

(No Model.)

4 Sheets—Sheet 1.

D. E. KEMPSTER.
STEAM ENGINE.

No. 436,068

Patented Sept. 9, 1890.

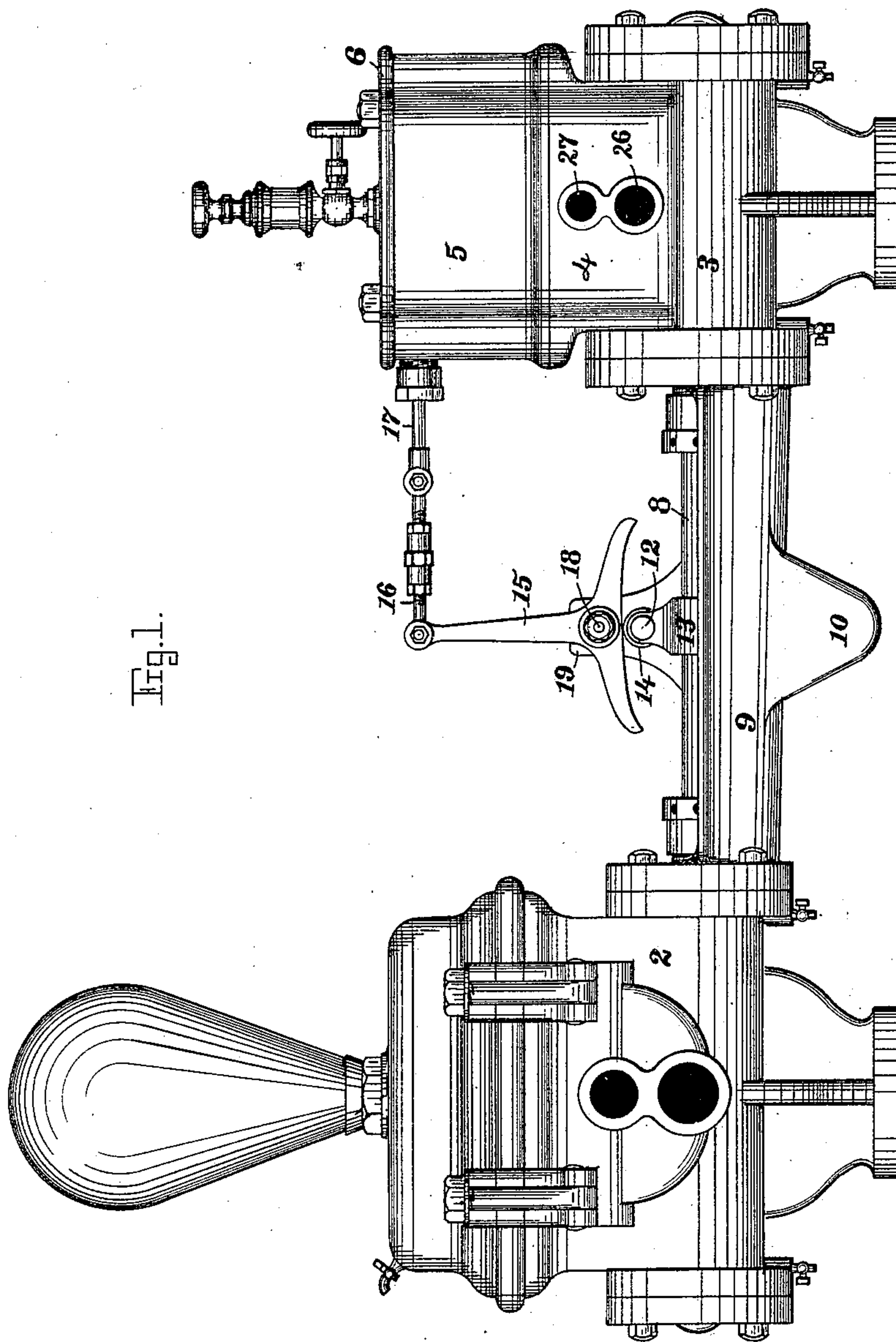


Fig. 1.

Witnesses

Frank E. Greenwood.
M. H. Army.

Inventor

Daniel E. Kempster.

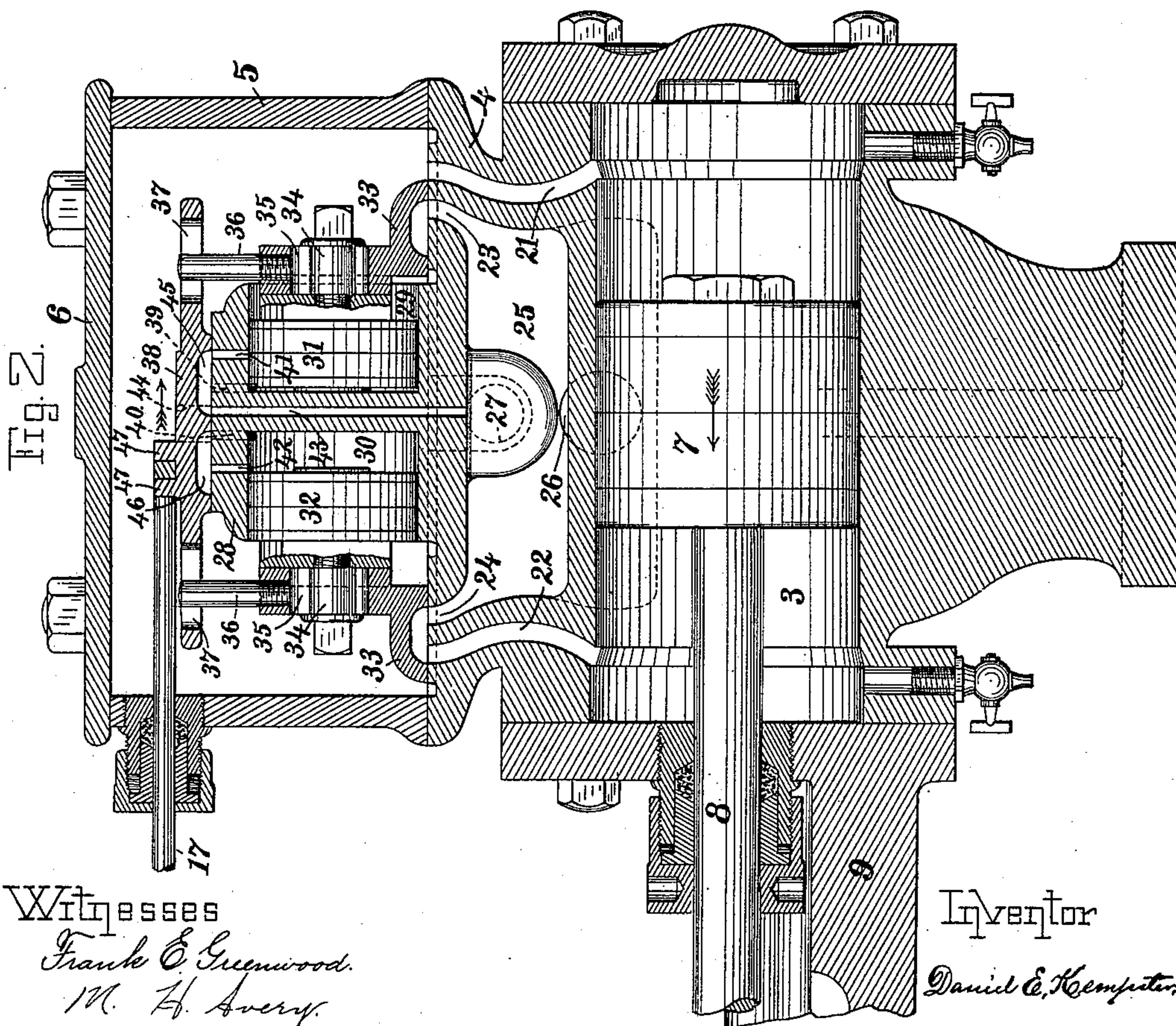
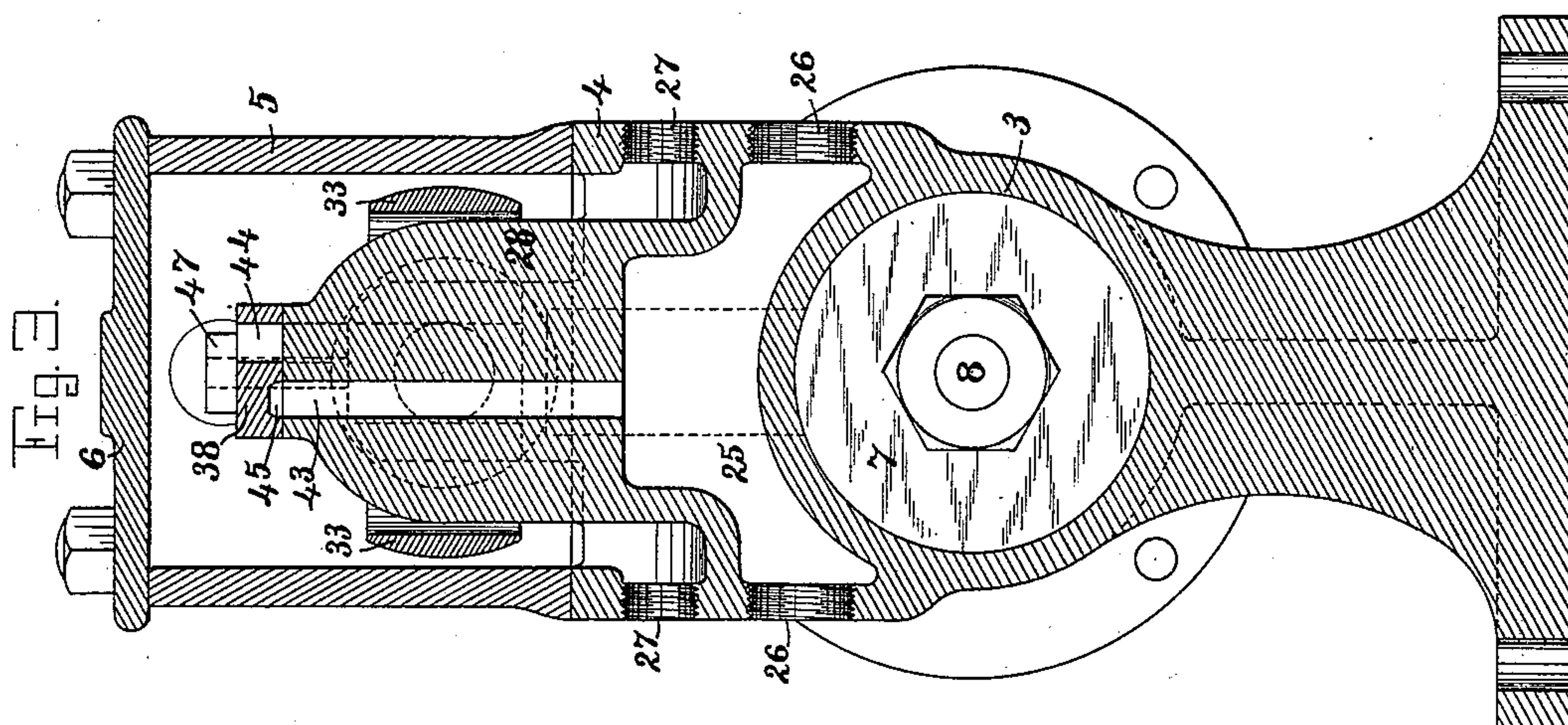
(No Model.)

4 Sheets—Sheet 2.

D. E. KEMPSTER.
STEAM ENGINE.

No. 436,068.

Patented Sept. 9, 1890.



Witnesses
Frank C. Greenwood.
M. H. Avery.

Inventor
Daniel E. Kempster.

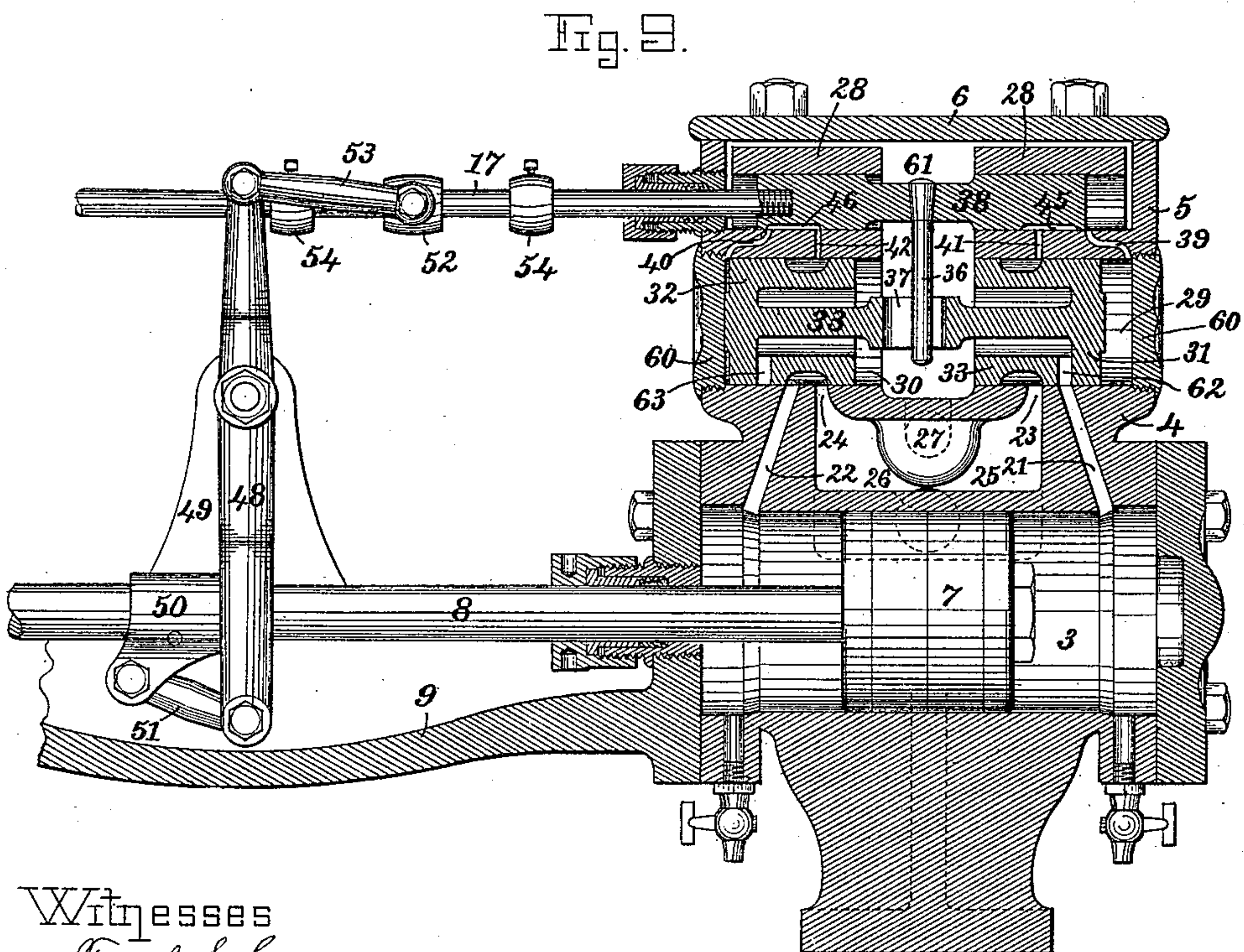
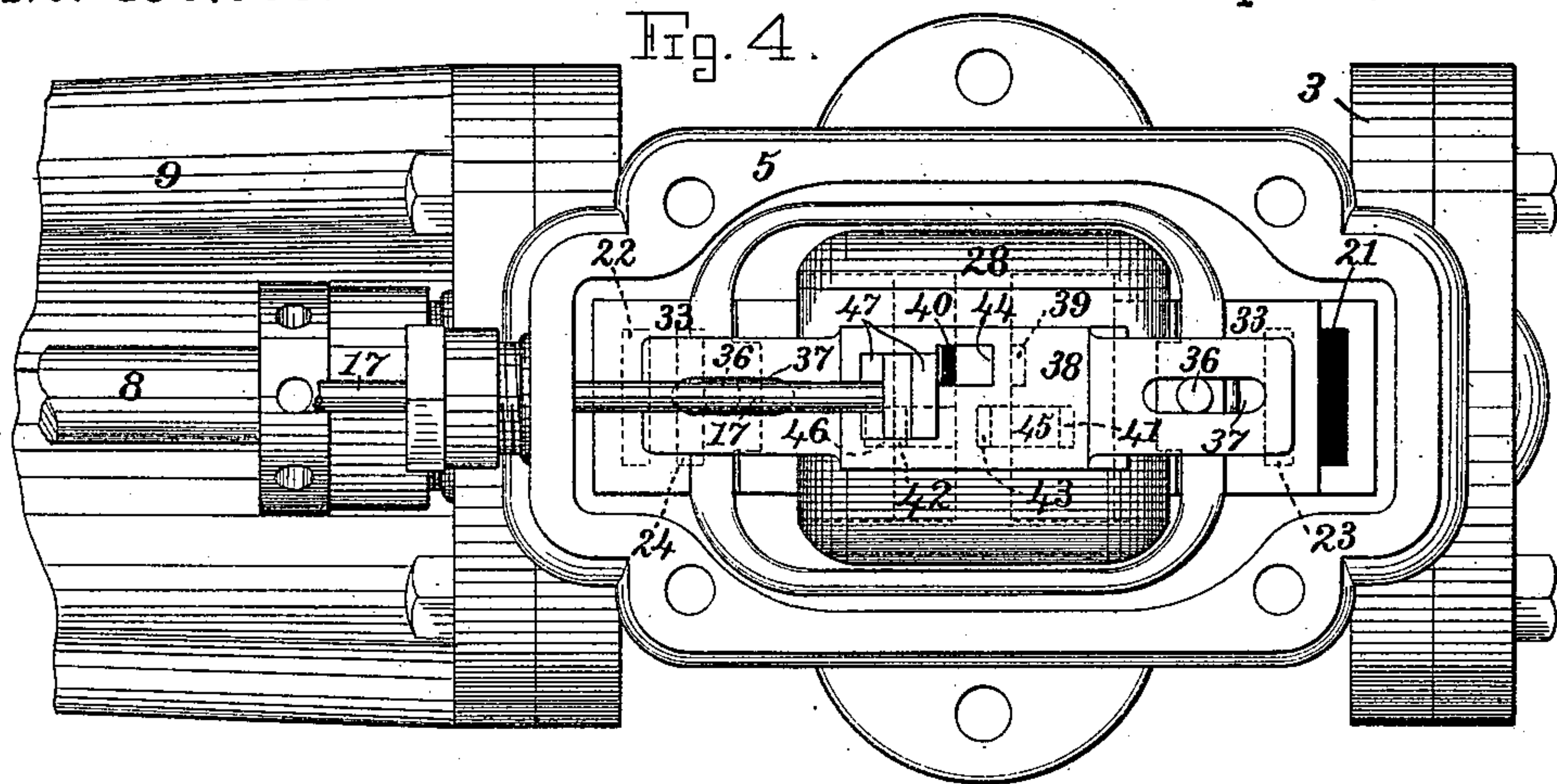
(No Model.)

4 Sheets—Sheet 3.

D. E. KEMPSTER.
STEAM ENGINE.

No. 436,068.

Patented Sept. 9, 1890.



Witnesses

Frank E. Greenwood.
M. H. Avery.

Inventor

Daniel E. Kempster.

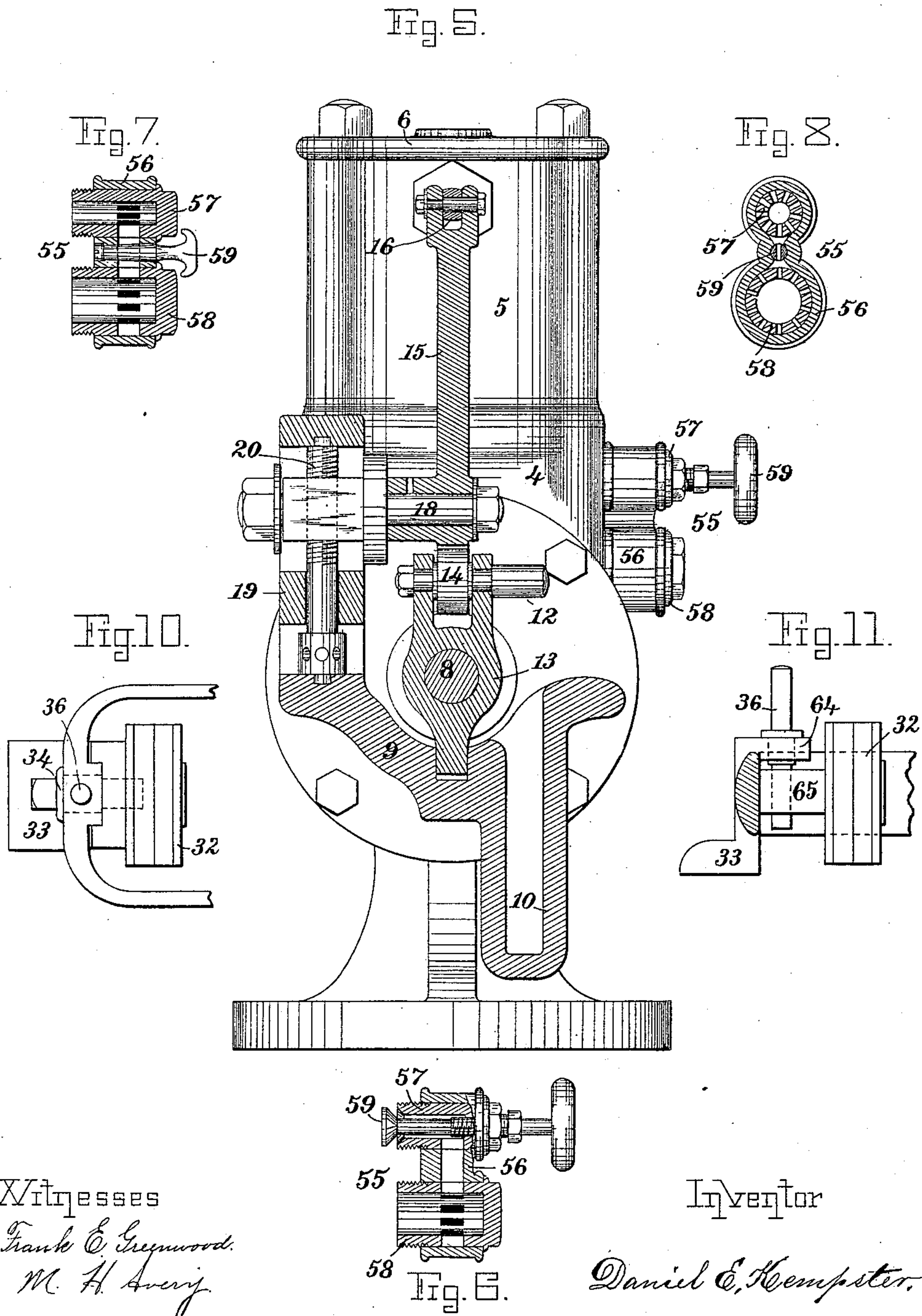
(No Model.)

4 Sheets—Sheet 4.

D. E. KEMPSTER.
STEAM ENGINE.

No. 436,068.

Patented Sept. 9, 1890.



UNITED STATES PATENT OFFICE.

DANIEL E. KEMPSTER, OF BOSTON, MASSACHUSETTS.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 436,068, dated September 9, 1890.

Application filed June 14, 1890. Serial No. 355,509. (No model.)

To all whom it may concern:

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

My invention relates to direct-acting engines of that class in which the main valve is actuated by steam or other fluid under pressure through the medium of minor pistons working in minor cylinders, which are controlled by an auxiliary valve operated by the main piston of the engine.

My invention has for its object to improve and simplify this class of engines; and it consists in the hereinafter-described construction and arrangement of the valves and their actuating mechanism, whereby both the main and auxiliary valves may be flat slide-valves moving in parallel lines with the main piston, and mechanically connected thereto, so as to be controlled thereby, and both valves, together with the main-valve-actuating pistons may be readily inspected without disconnecting any part of said valve mechanism by simply removing the cover of the steam-chest.

My invention also consists in other minor details of construction, and in the various combinations of devices, which will all be fully described hereinafter, and the special features thereof clearly pointed out in the claims at the end of this specification.

In the accompanying drawings similar figures of reference indicate corresponding parts wherever they occur thereon.

Figure 1 represents a side elevation of a steam-pump embodying my invention. Fig. 2 is a longitudinal section of the steam end of said pump. Fig. 3 is a central cross-section of the same. Fig. 4 is a top or plan view of said steam end with the cover of the steam-chest removed. Fig. 5 is a central cross-section of the intermediate frame, looking toward the

steam end of the pump and showing thereon the waste-water-valve device for carrying the water of condensation from the steam-chamber of the steam-chest into the exhaust-chamber thereof. Fig. 6 is a detail view of said waste-water drip-valve, shown partly in longitudinal section. Fig. 7 is a similar view of a little different construction of the same. Fig. 8 is a cross-section of said latter construction. Fig. 9 is a central longitudinal section of the steam end of my invention when using cylindrical valves instead of the flat valves shown in Fig. 2, and also shows another style of lever mechanism for operating the auxiliary valve. Fig. 10 is a detail plan view of one end of the main slide-valve and one of its actuating-pistons, showing the groove-and-tongue connection and holding-screw. Fig. 11 is a detail side view of the same, showing a different connection or arrangement, whereby the groove and tongue and holding-screw are dispensed with and a simpler and cheaper device made use of.

In the drawings, 2 represents the main water-cylinder.

3 represents the main steam-cylinder, and 4, 5, and 6 its steam-chest.

The main steam-cylinder is provided with the piston 7 and its piston-rod 8. Said piston is preferably provided with the usual spring-packing rings, and its rod extends through the stuffing-boxes on the steam and water cylinders, and has upon its water end the usual piston or plunger. Said water-cylinder is provided with valve and air chambers, and is constructed in the usual manner with water ends of steam-pumps.

The steam and water cylinders are separated by the intermediate frame 9, preferably provided with a projection 10, having a cavity or device for holding the lower end of the usual hand-lever, which engages the stud or pin 12 in the cross-head 13 by a slot in said lever, thereby admitting of operating the pump by hand in a well-known manner.

The piston-rod has fastened upon it about midway of its length the cross-head 13, before mentioned. Said cross-head preferably extends downward, and its lower end forms a bearing which runs in a groove or slot in the bottom of the intermediate frame 9, thereby holding said cross-head and its piston-rod

from revolving. The upper end of said cross-head is forked and provided with a projection, or, preferably, an anti-friction roll 14, held so as to revolve therein by the screw stud 5 or pin 12. Above said roll 14 is adjustably pivoted the rocker-lever 15 in a suitable position to be rocked or tilted by the reciprocation of said roll, so that the upright arm of the rocker-lever will be vibrated back and forth intermittently by the movement of the main piston-rod. To the upper end of said lever 15 is pivoted a connecting-rod 16, said rod being made in two parts and connected by a right and left nut having suitable check-nuts, so as to be readily adjusted as to length. The other end of said connecting-rod is pivoted to the auxiliary-valve stem 17, which passes through its stuffing-box on the steam-chest and connects with the auxiliary valve 20 to be described hereinafter.

The rocker-lever 15 is pivoted on a stud or bearing 18, and held in place thereon by a suitable collar and nut provided therefor. The stud or bearing 18 is squared or flattened, and said flattened portion extends through the slotted bracket or stand 19, fast on the side of the frame 9, and is held therein by a suitable nut and washer. A vertical adjusting-screw 20 passes through the squared or flattened portion of the pivotal stud 18, and is held from longitudinal movement by the respective ends of said screw engaging the frame and slotted stand. The screw 20 is provided with a suitable head, so as to be revolved by a wrench or pin, and thus raise or lower the rocker-stud 18 in the slotted stand 19, said vertical adjustment of the rocker determining the point in the stroke of the anti-friction roll 14, at which said roll shall tilt said rocker and reverse the auxiliary valve, thereby changing the motion of the main piston. The vertical adjustment of said rocker-lever, together with the adjustable connecting-rod 16, is used to regulate the length and position of the stroke of the engine, as will be readily understood without further explanation herein.

The steam-chest comprises all that portion of the steam end above the main cylinder, the part 4 of said chest being preferably cast integral with said main cylinder, and its upper face provided with the main-valve seat having steam-ports 21 22 and exhaust-ports 23 24. Said steam-ports extend downwardly into opposite ends of the main cylinder, and the exhaust-ports extend down into an exhaust-chamber 25 within said steam-chest, said exhaust-chamber being provided on each side with an outlet 26, to either one of which the exhaust-pipe may be connected. The steam-chest has upon each side, just above said outlets for the exhaust-pipe, the inlets 27 to either one of which the steam-supply pipe may be connected, said inlets entering into the sides of the part 4 of said chest, and then turning upwardly, opening through the face thereof into the valve-casing or part 5 of said

steam-chest, said valve-casing 5 and its cover 6 being secured fast upon the part 4 of said steam-chest by suitable screw-bolts in the usual manner.

The part 4 of the steam-chest is provided with the upwardly-extending portion 28, having formed therein the minor cylinders 29 and 30 arranged in line with the main cylinder and separated from each other by a central head or partition, the outer ends of said cylinders being preferably left open, thus avoiding the disadvantage of any stuffing-boxes therefor, and said cylinders are provided with suitable pistons 31 and 32, preferably having suitable spring packing-rings arranged in the ordinary manner with steam-pistons. Said pistons are attached to the main slide-valve 33 by vertical grooves and tongues and held together by suitable screws 34, passing through slots 35 in said valve and screwing into said pistons, so as to connect said pistons to opposite ends of said valve in such a manner as to allow the valve a certain amount of vertical movement or play, whereby as the valve and valve-seat wear away, the valve may follow down and keep tight upon its seat; also, when water from condensation in the steam-chest or otherwise is forced by the steam through the main cylinder into the exhaust-pipe, the main valve is free to rise from its seat and release itself from the water, thus avoiding danger or breakage of the valve or its connections. The main valve is preferably a flat slide-valve of a double D-pattern and covers the ports at opposite sides of the central portion 28, and is constructed with side arms, which encircle said central portion of the steam-chest and connect the two ends or faces of the valve together, said faces being provided with the usual exhaust-cavities for co-operation with the steam and exhaust ports in the ordinary manner with this class of valves.

The main valve is provided with one or two—in the present instance two—upwardly-extending projections or pins 36, fast in said valve at each end thereof just above the faces of the same and in a central line therewith. Said pins pass through slots 37 in opposite ends of the flat auxiliary slide-valve 38 on the auxiliary valve seat or face of the central portion 28 of the steam-chest, and hold said valve 38 centrally upon said seat, so as to be free to adjust itself thereon to compensate for any wear between said valve and its seat.

The auxiliary-valve seat on the part 28 of the steam-chest is provided with small steam-ports 39 40, extending through the same into the minor cylinders 29 and 30, said steam-ports being located therein at one side of a central longitudinal line and close up to the central head, which separates and forms the inner ends of said minor cylinders. The said auxiliary-valve seat is also provided with the small exhaust-ports 41 42 43, and said exhaust-ports are located therein at the opposite side of a central longitudinal line

from that of the small steam-ports 39 and 40, the exhaust-ports 41 and 42 extending through into the minor cylinders, and are situated a sufficient distance from the central head forming the ends of said cylinders to insure a proper amount of cushion for the minor pistons reciprocating therein, as will be more fully explained hereinafter. The small exhaust-port 43 opens into a passage extending from the auxiliary-valve seat downwardly through the central head between the two minor cylinders and into the exhaust-chamber 25.

The auxiliary slide-valve 38 is provided with an aperture 44 of suitable size and adapted to intermittently and alternately register with the auxiliary steam-ports 39 and 40. Said valve 38 is also provided on its under or face side with two exhaust-cavities 45 and 46 of suitable size and adapted to intermittently and alternately register with and connect the small exhaust-ports 41 and 42 with the central exhaust-port 43, and thus as said valve 38 is reciprocated back and forth upon its seat by the valve-stem 17, which connects with said valve by suitable ears 47 on the back thereof, and is operated by the connected rocker-lever and its actuating roll through the movement of the main piston, steam is admitted and exhausted to and from the minor cylinders, and, actuating the minor pistons therein, operates their connected main valve 33 and causes it to reciprocate and admit and exhaust steam to and from opposite ends of the main cylinder through the main ports 21, 22, 23, and 24, as will now be more fully explained.

The operation of my invention is as follows: Referring to Figs. 1, 2, 3, and 4 of the drawings, steam enters through one of the inlets 27 and fills the valve-casing or steam-chest 5, passing down through the main port 21 into the main cylinder 3, where it forces the main piston 7, together with its rod 8, to the left, as indicated by the arrow thereon, the steam or other vapor on the opposite side of said piston passing up through the main port 22, and turning in the exhaust-cavity of the main valve passes down through the exhaust-port 24 into the exhaust-chamber 25, and thence through one of the outlets 26 into the exhaust-pipe. As shown in Figs. 2 and 4, the valve 38, the valve 33, and its connected actuating minor pistons 31 and 32, stand to the left of their stroke, and the auxiliary steam-port 40 and the main steam-port 21 are both wide open to the direct steam or other fluid pressure. As the main piston 7 travels to the left and approaches the end of its stroke, the roll 14 on the piston-rod 8 engages the under side of the left hand end of the rocker-lever 15 and gradually raises it until the upright arm of said lever, through its connected valve-stem 17, has moved the auxiliary valve 38 to the right, thereby admitting steam through its aperture 44 and the port 39 into the minor cylinder 29 behind its piston 31,

and at the same time the cavity 46 in said auxiliary valve connects the exhaust-port 42 with the central exhaust port or passage 43, 70 and exhausts the steam from cylinder 30 into the exhaust-chamber, thus instantly moving the minor pistons 31 and 32, together with their connected main valve 33, to the right. As the minor piston 32 travels to the right, it passes and covers the inner end of the exhaust-port 42, and then cushions on the vapor shut up within its cylinder 30 as the other or steam port 40 of said cylinder is tightly closed by the face of the auxiliary valve, and thus 80 the said main valve is quickly actuated by direct steam-pressure and properly cushioned at the end of its stroke. The above-described movement of the main valve to the right establishes communication between the main 85 ports 21 and 23 and thus opens the exhaust to the right-hand end of the cylinder, and at the same time steam or other motive fluid is admitted through the main port 22 into the left-hand end of said cylinder, thereby reversing the movement of the main piston, 90 and as said piston travels to the right the movement of the main valve to the left into its original position (see Fig. 2) to reverse the stroke of said piston is accomplished by 95 a precisely identical operation of the auxiliary-valve mechanism as just described with relation to the movement of the main piston to the left, and therefore a redescription of the movement of the parts in the opposite 100 stroke of the engine would seem superfluous. The object of the projections or pins 36 on the ends of the main valve 33 entering into slots 37 in the auxiliary valve 38 are not only for holding said auxiliary valve centrally 105 upon its seat, as before stated, but are principally for the purpose of establishing a positive mechanical connection between the main valve and the auxiliary valve and main piston of the engine, whereby if at any time, by 110 reason of the small auxiliary ports or passages becoming clogged up, or by reason of a very great speed of the engine occasioned by suddenly relieving it of the load against which it was working—as, for instance, when 115 a pump loses its water and the steam did not act upon the minor pistons to reverse the main valve quick enough to prevent the main piston from striking the cylinder-heads—one or the other ends of the slots 37 in the said 120 auxiliary valve would engage the projections or pins 36 in the main valve and reverse it mechanically in the proper time to absolutely prevent the main piston from ever striking the cylinder-heads at any speed of the engine. 125 The contacting parts on the two valves are so located with relation to each other as to positively engage after the auxiliary ports have opened to admit steam to the minor pistons and the main valve has not been 130 moved in proper time thereby. The reversal of said main valve is then assured by the operation of the mechanical connections between said valve and the main piston-rod,

backed by the full power of the engine. The steam acting on the minor pistons will ordinarily operate the main valve as required, in which case the projections on the two valves will never come in contact with each other, their office being simply a positive safeguard against accidents which might occur under some such circumstances as are above mentioned.

It is evident I may connect the minor pistons to the ends of the main slide-valve by other means than are shown in Figs. 2 and 10, and Fig. 11 illustrates one very simple and cheap construction, in which the main valve is formed with ears 64 at each end, and the pins 36 extend through and are fast in said ears, and their lower ends enter holes drilled in a projection or lug 65 on the back of the minor pistons, the upper ends of the pins 36 entering the slots in the auxiliary valve, as before described. This construction is very convenient, as by removing the steam-chest cover 6 the auxiliary valve, the main valve, and the minor pistons may all be quickly removed from the steam-chest, as will readily be seen and understood by any mechanic.

It is evident I may reciprocate the auxiliary valve by other mechanism than that hereinbefore described, and I have shown in Fig. 9 one other form of said connecting and operating mechanism as arranged between said auxiliary valve and the main piston-rod. In this case a lever 48, forked at both of its ends, is pivoted on a stand or bracket 49 on the side of the frame 9. The lower forked end of said lever straddles the main piston-rod 8 and is pivotally connected to a collar 50 fast on said piston-rod by the short connecting-rod 51. The upper forked end of said lever 48 straddles the valve-stem 17, and is pivotally connected to a sliding collar 52 loose on said valve-stem by two short connecting-rods 53 53. The collars 54 54 on said valve-stem are adjustably held by set-screws, and their position thereon regulates the length and position of the stroke of the engine. The continuous reciprocation of the piston-rod produces a like movement of the sliding collar 52, and the engagement of said collar at or near the limit of its stroke in both directions with the properly-adjusted collars 54 54 on the valve-stem produces an intermittently-reciprocating movement of said valve-stem and its connected auxiliary valve, as must be clearly understood without further description.

As shown in Figs. 5, 6, 7, and 8, I provide a suitable waste-water valve 55, which I connect to the side of the steam-chest so as to draw the water from condensation or otherwise out of the valve-casing or part 5 and pass it into the exhaust-chamber 25 of said chest, thereby avoiding when first starting the engine forcing said water through the main ports into the cylinder, said cylinder being also provided with suitable drip-cocks for removing the water from condensation or otherwise, in the usual manner.

The waste-water valve 55 is preferably constructed as shown in Fig. 6, in which a suitable hollow casting 56 is provided with two hollow screw-threaded nipples or fittings 57 and 58, adapted to fit the inlets 27 and outlets 26, respectively. The nipple 57 is constructed with a suitable valve 59, provided with a suitable screw-stem, stuffing-box, and hand-wheel, as shown. Said nipple is also provided with a suitable collar, which clamps and holds the hollow fitting or casting 56 against the side of the steam-chest when said nipple is passed through said casting and screwed tightly into one of the inlets 27 in said chest. The nipple 58 is closed at its outer end and is also provided with a suitable collar which clamps the lower end of the casting 56 when passed through the latter and screwed tightly into one of the outlets 26 in the steam-chest. Both of said screw-nipples 57 and 58 are provided about midway of their length with perforations on all sides, so as to give a free passage to the water, as plainly shown in the drawings.

Figs. 7 and 8 show the waste-water valve 55, constructed with a tapering plug in the casting 56, like a stop-cock, instead of the valve and valve-seat shown in Figs. 5 and 6, and this construction may be preferred under some circumstances.

In Fig. 9 I have shown my invention constructed in a little different manner from that hereinbefore described, and in which I use cylindrical instead of flat valves, although the general and essential principle of my invention is clearly retained in my said latter construction. In this case the upwardly-extending portion 28 of the part 4 of the steam-chest, and which is preferably cast in one piece with the main cylinder 3, is formed in two parts instead of one, as in the first instance, and said two parts are also formed integral with the valve-casing or part 5 of said steam-chest, said chest 4 5 being provided with the cover 6, held thereon by suitable screws. The portions 28 28 of said steam-chest are bored to form the minor cylinders 29 30, which are closed at their outer ends by the screw caps or heads 60 60 and their inner ends left open, said cylinders being separated by a central space 61, as shown. The minor pistons 31 32 are formed in one piece with the main valve 33, which is cylindrical in form and provided with suitable ports 62 63 and the usual D-shaped exhaust-cavities in the outer face, said cavities in this case extending entirely around the valve. Above the main valve within the upper part of the portions 28 28 is formed the cylindrical auxiliary-valve-seat provided with the auxiliary steam-ports 39 40 and exhaust-ports 41 42. The cylindrical auxiliary valve 38, having the exhaust-cavities 45 46, is connected to the valve-stem 17 and reciprocates within its cylindrical seat. A downwardly-extending pin 36 in the center of said valve 38 passes through the central slot 37 in the main valve 33, holding

said valve from revolving, and said pin and slot perform the same office and operate in substantially the same manner to mechanically connect the main valve with the auxiliary valve and main piston, and thus insure the operation or reversal of said main valve, so as to absolutely preclude the possibility of the main piston ever striking the cylinder-heads at any speed of the engine, as before described with relation to the first construction having flat valves.

The operation of this construction of cylindrical valve mechanism, shown in Fig. 9, is as follows: The main piston in its former movement to the right through its mechanical connections between the piston-rod and the auxiliary valve moved said valve 38 to the left, as shown, and steam from the chest passed into the right-hand open end of the valve-seat through the small steam-port 39 and behind the minor piston 31, thereby moving the minor pistons 31 32 to the left, the auxiliary exhaust-cavity 46 having connected the small steam-port 40 with the exhaust-port 42, so as to freely exhaust the steam from the minor cylinder 30 through the exhaust-cavity of the main valve 33 and through the main exhaust-port 24 into the exhaust-chamber 25. The movement of the minor pistons, together with the main slide-valve 33, of which it forms a part, to the left connects the valve-port 62 with the main steam-port 21, thereby admitting steam from the central chamber 61 of the chest into the right-hand end of the main cylinder 3 and reversing the movement of the main piston, causing it to travel to the left, as shown. The steam in the left-hand end of the main cylinder escaping through the main steam-port 22 and turning in the exhaust-cavity of the main valve passes through the main exhaust-port 24 into the exhaust-chamber 25 and thence into the exhaust-pipe. As the main piston nears the end of its stroke to the left, the sliding collar 52 strikes the right-hand collar 54 on the valve-stem 17, and moves said stem and its connected auxiliary valve to the right, when the steam effects the reversal of the main valve and main piston in a precisely similar manner to that just described with relation to the opposite stroke of the engine.

In my invention the auxiliary and main valves are preferably flat slide-valves, easily reseated in case of wear, and moving in straight parallel lines, and the arrangement of said valve mechanism is such that both of said valves, together with the main-valve-actuating pistons, may all be readily inspected or quickly removed from the steam-chest without disconnecting any of the pipes or outside joints or connections by simply removing the cover 6 of said steam-chest. These features are great advantages, and together with the described feature of the mechanical connection between the main piston and its valve, whereby the said valve is absolutely certain

to always lead said piston, so that it is impossible for said piston to ever strike the cylinder-heads under any speed at which the engine can be run, will be understood and appreciated by engineers and others familiar with this class of engines.

It will be of course evident to any mechanic that, if preferred, the auxiliary slide-valve 38 and the valve-seat and ports therefor may be located upon the side of the minor cylinders instead of above them; and furthermore, if preferred, the entire steam-chest 4 5 6 may be arranged upon the side of the main cylinder instead of upon the top of the latter, as now shown. It is also evident that the pins 36 in the main slide-valve 33 might be fast in the auxiliary slide-valve 38 and engage with the outside of opposite ends of the said main valve 33 and operate equally as well as in the former case.

The invention is of course applicable to any fluid-pressure engine, and is susceptible of minor changes and modifications within the scope of mechanical skill without departing from the essential spirit of my invention.

Having thus fully described the nature and construction of my invention, I wish to secure by Letters Patent, and claim—

1. In a direct-acting engine, the combination of the main cylinder, the main piston and piston-rod, the steam-chest on said cylinder having motive fluid supply and exhaust pipe openings, the two minor cylinders and pistons therein, the main-valve seat having induction and eduction ports for said main cylinder, the flat reciprocating main slide-valve thereon having the projection or pin 36 and controlling said ports, suitable connecting devices between said minor pistons and said main valve, the auxiliary-valve seat having suitable ports for said minor cylinders, the flat auxiliary slide-valve thereon having the slot 37 and reciprocating parallel with said main valve, but on a different plane and controlling said ports, and the connected auxiliary-valve-actuating mechanism connecting with and operated by the main piston of the engine, substantially as described.

2. In a direct-acting engine, the combination, with the steam-actuated main slide-valve and the auxiliary slide-valve reciprocating parallel therewith, but on a different plane and actuated by the main piston of the engine, of the pin 36, and the slot 37, or equivalent mechanism, adapted to operate substantially as and for the purpose set forth.

3. In a direct-acting engine, the steam-actuated flat reciprocating main slide-valve 33, having the projecting pins 36 36, in combination with the flat auxiliary slide-valve 38, having the co-operating slots 37 37, and the connecting valve-actuating mechanism, substantially as described.

4. In a direct-acting engine, the combination, with the piston and piston-rod thereof, of the cross-head 13, projection or roll 14, piv-

oted rocker-lever 15, connecting-rod 16, valve-stem 17, and a reciprocating valve, substantially as described.

5 5. In a direct-acting engine, the intermediate frame 9, the slotted stand 19, and the rocker-lever stud or bearing 18 therein, combined with the adjusting-screw 20, substantially as described, and for the purpose set forth.

10 6. In a steam-engine, the combination, with the steam-supply inlet 27 and the steam-exhaust outlet 26, of the waste-water valve 55, substantially as described.

15 7. The waste-water valve comprising the hollow casting or fitting 56, the two perforated screw-threaded nipples or fittings 57 58, and the valve 59, all substantially as and for the purpose herein set forth.

20 8. In a direct-acting engine, the valve-actuating minor pistons 31 32, and their cylinders 29 30, provided with the auxiliary-valve seat having the auxiliary ports, substantially as described, combined with the auxiliary slide-valve 38, reciprocating on said valve-
25 seat and controlling the passage of the motive fluid through said ports, and actuating mechanism connecting with said auxiliary valve and the main piston of the engine, all substantially as described.

30 9. In a direct-acting engine, the combination, with the main cylinder, its piston, and

piston-rod, of the parts 4 5 6 of the steam-chest affixed centrally to said main cylinder, the main-valve seat on said part 4 having
35 the ports 21 22, leading into said cylinder, and the ports 22 23 into the exhaust-chamber 25, between said main cylinder and said steam-chest, the flat main slide-valve 33, controlling the motive fluid supply and exhaust of said
40 main cylinder and constructed with two end faces connected by arms, substantially as described, the part 28 of the steam-chest 4 encircled by said arms, the minor cylinders therein having a central separating-head, the
45 auxiliary-valve seat thereon having the ports 39 40 41 42 leading into said minor cylinders, and the companion port or passage 43, leading from said valve-seat through the central head into the exhaust-chamber, the minor pistons
50 31 32, within said minor cylinders, connected with and reciprocating the main slide-valve, the auxiliary flat slide-valve 38, controlling the motive fluid supply and exhaust of the minor cylinders and connecting actuating mechanism operated by the main piston of the engine,
55 substantially as described.

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

DANIEL E. KEMPSTER.

Witnesses:

HENRY CHADBURN,
FRANK E. GREENWOOD.