No. 760,165. PATENTED MAY 17, 1904.

T. E. STURTEVANT.

DIRECT ACTING ENGINE.

APPLICATION FILED NOV. 12, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1

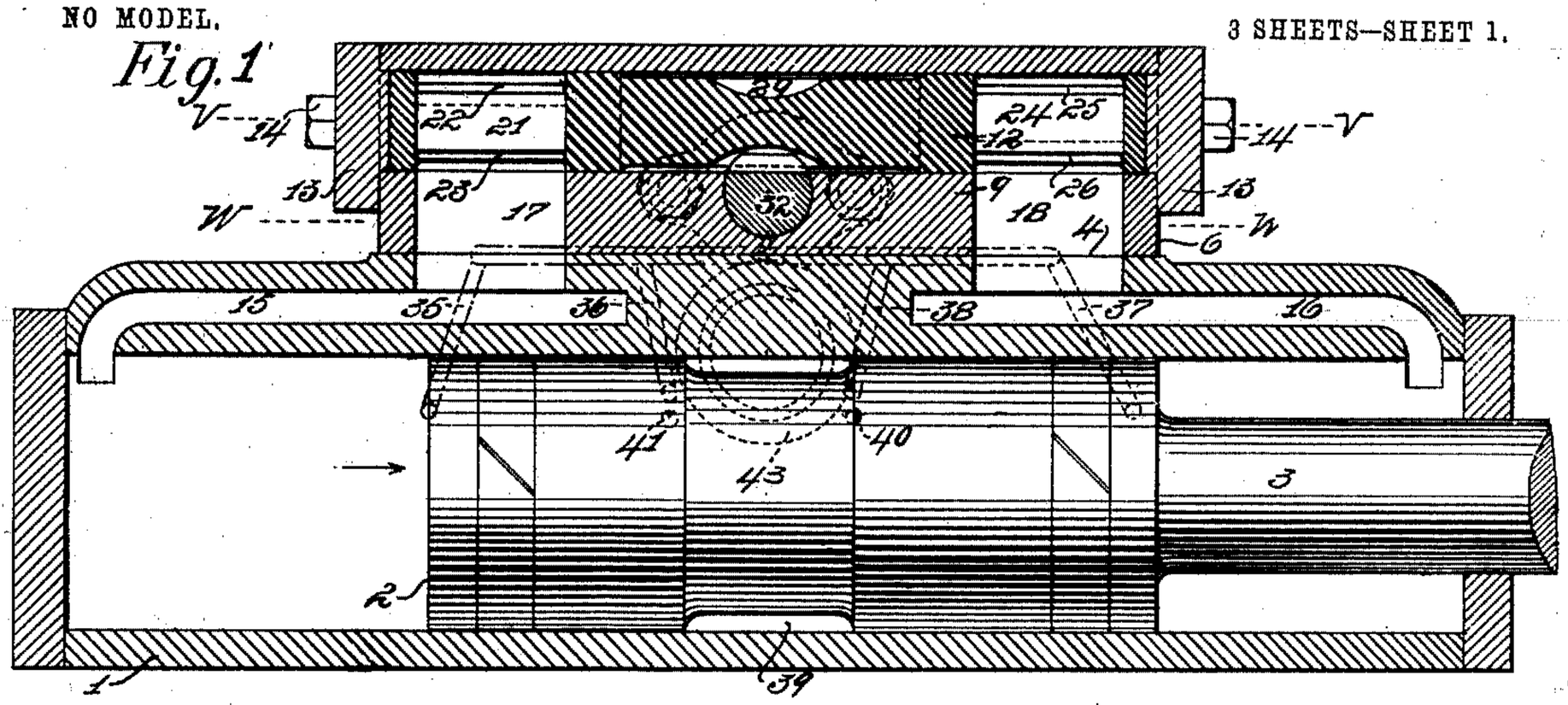


Fig. 2

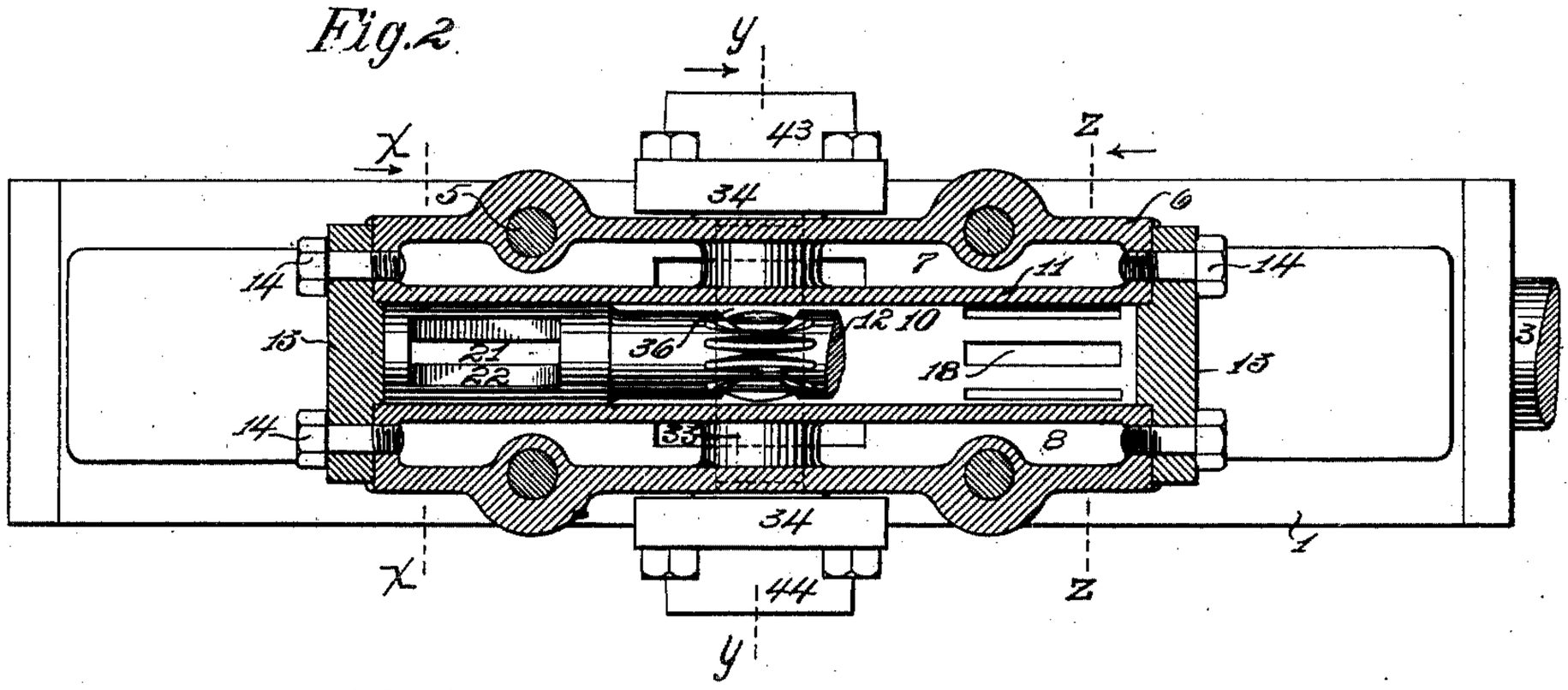
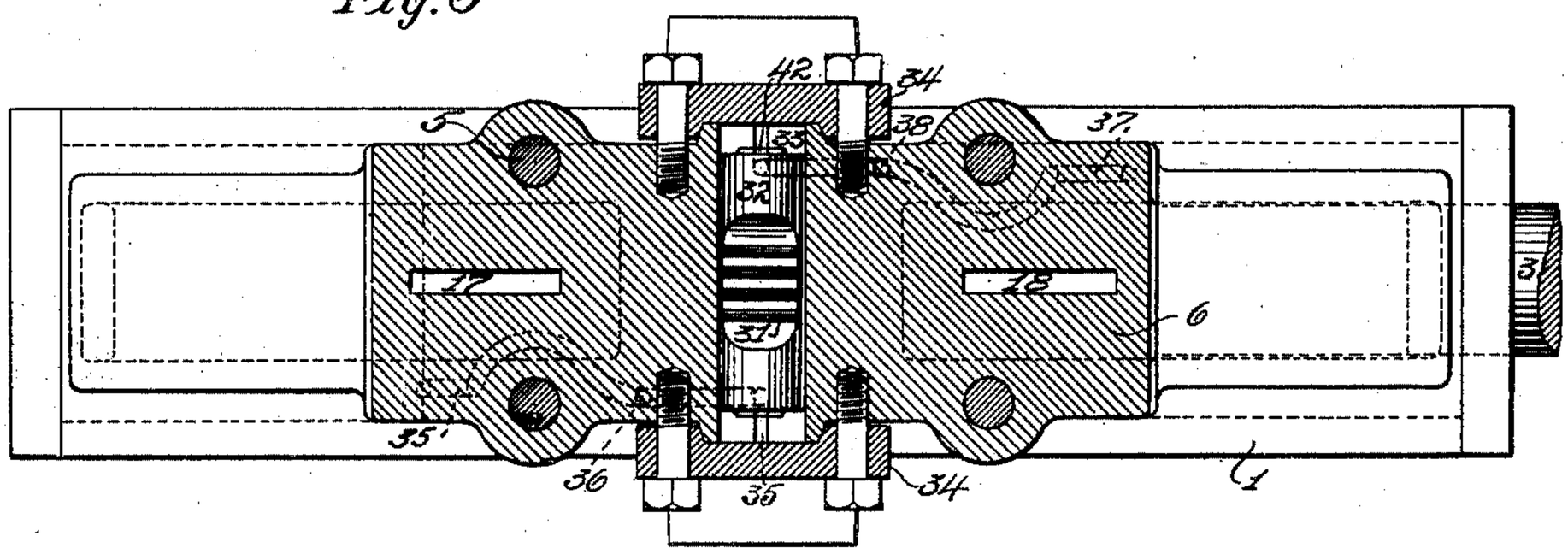


Fig. 3



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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 4.

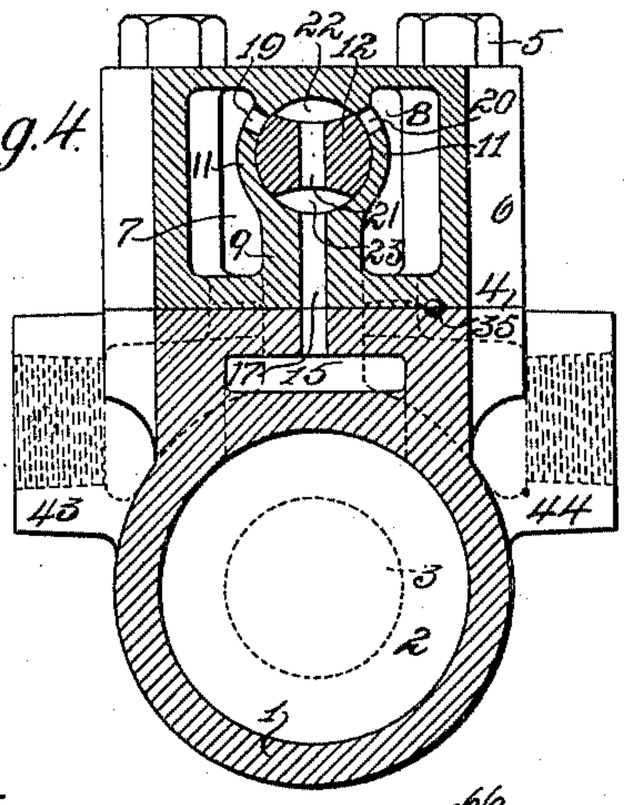


Fig. 5.

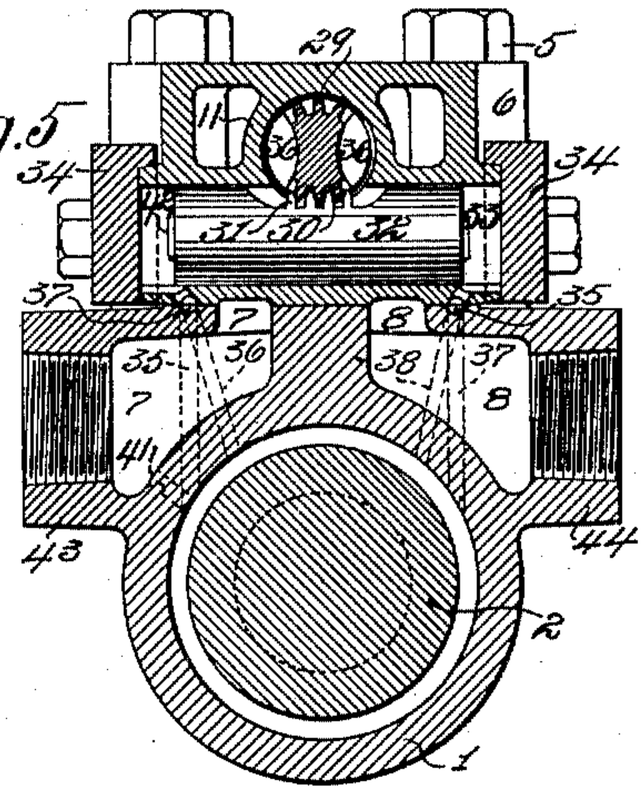
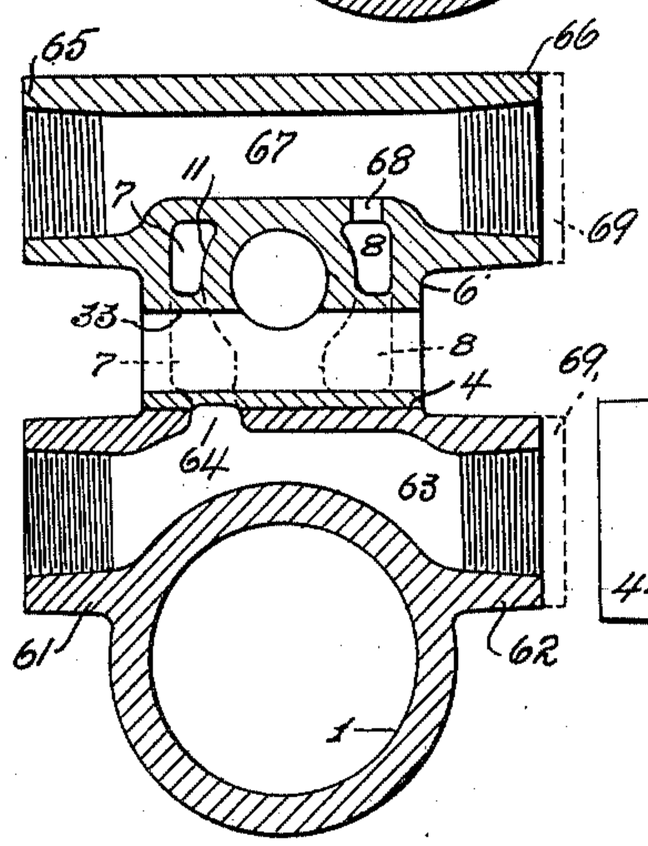


Fig. 6.



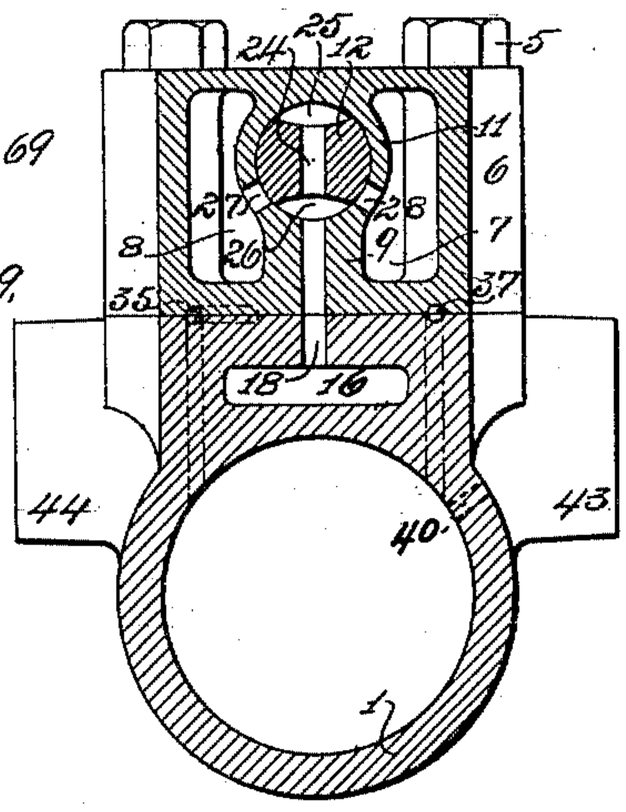
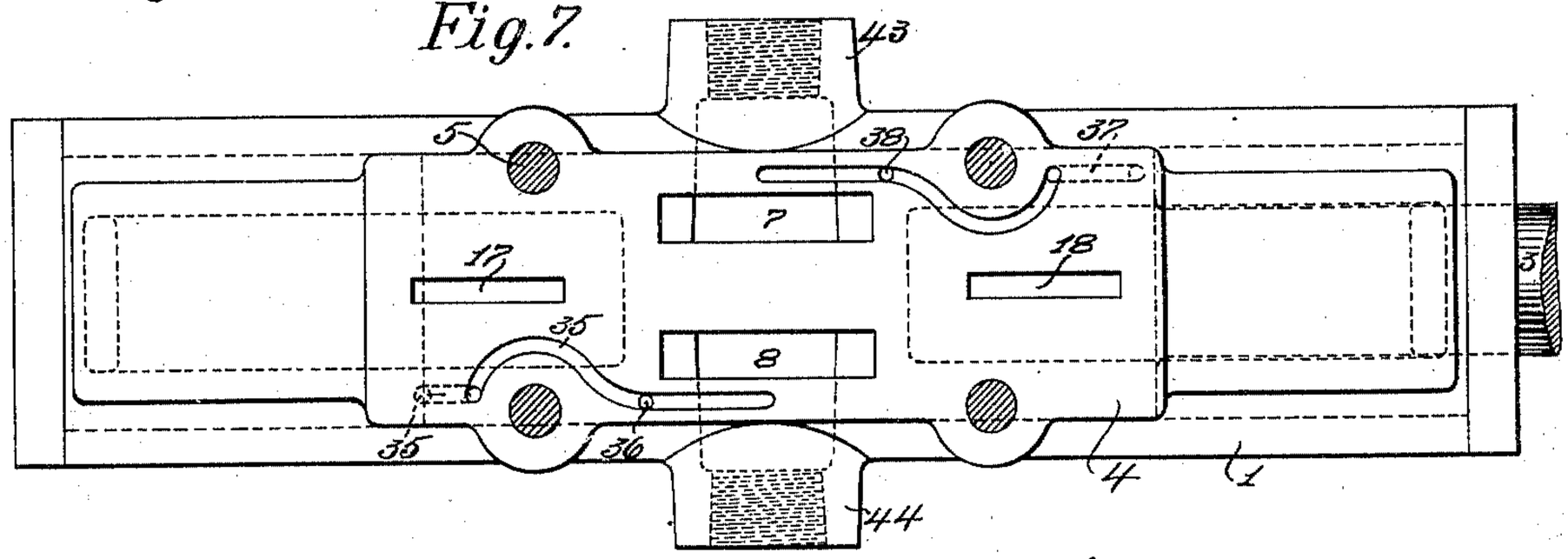


Fig. 13

Fig. 7.



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APPLICATION FILED NOV. 12, 1903.

NO MODEL. 3 SHEETS—SHEET 3.

Fig. 8

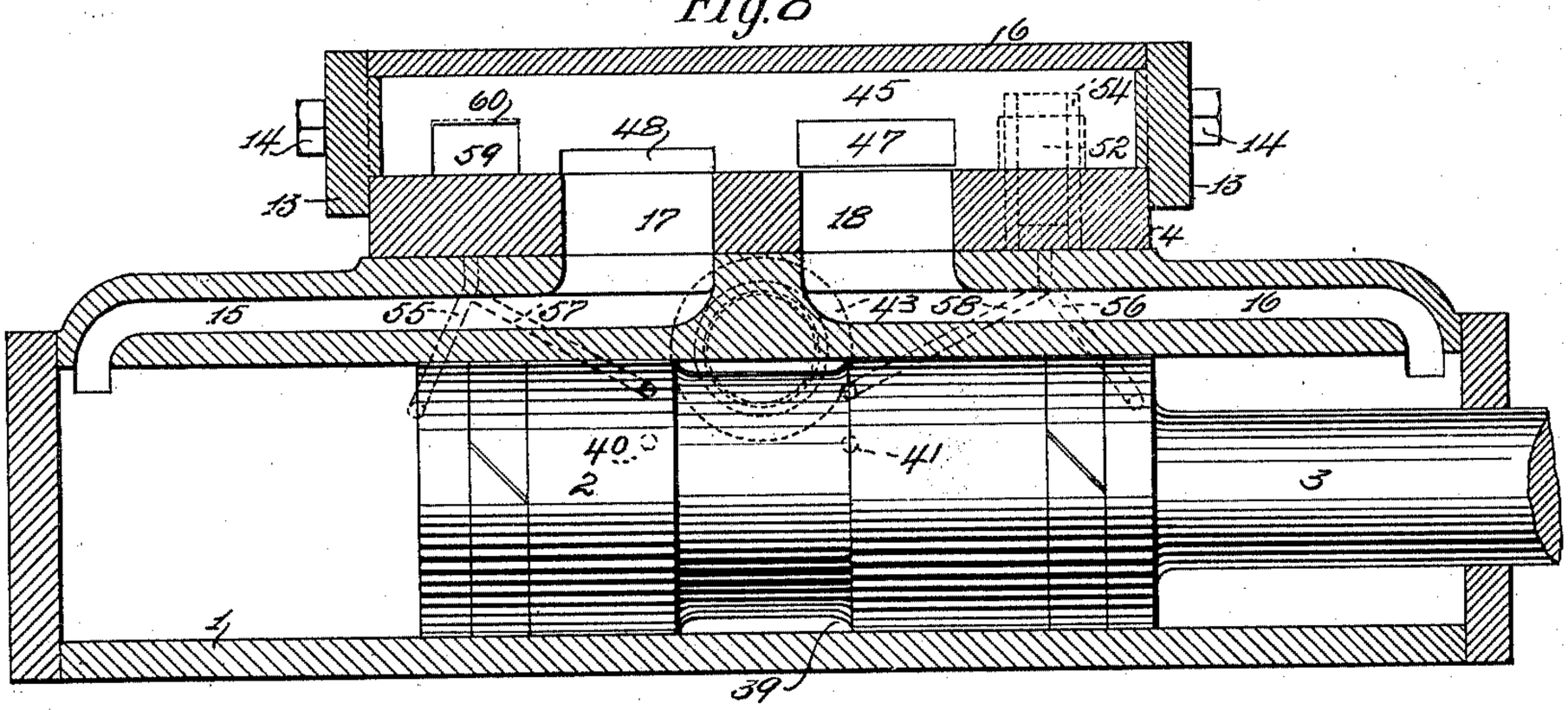


Fig. 9

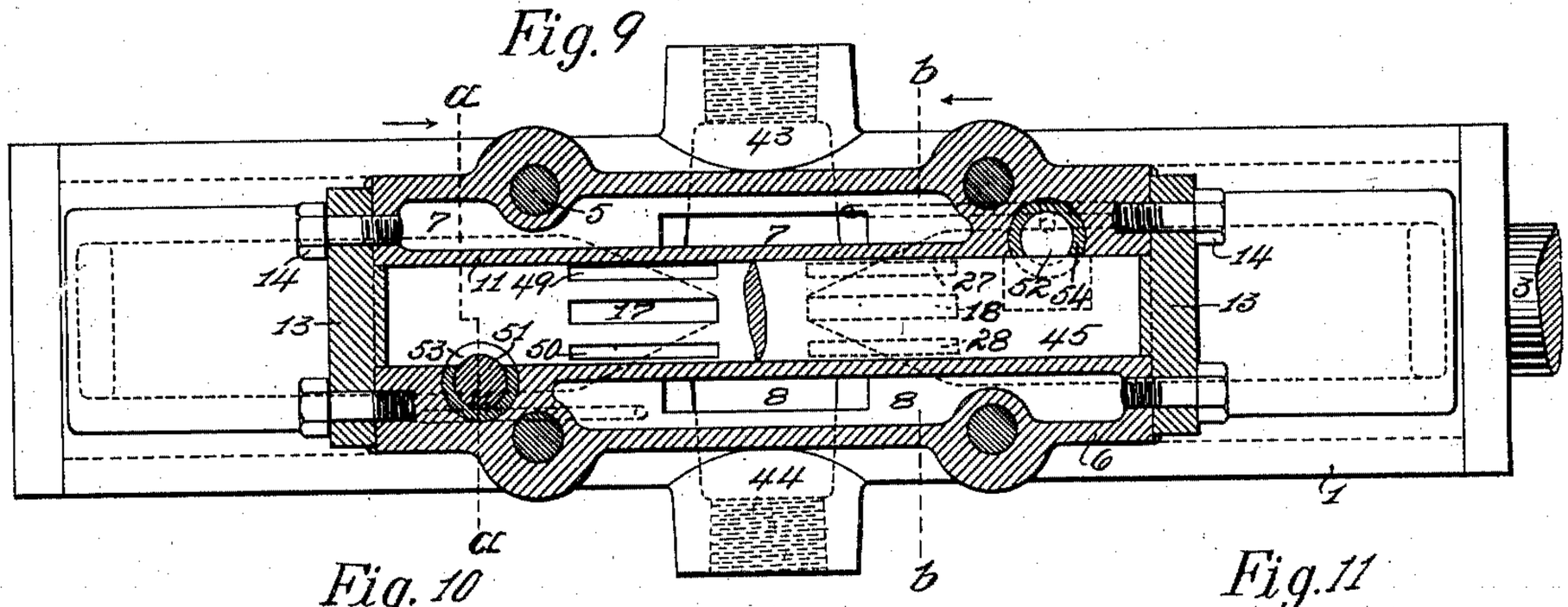


Fig. 10

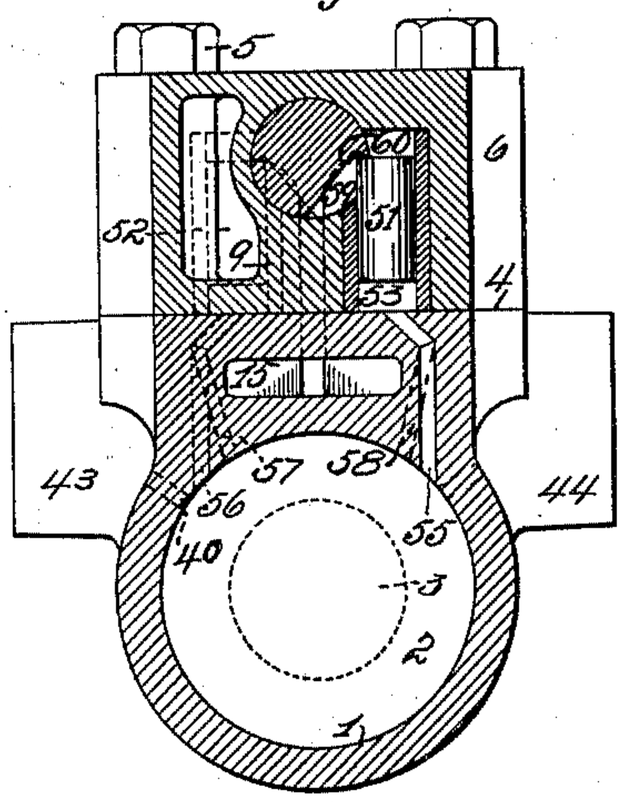


Fig. 11

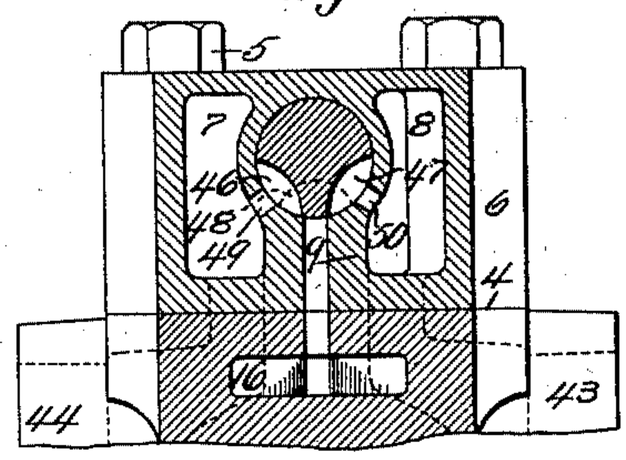
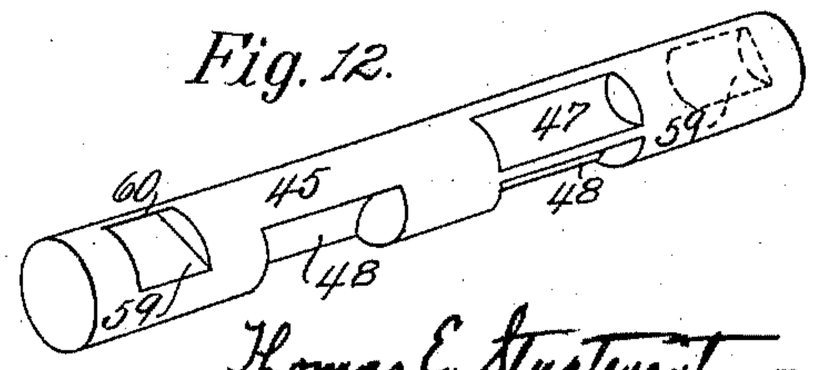


Fig. 12.



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No. 760,165. Patented May 17, 1904.

UNITED STATES PATENT OFFICE.

THOMAS E. STURTEVANT, OF DOVER, NEW JERSEY.

DIRECT-ACTING ENGINE.

SPECIFICATION forming part of Letters Patent No. 760,165, dated May 17, 1904.

Application filed November 12, 1903. Serial No. 180,810. (No model.)

To all whom it may concern:

Be it known that I, THOMAS E. STURTEVANT, a citizen of the United States, residing in the town of Dover, county of Morris, State of New Jersey, have invented a new and useful Improvement in Direct-Acting Engines, of which the following is a full, clear, and exact specification and description, reference being had to the drawings accompanying and forming a part of the same.

This invention relates to direct-acting engines used for rock-drills, &c., and operated by steam, compressed air, or other motive fluid; and its objects are to simplify and improve the construction and operation, to reduce the cost of manufacture, to increase the durability, to facilitate the assembling, disassembling, and the making of repairs, to provide an easily and positively acting valve, to conduce to the economy of motive fluid, and, where the engine is designed to form part of a rock-drill, to enable the drill to be worked conveniently close to the side of a wall or in other difficult positions.

In the drawings forming part of this specification, Figure 1 is a central longitudinal section of an engine embodying my improvements. Fig. 2 is a sectional plan taken at about the line *v v* of Fig. 1. Fig. 3 is a sectional plan taken at about the line *w w* of Fig. 1. Fig. 4 is a cross-section taken at line *x x* of Fig. 2. Fig. 5 is a central cross-section taken at the line *y y* of Fig. 2. Fig. 6 is a cross-section on the line *z z* of Fig. 2. Fig. 7 is a plan of the cylinder, the chest being removed. Fig. 8 is similar to Fig. 1, but shows another form of chest, valve, and valve-actuator. Fig. 9 is a sectional plan corresponding to Fig. 2, but showing the form of the invention seen at Fig. 8. Fig. 10 is a cross-section taken through the line *a a* of Fig. 9. Fig. 11 is a fragmentary cross-section through the line *b b* of Fig. 9. Fig. 12 is a perspective of a valve seen at Fig. 8. Fig. 13 is a median cross-section showing the preferred construction of cylinder and chest, having duplicate lateral plugs for steam or air hose and exhaust.

In the several views like signs identify like parts.

Within a cylinder 1 reciprocates a piston 2, provided with a rod 3, connected to a drill or other mechanical device to be worked by the engine. Upon a seat 4 formed upon one side of the cylinder is secured by bolts 5 a chest 6, extending longitudinally of the cylinder. The chest is divided into two chambers 7 and 8 by means of a central longitudinal partition 9. A bore 10 extends from end to end of the chest, said bore passing longitudinally through said partition and forming a cylinder 11 to receive a valve 12, which extends from end to end of said cylinder 11 and is closely confined by caps 13, detachably secured by bolts 14 upon the ends of said cylinder 11.

Ports 15 and 16 extend from the ends of the main cylinder 1 to the under side of the valve-cylinder 11, opening separately into the latter by means of slits 17 and 18, extending longitudinally of said valve-cylinder. The function of the valve 12, which is adapted to oscillate, is to put the main cylinder-ports 15 and 16 into communication alternately with the chest-chambers 7 and 8, one of which may be an admission-chamber and the other an exhaust. The valve enables the port 15 to communicate with passages 19 and 20, Fig. 4, through the walls of the valve-cylinder 11, into said chambers, said passages being formed in the upper side of the cylinder—that is, upon the side opposite to the port 15 or slit 17 and in register therewith. A transverse passage 21 is formed in the valve at this point, said passage terminating at its ends in similar cut-aways or depressions 22 and 23, the former to coact with the passages 19 and 20 and the latter with the port or slit 17, so that by the oscillation of the valve the port 17 is put into communication alternately with the passages 19 and 20, and hence with the admission and exhaust chambers. At its opposite end said valve is provided with a similar passage 24 and similar cut-aways 25 and 26, whereby the valve is balanced, and hence works freely at all times. The cut-away 26, which is seen upon the under side of the valve at Fig. 6, coacts with passages 27 and 28, formed in the valve-cylinder 11 adjacent to the port 18, enabling said port to communicate with first one passage and then the other, and hence with the cham-

bers 7 and 8. The valve may therefore be regarded as comprising two valves—one for each port 17 and 18—and each valve having a two-way port for enabling the ports 17 and 18 to communicate with either admission or exhaust. By forming the passages 19 and 20 upon the opposite side of the valve-cylinder from the passages 27 and 28 the two-way ports are rendered oppositely acting, so that when port 17 is put into communication with the admission-chamber port 18 is put into communication with the exhaust-chamber, and vice versa. It will be observed that the valve is reversible end for end and side for side, the two-way ports being equidistant from its ends and similarly formed, so that it may be slipped in position either end first and either side up, which is an advantage in assembling either during manufacturing or in making repairs or inspection. The valve is also provided midway of its length with means whereby it may be oscillated, consisting of pinion-teeth in two sets 29 and 30 upon opposite sides, either of which sets may mesh with a rack 31, formed upon a plunger 32. The latter is placed transversely of the valve and preferably beneath the same and works in a bore or cylinder 33, extending through the chest from side to side and provided with caps 34, secured by bolts. To assemble the valve and the plunger, the first is placed in its cylinder and then the plunger is slipped into position. The valve is cut away upon its sides between the sets of teeth, as at 36, Figs. 2 and 5, to permit the leading end of the plunger to pass. It will be seen that aside from the main piston 2 the engine need have no other moving parts except the valve and plunger, each whereof may be made in one piece and readily slipped into and out of place, as required, and without liability of error, while by removing the caps the valve and plunger are found readily accessible for inspection or removal.

The plunger 32 is adapted to be reciprocated by the pressure of motive fluid, and means are provided whereby the piston 2 may also act as valve to control the admission of motive fluid to said plunger-cylinder and its exhaust therefrom. Two sets of secondary ports lead from the main cylinder 1 to the plunger-cylinder 33, one set to each end of the latter cylinder, the ports in one set being designated as 35 and 36 and those in the other set as 37 and 38. For a portion of its length the port 35, Figs. 1, 6, and 7, consists of a pair of grooves cut in the adjoining faces of the cylinder and chest, while the port 36 joins the port 35 at said grooves, the port 35 continuing to the end of the plunger-cylinder, as at Fig. 3. The ports 37 and 38 are similarly related, the former terminating at the opposite end of the plunger-cylinder. These sets of secondary ports may be made in various ways within the scope of my invention. They are covered and uncovered by the piston 2 in its reciprocatory movements, so that by a movement of the piston in one direction the plunger is driven to one end of its cylinder, causing the valve to oscillate, whereby the piston is caused to return, whereby the plunger is caused to be driven back to its first position, and so on.

Assuming that 7 is the admission and 8 the exhaust chamber and that the valve at Fig. 4 is turned far enough to open passage 19 and close 20, steam or fluid is admitted, through 19, 21, 17, and 15, to the main cylinder 1, driving the piston out in the direction of the arrow. When about midway of its stroke, the piston uncovers secondary port 35 (port 36 being covered by the piston) and steam passes through 35 from the main cylinder 1 to the right-hand end of the plunger-cylinder at Fig. 5 and presses the plunger to the left-hand end of the cylinder, steam simultaneously exhausting from the latter through port 38 (37 being covered by piston 2.) At this moment a peripheral groove 39, formed in the piston 2, is in communication with port 38, as seen at Fig. 1, and also with a passage 40, through the wall of cylinder 1, to chamber 8, which is serving as an exhaust. Said groove 39 is sufficiently wide to enable steam to exhaust through 38 and 40 during a considerable portion of the stroke of piston 2, during which time the plunger 32 is moving from right to left at Fig. 5 (said plunger being shown at mid-stroke in the several views) and live steam is passing from chamber 7, through passage 27, Fig. 6, valve-port 26, slit 18, and port 16, to the right-hand end of the cylinder 1 at Fig. 1, thereby insuring that piston 2 shall not drive against the head of the cylinder 1 and also reversing the stroke of the piston, while, owing to the described movement of the valve, port 15 is put into communication, through 17, 23, 21, and 20, with the exhaust-chamber 8. During the return stroke of the piston 2 port 37 is uncovered and steam from cylinder 1 passes through said port to the left-hand end of the plunger-cylinder at Fig. 5 to return the plunger to its initial position, while port 36 in the cylinder 1 is enabled by the piston-groove 39 to communicate with a passage 41, through the wall of cylinder 1, to the exhaust-chamber 8, ports 35 and 40 being at this time closed by the piston 2. By this means the valve is returned to its initial position, steam is admitted to the cylinder 1 through main port 15, and the operation is repeated.

The ends of the plunger are provided with protruding stops 42, adapted to contact with the caps 34, leaving a small space between the cap and the body of the plunger into which the steam can enter.

The chambers 7 and 8 are provided with suitable inlet and outlet passages, terminating in plug-sockets 43 and 44, projecting from opposite sides of the cylinder or chest and

threaded to enable attachment of steam or air hose.

Referring now to Figs. 8 to 12, inclusive, the valve 45 is provided at one point upon its under side with a pair of cut-aways 46 and 47 to coöperate with the port 18 and also upon its under side with a single cut-away or port 48 to coöperate with the port 17. Adjoining the port 17 are passages 49 and 50, similar to 27 and 28. When the valve is rocked in one direction, steam passes from chamber 7, through 49, 46, and 17, to the main cylinder, while from the other end of the latter the steam exhausts, through 18, 48, and 28, to chamber 8. When the valve is rocked to the opposite extreme, steam enters the main cylinder through 27, 48, and 18 and exhausts from said cylinder through 17, 47, and 50. The oscillations of the valve are effected by means of vertical plungers engaging the valve upon opposite sides, said plungers being designated as 51 and 52 and being preferably located at opposite ends of the valve and working in cylinders 53 and 54, from which secondary ports 55 and 56 extend to the main cylinder 1, said ports having branches 57 and 58, leading to the middle portion of the cylinder, the functions of said secondary ports being analogous to those already described with reference to ports 35, 36, 37, and 38. As may be seen at Fig. 10, the upper end of plunger 51 protrudes into a niche 59, formed in the side of the valve, so as to leave an overhanging lip or lug 60. When steam enters through port 55 into the plunger-cylinder 53, the plunger is thrust up, and by means of the lug 60 the valve is rocked. The other plunger, 52, is similarly connected and operated, the steam exhausting beneath one plunger when live steam forces up the other plunger, as will be understood.

Referring now to Fig. 13, the cylinder 1 is provided with lateral plug sockets or inlets 61 62, connected by a passage 63, extending transversely above the cylinder, said passage opening at 64 into the admission-chamber 7. The steam-chest is provided with similar plug-sockets 65 66, connected by a transverse passage 67, the latter opening at 68 into the exhaust-chamber 8. Thus it will be seen that either one or both of the hose connections may be attached at either side of the engine and the unused sockets closed by plugs or caps 69. In this way it is made convenient to use a rock-drill in much closer quarters than heretofore, particularly when the drill must stand close to a wall.

It will be understood that the chest may be made as long as the cylinder and the valve 12 of corresponding length, thereby enabling the ports 15 and 16 to be shortened and clearance correspondingly reduced. It will be perceived that a positive motion is given to the valve, practically regardless of the wear of the parts. The valve is actuated by live steam, which, moreover, cannot actuate the valve until the secondary ports are open. At the same time the steam is exhausted from the opposite side of the valve, thus insuring satisfactory action under all the varying and exacting conditions met in practice. The stroke of the piston 2, it will be understood, may vary from a fraction of an inch to several inches, according to the length of the cylinder 1, the length of the stroke depending upon the adjustment of the drill. The secondary admission-ports 55 and 56 are separated by a distance approximately equal to the length of the piston 2, said distance being preferably a trifle shorter than said length. Upon the driving stroke there is a little or no cushioning effect in the cylinder 1, so that an effective blow is delivered by the drill upon the rock. The plunger 32 is small and of little weight and makes but a short stroke and is not liable to damage the ends of its cylinder. It will be seen that the parts are not only few in number, but that the whole device is durable in every part and that the usual wear will not effect the action of the engine.

Other variations may be resorted to within the scope of my invention, and portions of my improvements may be used without others.

Having thus described my invention, I claim—

1. The combination with a main cylinder provided with ports and a piston in said cylinder, of admission and exhaust chambers, a valve-cylinder extending between said chambers, said ports opening into the same side of said valve-cylinder, the latter being provided adjacent to one of said ports with passages into said admission and exhaust chambers, and being also provided at points remote from the other of said ports with like passages, a cylindrical valve member in said valve-cylinder, a two-way port upon one side of said valve member, a two-way port upon the other side of said valve member, one of said two-way ports comprising a passage transversely through the body of the valve member, and means including secondary ports opened and closed by said piston in its movements for oscillating said valve member.

2. The combination with a main cylinder and a piston therein, of a chest which is divided longitudinally of said cylinder with a partition in which is formed a valve-cylinder, separate ports extending from the ends of said main cylinder through said partition to the same side of said valve-cylinder, passages being formed through the walls of said valve-cylinder adjacent to one of said ports, to communicate with the chambers on both sides of said partition, and like passages being formed through the walls of said valve-cylinder upon its opposite side and opposite to the other of said ports, a valve member fitting in said valve-cylinder and provided upon its opposite sides with two-way ports for coöperation with

said ports and passages, one of said two-way ports comprising a transverse passage through the body of the valve member, and means for oscillating said valve member.

3. A cylindrical valve member reversible end for end and side for side and provided equidistant from its ends with two sets of two-way ports, the ports in each set being upon opposite sides and communicating with each other through the body of the valve member, said valve member being also provided with means whereby it may be oscillated in either position.

4. The combination with a main cylinder provided with ports and a piston in said cylinder, of an admission-chamber, an exhaust, a valve-cylinder into one side of which said ports open, said valve-cylinder being provided adjacent to one of said ports with passages to both said admission-chamber and said exhaust, and being also provided with like passages at points in line with the other of said ports but upon the opposite side of said cylinder therefrom, a cylindrical balanced valve fitting in said valve-cylinder, said valve having separate transverse passages therethrough opposite said ports, each passage terminating at its ends in similar cut-aways or ports of such form that those adjacent to said passages may serve as two-way ports, and means for oscillating said valve.

5. The combination with a cylinder provided with ports, of a piston in said cylinder, an oscillatable valve controlling the admission and exhaust of motive fluid through said ports, and means, inclusive both of an opening in the body of the piston and also of admission and exhaust ports covered and uncovered by the piston in its movements, for enabling the motive fluid to oscillate said valve.

6. The combination with a cylinder provided with ports, of a piston in said cylinder, an oscillatable valve controlling the admission and exhaust of motive fluid through said ports, a plunger operatively connected to said valve, and means controlled by said piston for enabling the motive fluid to act against said plunger.

7. The combination with a main cylinder provided with ports, of a piston in said cylinder, an oscillatable valve controlling the movements of motive fluid through said ports, a plunger operatively connected to said valve, a cylinder in which said plunger works, and means controlled by said piston in its movements, for admitting motive fluid from said main cylinder to said plunger-cylinder, and for exhausting motive fluid from the latter.

8. The combination with a main cylinder provided with ports, of a piston in said cylinder, an oscillatable valve controlling the movements of motive fluid through said ports, a plunger operatively connected to said valve, a cylinder in which said plunger works, means, controlled by said piston in its movements, for admitting motive fluid from said main cylinder to the ends of said plunger-cylinder in alternation, and means for exhausting the motive fluid from said plunger-cylinder.

9. The combination with a cylinder provided with main ports, of a piston in said cylinder, a valve controlling the movements of motive fluid through said ports and provided with actuating means operable by pressure of the motive fluid, and means controlled by said piston in its movements and including secondary admission and exhaust ports in said cylinder, for admitting motive fluid from said cylinder to and exhausting the motive fluid from said actuating means.

10. The combination with a cylinder provided with main ports, of a piston working in said cylinder and provided with a peripheral groove, an admission-chamber, an exhaust, a valve controlling admission and exhaust of motive fluid through said main ports and provided with an actuator operable by pressure of the motive fluid, two sets of secondary ports leading from said cylinder to said actuating means, one set of said secondary ports communicating with one side of said actuator and the other set with the other side thereof, one port in each set terminating at such a point that it may open into said piston-groove, and the other ports in said sets opening at such points that they may be covered and uncovered by the ends of said piston, and a secondary port also leading to one of said admission and exhaust elements from a point where it may open into said piston-groove; both of said sets of secondary ports being covered and uncovered by the piston in its movements.

11. The combination with a cylinder provided with main ports, of a piston working in said cylinder, a valve operable by the pressure of motive fluid and controlling admission and exhaust of motive fluid through said ports, and means, including secondary admission-ports and secondary exhaust-ports in said cylinder, for enabling said piston to act as a valve for controlling the admission and exhaust movements of motive fluid with reference to the first-mentioned valve, to cause the latter to oscillate.

12. The combination with a cylinder provided with main ports, of a piston working in said cylinder, a valve controlling admission and exhaust of motive fluid through said ports, an actuator mechanically connected to said valve, a cylinder in which said actuator works, and means, including secondary admission-ports in said cylinder, for enabling said piston to act as a valve to control the passage of motive fluid to and from the ends of said actuator-cylinder, said secondary admission-ports being separated by a distance approximately equal to the length of the piston.

13. The combination with a main cylinder provided with ports, of a piston in said cylinder, an oscillatable valve controlling the

movements of motive fluid through said ports, a cylinder in which said valve works, a plunger mechanically connected to said valve, a cylinder in which said plunger works, and means for enabling said piston to act as a valve to control the passage of motive fluid to and from the ends of said plunger-cylinder.

14. The combination with a main cylinder provided with main ports, of a piston working in said cylinder and provided with a peripheral groove, a valve mounted for oscillation and controlling admission and exhaust of motive fluid through said main ports, a cylinder in which said valve works, a plunger mechanically connected to said valve, a cylinder in which said plunger works, a set of secondary ports leading from said main cylinder to one end of said plunger-cylinder, a set of secondary ports leading from said main cylinder to the other end of said plunger-cylinder, an additional secondary port in said main cylinder for passage of motive fluid, said peripheral groove being in such a position that it may during the piston movements enable said additional port to communicate in alternation with one secondary port in each set, and the remaining ports in said sets opening at such points that they may be covered and uncovered by the ends of said piston; both of said sets of secondary ports being covered and uncovered by the piston in its movements.

15. The combination with a main cylinder provided with ports, of a piston in said cylinder, oppositely-acting two-way valves for controlling the passage of motive fluid through said ports, a plunger connected to said valves and operable by fluid-pressure, and means for enabling said piston to act as a valve to control the passage of motive fluid to and from said plunger.

16. The combination with a main cylinder provided with main ports, of a piston therein, oppositely-acting two-way valves controlling the passage of motive fluid through said ports, said valves being formed upon a single member which extends longitudinally of said main cylinder, a cylinder in which said valve member works, a plunger operatively connected to said valve member, a cylinder in which said plunger works, and secondary ports leading from the ends of said plunger-cylinder to said main cylinder and opening into the latter at such points as to enable said piston to act as a valve for said plunger.

17. The combination with a main cylinder and a piston therein, said cylinder being provided with ports, of a valve-cylinder, a cylindrical valve member in said valve-cylinder, a two-way port upon one side of said valve member for coöperation with one of said main cylinder-ports, a two-way port upon the other side of said valve member for coöperation with the other of said main cylinder-ports, a plunger connected to said valve member and operable by the pressure of motive fluid, and means for controlling the movements of said plunger.

18. The combination with a main cylinder provided with main ports and a piston in said cylinder, of admission and exhaust chambers, a valve-cylinder extending between said chambers longitudinally of said main cylinder, said ports opening into the same side of said valve-cylinder, a cylindrical valve member in said valve-cylinder, said valve member being provided with oppositely-acting two-way ports for controlling the passage of motive fluid through said main ports, a cylindrical plunger mounted transversely of said valve member and geared thereto, a cylinder in which said plunger is mounted, and means for admitting motive fluid to and exhausting it from said plunger-cylinder.

19. The combination with a main cylinder provided with main ports and a piston in said cylinder, of a chest which is divided longitudinally of said cylinder with a partition in which is formed a valve-cylinder, said chest being provided upon its opposite sides with openings into the chambers formed by said partition, a valve member fitting in said valve-cylinder to control the passage of motive fluid through said ports, said valve being provided with oppositely-acting two-way ports one for each of said main ports, a plunger connected to said valve, a cylinder in which said plunger works, and means, inclusive of secondary ports leading from said plunger-cylinder to said main cylinder and a secondary passage from said main cylinder to one of the chambers in said chest, for enabling said piston to act as a valve for said plunger.

20. The combination with a piston and its cylinder, of an oscillatable valve extending longitudinally of said cylinder and having at its ends separate ports for controlling the passage of motive fluid to and from the ends of said cylinder, and means for enabling said valve to be oscillated by the pressure of motive fluid and for enabling said piston to act as a valve for controlling the movements of said oscillating valve.

21. The combination with a piston and its cylinder, of an oscillatable valve for controlling the movements of said piston, a plunger operatively connected to said valve, and means for enabling said plunger to be reciprocated by the pressure of motive fluid thereon.

22. The combination with a piston and its cylinder, of an oscillatable valve for controlling the movements of said piston, a plunger having a rack whereby it is geared to said valve, and means operating automatically for alternately admitting and exhausting motive fluid from the ends of said plunger.

23. The combination with a piston and its cylinder, of a valve member set longitudinally of said cylinder and having separate ports for controlling the passage of motive fluid to and from the ends of said cylinder, pinion-teeth

upon said valve member, a transverse plunger having a rack in engagement with said pinion-teeth, and automatically-operating means for enabling the motive fluid to reciprocate said plunger.

24. The combination with a cylinder having ports and a piston in said cylinder, of a chest upon said cylinder bored through transversely to form cylinders, detachable caps closing the ends of said bores, a valve in one of said bores having separate ports one for coöperation with each of said cylinder-ports, a plunger in the other of said bores and having between its ends means for engaging said valve, to oscillate the same, and automatically-operating means for enabling the motive fluid to reciprocate said plunger.

25. The combination with a cylinder having ports, of a piston in said cylinder, a chest upon said cylinder, said chest being divided into chambers by a partition extending longitudinally of said cylinder, a cylindrical bore extending through said chest and partition longitudinally of the latter, an oscillatable valve in said bore, detachable caps closing the end of said bore, said valve being provided with separate two-way ports for coöperation with said cylinder-ports, and being provided between said ports with pinion-teeth, a bore through said chest forming a transverse cylinder, a pair of caps closing said transverse bore, a plunger in said transverse bore and having between its ends a rack to engage said pinion-teeth, and automatically-operating means for effecting the reciprocation of said plunger by pressure of motive fluid thereon.

26. A cylindrical balanced valve having separate passages therethrough from side to side, each passage terminating at its ends in cut-aways or openings adapted to operate as two-way ports, said cut-aways being similar in form, and sets of pinion-teeth provided upon said valve between said passages and upon opposite sides of said valve, the latter being provided with cut-aways between the sets of pinion-teeth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS E. STURTEVANT.

Witnesses:
LEWIS J. AUGEVINE,
ERNEST W. STRATMANN.