No. 617,807. Patented Jan. 17, 1899.

W. S. COLWELL.

ENGINE.

(Application filed Nov. 15, 1897.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.

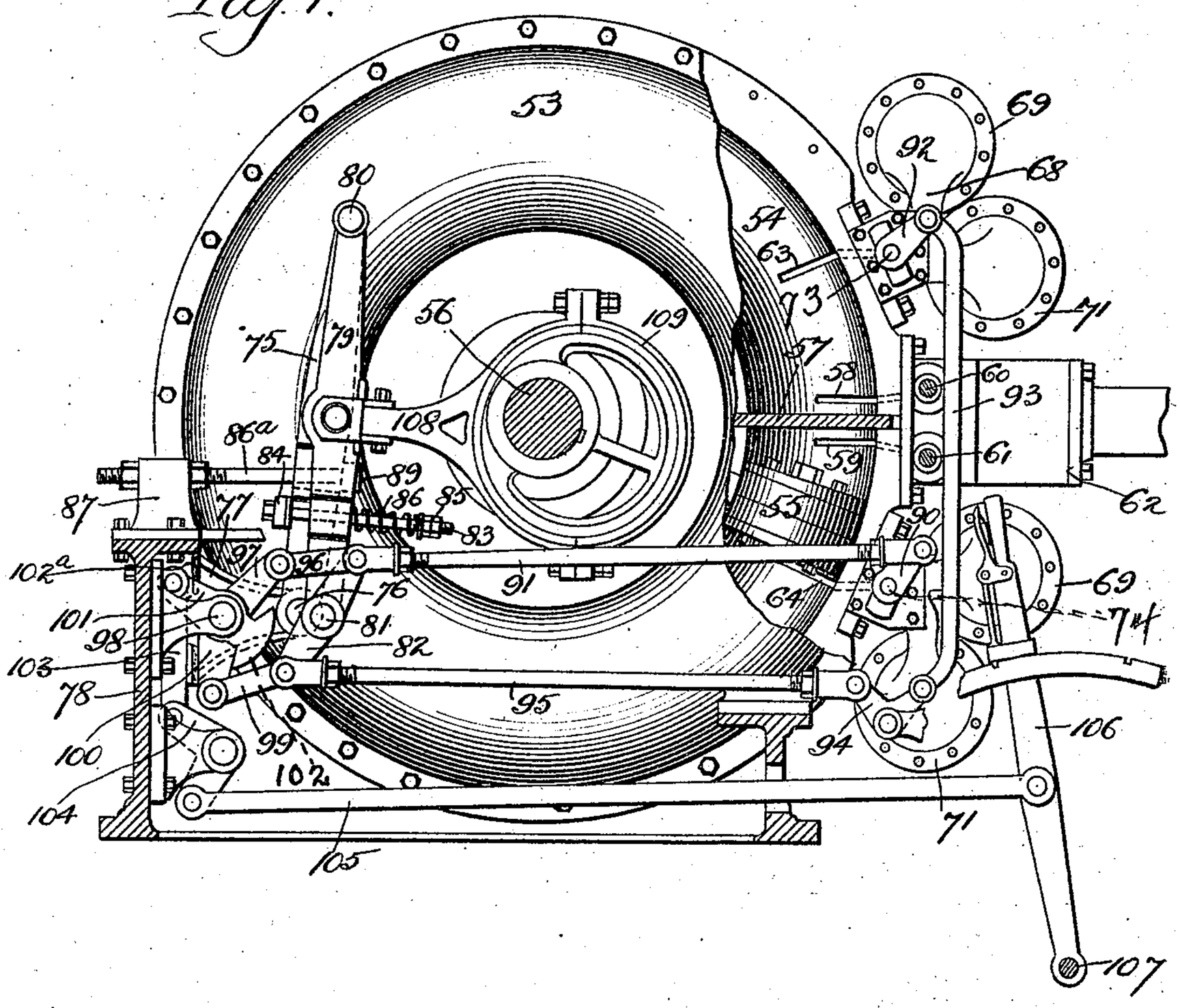
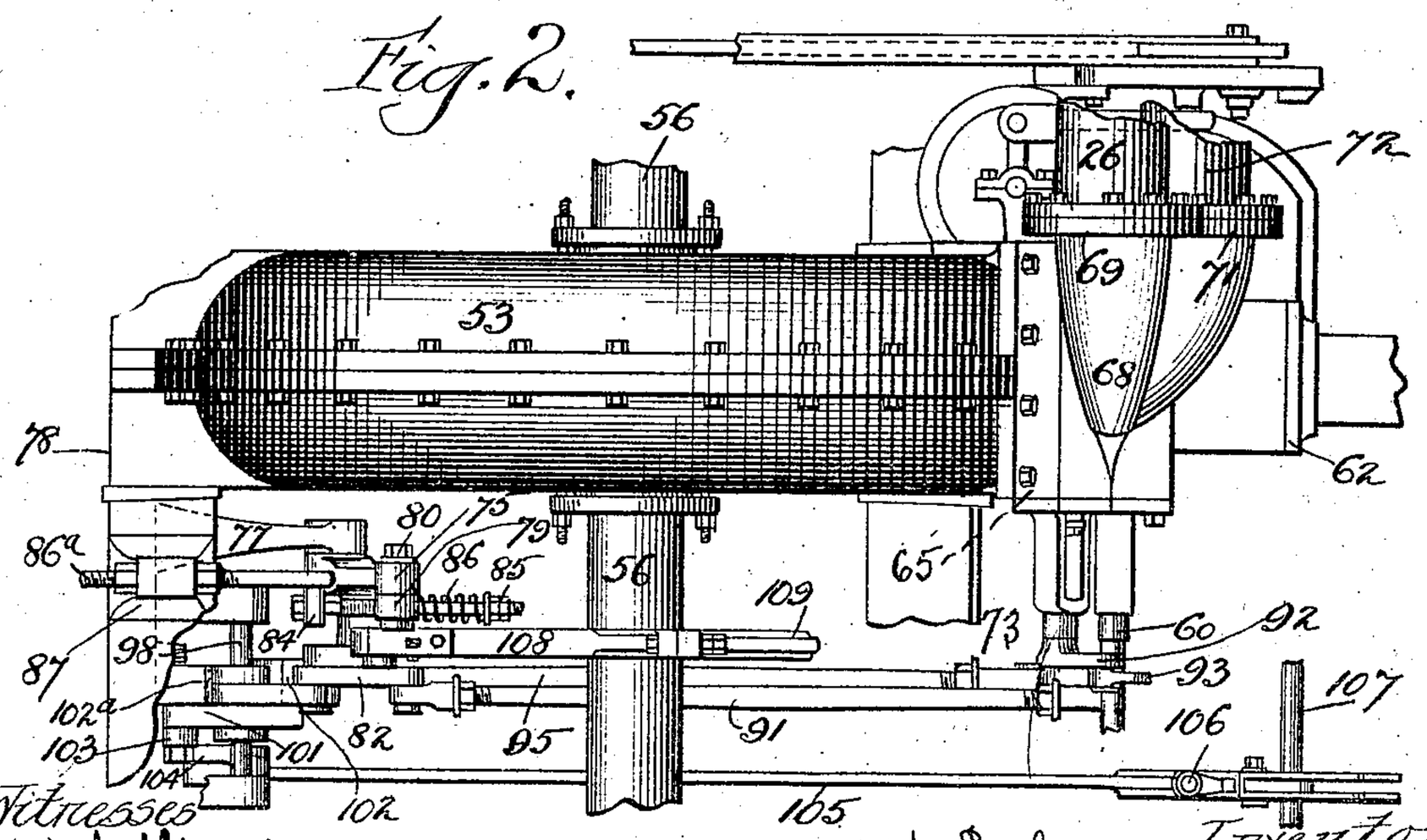


Fig. 2.



Witnesses
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Wm. N. Rheem.

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(No Model.) 4 Sheets—Sheet 2.

Fig. 3.

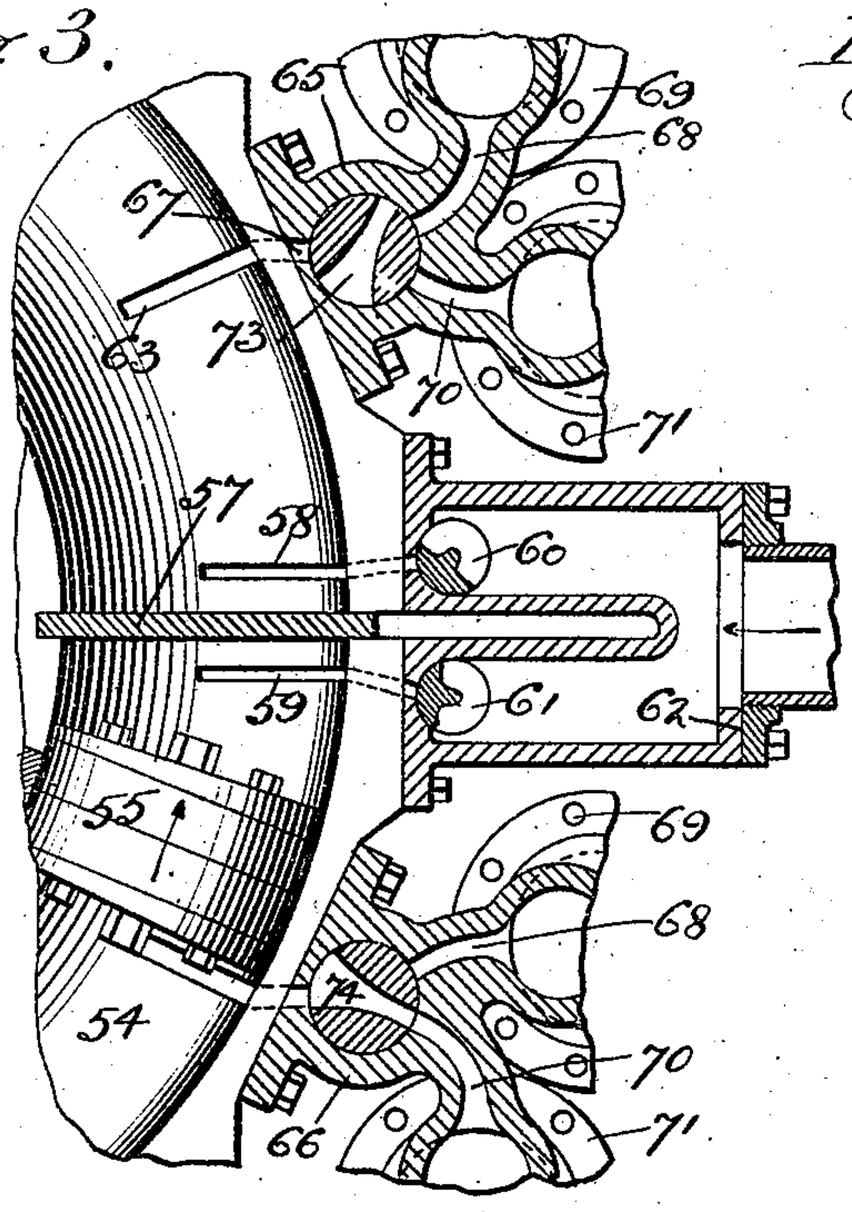


Fig. 1.

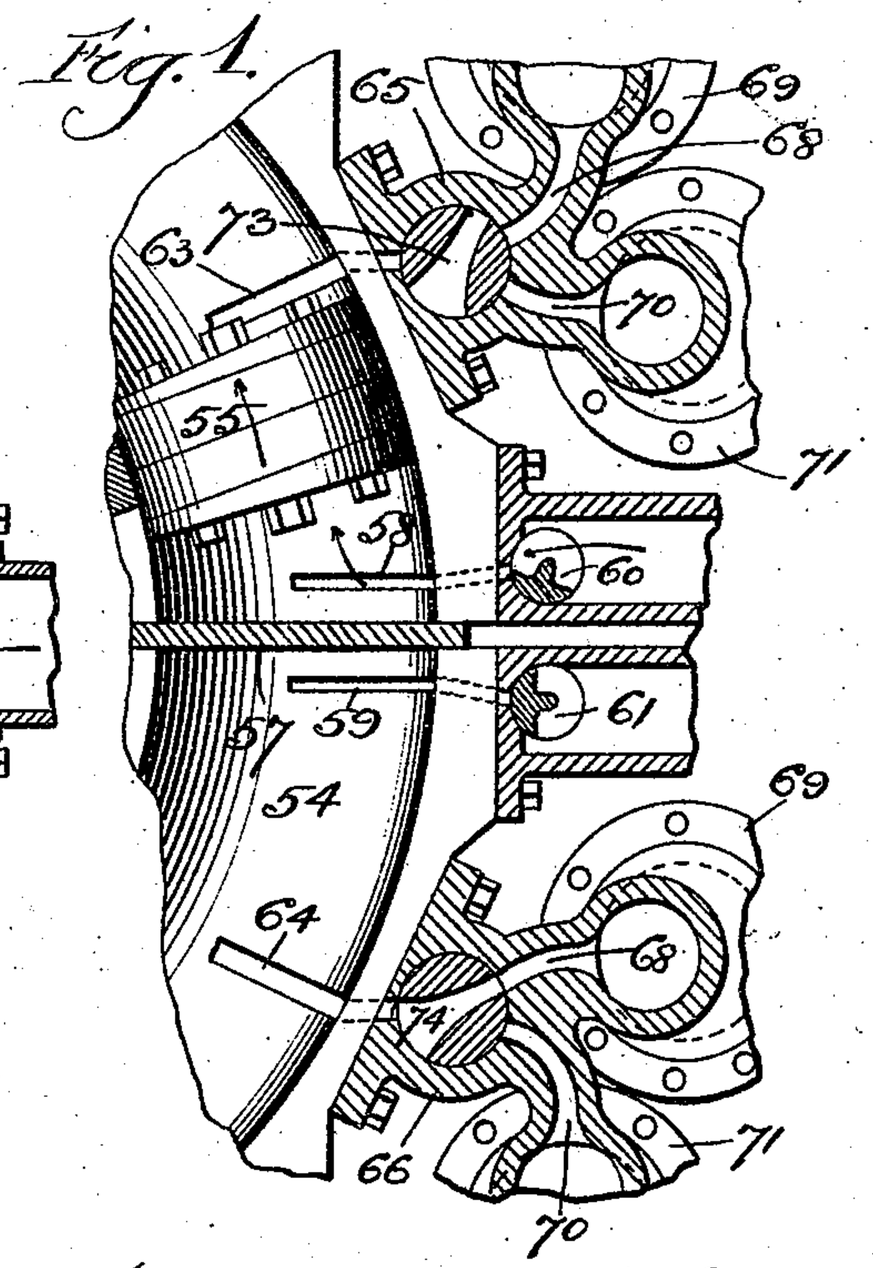


Fig. 5.

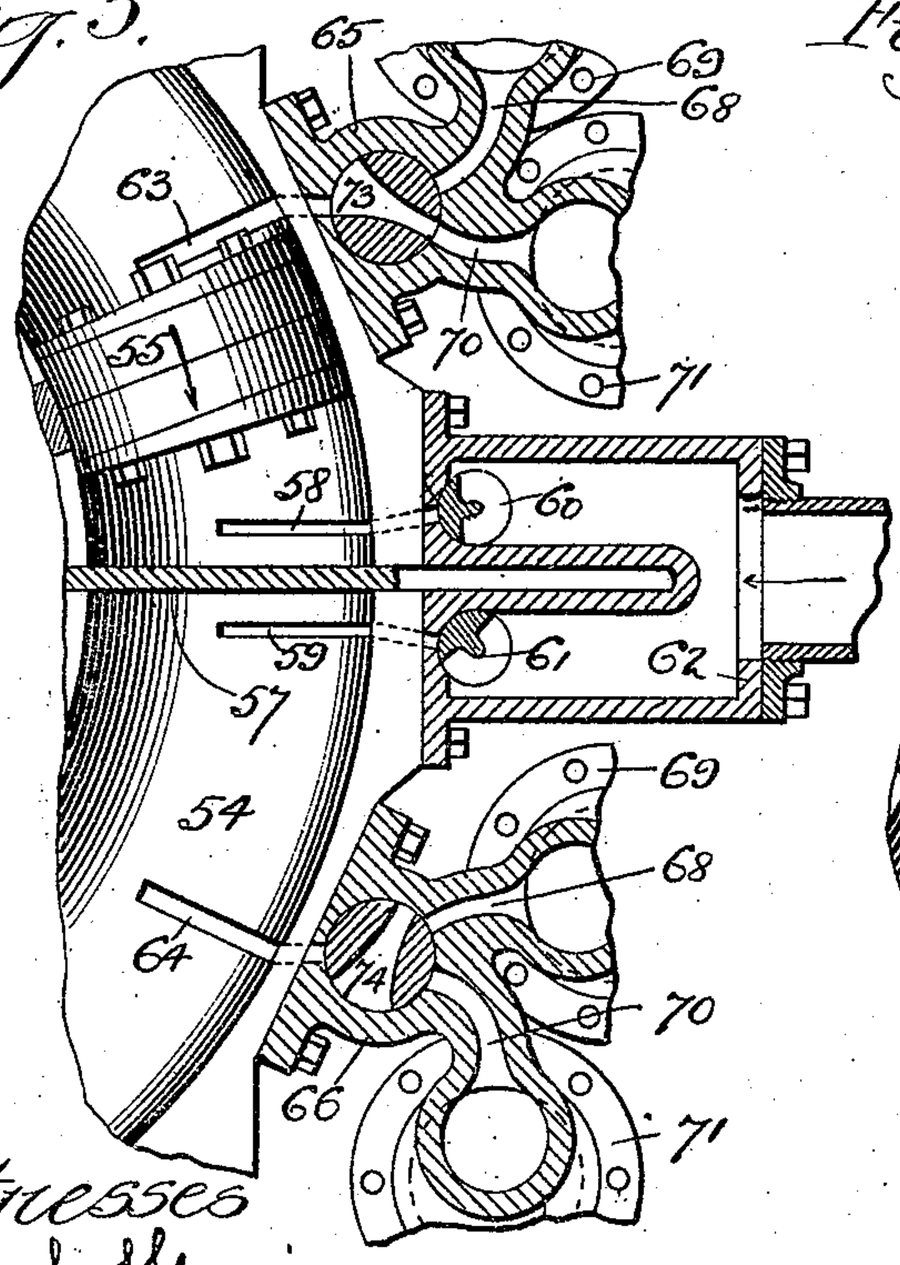
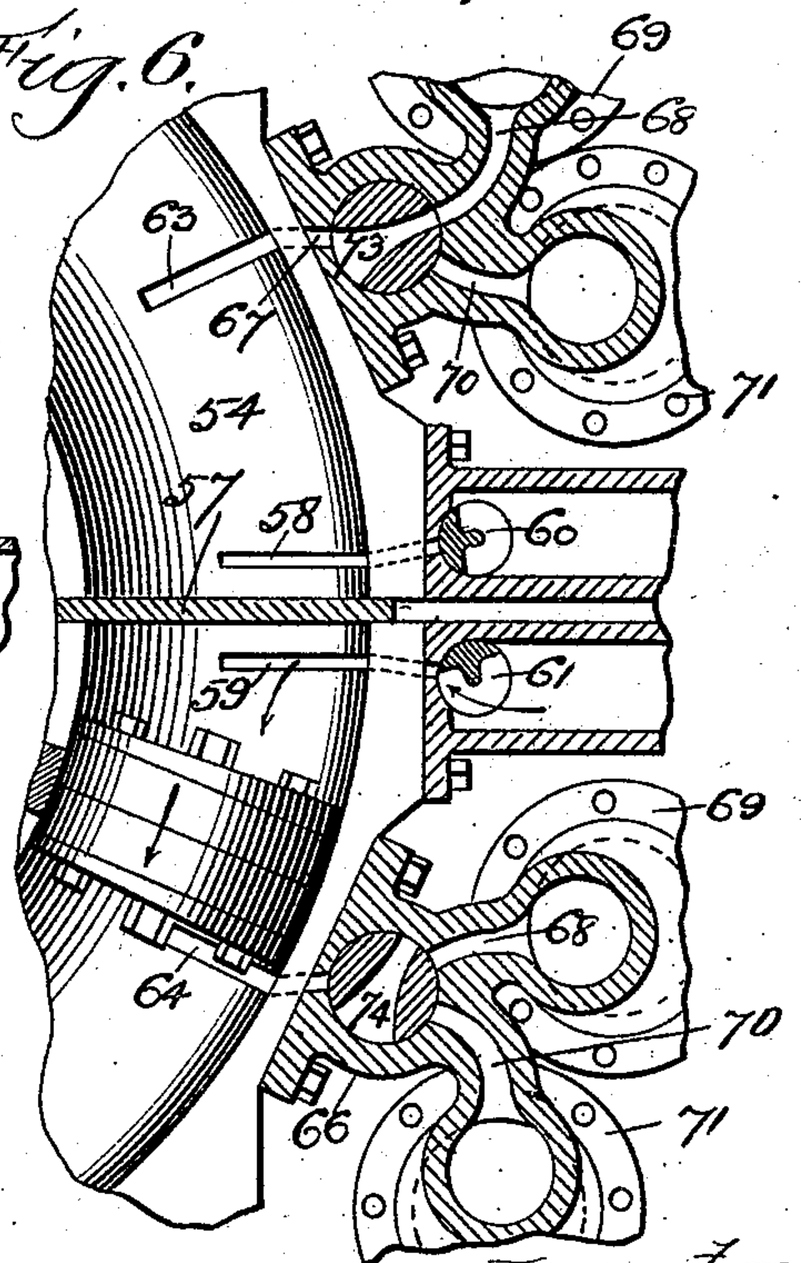


Fig. 6.



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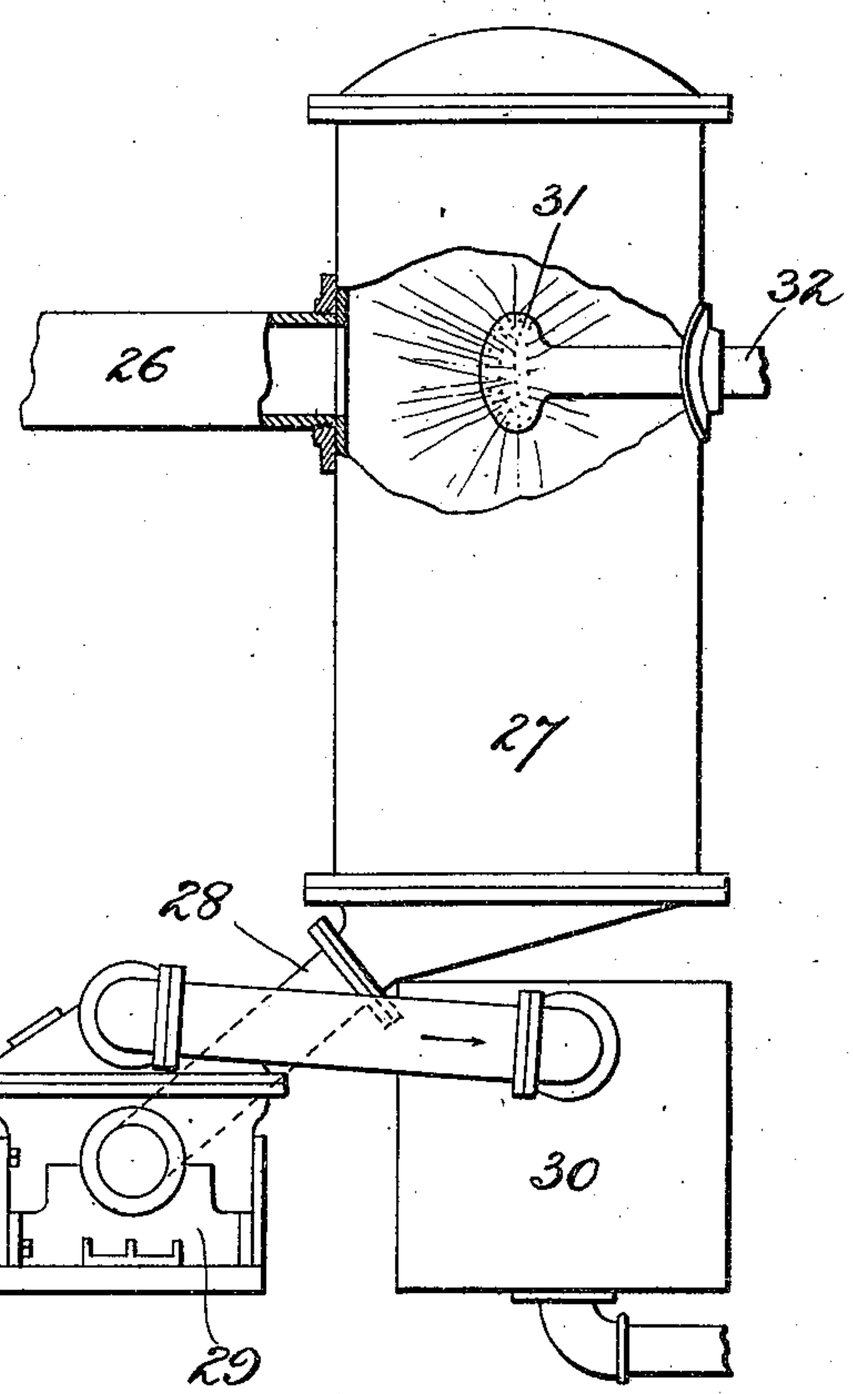
(No Model.) 4 Sheets—Sheet 3.

Fig. 7.



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ENGINE.

(Application filed Nov. 15, 1897.)

(No Model.) 4 Sheets—Sheet 4.

Fig. 8.

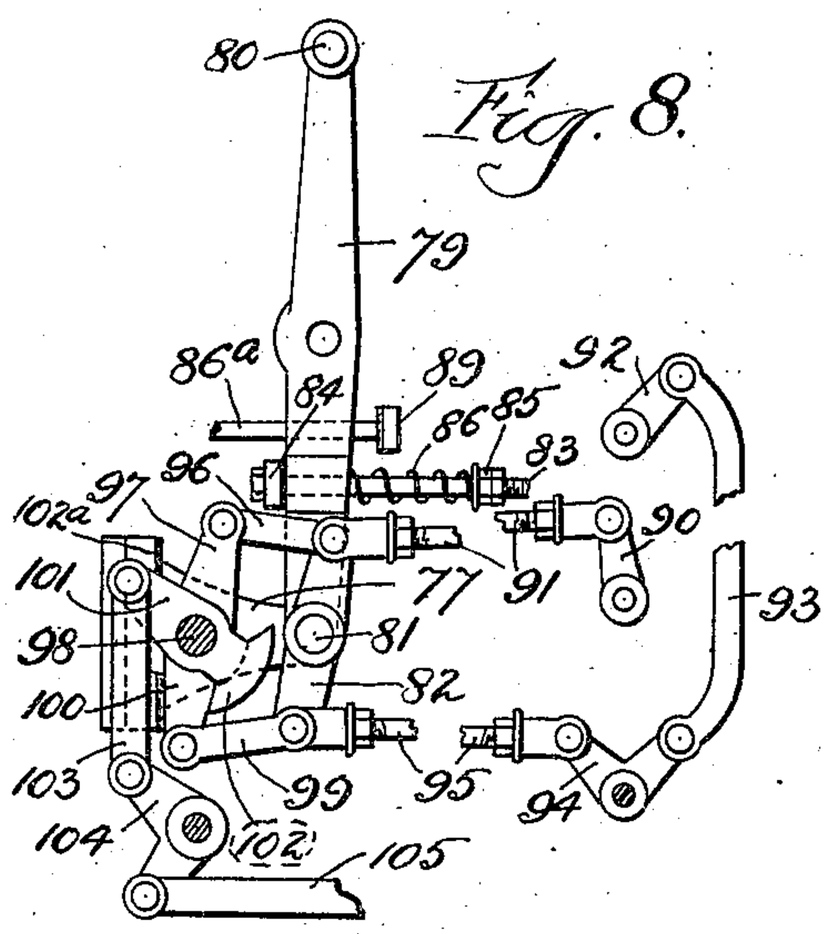


Fig. 9.

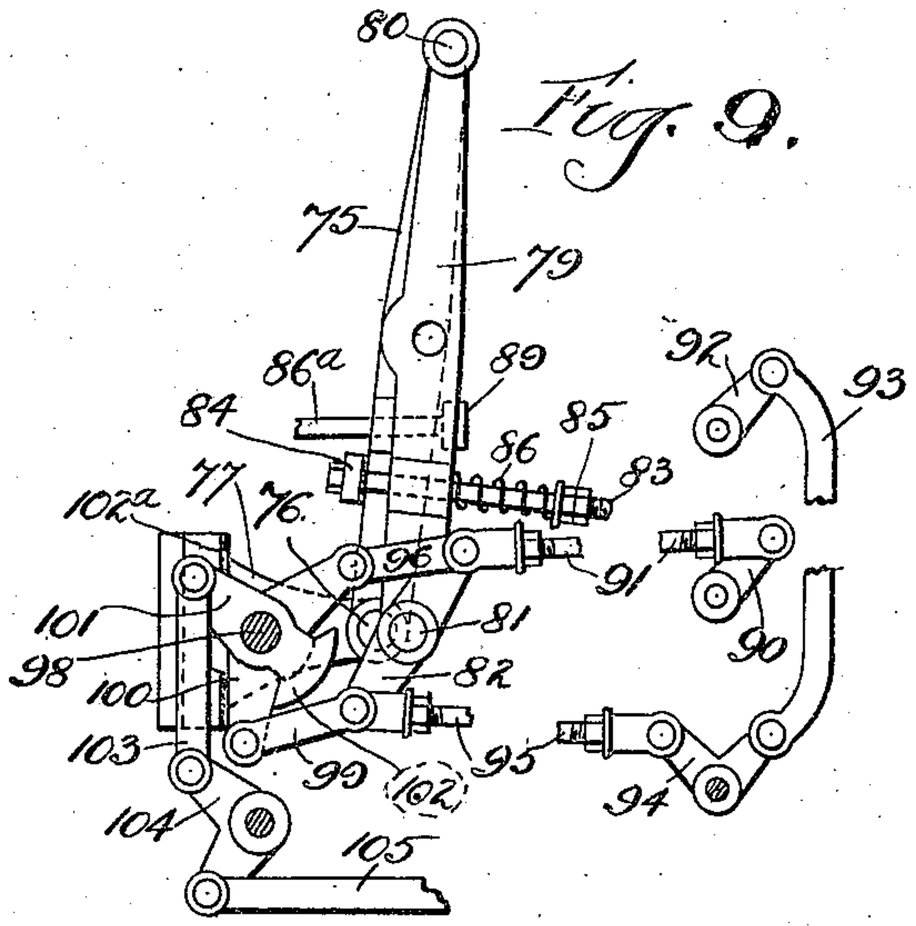


Fig. 10.

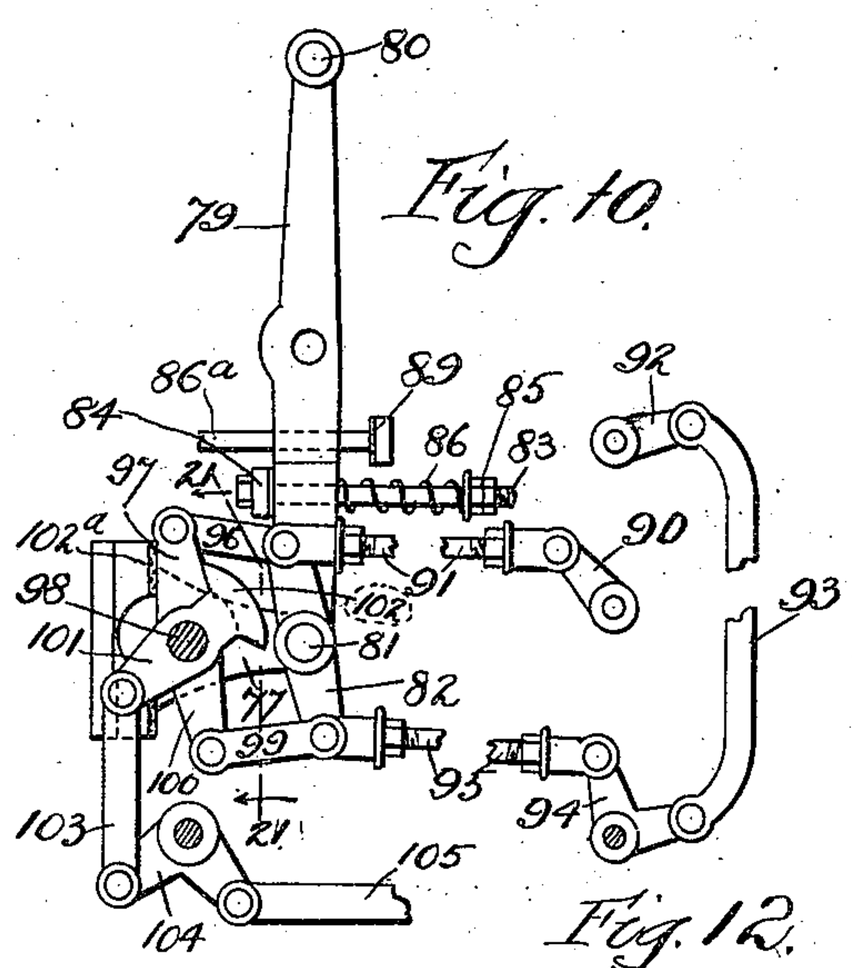


Fig. 11.

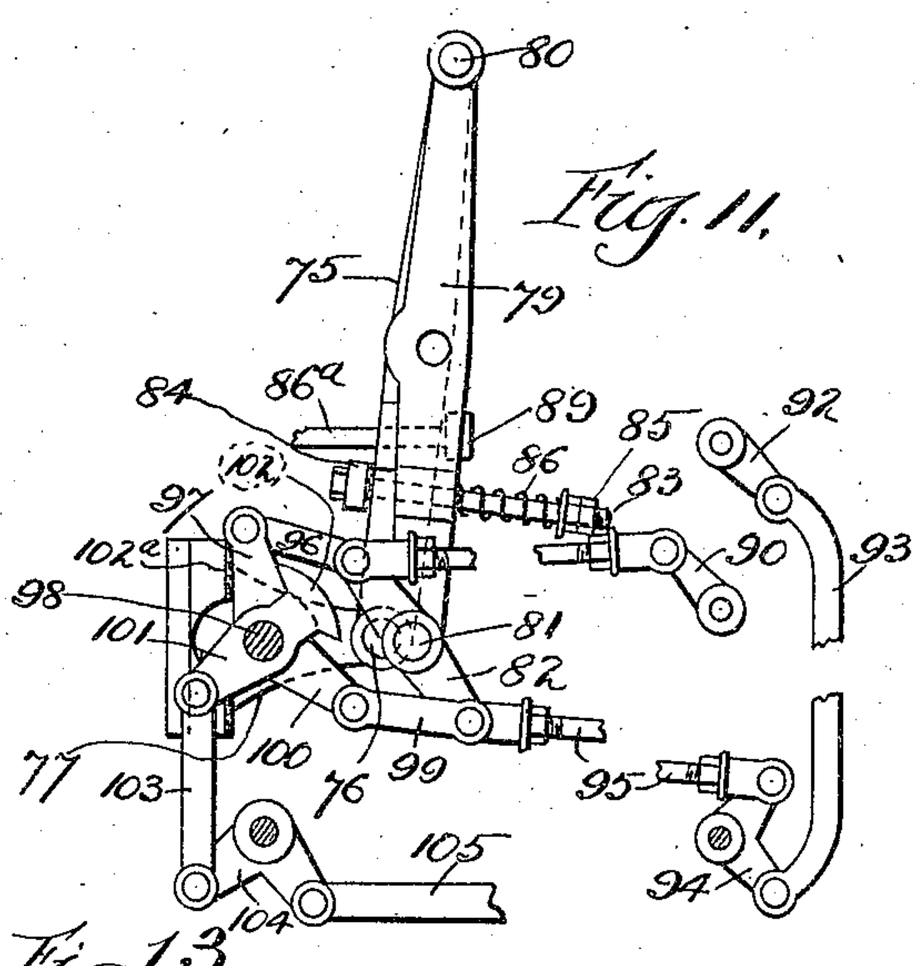


Fig. 12.

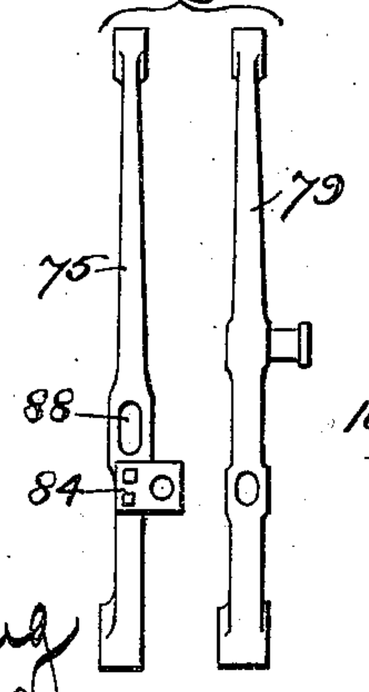


Fig. 13.

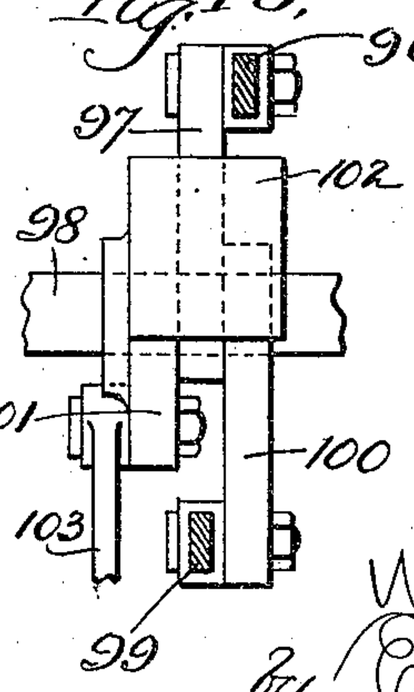
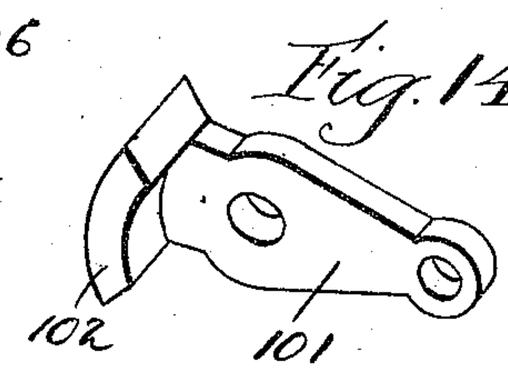


Fig. 14.



Witnesses
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Attys

UNITED STATES PATENT OFFICE.

WILLIAM S. COLWELL, OF CHICAGO, ILLINOIS.

ENGINE.

SPECIFICATION forming part of Letters Patent No. 617,807, dated January 17, 1899.

Application filed November 15, 1897. Serial No. 658,551. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM SAMUEL COLWELL, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Fluid-Pressure Engines or Motors, of which the following is a full, clear, and exact specification.

My invention relates to fluid-pressure engines or motors generally, but more particularly to the rotary steam engine or motor and to those types employing a piston-way or other chamber or space for the pressure to act in and a piston or other member for the pressure to act against; and the improvements have more especial reference to means for subjecting the advance side of the piston to a vacuum without depending upon the condensation of the exhaust-steam for the production of such vacuum.

The primary object of my invention is to provide improved means for subjecting the piston on its advance side to vacuous action.

A further object of my invention is to provide a valve-gear for engines whereby the exhaust will be opened during a short length of the stroke and the piston-way then shut off from the exhaust and opened to a vacuum during a comparatively longer length of the stroke.

With these ends in view my invention consists in certain features of novelty in the construction, combination, and arrangement of parts by which the said objects and certain other objects hereinafter appearing are attained, all as fully described, with reference to the accompanying drawings, and more particularly pointed out in the claims.

In the said drawings, Figure 1 is a side elevation, partly in vertical section, of a rotary engine equipped with my improvements. Fig. 2 is a plan view thereof. Fig. 3 is a vertical sectional view, partly broken away, showing the parts in the position they assume when the engine is running to the left, or away from the engineer, with the exhaust taking place. Fig. 4 is a similar view showing the parts in the position they assume when the engine is running in the same direction and taking pressure or steam. Figs. 5 and 6 are similar views showing the engine running in the reverse direction, or to the right. Fig. 7 is a side elevation of the vacuum-chamber, pump, and hot-well. Figs. 8, 9, 10, and 11 are detail views of the valve mechanism, partly broken away, corresponding in position, respectively, with the positions of the parts as illustrated in Figs. 3, 4, 5, and 6. Fig. 12 is a rear elevation of the floating lever and its pivotal standard or support, hereinafter described. Fig. 13 is a detail plan view of certain parts of the valve mechanism or gear, hereinafter explained; and Fig. 14 is a perspective view of a clog, hereinafter described.

Like signs of reference indicate like parts throughout the figures of the drawings.

In illustrating my invention I have shown it as applied to a rotary engine of the steam-engine type, as an example of the various forms of motors to which my improvements are equally applicable, and in describing the invention in connection with such motors I herein refer to the member which is actuated by the fluid-pressure as the "piston;" but this term I employ as a convenient and generic term, meaning that part or member of any motor which corresponds to the piston or other part that converts the pressure into motion; and I also employ herein the expression "piston-way," which is to be considered a generic term meaning that space or chamber in which the pressure acts for converting its power into motion.

It will also be evident that while the example of motor illustrated and described is of the reversible type the invention is in its broadest aspect nevertheless equally applicable to non-reversible or one-way motors.

53 represents the shell or casing; 54, the piston-way therein; 55, the piston secured to main shaft; 56 57, the movable abutment; 58 59, the inlet-ports on either side of the abutment; 60 61, the valves controlling such inlet-ports, respectively; 62, the steam-chest, in which said valves 60 61 are housed, and 63 64 the exhaust-ports on either side of the abutment. All of these parts may be of the usual or any suitable construction, and the mechanism for controlling the admission of pressure through either of the ports 58 59 may be of any of the valve mechanisms well known in the art.

In applying my improvements to a rotary engine of the reversible form I provide a valve-

housing, preferably, for each of the exhaust-ports 63 64, and each of which is placed in communication with one of said ports and also with a vacuum-chamber 27 through pipe or passage 26, as well as provided with an exhaust-discharge passage. One of these valve-housings is shown at 65, the other at 66, and each is provided with a port 67, communicating with one of the exhaust-ports 63 64, a port or passage 68, leading to any suitable fitting, having a flange 69 or other suitable attachment whereby it may be connected with the pipe 26, Fig. 7, leading to the vacuum-chamber 27, and also an exhaust-discharge passage 70, leading to a similar fitting 71, which may be connected with an exhaust-discharge pipe 72. Each of these valve-housings may be bolted or otherwise suitably secured to the shell of the engine.

Contained in each of the housings 65 66 is a plug-valve 73 74. When the engine is running to the left, or away from the engineer, assuming the engineer's post to be on the right, the upper valve 73 is turned so as to close the exhaust-port 63, and is rendered inactive during the rotation of the engine in this direction by mechanism presently to be described, while the valve 74, or lower valve, places the piston-way through the port 64 first in communication with the vacuum, where it remains until the piston has almost completed the circuit or stroke and passed such exhaust-port 64, whereupon the pressure which impelled the piston to this position escapes into the port 64, and at the same time the valve 74 shifts the narrower side of its passage from the vacuum to the exhaust-discharge passage 70, and remains in this position until the abutment 57 has been withdrawn to permit the piston to pass and again inserted behind the piston. By the time the abutment is again installed the piston will have risen beyond the upper inlet-port 58 and pressure is again admitted through such port 58 to impel the piston throughout another stroke, and at the same time the valve 74 shifts back to its normal position (shown in Fig. 4) with the vacuum in communication with the piston-way, and consequently enabling the vacuum to exert a propulsive action on the piston throughout the time that the piston is approaching the exhaust-port 64.

Fig. 5 shows the parts in the position they assume at the instant of the exhaust when the engine is running to the right, or toward the engineer, and Fig. 6 illustrates their position at the instant of or shortly after taking steam or pressure.

Any lingering products of the exhaust remaining in the piston-way and connected passages under atmospheric pressure are of course sucked into the vacuum-chamber 27, and in order that such products or portion of the exhaust may not tend to reduce the vacuum I provide the vacuum-chamber with an ordinary spray or rose 31, having cold-water-pipe connection 32 and being arranged, preferably, directly opposite the pipe 26, which leads from the engine, so that any portion of the exhaust pressure fluid drawn into the vacuum will be instantly condensed, and when the pressure employed is steam the waters of condensation, together with the small amount of water sprayed in through the rose 31, will fall to the bottom of the vacuum-chamber 27 and serve the useful purpose of packing the pump 29, which in the absence of such water would in all probability require a special supply of water for this purpose. The water discharged from the pump may be delivered to the hot-well 30 or any other desired place and thence to the boiler.

I have not shown herein any mechanism for operating the abutment 57 nor the pressure-admission valves 60 61; but any desired means may be employed for these purposes.

I will now describe the mechanism for holding one of the valves 73 74 at rest or inactive and imparting the described movements to the other.

75 represents a pivoted standard or support whose lower end is pivotally supported at 76 to a bracket 77, secured to a part 78 of the engine-bed, and 79 is a floating lever whose upper end is pivoted at 80 to the upper end of the standard 75, while its lower end is pivoted at 81 to a second lever 82, the pivots 76 81 being so arranged with relation to each other that when the lever 79 is brought into parallelism with the standard 75 such pivots will be coincident. The lever 79 is also elastically connected to the standard 75, and the movement of the standard 75 is limited in one direction, while the lever 79 is capable of further movement in the same direction. I accomplish this elastic connection between the standard 75 and lever 79 by means of a rod 83, passing loosely through the lever 79 and being secured by means of lug 84 (see Fig. 12) to the back of the standard 75 and having sleeved on it between the opposite side of the lever 79 and a head or nut 85 a coil-spring 86, which when the lever 79 is pulled out of parallelism with the standard 75 tends to restore the pivots 76 81 to their coincident position. The movement of the standard 75 to the right is limited by means of a stop composed of a rod 86, secured in block 87 and passing through a vertical slot 88 in the standard and having a head 89, against which the standard abuts.

Each end of the bodily-moving lever 82 is provided with pivotal operative connection with one of the valves 73 74. The lower valve 74 is provided with a crank-arm 90, connected by rod 91 with the upper end of the lever 82. The upper valve is provided with a crank-arm 92, which is connected by rod or link 93 with one arm of a bell-crank 94, whose other arm is connected by a rod 95 with the lower end of the lever 82. The upper end of the lever 82 is also connected by link 96 with a crank-arm

97, pivoted loosely on shaft 98, while the lower end of the lever 82 is connected by link 99 with a downwardly-projecting crank-arm 100, also pivoted on the shaft 98, and in combination with these crank-arms 97 100 I employ suitable means for holding one of them at rest while the other is permitted to oscillate, such means being controlled, preferably, by the reversing device, which also shifts the inlet-valves of the engine, so that when the reversing device is moved in one direction one of the inlet-valves of the engine will be closed or rendered inactive and the other put in condition for operation, and one end of the lever 81 will be held stationary while the other end is permitted to oscillate with the lever 79, thus holding one of the valves 73 74 at rest and closed while the other operates through the oscillation of the lever 82. A convenient means of accomplishing this consists of an arm 101, preferably pivoted on the shaft 98 and having a clog or lock 102 projecting into the plane of oscillation of both of the arms 97 100, so that when the arm 101 is thrown in one direction its clog 102 will press against one of the arms 97 100 and hold it against oscillation, and consequently hold that end of the lever 82 at rest, while the other end is permitted to oscillate, and when the arm 101 is thrown in the opposite direction the opposite end of the lever 82 will accordingly be locked and its other end freed. This motion of the arm 101 also shifts the lever 82 and through such action turns the valve 73 or 74 controlled thereby into such a position that its blank side will permanently close the exhaust-port 63 or 64 controlled thereby. 102^a represents a cushion-block or buffer having a padded surface for the arms 97 100 to strike against. The arm 101 is connected by link 103 with one arm of a bell-crank lever 104, whose other arm is connected by rod 105 to the reversing lever or device 106, the latter being secured to a shaft 107 and controlling the inlet-valves and abutment mechanism in any suitable way.

The lever 79 is connected at about its mid-length to the arm 108 of an eccentric-strap 109, operated by an eccentric on the shaft 56 of the engine. While the eccentric is moving to the right and carrying the lever 79 and standard 75 in the same direction such lever and standard turn on a common axis passing through the centers 76 81, and as a consequence no movement of either valve 73 74 is produced until the standard 75 comes against its stop 89, whereupon the eccentric in continuing to pull the lever 79 will impart pivotal movement to it on its pivot 81, and in so doing compress the spring 86 and carry the center 81 away from the center 76. This produces an independent oscillation of the lever 82, which turns on the pivot at the end thereof which happens to be fixed by the clog 102, and in thus oscillating it effects, through the rod 91 or 95, the shifting of one of the valves 73 74 in such a manner as to disconnect the vacuum from the piston-way through the exhaust-discharge passage 70, whereupon the exhaust rushes out of the piston-way and escapes independently of the vacuum. When the eccentric has completed its movement to the right and begins to return the eccentric-rod 108 toward the left, the spring 86 will follow up the movement by pressing against the lower end of the lever 79 and will return the pivot 81 to a coincident position with the pivot 76, thus shifting the valve 73 or 74 to its normal position with the vacuum in communication with the piston-way and the exhaust-discharge passage 70 cut off. As soon as the centers 76 81 arrive at a coincident position the lever 79 and standard 75 oscillate to the left on the same center, and the lever 82 therefore remains at rest, and consequently the valve 73 or 74 will keep the piston-way in communication with the vacuum during the balance and greater part of the stroke or rotation of the piston, the only time that the valve 73 or 74 is acted upon being the time the center 81 is passing to and fro on the right of the center 76.

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

1. A motor having in combination a continuous piston-way; a piston; an abutment, said piston-way having a supply and an exhaust port on each side of said abutment; a vacuum-chamber connected with both of said exhaust-ports and each of said exhaust-ports being also connected with an exhaust-discharge passage; means for holding one of said exhaust-ports closed and means for placing the other of said exhaust-ports alternately in communication with first the vacuum-chamber and then said exhaust-discharge passage, substantially as set forth.

2. A motor having in combination a continuous piston-way; a piston therein; an abutment, said piston-way having a supply and an exhaust port on each side of said abutment; means for admitting pressure through either of said supply-ports; a vacuum-chamber connected with both of said exhaust-ports and each of said exhaust-ports being also connected with an exhaust-discharge passage; a valve adapted to place each of said exhaust-ports in communication with either said vacuum or exhaust-discharge passage; means for holding either of said valves inactive; a reversing device connected with the last said means and also having operative connection with the means for admitting pressure through the inlet-ports and being adapted to hold one inlet-port closed while the other is in operation, and means having operative connection with said reversing device for periodically opening either of said exhaust-ports first to the vacuum and then to the exhaust-discharge passage, substantially as set forth.

3. A motor having in combination a piston-

way having an exhaust-port; means for admitting pressure to said piston-way; a vacuum-chamber; a valve-housing connected with said exhaust-port and vacuum-chamber and also having an exhaust-discharge passage; a valve in said housing adapted to place said exhaust-port in communication with said vacuum and exhaust-discharge passage alternately; a pivoted floating lever having a limited movement at one end and a further movement at its other end and said other end being operatively connected with said valve, and means for oscillating said lever bodily and also on an independent axis, substantially as set forth.

4. A motor having in combination a piston-way having an exhaust-port; means for admitting pressure to said piston-way; a vacuum-chamber; a valve-housing connected with said exhaust-port and vacuum-chamber and also having an exhaust-discharge passage; a valve in said housing adapted to place said exhaust-port in communication with said vacuum and exhaust-discharge passage; a movable member having a pivotal support and having also pivotal operative connection with said valve and the latter one of said pivots being adapted to coincide with the axis of the other whereby the movement of said member will not affect the position of said valve when said pivots are coincident; means for moving said member with one of its said pivotal connections away from the other and means for tending to restore said pivotal connections to a coincident position, substantially as set forth.

5. A motor having in combination a piston-way having an exhaust-port; means for admitting pressure to said piston-way; a vacuum-chamber; a valve-housing connected with said exhaust-port and vacuum-chamber and also having an exhaust-discharge passage; a valve in said housing adapted to place said exhaust-port in communication with said vacuum and exhaust-discharge passage alternately; a pivoted floating lever having a limited movement at one end and a further movement at the other and said other end being operatively connected with said valve; a cushion for resisting the pivotal movement of said lever and means for oscillating said lever bodily, substantially as set forth.

6. A motor having in combination a piston-way having an exhaust-port; means for admitting pressure to said piston-way; a vacuum-chamber; a valve-housing connected with said exhaust-port and vacuum-chamber and also having an exhaust-discharge passage; a valve in said housing adapted to place said exhaust-port in communication with said vacuum and exhaust-discharge passage alternately; a pivotal support or standard having a limited movement; a lever pivoted at one end to said standard and having elastic connection therewith for resisting the pivotal movement of said lever and said lever also having operative connection with said valve, and means for oscillating said lever bodily, substantially as set forth.

7. A motor having in combination an abutment; a piston; a continuous piston-way having an exhaust-port at each side of said abutment; a vacuum-chamber; a valve-housing having communication with said vacuum-chamber and with each of said exhaust-ports and being also provided with an exhaust-discharge passage; a valve in each of said housings adapted to place either of said exhaust-ports in communication with the vacuum-chamber and with said exhaust-discharge passage alternately; a floating lever; means for bodily oscillating said lever; a second lever pivoted to said first lever and having each end provided with pivotal operative connection with said valves respectively; means for holding either end of said second lever inactive while the other end oscillates with said floating lever; and means for admitting pressure to the piston-way at either side of the abutment; substantially as set forth.

8. A motor having in combination an abutment; a piston; a continuous piston-way having an exhaust-port at each side of said abutment; a vacuum-chamber; a valve-housing having communication with said vacuum-chamber and with each of said exhaust-ports and being also provided with an exhaust-discharge passage; a valve in each of said housings adapted to place either of said exhaust-ports in communication with said vacuum-chamber and with said exhaust-discharge passage alternately; a floating lever; means for bodily oscillating said lever; a second lever pivoted to said first lever and having each end provided with pivotal operative connection with said valves respectively; a reversing device having means arranged in operative relation to both ends of said second lever for forcing said second lever in either direction on its pivotal connection with the floating lever, and means for admitting pressure to the piston-way at either side of the abutment, substantially as set forth.

9. A motor having in combination an abutment; a piston; a continuous piston-way having an exhaust-port at each side of said abutment; a vacuum-chamber; a valve-housing having communication with said vacuum-chamber and with each of said exhaust-ports and being also provided with an exhaust-discharge passage; a valve in each housing adapted to place either of said exhaust-ports in communication with said vacuum-chamber and said exhaust-discharge passage alternately; a floating pivoted lever having a movable support and being elastically connected therewith; means for bodily oscillating said lever; a second lever pivoted to said first lever and having each end provided with pivotal operative connection with said valves respectively; means for holding either end of said second valve inactive while the other end oscillates,

and means for admitting pressure to the piston-way at either side of the abutment, substantially as set forth.

10. A motor having in combination an abutment; a piston; a continuous piston-way having an exhaust-port at each side of said abutment; a vacuum-chamber; a valve-housing having communication with said vacuum-chamber and with each of said exhaust-ports and being also provided with an exhaust-discharge passage; a valve in each of said housings adapted to place either of said exhaust-ports in communication with said vacuum-chamber and said exhaust-discharge passage alternately; a floating lever; a pivotal support or standard pivotally and elastically connected to said lever; means for bodily oscillating said lever; a second lever pivoted to said first lever and having each end provided with pivotal operative connection with said valves respectively; means for holding either end of said second valve inactive while the other end oscillates, and means for admitting pressure to the piston-way at either side of the abutment, substantially as set forth.

11. A motor having in combination an abutment; a piston; a continuous piston-way having an exhaust-port at each side of said abutment; a vacuum-chamber; a valve-housing having communication with said vacuum-chamber and with each of said exhaust-ports and being also provided with an exhaust-discharge passage; a valve in each of said housings adapted to place either of said exhaust-ports in communication with said vacuum-chamber and said exhaust-discharge passage alternately; a floating lever; means for forcing said lever in one direction; a cushion for returning said lever in the other direction; a second lever pivoted to said first lever and having each end provided with pivotal operative connection with said valves respectively; means for holding either end of said second lever inactive while the other end oscillates, and means for admitting pressure to the piston-way at either side of said abutment, substantially as set forth.

12. A motor having in combination an abutment; a piston; a continuous piston-way having an exhaust-port at each side of said abutment; a vacuum-chamber; a valve-housing having communication with said chamber and with each of said exhaust-ports and being also provided with an exhaust-discharge passage; a valve in each of said housings adapted to place either of said exhaust-ports in communication with said vacuum-chamber and said exhaust-discharge passage alternately; a floating lever; a pivotal support or standard having limited oscillation and being pivotally and elastically connected to said lever; means for bodily oscillating said lever; a second lever pivoted to said first lever and having its ends provided with pivotal operative connection with said valves respectively; means for holding either end of said second lever inactive while the other end oscillates; and means for admitting pressure to the piston-way at either side of the abutment, substantially as set forth.

13. A motor having in combination an abutment; a piston; a piston-way having an exhaust-port at each side of said abutment; a vacuum-chamber; means for admitting pressure to either side of the abutment; a valve-housing having communication with said vacuum-chamber and with each of said exhaust-ports and being also provided with an exhaust-discharge passage; a valve in each of said housings adapted to place either of said exhaust-ports in communication with said vacuum-chamber and exhaust-discharge passage alternately; a floating lever having limited bodily movement at one end and being pivoted at said end; means for bodily oscillating said lever; a cushion resisting said lever; a second lever pivotally connected with the other end of said first lever and being bodily movable and having its ends operatively connected with said valves respectively, and means for holding either end of said second lever at rest while its other end oscillates, substantially as set forth.

14. A motor having in combination a piston; an abutment; a piston-way having an exhaust-port on each side of said abutment; a vacuum-chamber; a valve-housing connected with each of said exhaust-ports and said vacuum-chamber, and also having an exhaust-discharge passage; a valve in each of said housings adapted to place each of said exhaust-ports alternately in communication with the vacuum-chamber and exhaust-discharge passage; a pivoted standard; a lever pivoted to said standard; a second lever pivoted to said first lever and having its pivot arranged to coincide with the pivot of said standard and each end of said second lever having operative connection with one of said valves; means for oscillating said first lever and means for holding one end of said second lever at rest while the other end oscillates, substantially as set forth.

15. A motor having in combination a piston; an abutment; a piston-way having an exhaust-port on each side of said abutment; a vacuum-chamber; a valve-housing connected with each of said exhaust-ports and said vacuum-chamber and also having an exhaust-discharge passage; a valve in each of said housings adapted to place each of said exhaust-ports alternately in communication with said vacuum-chamber and exhaust-discharge passage; a pivoted standard; a stop for limiting the movement of said standard; a lever pivoted to said standard and also having elastic connection therewith; a second lever pivoted to said first lever and having its pivot arranged to coincide with the pivot of said standard and each end of said second lever having operative connection with one of said valves; means for oscillating said first

lever and means for holding one end of said second lever at rest while its other end oscillates, substantially as set forth.

16. A motor having in combination a piston; an abutment; a piston-way having an exhaust-port on each side of said abutment; a vacuum-chamber; a valve-housing connected with each of said exhaust-ports and said vacuum-chamber and also having an exhaust-discharge passage; a valve in each of said housings adapted to place each of said exhaust-ports alternately in communication with said vacuum-chamber and exhaust-discharge passage; a pivoted standard; a lever pivoted to said standard; a second lever pivoted to said first lever and having its pivot arranged to coincide with the pivot of said standard, and each end of said second lever having operative connection with one of said valves; means for oscillating said first lever; a pair of independent pivoted arms pivotally connected with the ends of said second lever and a lock for holding either of said arms against movement, substantially as set forth.

17. A motor having in combination a piston; an abutment; a piston-way having an exhaust-port on each side of said abutment; a vacuum-chamber; a valve-housing connected with each of said exhaust-ports and said vacuum-chamber and also having an exhaust-discharge passage; a valve in each of said housings adapted to place each of said exhaust-ports alternately in communication with said vacuum-chamber and exhaust-discharge passage; a pivoted standard; a lever pivoted to said standard; a second lever pivoted to said first lever and having its pivot arranged to coincide with the pivot of said standard, and each end of said second lever having operative connection with one of said valves; means for oscillating said first lever; a pair of independent pivoted arms pivotally connected with the ends of said second lever; a lock for holding either of said arms against movement and a reversing device operatively connected with said lock for throwing it into engagement with either of said arms, substantially as set forth.

18. A motor having in combination a piston; an abutment; a piston-way having an exhaust-port on each side of said abutment; a vacuum-chamber; a valve-housing connected with each of said exhaust-ports and said vacuum-chamber and also having an exhaust-discharge passage; a valve in each of said housings adapted to place each of said exhaust-ports alternately in communication with said vacuum-chamber and exhaust-discharge passage; a pivoted standard; a lever pivoted to said standard; a second lever pivoted to said first lever and having its pivot arranged to coincide with the pivot of said standard and each end of said second lever having operative connection with one of said valves; means for oscillating said first-lever; a stop for limiting the movement of said standard; a rod passing loosely through said lever and having a spring or cushion on one end bearing against said lever and the other end being secured to said standard whereby said pivot of the second lever will be drawn into coincidence with the pivot of said standard, substantially as set forth.

19. A motor having in combination a piston, an abutment; a piston-way having an exhaust-port on each side of said abutment; a vacuum-chamber; a valve-housing connected with each of said exhaust-ports and said vacuum-chamber and also having an exhaust-discharge passage; a valve in each of said housings adapted to place either of said exhaust-ports alternately in communication with said vacuum-chamber and one of said discharge-passages; a pivoted standard; a lever pivoted to said standard; a second lever pivoted to said first lever and having its pivot coincident with the pivot of said standard; a stop for limiting the movement of said standard; an elastic connection between said standard and first lever; two independent crank-arms having link connection respectively with the ends of said second lever; a pivoted arm having a clog adapted to rest against either of said crank-arms and hold it inactive; a reversing device connected with said clog-arm, and an operative connection between each end of said second lever and one of said valves, substantially as set forth.

WILLIAM S. COLWELL.

Witnesses:
F. A. HOPKINS,
EDNA B. JOHNSON.