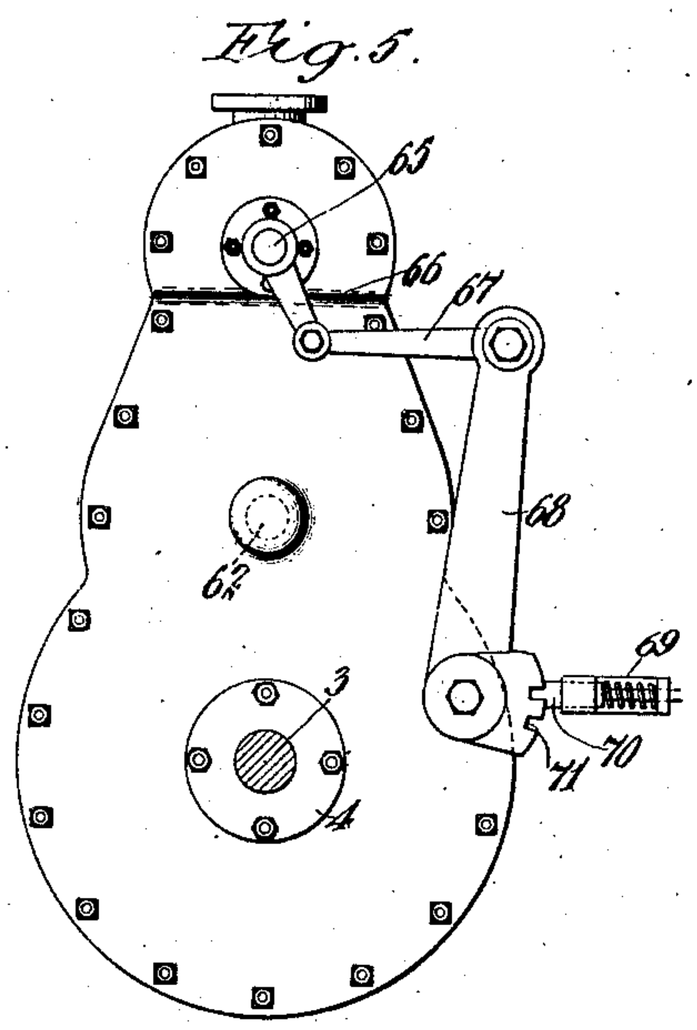


Fig. 4.

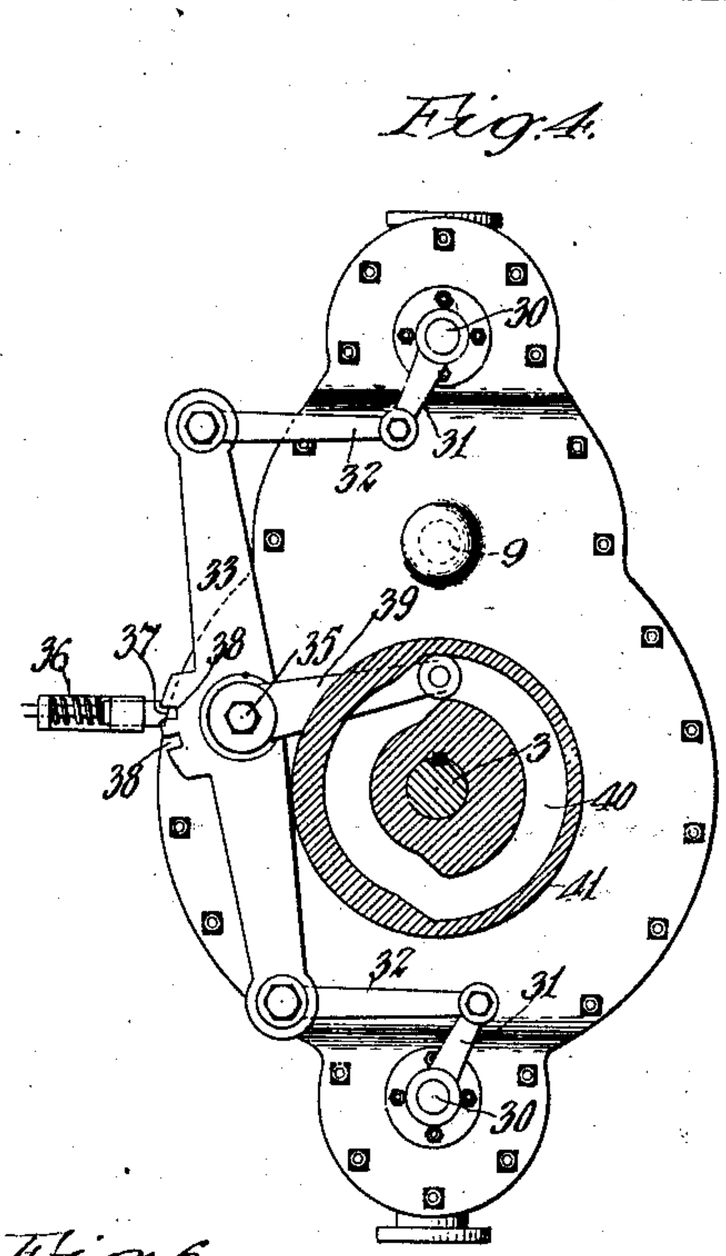
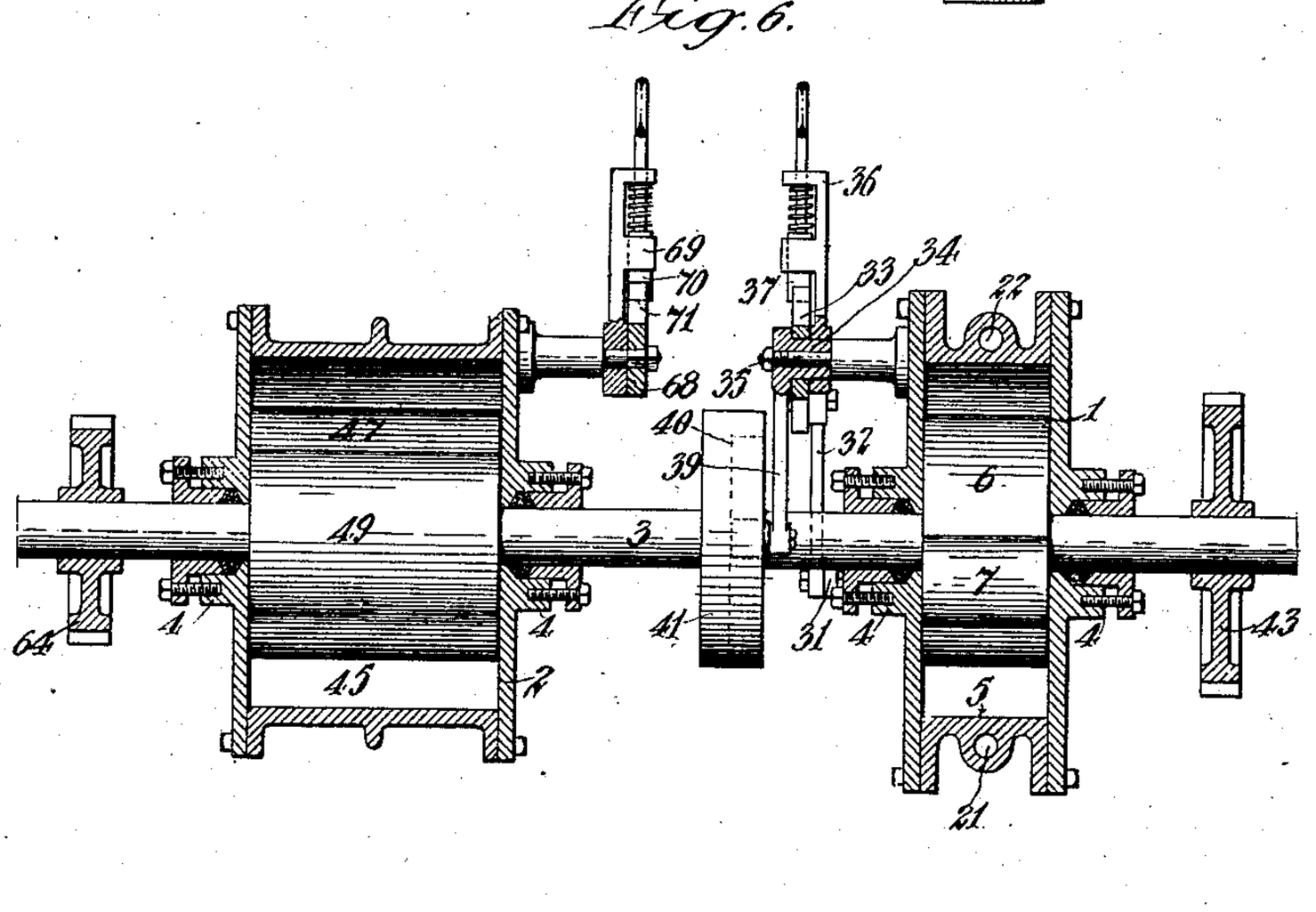


Fig. 6.



Witnesses:

Louis W. Gratz

Frank L. Abraham

Inventor

John Grindrod.

by Townsend Lyon & Hackley

His Attorneys

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3 SHEETS—SHEET 3.

Fig. 7.

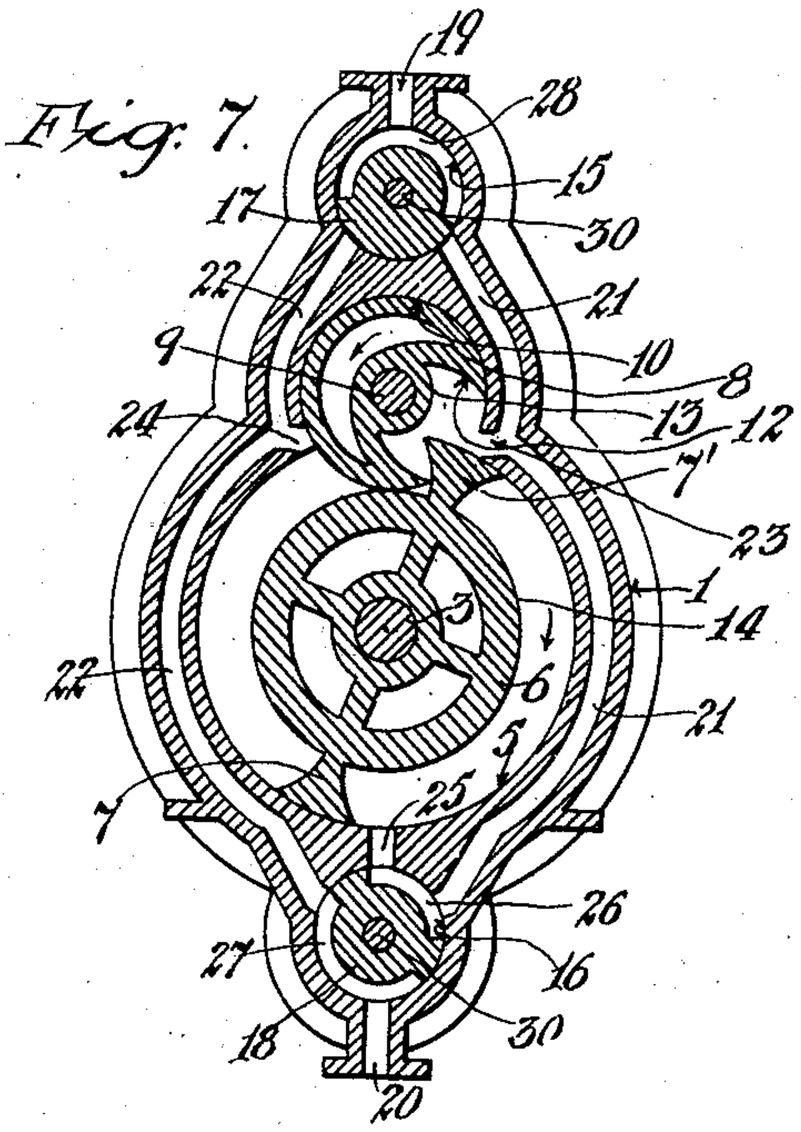
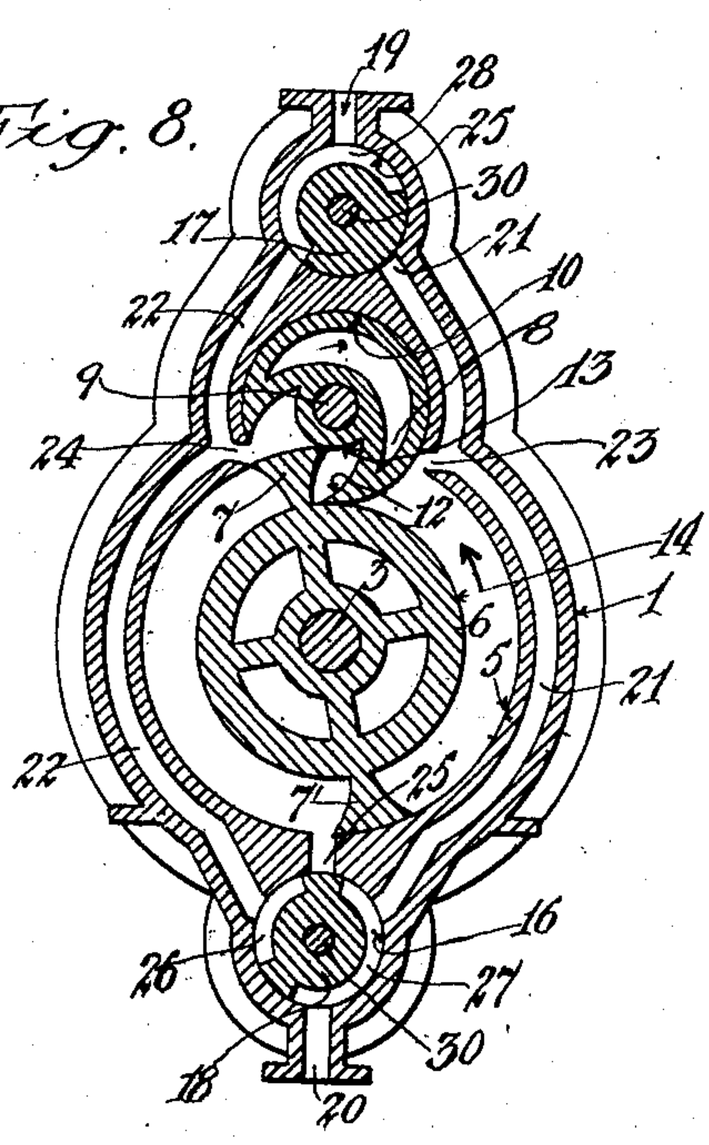


Fig. 8.



Witnesses:-
Louis W. Gratz
Frank L. Graham

Inventor
John Grindrod
by Townsend Lyon & Hackley
his Attys

UNITED STATES PATENT OFFICE.

JOHN GRINDROD, OF BAKERSFIELD, CALIFORNIA.

ROTARY ENGINE.

994,313. Specification of Letters Patent. Patented June 6, 1911.

Application filed August 30, 1907. Serial No. 390,808.

To all whom it may concern:

Be it known that I, JOHN GRINDROD, a citizen of the United States, residing at Bakersfield, in the county of Kern and State of California, have invented a new and useful Rotary Engine, of which the following is a specification.

This invention relates to a rotary engine for use with steam, or other fluid pressure, and its main object is to provide for successive expansions of the steam or fluid pressure medium in the same cylinder.

A further object of the invention is to provide, in connection with this invention, for further expansion of the steam in another cylinder.

In the accompanying drawings:—Figure 1 is a vertical section of the main or high pressure engine cylinder on the line x^1—x^1 in Fig. 3. Fig. 2 is a vertical section of the supplementary or low pressure cylinder on the line x^2—x^2 Fig. 3. Fig. 3 is a longitudinal section of the engine. Fig. 4 is a section on the line x^4 in Fig. 3, looking toward the high pressure cylinder. Fig. 5 is a section on the line x^5 in Fig. 3, looking toward the low pressure cylinder. Fig. 6 is a horizontal section on line x^6—x^6 in Fig. 3. Fig. 7 is a view similar to Fig. 1, showing the position of the valves when the steam is being expanded. Fig. 8 is a view similar to Fig. 1, showing the position of the valves for reversal.

The invention comprises, as a whole, a main or high pressure cylinder 1, a supplementary or low pressure cylinder 2, and shafts 3 extending through both of said cylinders, the cylinders having stuffing-boxes 4 therefor, said shafts having bearings, not shown.

Certain features of the invention are embodied wholly in the main cylinder 1, and the supplementary cylinder may or may not be used, according to the degree of expansion required. In the main cylinder 1 is provided a cylinder chamber 5, within which works the piston member 6 mounted on shaft 3 and provided with pistons 7 which fit and slide within the cylinder, the body of the piston member 6 being cylindrical and of smaller diameter than the cylinder 5. An abutment member 8 is fast on the shaft 9, which is mounted to turn in the side walls of the casing of cylinder 1 and is connected by gears 42, 43 to shaft 3. Said abutment being of cylindrical shape, fits and turns within a cylindrical chamber 10 in the cylinder casing 1 and has a recess 12 formed therein to receive and allow passage of the piston 7 of the piston member 6, the bottom 13 of said recess being formed concentric with the shaft 9 and of such diameter that the cylindrical peripheral portions of pistons 7 will roll closely on said bottom 13 to form a steam-tight joint, the cylindrical periphery of abutment member 8 also rolling on the cylindrical portion 14 of the piston member 6 to give a steam-tight joint. At the top and bottom of the casing 1 are provided chambers 15, 16 for inlet valves 17 and controlling valve 18, the upper chamber communicating with the steam supply passage or inlet 19 for the engine, and the lower chamber communicating with a steam exhaust or outlet 20 for the engine. Between these two valve chambers extend channels or passages 21, 22 at the respective sides of the cylinder, said channels communicating by openings 23, 24, with the cylinder chamber. The lower valve chamber 16 also communicates through a port 25 with the cylinder chamber 5, the valve member 18 having two recesses 26, 27 for establishing communication between the several passages. The valve member 17 in the upper valve chamber has a single recess 28. Valve members 17, 18 are carried by rock shafts 30, having arms 31 connected by links 32 to a rocking lever 33 mounted to turn on a sleeve 34. Said sleeve is hollow and is itself mounted to turn on a stud 35, said sleeve having a handle member 36 with a latch 37 to engage in either one of two notches 38 in the side of lever 33. Said sleeve also carries a lever 39 to be engaged and operated by a cam slot 40 in a disk 41 on shaft 3, this cam slot 40 having two concentric portions of different diameter connected by inclined portions of short circumferential length, so that the valves are held in set position during the greater part of the circular stroke and are rapidly changed from one position to the other at the times when the pistons are passing the abutments.

The low pressure engine comprises the casing 2 having a cylinder chamber 45 therein and an abutment chamber 46 to receive respectively the piston member 47 on shaft

3 and an abutment 48 on shaft 62 connected to shaft 3 by gears 63, 64. The piston member carries a piston 49 whose cylindrical periphery fits the wall of the cylinder and joins steam tight against the cylindrical bottom 50 of the recess 51 in the abutment 48. At its upper part the casing 2 is provided with an inlet 53 which is connected by pipe 53′ with the outlet 20 of the high pressure cylinder, said inlet leading to a valve chamber 54 containing a valve 55 having two recesses 56, 57, this valve chamber communicating by two passages 58, 59 with ports 60, 61 at the opposite sides of abutment chamber 48 where it opens into the cylinder chamber 45, said valve chamber also communicating with exhaust port 73. The piston 49 is of sufficient circumferential length to close the communication between the two chambers 45, 46, into which the ports 60, 61 communicate, so that when the piston is passing the abutment, communication between these ports and the piston chamber is cut off, thereby avoiding direct passage of steam from the inlet port through the piston chamber to the outlet port at this time.

Valve 55 is carried by a shaft 65, having an arm 66 connected by links 67 to a lever 68, said lever having an operating handle 69 and provided with a latch 70 working in a fixed rack 71 to lock the lever in one position or the other for direct or reverse motion of the engine.

The operation is as follows:—Referring to the high pressure cylinder and assuming the parts to be in position shown in Fig. 1, the piston 7 is just at the beginning of the full pressure motion, the valves having just moved to position shown. Valve 17 cuts off connection to passage 22 but opens connection from steam pressure inlet 19 to passage 21, and as this passage is always open to the cylinder and abutment chamber, through port 23, pressure is thus admitted to the rear face of the abutment, or to the rear face of the piston 7, to drive the piston forwardly in the direction of the arrow. At this time, and in fact at all times, when the engine is running in this direction, valve 17 shuts off connection to passage 22. This passage is open to the cylinder and abutment space at all times, through port 24, and at this time it is also open to outlet 20 through valve 18, so that steam in the piston chamber in front of piston 7′ exhausts through the outlet. As the piston 7 about completes a semirotation, it passes expansion port 25, and at the same time piston 7′ passes the abutment. At this moment the valves 17 and 18 are shifted by the automatic operating means therefor, to the position shown in Fig. 7, valve 17 then cutting off connection to passage 21 as well as to passage 22 and valve 18 opening connection from port 25 to passage 21. Piston 7 having passed port 25, the steam which has passed in back of piston 7 and has been impounded between said piston 7 and the following piston 7′ flows through port 25, valve recess 26, passage 21, port 23 to the piston and abutment space, exerting pressure on the rear face of said following piston 7′. The steam thus produces a second effect on the back of piston 7′, and expands until it is reduced to about one half the initial pressure. As the revolution is completed, piston 7 passes port 24, opening this space to exhaust, the valve 18 maintaining the connection of passage 22 to outlet 20 at all times when the engine is running in this direction. At this time the valves 17 and 18 are shifted back to position shown in Fig. 1 by operation of the cam slot 40, and the operation is then repeated. During the next semirotation, the space between the pistons 7, 7′ (in front of piston 7) remains filled with steam at about one half pressure, and as soon as piston 7′ passes port 24, this steam also passes out at 24, through passage 22 and outlet 20. To reverse the engine, the lever 36 is operated to turn the valves relatively to the operating means, so that although the angular automatic motion of the valves remains unchanged in amount, it is shifted in position to the other side of the valve chambers so as to reverse the operative relation of the valves with reference to the two passages 21, 22, as shown in Fig. 8, thereby reversing the engine.

In case the low pressure cylinder is used, its operation will be as follows. The valve member 55 is stationary, except on reversal of the engine, and continually opens communication from inlet 53 through one or the other of the channels, for example, channel 58, and through port 60 to one side of the cylinder chamber or to the abutment space above the same. Assuming the parts to be in the position shown in Fig. 2, the pressure will be exerted against the wall of the abutment recess, turning the abutment in the direction of the arrow and causing the piston member to also turn in the direction of the arrow. At this moment the piston closes the communication from the steam recess in the abutment to the cylinder chamber, and also form the cylinder chamber to the channel 59 which, in this position of the valve 55, is connected to the exhaust 73. Immediately upon further movement of the piston member 47, the piston opens exhaust connection through channel 59. The pressure of the incoming steam is exerted first against the wall of the abutment recess, and then on further rotation of the parts, as the periphery of the piston leaves the bottom of the recess and the periphery of the abutment comes against the cylindrical body of the piston member, the pressure is delivered against the rear face of the piston and continues to drive the piston in the same direc-

tion until the circular stroke being completed, the piston member opens to exhaust at this rear face and the steam remaining behind it is allowed to escape through the exhaust port 73. It will be noted that the low pressure cylinder is expanding the steam from the high pressure cylinder, and as both the cylinder members are rotating at the same speed it is necessary that in order that there may be continuous increase of volume, and therefore expansion and development of energy by the steam in this operation, that the length of the low pressure pistons and cylinders should be greater than that of the corresponding parts of the high pressure cylinder, to the extent required to give the proper further expansion in the low pressure cylinder. To reverse the engine, it is only necessary to move both of the handle members 36, 69 simultaneously, the operation of the handle member 36 for the high pressure cylinder serving to shift the position of the controlling lever 33 of the valve members relatively to the operating lever 35, so that though the valve members operate through the same stroke, they are in a different angular position and operate with respect to the left hand instead of with respect to the right hand channel. The operation of the reversing lever 69 for the low pressure cylinder is direct, simply shifting the connection for induction and eduction respectively from the right to left and left to right.

What I claim is:—

1. A rotary engine comprising a cylinder chamber, a piston member rotating therein and carrying pistons, abutment means cooperating with the pistons and piston member to divide the space within the cylinder chamber, valve means for supplying steam to the cylinder chamber between the abutment means and the rear face of the piston and for shutting off such supply when the piston has traveled through a determinate circular stroke, and valve means for opening communication from the space between the said piston and the following piston to the space between the said following piston and the abutment, whereby the steam maintained between the two pistons is allowed to exert pressure in expansion against the rear face of the following piston.

2. A rotary engine comprising a cylinder chamber, a rotary piston member therein carrying a plurality of pistons in rigid relation to the piston member, an abutment chamber and a movable abutment therein coöperating with the piston member, valve means for supplying steam to the cylinder between the abutment and the piston during a portion of each rotation and cutting off such supply during a further portion of the rotation, valve means for conveying steam so supplied between one of the pistons and the following piston, to act on the rear of the said following piston during such further portion of the rotation, and means operated by the piston member to operate the said valve means.

3. A rotary engine comprising a casing provided with a cylinder chamber, a rotary piston member therein carrying a plurality of pistons in rigid relation to the piston member, an abutment chamber, a movable abutment therein coöperating with the piston member, valve means for supplying steam to the cylinder between the abutment and the piston at either side of the engine during a portion of each rotation and for cutting off such supply during a further portion of such rotation, valve means for conveying steam so supplied during the first portion of the rotation between a piston and a following piston to act on the rear of said following piston during such further portion of the rotation, and means for operating said valve means to supply steam at one or the other side of the engine to reverse the same.

4. A rotary engine comprising a cylinder casing having a chamber, a rotary piston member therein provided with a plurality of pistons, an abutment coöperating with the piston member and pistons and geared to rotate in correspondence with the piston member, a steam supply connection, steam outlet means, the cylinder having a port at each side adjacent to the abutment, and an expansion port, and the cylinder casing having a passage at each side communicating with the port at that side and with the steam supply connection at one end and with the expansion port and the steam outlet at the other end, a valve controlling communication from such passage at each side to the steam outlet alternatively and also controlling the expansion port, and means operated by the engine for controlling said valve automatically.

5. A rotary engine comprising a cylinder casing having a chamber, a rotary piston member therein provided with a plurality of pistons, an abutment coöperating with the piston member and the pistons and geared to rotate in correspondence with the piston member, a steam supply connection, steam outlet means, the cylinder having a port at each side adjacent the abutment and an expansion port, and the cylinder casing having a passage at each side communicating with said port at that side, a valve controlling communication between said passage at each side and the steam supply connection, a valve controlling communication from the passage at each side to the steam outlet, said valve also controlling communication through the expansion port to said passages, and means operated by the engine for controlling said valves automatically.

6. A rotary engine comprising a cylinder casing having a chamber, a rotary piston member therein provided with a plurality of pistons, an abutment coöperating with the piston member and the pistons and geared to rotate in correspondence with the piston member, a steam supply connection, steam outlet means, the cylinder having a port at each side adjacent the abutment and an expansion port, and the cylinder casing having a passage at each side communicating with said port at that side, a valve controlling communication between said passage at each side and the steam supply connection, a valve controlling communication from the passage at each side to the steam outlet, said valve also controlling communication through the expansion port to said passages, means operated by the engine for controlling said valves automatically, and means for shifting the valves relatively to the automatic operating means to reverse their operative relation to the passages at the sides of the cylinder.

7. A rotary engine comprising a cylinder casing having a chamber, a rotary piston member therein provided with a plurality of pistons, an abutment coöperating with the piston member and pistons and geared to rotate in correspondence with the piston member, a steam supply connection, steam outlet means, the cylinder having a port at each side adjacent to the abutment and an expansion port, and the cylinder casing having a passage at each side communicating with said port and with the steam supply connection at one end and with the steam outlet at the other end, a valve controlling the communication of such passage at each side to the steam supply alternatively, and a valve controlling the communication from such passage at each side to the steam outlet alternatively and also controlling the expansion port, and means operated by the engine for controlling said valves automatically, comprising a cam operated by the engine, a lever operated by said cam, and a rocking lever provided with latch means engaging the cam-operated lever in two different positions, said rocking lever being connected to operate the valves.

8. A rotary engine comprising a cylinder casing having a chamber, a rotary piston member therein provided with a plurality of pistons, an abutment coöperating with the piston member and pistons and geared to rotate in correspondence with the piston member, a steam supply connection, steam outlet means, the cylinder casing having a passage opening into the piston-containing chamber and the said chamber having an expansion port, a valve controlling communication between said passage and the steam supply connection, a valve controlling communication between the expansion port and said passage, and means operated by the engine for controlling said valves automatically.

9. A rotary engine comprising a cylinder casing having a chamber, a rotary piston member therein provided with a plurality of pistons, an abutment coöperating with the piston member and pistons and geared to rotate in correspondence with the piston member, a steam supply connection, steam outlet means, the cylinder having a port at each side adjacent to the abutment and an expansion port and the cylinder casing having a passage at each side of the cylinder piston communicating with said port and with the steam supply connection at one end and with the steam outlet at the other end, a valve controlling the communication of such passage at each side of the steam supply alternatively, a valve controlling the communication from such passage at each side to the steam outlet alternatively and also controlling the expansion port, means operated by the engine for controlling said valves automatically, and a low pressure cylinder connected to receive the exhaust from the first cylinder and provided with piston and abutment means, operating in correspondence with those of the first cylinder to further expand the steam, and a manually operated reverse valve for the low pressure cylinder.

10. In a reversible rotary engine, a cylinder casing formed of two communicating cylindrical chambers and with passages communicating into said chambers at opposite sides, a recessed abutment member rotating in one chamber and a piston member rotating in the other of said chambers, the recess in the abutment member being of a less length than the unrecessed portion and the piston of the other member being of a less length than the remainder of the periphery of said member, but of sufficent circumferential length to close communication between said chambers as the piston passes the abutment to prevent direct passage of fluid between the said passages.

11. In a rotary engine, a casing provided with a chamber, an inlet and an outlet for said chamber and a passage connecting the inlet and the outlet, a cut off valve for the inlet, a piston member rotatably mounted in the chamber provided with pistons adapted to be acted upon by a motive fluid, and means for causing said fluid to return through said passage and act upon the succeeding piston in an expanded condition while the cut off valve is closed.

12. In a reversible rotary engine, a casing provided with two communicating chambers and passages communicating with said chambers at their points of union, a piston member in one chamber provided with a piston, a recessed member in the other cham-

ber adapted to co-act with the piston member, a valve at each end of said passages, and means for actuating said valves and members so as to close the inlet valve while the piston is co-acting with the abutment member.

13. In a reversible rotary engine, a casing provided with two communicating chambers and passages at each side of said chambers communicating with said chambers at the points of union of said chambers, said casing being provided with an inlet passage at one end of said first named passages adapted to communicate with both of said first named passages, and outlet passages at the other end of said first named passages adapted to communicate with both of said first named passages, a valve controlling communication from said inlet to either of said first named passages, a valve controlling communication from either of said first named passages to said outlet passage, a piston member rotatably mounted in one chamber provided with pistons, a recessed member in the other chamber adapted to co-act with the piston member, and means for actuating said valves and members so as to close the inlet valve while the piston is co-acting with the abutment chamber.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 2nd day of July 1907.

JOHN GRINDROD.

In presence of—
FREDERICK S. LYON,
FRANK L. A. GRAHAM.