(No Model.) 2 Sheets—Sheet 1.

D. E. KEMPSTER.

FLUID PRESSURE MOTOR.

No. 424,609. Patented Apr. 1, 1890.

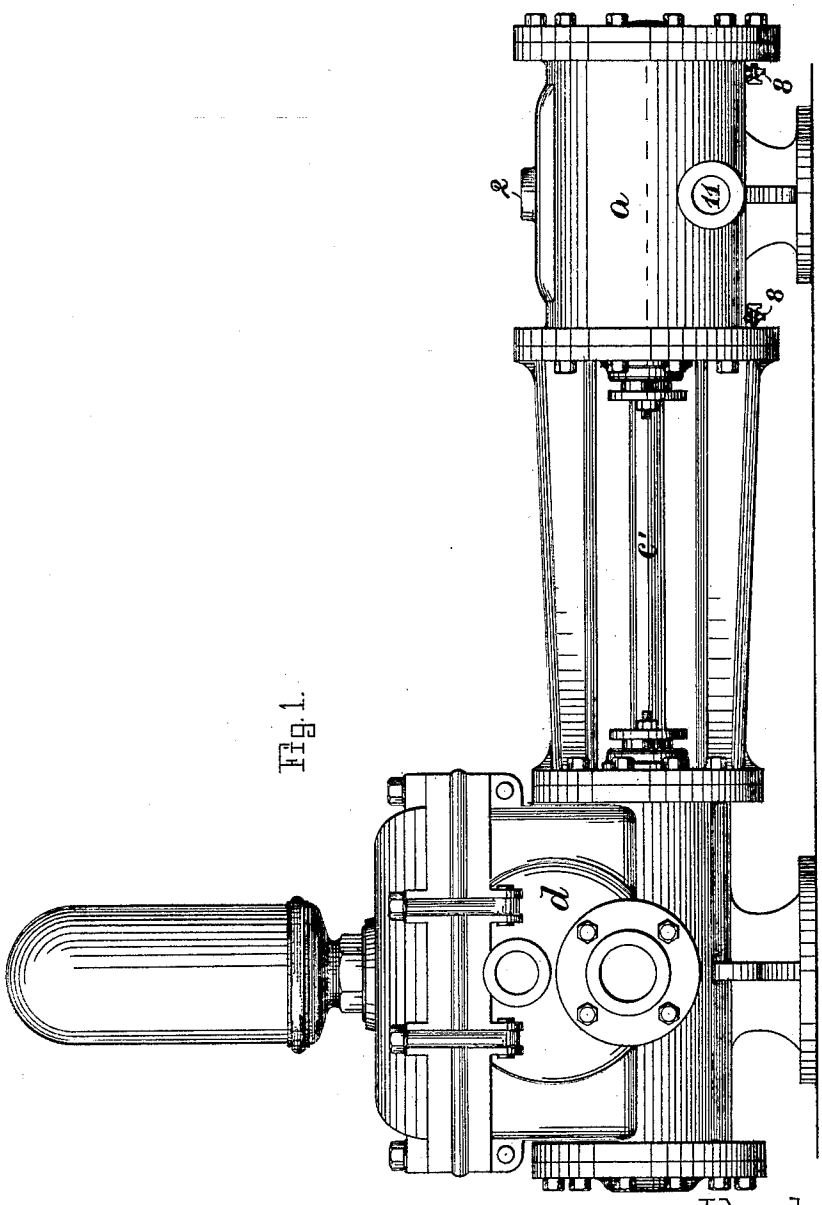

Fig. 1.

Witnesses.
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(No Model.) 2 Sheets—Sheet 2.

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Fig. 4.

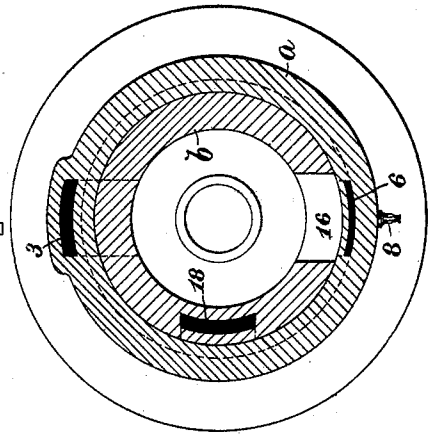


Fig. 5.

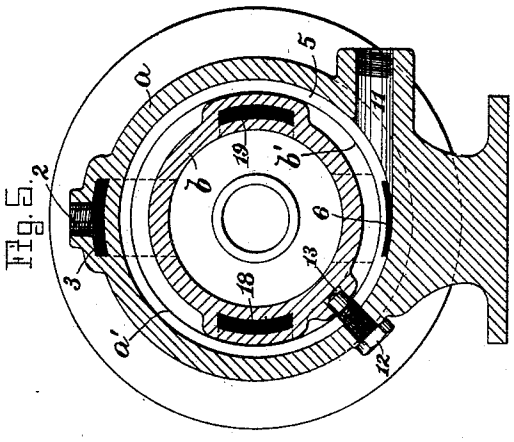


Fig. 2.

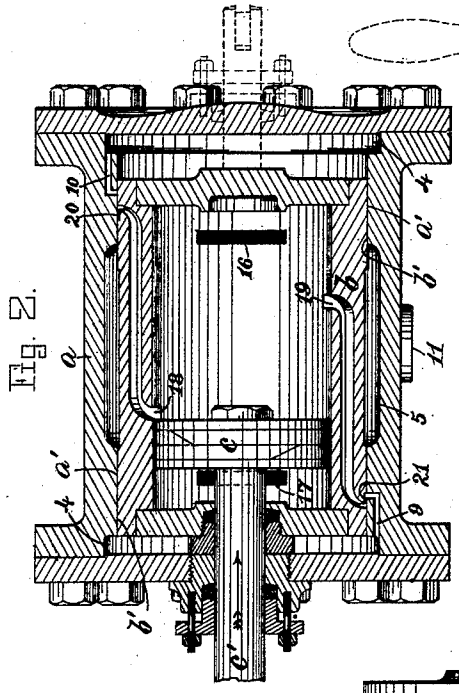


Fig. 3.

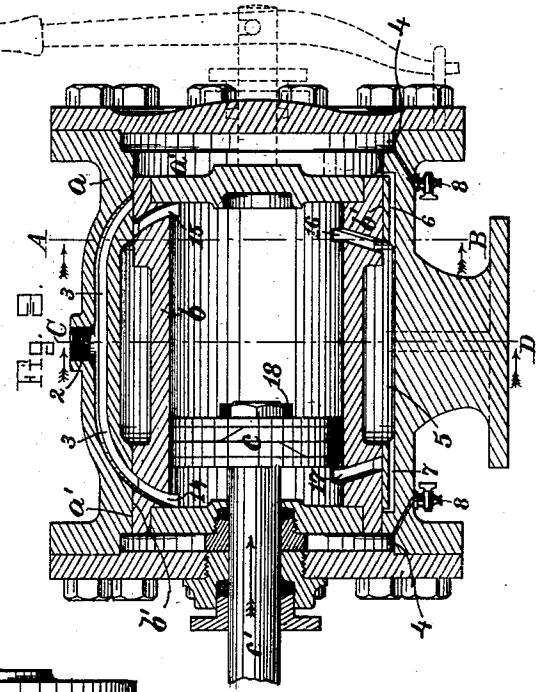
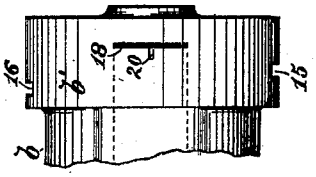


Fig. 6.



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UNITED STATES PATENT OFFICE.

DANIEL E. KEMPSTER, OF BOSTON, MASSACHUSETTS.

FLUID-PRESSURE MOTOR.

SPECIFICATION forming part of Letters Patent No. 424,609, dated April 1, 1890.

Application filed July 13, 1889. Serial No. 317,394. (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 Fluid-Pressure Motors; 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 letters and figures of reference marked thereon, which form a part of this specification.

My invention relates to improvements in motors operated by steam, water, compressed air, or other fluid under pressure as a motive power, and especially to that class of such motors as have their valves actuated by fluid-pressure alone without the intervention of moving parts.

The object of my invention is to provide a simple, compact, and inexpensive motor composed of few parts, and one which shall be more positive in its action and more lasting in its results, thus especially adapting it to service as a pumping or blowing engine, boiler-feeder, or other direct-acting engine.

Direct-acting engines have been constructed having a steam-chest attached to the main cylinder and provided with some form of main valve, and in some cases also provided with an auxiliary valve adapted to move said main valve, in both cases the valve-movement for admitting and exhausting the steam or other motive fluid to and from the main cylinder being accomplished by the direct pressure of said motive fluid taken from said main cylinder without the intervention of any devices for mechanically actuating said valves. This method of automatically steam-actuating the valves of direct-acting engines is very much more preferable than any form of mechanism as yet devised for mechanically accomplishing the same object, as it dispenses entirely with all tappets, rockers, levers, and other devices usually employed therefor, and which are a source of annoyance and expense.

In direct-acting engines of the class in which the valves are actuated entirely by the steam or other fluid pressure it has been found exceedingly difficult to prevent the occurrence of short strokes of the piston through a premature shifting of the valve occasioned by unequal back-pressure on said valve or by the jar and concussion of the parts when the water or other load against which the engine is working is suddenly relieved therefrom. This disadvantage has been in a measure overcome by balancing the valve, increasing its area, and adding to its weight by "loading" said valve with a pressure of live steam, thus holding it down to its seat. This loading of the valve necessarily causes great friction, and is objectionable, as it requires an expenditure of too much power to move it, and when so moved to the limit of its stroke in either direction is dependent solely upon its frictional contact with its seat to prevent its premature movement under any inequality of back-pressure exerted thereon or by any shock or vibration to which an engine in active service is necessarily subjected, and when arranged in a vertical position, as is desirable for wrecking and mining pumping-engines, the liability of the premature shifting of the valve is greatly augmented by reason of its gravity. From this disadvantage, and also the fact that direct-acting engines, as heretofore constructed, usually have small steam-actuating valve-areas and small connecting port-passages therefor, said valves are easily rendered inoperative by corroding or sticking, and the small port-passages are susceptible to becoming easily clogged up, all of which combine to render this class of engine undesirable by reason of its increased liability of uncertain action and durability.

I have thus fully set forth and clearly pointed out some of the principal disadvantages existing in the present forms of construction of this class of engine, and I believe that my invention will practically demonstrate that the best results obtainable by the use of steam-actuated valves have not heretofore been attained.

My invention primarily consists in dispensing with the usual valve or valves and connecting mechanism, and by a movement of the main cylinder within a suitable jacket or casing cause it to perform the function of its own valve, and through suitable ports admit and exhaust steam or other motive fluid al-

ternately to and from opposite ends of the cylinder, and thus reciprocate the main piston within it, suitable passages being provided whereby the direct pressure of the steam or other motive fluid which acts to automatically reciprocate the piston also acts to intermittently move the cylinder, and all of the aforesaid ports being so constructed and arranged as to cause the perfect cushioning of said piston and cylinder, so that the engine may be run at any desired speed.

My invention also further consists in other minor details of construction, all of which I will now plainly describe, and particularly point out in the claims.

The accompanying drawings show the preferred form of construction of my invention, which is of course susceptible to various modifications within the power of mechanical skill.

Figure 1 represents a side elevation of my invention as applied to a pump for boiler-feeding and other purposes. Fig. 2 is a central horizontal longitudinal section of my invention. Fig. 3 is a central vertical longitudinal section thereof. Fig. 4 is a cross-section on the line A B in Fig. 3. Fig. 5 is a cross-section on the line C D in Fig. 3. Fig. 6 is a detail showing one end of the cylinder and one of the cylinder-moving ports and its co-operating grooved passage.

Similar letters of reference indicate corresponding parts wherever they occur on the drawings, in which—

a designates the outer jacket or casing, *b* the main cylinder, and *c* the main piston, these three parts constituting the improved motor constructed to operate in the manner stated. Said casing *a* is preferably composed of a cylindrical casting having tight heads and a suitable base, one of said heads, when desired, having a stuffing-box in the ordinary manner.

2 is the motive-fluid inlet at the top of the casing *a*, to which the supply-pipe is connected, having branch passages 3 3 leading downwardly to opposite ends through the top of the seats or bearings *a' a'* within the bore of said casing. The casing is preferably formed with the counterbores 4 4 within its extreme ends, and the enlarged central bore or passage 5 between the seats or bearings *a' a'*.

6 7 are auxiliary exhaust-passages at the bottom of the casing, leading from the seats or bearings *a' a'* in opposite ends of said casing downwardly into the central passage 5 thereof.

8 8 are the ordinary petcocks for removing any water by condensation from the counterbores 4 4.

9 10 are auxiliary inlet-passages at opposite sides and ends of the casing, leading from the seats or bearings *a a'* outwardly into the counterbores 4 4 at the ends of the casing.

11 is the outlet to said casing and to which the exhaust-pipe is connected.

The casing *a* is bored out at its ends where the seats or bearings *a' a'* are formed, in which is fitted the cylinder *b*, so as to freely reciprocate therein upon its bearings or heads *b' b'*, and is prevented from revolving by the screw 12, passing through the outer casing *a* and its inner end, on which is placed a small anti-friction roll, entering the groove 13 in the outside of the cylinder, said cylinder being reduced externally between said heads, forming in connection with the enlarged bore 5 of the casing an exhaust passage or chamber, which nearly envelops the entire cylinder and acts as a steam-jacket therefor.

The cylinder *b* is bored out its entire length, and is provided with tight heads, one, if so desired, having the usual stuffing-box thereon.

14 15 are the main inlet-ports, and 16 17 are the main outlet or exhaust ports.

18 19 are auxiliary side passages leading from the interior of said cylinder and extending longitudinally in opposite directions out through the seats or heads *b' b'* at opposite ends of said cylinder, and having small return grooved passages 20 21 sunk within the faces of said seats or bearings. (See Figs. 2 and 6.)

The piston *c* is provided with the ordinary packing spring-rings, and, if so desired, a suitable rod *c'*, which may be connected to any desired mechanism in accordance with the work to be performed, said piston-rod passing through the cylinder and casing, being packed by suitable stuffing-boxes therefor.

The position of the internal ports or openings of the auxiliary side passages 18 19 are arranged longitudinally within the cylinder with relation to the piston *c*, so that the open passage in communication with the counterbored chamber in the end of the casing *a* will be uncovered by said piston when it has reached about the limit of its stroke, and therefore the width of the face of said piston or its packing-rings must necessarily be taken into account when locating said openings.

In operation, and assuming the piston to be moving in the direction indicated by the arrows, the cylinder stands to the left of its stroke or movement, as shown, and motive fluid is admitted by the inlet 2, filling the branch passages 3 3, and passes down the left branch, (the other being closed, see Fig. 3,) through the inlet-port 14, into the cylinder *b* behind the piston *c*, causing said piston to move in the direction of the arrows, (the exhaust-ports 17 and 7 being closed,) meanwhile the fluid which performed the preceding stroke of said piston being exhausted through the exhaust-port 16, and the fluid which effected the last movement of the cylinder to the left being exhausted through the auxiliary exhaust-passage 6, both exhausting into the enlarged chamber or passage 5, and thence through the outlet 11 into the exhaust-pipe. The piston travels to the right and passes the auxiliary side passage 18, (see Fig. 2;) but no fluid can pass out, as the other end of said passage is closed by reason of it not register-

ing with the passage 10, through its co-operating grooved passage 20, and said piston, continuing its stroke, passes the auxiliary side passage 19, and covers the exhaust-port 16, and thus finishes the stroke by properly cushioning the piston on the vapor at the end of the cylinder and comes quietly to rest, and pauses while the fluid is passing from the cylinder through the passage 19, the small grooved passage 21, and the passage 9 into the counterbored chamber 4, and fills said chamber back of the left cylinder-head, and moves said cylinder to the right, which it does with absolute positiveness, by reason of the large area upon which the power is being applied. When said cylinder passes the center of its movement, the inlet-port 14, exhaust-port 16, and auxiliary exhaust-port 6 are closed. The inlet-port 15 then begins to open to admit fluid between the piston and the cylinder-head at the right of the cylinder, helping to shift the cylinder the remainder of its stroke, the auxiliary passage 10 closing in due time to cause the cylinder to properly cushion against the vapor at the end of the casing, and come quietly to rest with the exhaust-passages 17 and 7 open and the stroke of the piston reversed. It will thus be seen that the piston and cylinder are properly cushioned at the limit of their strokes in either direction, preventing the unpleasant noise, shock, and wear occasioned by the blow of contacting metal parts; also, by my peculiar construction the cylinder or valve can never shift prematurely, causing a short stroke of the piston, as the whole power being applied to said piston is also applied to hold the cylinder in its position until the piston has made its full and complete stroke, when the motive fluid automatically passes back into the chamber behind that end of the cylinder from which the piston has last traveled, and by reason of the enlarged area of said chambers over and above the area of said piston, overbalances the pressure within the cylinder and moves said cylinder in the direction last traveled by the piston, thus changing the relative position of all the ports and passages and reversing the stroke of the engine. This construction is especially desirable in vertically-arranged direct-acting engines, as with my invention the gravity of the parts and the vibrations caused by the working of the engine have no power to prematurely shift the valve, as is liable in all other forms of construction of this class of engines.

By having the passages 9 and 10 connect, respectively, with the passages 19 and 18, through the medium of the respective small co-operating grooved passages 21 and 20, when the cylinder is nearing or at the limit of its stroke in either direction, I accomplish two objects: First, I am able to fully cushion the cylinder and yet have a passage to admit fluid to again start said cylinder in its reverse movement, and, second, the piston is caused to pause and not at once start on its reverse stroke, which is a great advantage when applied to pumping or blowing engines, as the piston stops and holds the load against which it is working, permitting the pump-valves to quietly settle upon their seats by gravity instead of being violently closed by the action of the return-currents of water or air, as the case may be, which soon destroys the valves and valve-seats.

If preferred, the cylinder may have a stem extending through a stuffing-box on the rear head of the casing and a removable lever arranged to connect therewith, as shown in dotted lines in Figs. 2 and 3, so as to move said cylinder by hand, which might be desirable when warming the engine preparatory to starting in very cold weather.

In Fig. 1 I have shown my invention as applied to a pump *d*, and the water and motor cylinders are shown as separated from each other the usual distance, as when using some form of mechanical device operated by the piston-rod for actuating the valves; but in practice I separate said cylinders only sufficiently far apart to admit of conveniently packing the stuffing-boxes, thus shortening up the pump nearly one-third and making a more compact machine, requiring less room and floor space.

By referring to the drawings and the position of the various ports and passages thereon it will be observed that all water from condensation or otherwise may readily gravitate and will be freely exhausted from the cylinder and casing, as the motive fluid enters at the top and passes out at the bottom, which is a very great advantage to any fluid-pressure engine.

For convenience in making the drawings, the external cylinder-bearings *b' b'* are shown as solid and not provided with the usual packing; but it should be understood that in practice I provide suitable packing spring-rings for each of said bearings, thus preventing any leakage and compensating for any unequal expansion or undue wear of the ports.

My invention is simple and cheap, being composed of few parts—viz., casing, cylinder, and piston—and owing to its construction having a large valve or cylinder-actuating area. When motive fluid is admitted to the cylinder just barely sufficient to move the piston within it, owing to the difference of area between said piston and the outside of the cylinder-heads, there is absolutely more power being applied than is necessary to shift the cylinder or valve, and consequently the operation is positive, and the engine will never stop prematurely with the valve on the center, being in this respect as sure in its action as the more expensive duplex engine, in which one or the other valve is always open.

I may use my invention as a fluid-meter by dispensing with the piston-rod and its stuffing-boxes and adding a suitable registering device thereto. When used for this purpose, I prefer to make all inlet and outlet passages in dupli-

cate, locating them on opposite sides, so as to balance the cylinder and piston and lessen the friction thereof.

It is clearly obvious that the small or reduced grooved passages 20 21 may be formed in the casing *a* instead of in the cylinder *b'*, as shown, and will perform their functions equally as well as in the latter case. It will also be observed that the working parts are inclosed and beyond the control of ignorant or meddlesome persons, as well as protected from accidental injury.

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

1. In a fluid-pressure motor, the combination of a fluid-tight casing having fluid inlet and outlet passages, a cylinder adapted to reciprocate longitudinally within said casing, a piston adapted to reciprocate longitudinally within said cylinder, and suitable ports and passages, substantially as herein described, whereby the moving parts are caused to reciprocate and be cushioned at the ends of their strokes, for the purpose set forth.

2. In a fluid-pressure motor, the combination of a fluid-tight casing having fluid inlet and outlet passages and a suitable stuffing-box, a cylinder adapted to reciprocate longitudinally within said casing and having a suitable stuffing-box, a piston adapted to reciprocate longitudinally within said cylinder, a suitable rod connected with said piston, passing through said stuffing-boxes, and packed thereby, and suitable ports and passages, substantially as herein described, whereby said cylinder and piston are caused to reciprocate and be cushioned at the ends of their respective strokes, for the purpose set forth.

3. In a fluid-pressure motor, a casing, chambers at each end of said casing, ports or passages in said casing communicating with said chambers, a cylinder reciprocating longitudinally within said casing, ports or passages in said cylinder communicating with said cylinder, and reduced grooved passages intermittently connecting between the ports or passages in the casing and the ports or passages in the cylinder, for the purpose herein set forth.

4. In a fluid-pressure motor, a casing having inlet and outlet passages, fluid-pressure chambers at each end of said casing, an exhaust-chamber, and a cylinder adapted to be automatically reciprocated within said casing, ports or passages within said cylinder, communicating with the inlet-passages and exhaust-chamber of said casing, and a piston reciprocated within said cylinder, for the purpose set forth.

5. In a fluid-pressure motor, in combination, a casing *a a' a'*, having inlet-passages 2 3 3, end chambers 4 4, exhaust-chamber 5, auxiliary passages 6 7 9 10, and outlet 11, a cylinder *b b' b'* within said casing, having inlet-passages 14 15, outlet-passages 16 17, and auxiliary passages 18 19 20 21, and a piston *c* within said cylinder, having a rod *c'*, all substantially as herein shown and described, to operate as specified.

6. In a fluid-pressure motor, a piston adapted to reciprocate longitudinally, a cylinder having inlet and exhaust ports for the fluid to operate said piston within it, in combination with an outer casing having fluid inlet and exhaust passages adapted to intermittently communicate with the cylinder inlet and exhaust ports at alternate ends of said cylinder, and thereby admit and exhaust fluid to and from said cylinder to operate said piston, for the purpose set forth.

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

DANIEL E. KEMPSTER.

Witnesses:
HENRY CHADBOURN,
HERBERT L. CHAPIN.