No. 871,807. PATENTED NOV. 26, 1907.

J. E. LEHMAN.

ROTARY ENGINE.

APPLICATION FILED MAR. 20, 1907.

2 SHEETS—SHEET 1.

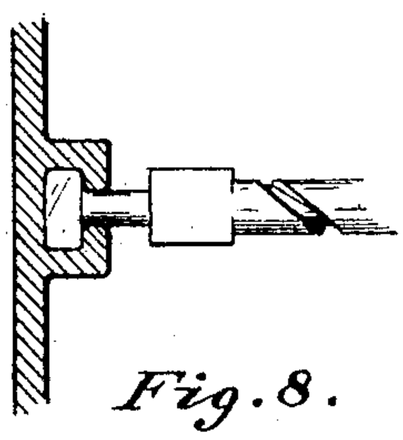

Fig. 8.

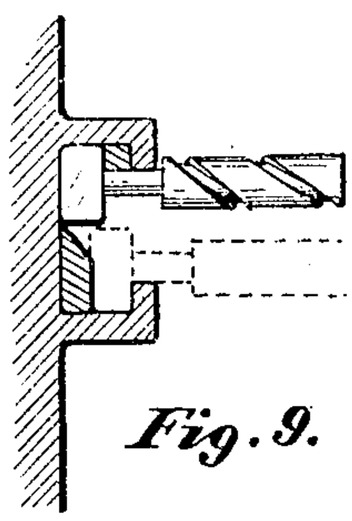

Fig. 9.

Fig. 1.

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2 SHEETS—SHEET 2.

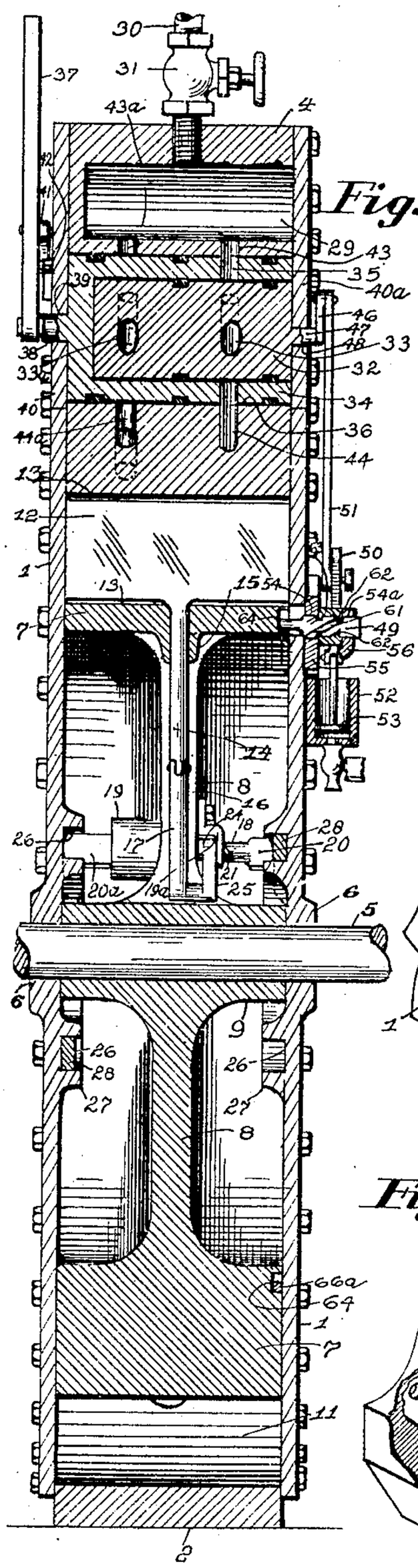

Fig. 2

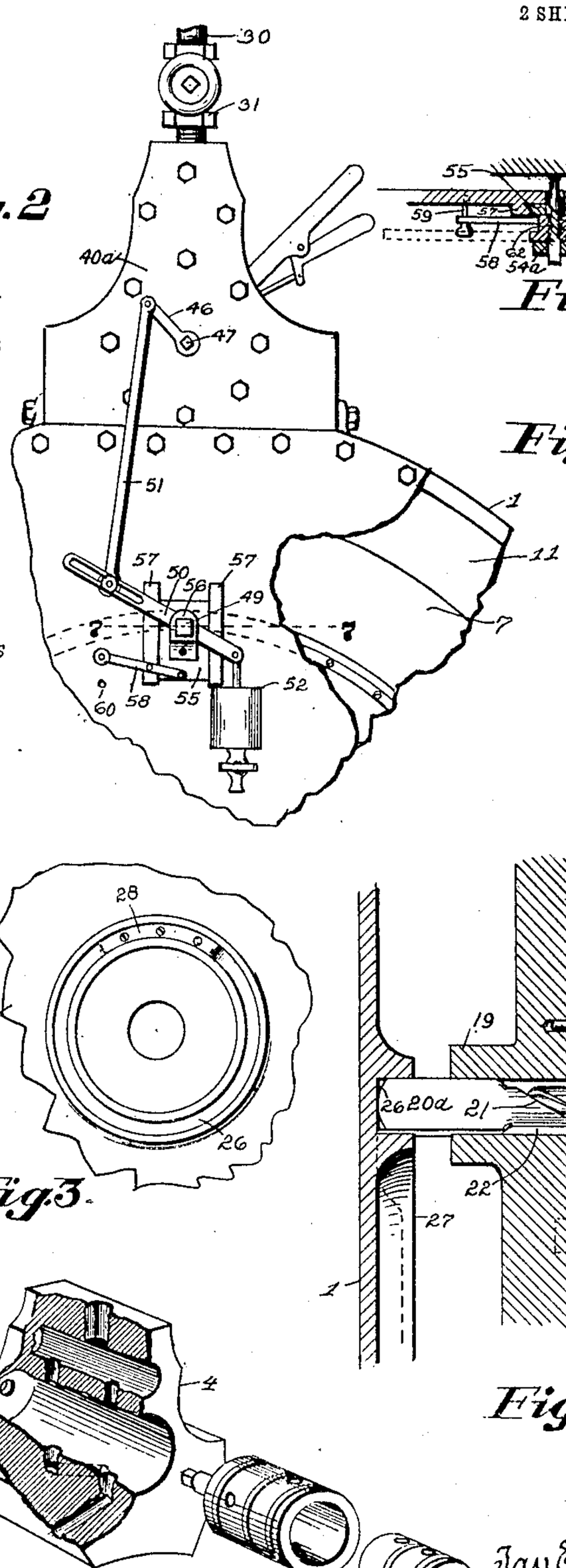

Fig. 6.

Fig. 7.

Fig. 3.

Fig. 4.

Fig. 5.

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ROTARY ENGINE.

No. 871,807. Specification of Letters Patent. Patented Nov. 26, 1907.

Application filed March 20, 1907. Serial No. 363,359.

To all whom it may concern:

Be it known that I, JAY E. LEHMAN, a citizen of the United States, residing at Canton, in the county of Stark and State of Ohio, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

This invention relates to that class of steam and gas engines in which a cylinder, having radially operating pistons thereon, is adapted to rotate in a diametrically larger case; and the objects of the improvement are to provide simple and efficient means for positively and quickly operating the radial-pistons at the proper time, and to provide and positively control a suitable valve for the engine, with means for reversing the rotation of the cylinder. These general objects and other minor ones, are attained by the construction, mechanism and arrangement illustrated in the accompanying drawing, in which—

Figure 1 is a section transverse the axis of the engine showing the end of the cylinder; Fig. 2, a longitudinal section on line 2—2, Fig. 1; Fig. 3, a fragmentary view of the annular piston-operating channel on the inner side of the case-wall; Fig. 4, a fragmentary section on line 4—4, Fig. 1, showing an enlarged view of the piston-operating screw; Fig. 5, a detached perspective view of the valve-block, the reversing-sleeve and the valve, all in axial line for assembling, with parts of the block broken away to show its interior; Fig. 6, a fragmentary side elevation of the engine, showing the exterior valve-operating mechanism; and Fig. 7, a fragmentary section on line 7—7, Fig. 6, showing the valve-operating screw.

Similar numerals refer to similar parts throughout the drawings.

The case 1 is cylindric in general form and is preferably provided with the base 2, in which the exhaust ports 3 and 3ª are formed. The valve-block 4 is formed or attached in the upper side of the case, and the driven-shaft 5 is axially journaled as in the hubs 6 in the side walls of the case.

The cylinder 7 is preferably formed as a ring, as illustrated, with its edges in contact with the end walls of the case, and having the disk-web 8 in the median line with the axial hub 9, by means of which hub the cylinder is securely attached to the driven-shaft, as by the key 10. The peripheral-diameter of the cylinder-ring is somewhat less than that of the peripheral-wall of the case, so that the annular steam-chamber 11 is formed between these parts.

The radial pistons 12 are located and operate in the slots 13 formed across the peripheral face of the cylinder-ring, and when operated outward these pistons are adapted to completely close the steam-chamber and to form a temporary and movable abutment for the steam or gas. The radially located shanks or stems 14 of the pistons are adapted to operate endwise in the bearings 15 formed in the inner part of the cylinder-ring, and extend inward into the radial slots 16 formed in the disk-web of the cylinder, to a pivotal connection with the links 17 located in the same slots.

The piston-operating screws 18 are located parallel with the engine-axis and are adapted to be endwise movable but not rotatable in the guide-bearing as 19 formed in one side of the disk-web of the cylinder. A small portion of one end 20 and a considerable portion of the other end 20ª of each screw are preferably formed square or angular in cross-section; and the corresponding-portion of the guide-bearing is formed of like section, so that the screw is held against rotation; and the spiral-groove 21 is provided in the intervening round portion 22 of the screw, in which groove the tongues 23 formed in the hub 24 of each piston-crank 25 are adapted to operate. The piston-cranks are held in place by means of the bracket-bearings 19ª and are rotatably mounted by their hubs on the round portion of the screws, and their free ends are pivotally connected with the links 17 likewise attached to the ends of the piston-stems.

The annular piston-operating channels 26 are formed in the inner sides of the end walls of the case, concentric with the engine-axis, and the squared ends of the piston-operating screws are adapted to travel and to operate in these channels, and to abut against the respective bottoms thereof,

It is evident that by making portions of one channel deeper, and the corresponding portions of the other channel shallower, an endwise movement is given to the piston operating screw, as the cylinder rotates on its axis; and that the extent, direction and location of this endwise movement of the screw can be controlled by the varying depth of the opposite parts of the operating channels. It is also evident that the operation of

the crank-tongues in the spiral grooves of the piston-operating screws, will rotate these cranks and operate the connected pistons outward and inward according as the screws are moved endwise one way or another, and that the movements of the pistons are controlled by the relative pitch of the spiral-grooves in the screws and the varying depths of the operating-channels in the end walls of the case. These channels are preferably formed in the annular-flanges 27 on these walls; and the depth of the channels is preferably varied by means of the inclined-ended filling plates 28 fastened in their bottoms, which plates are varied in thickness and location to give the proper endwise movement to the valve-operating screws.

The steam-chest 29 is formed or attached on the valve-block, into which chest the steam is received by means of the ordinary inlet pipe 30, preferably provided with the usual stop-valve 31. The valve-proper 32 is preferably a solid cylinder and is provided with the two parallel transverse ports 33 and 33ª. The valve is rotatably located in the hollow-cylindric reversing-sleeve 34, which is provided with the transverse ports 35 and 35ª through both walls and adapted to register at different times with the respective ports of the valve. The reversing-sleeve is rotatably located in the cylindric-cavity 36 in the valve-block, and is adapted to be operated by means of the ordinary-lever 37 attached on the axial-stem 38 which extends through the aperture 39 in the plate 40 on the end of the valve block, and to be locked by the usual bolt-41 and quadrant-42 devices.

The steam-chest ports 43 and 43ª are provided in the bottom of the steam-chest and these ports register with the respective ports of the reversing sleeve, according as one port or the other is rotated into a proper alinement, as shown for ports 35 and 43 in Figs. 1 and 2. And the engine-ports 44 and 44ª are provided in the lower part of the valve-block, and these ports lead from points diametrically opposite the steam-chest ports, first directly downward, thence in different directions, so that one port 44 opens into the steam-chamber of the engine on one side, and the other port 44ª on the other side of the valve-block. The lower part of the valve-block abuts against the periphery of the cylinder, and the opposite sides 45 and 45ª of the part of the block within the case form the fixed abutments for the steam or gas according as the engine is operated one way or the other.

It is evident that when the reversing-sleeve is rotated so that its port 35 registers with the corresponding ports 43 and 44 of the steam chest and the engine, as shown in Fig. 1, and the valve is rotated to bring one of its parallel ports 33 into proper alinement, as shown by broken lines in the same figure, the steam will pass freely into the steam-chamber of the engine through the engine port 44, on one side of the valve-block; and that when the reversing-sleeve is rotated to bring its other port 35ª into alinement with the corresponding ports 43ª, 33ª and 44ª of the steam-chest, the valve and the engine, the steam will pass freely into the steam-chamber through the engine port 44ª on the other side of the valve-block; so that the engine can be reversed by merely rotating the reversing-sleeve one way or the other as the case may be.

The engine-valve 32 is operated by means of the crank 46 attached on the outer end of the axial-stem 47 which extends through the aperture 48 in the plate 40ª on the end of the valve-block; and the valve-regulating mechanism comprises the screw 49, the rock-lever 50 rotatably mounted on the screw, the bar 51 pivotally connected at its ends to the valve-crank and one end of the rock-lever, the vacuum-cup 52 attached on the end wall of the engine-case, and the vacuum-piston 53 in the cup and pivotally connected with the other end of the rock lever.

The valve-screw is located in bearings 54 and 54ª, at one end in the plate 55 and at the other end in the bracket 56 which bracket is formed or attached on the plate, between which plate and bracket the journal bearing of the rock-lever is located; and the plate is dovetailed and adapted to be adjusted vertically between the reversely dovetailed guides 57 formed or attached on the end wall of the engine-case, by means of the lever 58 which is adapted to be locked as by means of the pin 59 engaging in apertures as 60 in the engine-wall. The outer end of the valve-screw is formed square or angular in cross-section and its bracket-bearing 54ª is likewise formed so that the screw is free to move endwise but cannot rotate, and the body of the screw is provided with the spiral-groove 61, in which the tongues 62 formed in the journal-bearing 63 of the rock-lever are adapted to engage and operate, by means of which tongues and groove the lever is rocked by an endwise movement of the screw.

The annular-channel 64 is formed in the side of the cylinder-ring, in which channel the preferably reduced end 65 of the valve-screw is adapted to operate. The end of the screw normally abuts the bottom of the channel, and by forming or attaching the inclined-ended filling-strips 66 and 66ª in the bottom of the channel, it is evident that when the cylinder is rotated and the end of the screw rides on these strips the screw is forced outward. By locating the filling strips 66 in the inner half of the channel, and the strips 66ª in the outer half thereof, it is evident that by adjusting the bearing-plate of the screw in its guides by means of

the lever 58, the end of the screw can be thrown either to the inner side or the outer side of the channel and will ride on one or the other series of filling-strips as may be desired; and by locating the strips of each series at the proper intervals apart around the groove, means are provided for properly coördinating the endwise movements of the valve-screw for the operation of the engine-cylinder either one way or the other.

It is evident that when the valve-screw is moved outward by one of the filling strips in the bottom of the cylinder-ring channel, the rock-lever will be rotated in the direction to rotate the valve to bring its ports in the vertical position, as shown by broken lines in Fig. 1, and thus to open either one or the other series of ports from the steam-chest to the engine-steam-chamber; and that by the reverse action of the suction cup when the filling strip in the bottom of the ring-channel has passed the end of the valve-screw, the same will be forced inward and the valve rotated to bring its ports out of alinement with the steam-chest, reversing-sleeve and engine ports, as shown in Fig. 1, thus shutting off the steam from the engine.

When three pistons are employed, as shown in the drawings, they are preferably located at equal intervals around the cylinder-ring, and the bottom of the annular-operating channel in the end walls of the engine are so formed or filled that the pistons will be held outward to close the steam-chamber at all points of rotation, excepting only when passing the valve-block which forms the two fixed abutments, at which place the pistons are each one in turn drawn inward to clear the block, as shown in Fig. 1; and the bottom of the annular-operating channel in the side of the cylinder is so formed or filled, that the valve will be opened when the respective pistons have been thrown outward after passing the valve-block-abutment, and then closed when the piston has rotated a sufficient distance toward the exhaust port for a proper utilization of the expansive energy of the steam or the explosive energy of the gas—according as the one or the other is used.

It will be noted that when the ends of the valve-operating screws are formed square, as shown, the screws will be held against rotation with respect to the cylinder by the contiguous sides of the grooves in which the ends travel, and in this case the angularity of the disk-web bearings is not essential for holding the screws against rotation. Also, that when the angular bearings in the disk-web are employed to hold the screws against rotation, the side walls can be omitted from the operating channels, in which case the bottoms of the channels can be considered as merely correspondingly varying annular faces abutting the ends of the screws. Furthermore, the opposing channels in the end walls of the case, taken together, can be considered a single channel abutting the screw in opposite directions, and a flanged channel embracing a headed screw can as well be formed on one end only of the case, as shown in Fig. 8, without affecting the principle of the invention. It will also be noted that it is not essential to use a vacuum cup for resisting and reversing the operation of the valve, and furthermore that the annular channel in the cylinder can be formed with a flange to embrace a head on the end of the screw for the purpose of operating the screw endwise in both directions, as shown in Fig. 9, without affecting the principle of its operation. And it is evident that it is not essential that the valve and the reversing-sleeve shall be rotatable, for by locating the transverse ports of the sleeve to be parallel but at different distances apart than the valve ports, the valve and the sleeve can be moved endwise without affecting the principle of their operation; and in this event it is not essential that they shall be cylindric or even rounded in form. And furthermore, it is not essential that the steam-chest and the steam-chamber shall be separated by walls from the sleeve-valve cavity; for the sleeve itself can constitute such walls and its ports open respectively into the chest and the chamber without affecting the mode of operating and reversing the valve.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. In a rotary-engine, a case, a rotatable cylinder therein, a piston on the cylinder, annular channels having correspondingly varying depths in the end walls of the case, an endwise-movable non-rotatable screw in the cylinder having its ends abutting the bottoms of the channels, and means connecting the screw with the piston whereby the piston is operated by the endwise movement of the screw.

2. In a rotary-engine, a case, a rotatable cylinder therein, a piston on the cylinder, an endwise-movable non-rotatable screw in the cylinder, correspondingly varying annular faces on the walls of the case abutting the ends of the screw, and means connecting the screw with the piston whereby the piston is operated by the endwise movement of the screw.

3. In a rotary-engine, a case, a rotatable cylinder therein, a piston on the cylinder, an endwise-movable non-rotatable screw in the cylinder, an annular channel in the case abutting the screw and adapted to move it endwise, and means connecting the screw with the piston whereby the piston is operated by the endwise movement of the screw.

4. In a rotary-engine, a case, a valve thereon, a rotatable cylinder in the case, an annu-

lar channel of varying depth in the end of the cylinder, an endwise-movable non-rotatable screw in the case having its end abutting the bottom of the channel, means connecting the screw with the valve whereby the valve is operated one way by the endwise movement of the screw and means acting to operate the valve the other way.

5. In a rotary-engine, a case, a valve thereon, a rotatable cylinder in the case, an endwise-movable non-rotatable screw in the case, a varying annular face on the cylinder abutting the end of the screw and adapted to move it endwise, means connecting the screw with the valve whereby the valve is operated one way by the endwise movement of the screw and means acting to operate the valve the other way.

6. In a rotary-engine, a case, a valve thereon, a rotatable cylinder in the case, an endwise movable non-rotatable screw in the case, an annular channel in the cylinder adapted to move the screw endwise, and means connecting the screw with the valve whereby the valve is operated by the endwise movement of the screw.

7. In an engine, a case having a steam-chest, an adjacent steam-chamber and an intervening cylindric-cavity therein, there being an abutment in the chamber, a rotatable cylindric-sleeve in the cavity and a rotatable cylindric-valve in the sleeve, there being two series of ports in the valve, the sleeve-walls and the walls between the cavity and the chest and the chamber, the ports of each series being adapted to register at certain positions of rotation of the valve and the sleeve at different positions of rotation of the sleeve, and the ports of the respective series entering the chamber on opposite sides of the abutment.

8. In an engine, a case having a steam-chest, an adjacent steam-chamber and an intervening cylindric-cavity therein, a rotatable cylindric-sleeve in the cavity and a rotatable cylindric-valve in the sleeve, there being two series of ports in the valve, the sleeve-walls and the walls between the cavity and the chest and the chamber, the ports of each series being adapted to register at certain positions of rotation of the valve and the sleeve at different positions of rotation of the sleeve.

9. In an engine, a case having a steam-chest, an adjacent steam-chamber and an intervening rounded cavity therein, there being an abutment in the chamber, a rounded-rotatable sleeve in the cavity and a rounded-rotatable valve in the sleeve, there being two series of ports in the valve, the sleeve-walls and the walls between the cavity and the chest and the chamber, the ports of each series being adapted to register at certain positions of rotation of the valve and the sleeve at different positions of rotation of the sleeve, and the ports of the respective series entering the chamber on opposite sides of the abutment,

10. In an engine, a case having a steam-chest, an adjacent steam-chamber and an intervening rounded cavity therein, a rounded-rotatable sleeve in the cavity and a rounded-rotatable valve in the sleeve, there being two series of ports in the valve, the sleeve-walls and the walls between the cavity and the chest and the chamber, the ports of each series being adapted to register at certain positions of rotation of the valve and the sleeve at different positions of rotation of the sleeve.

11. In an engine, a case having a steam-chest, an adjacent steam-chamber and an intervening cavity therein, there being an abutment in the chamber, a movable sleeve in the cavity and a movable valve in the sleeve, there being two series of ports in the valve, the sleeve-walls and the walls between the cavity, and the chest and the chamber, the ports of each series being adapted to register at certain positions of movements of the valve and the sleeve, at different positions of movement of the sleeve, and the ports of the respective series entering the chamber on opposite sides of the abutment.

12. In an engine, a case having a steam-chest, an adjacent steam-chamber and an intervening cavity therein, a movable sleeve in the cavity and a movable valve in the sleeve, there being two series of ports in the valve, the sleeve-walls and the walls between the cavity, and the chest and the chamber, the ports of each series being adapted to register at certain positions of movement of the valve and the sleeve, at different positions of movement of the sleeve.

13. In an engine, a case having a steam-chest and an adjacent steam-chamber therein, there being an abutment in the chamber, a rotatable cylindric-sleeve with a rotatable cylindric-valve therein located between the chest and the chamber, there being two series of ports in the valve and the sleeve-walls of which the latter open respectively into the chest and the chamber, the ports of each series being adapted to register at certain positions of rotation of the valve and the sleeve at different positions of rotation of the sleeve, and the ports of the respective series entering the chamber on opposite sides of the abutment.

14. In an engine, a case having a steam-chest and an adjacent steam-chamber therein, a rotatable cylindric-sleeve with a rotatable cylindric-valve therein located between the chest and the chamber, there being two series of ports in the valve and the sleeve-walls of which the latter open respectively into the chest and the chamber, the ports of each series being adapted to register at certain positions of rotation of the valve and the

sleeve at different positions of rotation of the sleeve.

15. In an engine, a case having a steam-chest and an adjacent steam-chamber therein, there being an abutment in the chamber, a rounded-rotatable sleeve with a rounded-rotatable valve therein located between the chest and the chamber, two series of ports in the valve and the sleeve of which the latter open respectively into the chest and the chamber, the ports of each series being adapted to register at certain positions of rotation of the valve and the sleeve at different positions of rotation of the sleeve, and the ports of the respective series entering the chamber on opposite sides of the abutment.

16. In an engine, a case having a steam-chest and an adjacent steam-chamber therein, a rounded-rotatable sleeve with a rounded-rotatable valve therein located between the chest and the chamber, two series of ports in the valve and the sleeve of which the latter open respectively into the chest and the chamber, the ports of each series being adapted to register at certain positions of rotation of the valve and the sleeve at different positions of rotation of the sleeve.

17. In an engine, a case having a steam-chest and an adjacent steam-chamber therein, there being an abutment in the chamber, a movable sleeve with a movable valve therein located between the chest and the chamber, there being two series of ports in the valve and the sleeve-walls of which the latter open respectively into the chest and the chamber, the ports of each series being adapted to register at certain positions of movement of the valve and the sleeve at different positions of movement of the sleeve, and the ports of the respective series entering the chamber on opposite sides of the abutment.

18. In an engine, a case having a steam-chest and an adjacent steam-chamber therein, a movable sleeve with a movable valve therein located between the chest and the chamber, there being two series of ports in the valve and the sleeve-walls of which the latter open respectively into the chest and the chamber, the ports of each series being adapted to register at certain positions of movement of the valve and the sleeve at different positions of movement of the sleeve.

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