(No Model.) 4 Sheets—Sheet 1.

E. G. SHORTT.

Direct Acting Pumping Engine.

No. 242,995. Patented June 14, 1881.

Fig. 2.

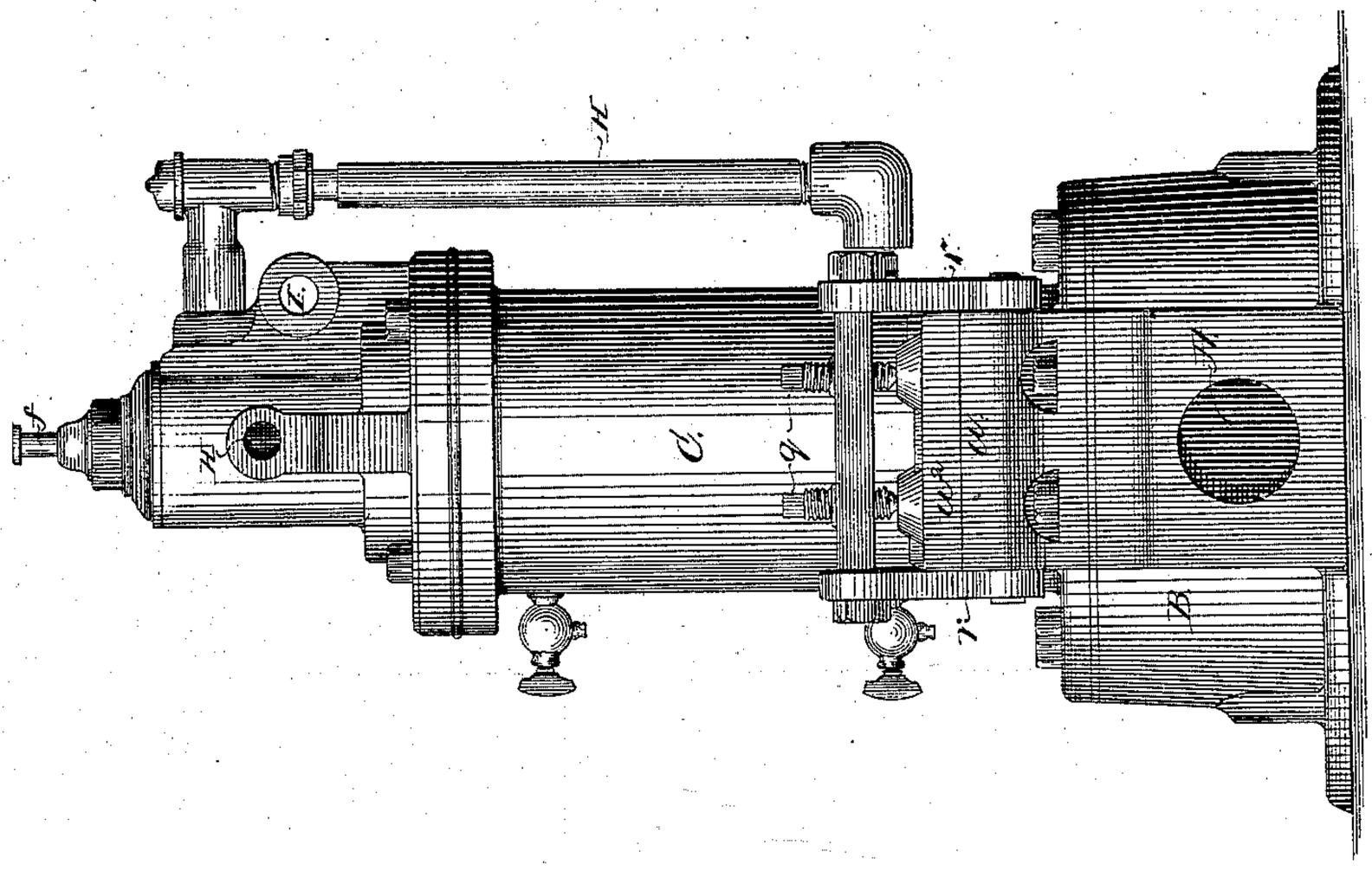
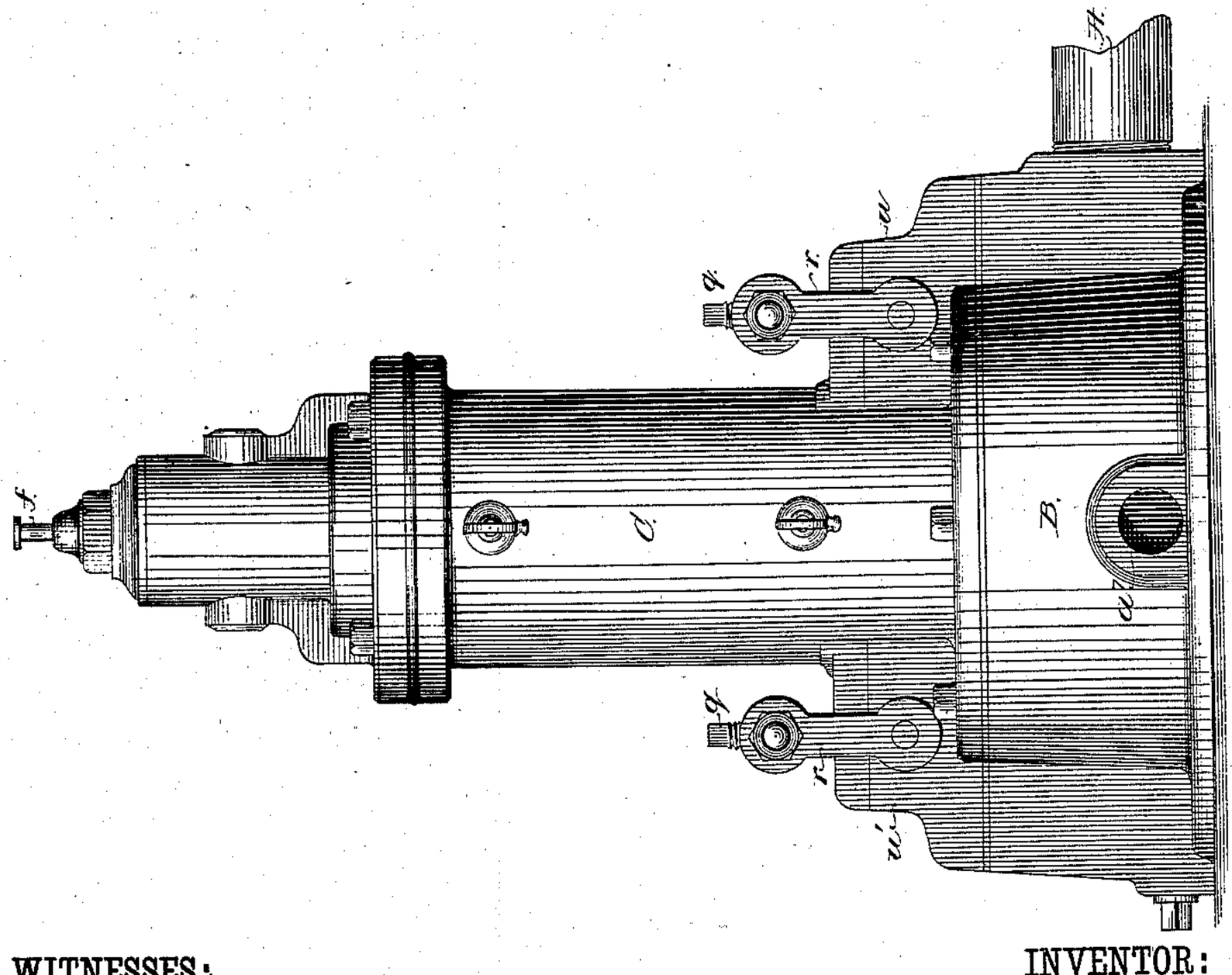


Fig. 1.



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(No Model.) 4 Sheets—Sheet 2.

E. G. SHORTT.

Direct Acting Pumping Engine.

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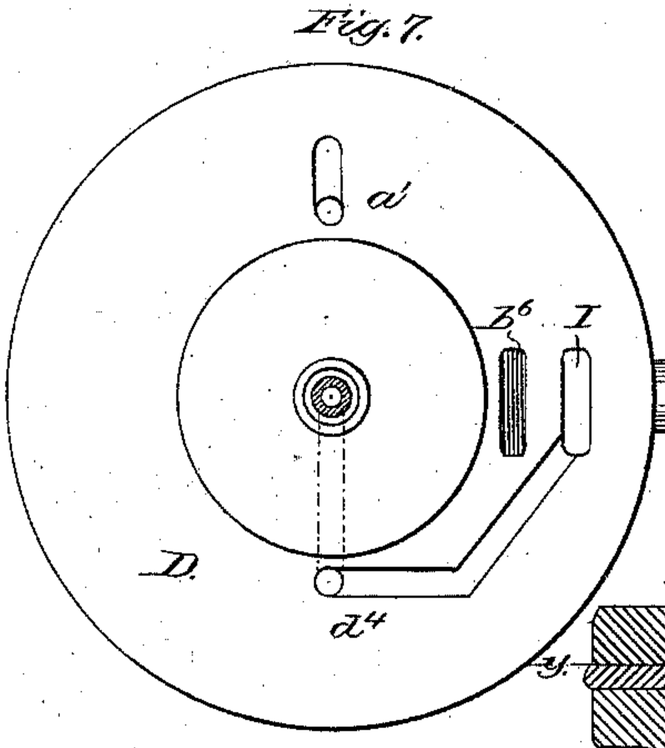
Fig. 7.



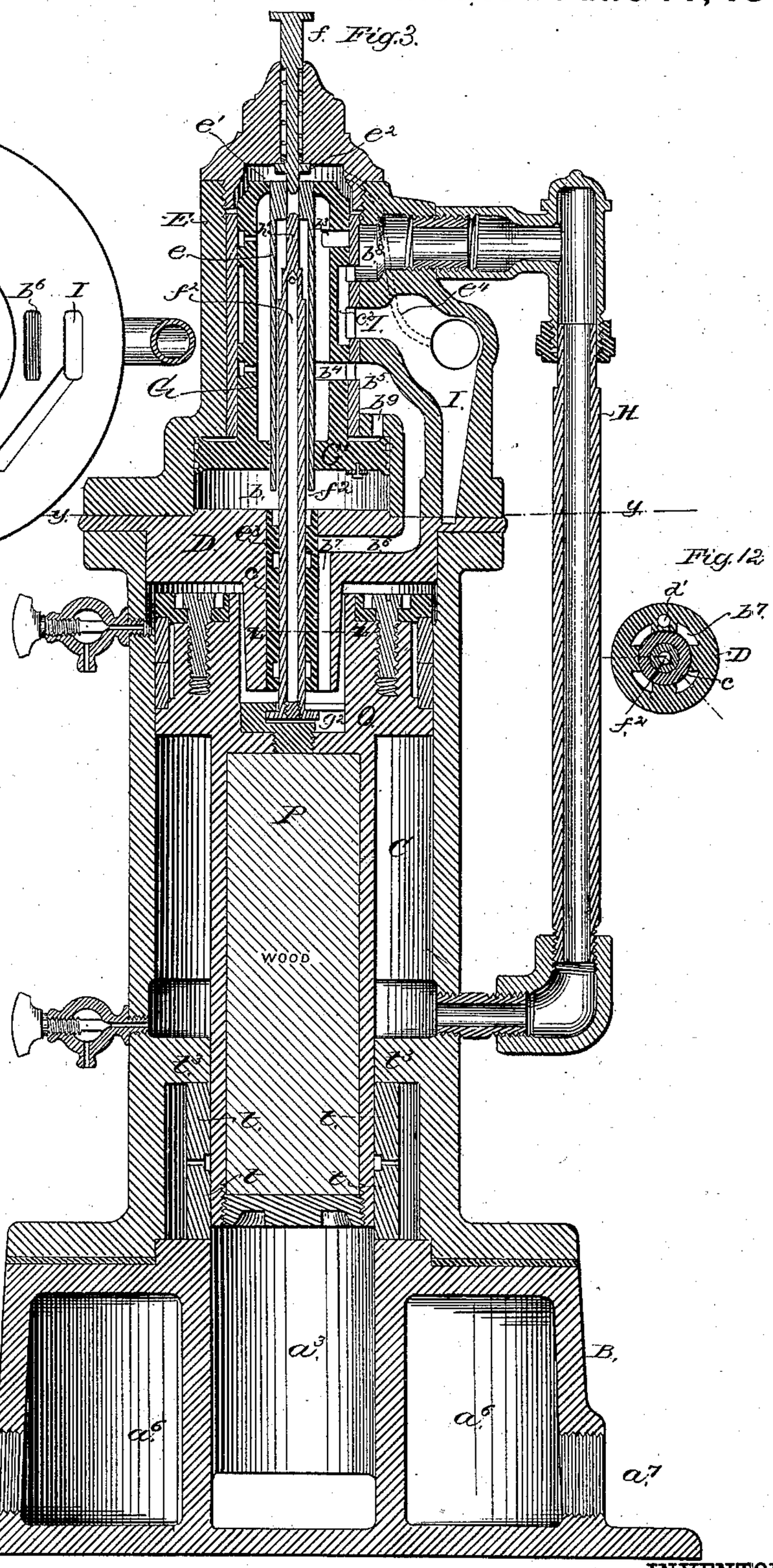


Fig. 12.

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(No Model.) 4 Sheets—Sheet 3.

E. G. SHORTT.

Direct Acting Pumping Engine.

No. 242,995. Patented June 14, 1881.

Fig. 4.

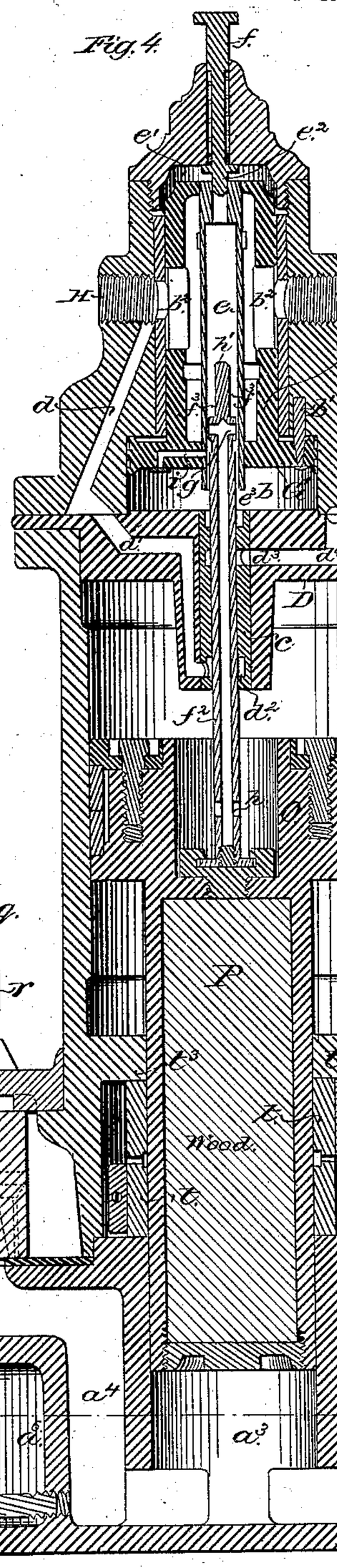


Fig. 8.

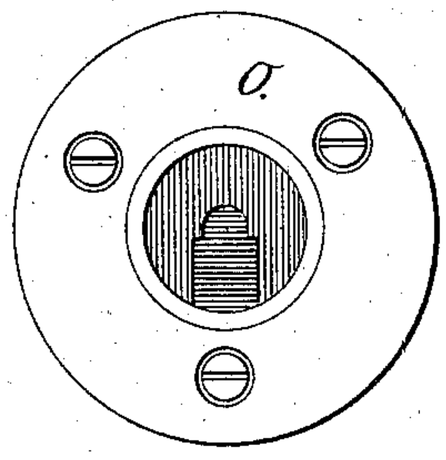


Fig. 9.

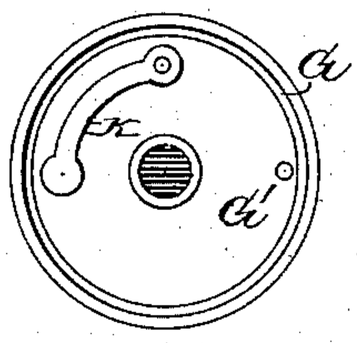


Fig. 10.

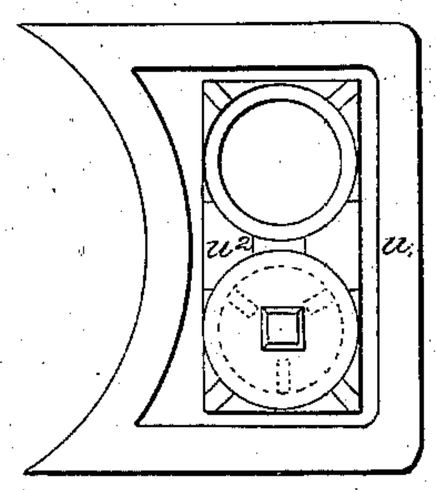
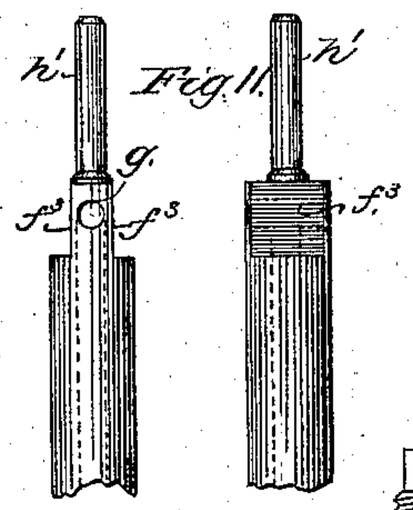


Fig. 11.



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(No Model.) 4 Sheets—Sheet 4.

E. G. SHORTT.

Direct Acting Pumping Engine.

No. 242,995. **Patented June 14, 1881.**

Fig. 6.

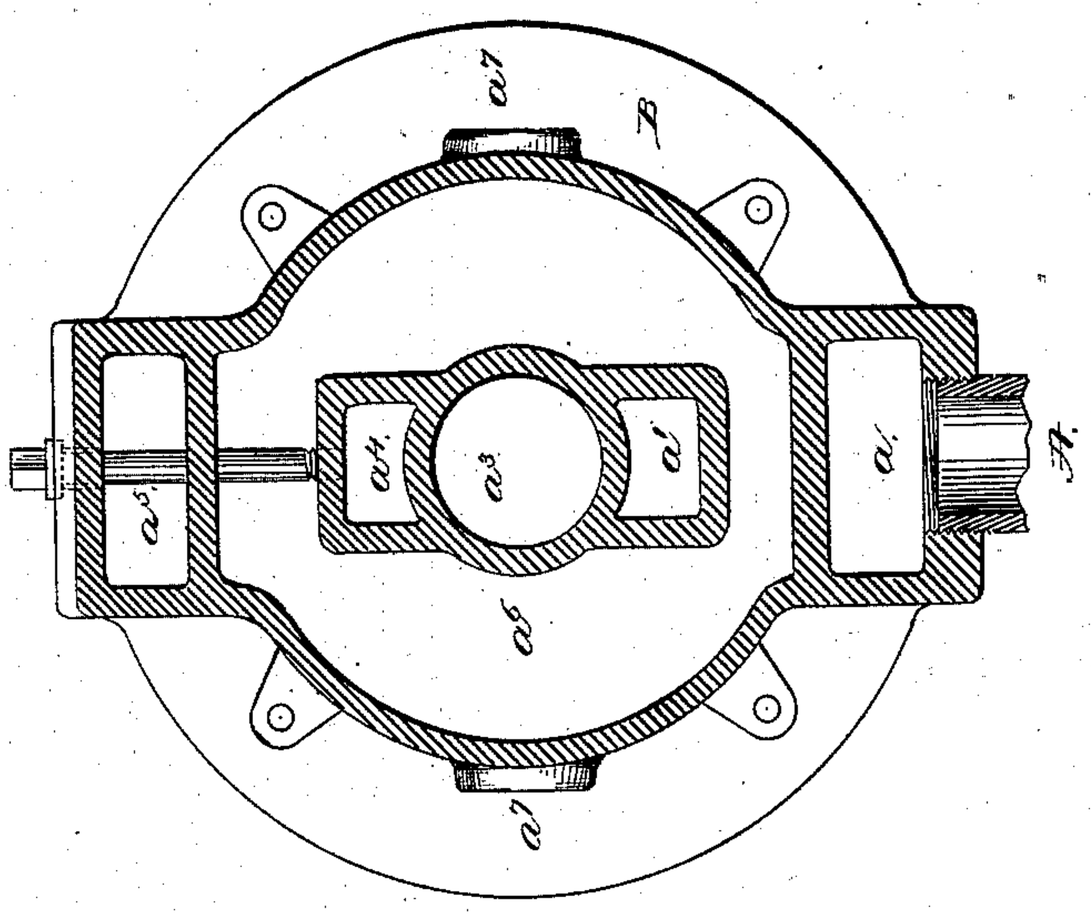

Fig. 5.

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UNITED STATES PATENT OFFICE.

EDWARD G. SHORTT, OF CARTHAGE, NEW YORK.

DIRECT-ACTING PUMPING-ENGINE.

SPECIFICATION forming part of Letters Patent No. 242,995, dated June 14, 1881.

Application filed December 20, 1880. (No model.)

To all whom it may concern:

Be it known that I, EDWARD G. SHORTT, of Carthage, in the county of Jefferson and State of New York, have invented a new and Improved Direct-Acting Pumping-Engine; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figures 1 and 2 are side elevations of the pumping-engine, the views being taken at right angles to each other. Figs. 3 and 4 are vertical central sections taken at right angles to each, and on a larger scale than Figs. 1 and 2, to more clearly show the internal structure. Fig. 5 is a top view of the base of the pump attached. Fig. 6 is a horizontal section through the line *x x* of Fig. 4. Fig. 7 is a section through line *y y*, Fig. 3, showing a top view of the upper cylinder-head. Fig. 8 is a top view of the steam-piston. Fig. 9 is an underside view of the main steam-valve. Fig. 10 is a plan view, showing the duplicate arrangement of water-valves, one of which is arranged to close in advance of the other to avoid ramming action. Fig. 11 are fragmental views of the upper end of the stem for controlling the flow of steam to and from the main valve. Fig. 12 is a section through *z z* of Fig. 3.

My invention relates to certain improvements in that class of direct-acting steam-pumps in which a single plunger is constructed at its upper end in the form of a piston to be acted upon by steam, while its lower end acts within a pump-cylinder in connection with suitable ports and check-valves, and in which the steam-cylinder is in one and the same piece with the pump-cylinder and in the vertical line of the same, with a valve-chest and gear mounted upon the top of the same and operated through a connection with the piston.

My invention consists in the following general features of improvement: First, in the construction of the steam-valve which controls the flow of steam to the cylinder, the said valve being made with a piston-head at its lower end and a central hollow stem rising therefrom, with openings registering with the steam-ports, and being operated on the upstroke by the increased area of steam-surface on its under side over and above the area on its upper side, steam being on both sides of the valve at the upstroke, and being brought down by the exhaustion of steam from its under side.

The second general feature of my invention consists in the means for controlling the admission of steam to the main valve to secure its proper movement, to which end I avoid the hammering action of tappet movements, which have heretofore been used, and construct a special form of piston-rod made with steam-conduits in it, with openings which smoothly admit and exhaust steam from the main valve with a perfect and noiseless action.

My third general feature of improvement consists in constructing the top of the steam-cylinder with a tapered and central boss or projection, through which the steam-passages to this end of the cylinder open, and forming a corresponding depression in the top of the piston, which together forms an annular steam-cushion at the top, which allows the piston on the upstroke (when it has but little work to do) to rise more quickly than it descends, and without shock and damage to the top cylinder-head, this quick upward movement of the piston serving to economize time and render the discharge of water from the pump more nearly continuous.

The fourth general feature consists in forming the lower part of the piston, constituting the water-plunger, in the shape of a metal shell open at the bottom, and filling it solid with wood or other non-conducting substance, this filling serving to prevent the condensation of steam in the steam-cylinder, and making the piston also lighter and lessening the work of the pump in driving its operating parts.

The fifth general feature consists in a means for preventing the hydrostatic pressure in the pump-cylinder from forcing water up into the steam-cylinder, for which purpose I place in the closed bearing between the two a vent communicating with the suction side of the pump.

The sixth feature consists in the peculiar construction and arrangement of valves and water-ways in the pump portion of the engine.

In addition to these general heads of invention there are others of more detailed charac-

ter, which can be better described in connection with the drawings, and will be afterward pointed out in the claims.

In the drawings, A represents the inlet-pipe for the water; and B is the circular base of the pump, with which said inlet-pipe connects.

C is the main cylinder, the upper portion of which is bored for the steam-piston, and the lower portion of which is contracted to a smaller diameter, and is formed on opposite sides with chambers *u u'* for the water-valves *w w'*, which are arranged in pairs on opposite sides, as in Figs. 2 and 10. The base B is firmly united to the cylinder C and valve-chambers *u u'* by bolts, and in said base are formed water-passages, which communicate as follows: from the inlet-pipe A to the passage *a*, (see Fig. 4,) then up through valve *w* to valve-chamber *u*, thence through two openings, w^2, (see Fig. 5,) straddling vent *v*, to passage *a'*, Fig. 4, thence into the pump-cylinder a^3 beneath the piston, thence out into passage a^4, up through valve *w'* to valve-chamber *u'*, thence down passage a^5 into annular chamber a^6, (see Figs. 4 and 6,) and thence out through the discharge-pipe a^7 a^7.

For the insertion or removal of the valve the chambers *u* are open at the top and covered by caps u^2, which caps are held down tight by bail-shaped clamps *r*, Figs. 1, 2, 4, and set-screws *q*, so that the valves may be readily taken out, inspected, or repaired without disturbing the rest of the pump.

P is the plunger, the upper portion of which, O, is made to fit the upper part of the cylinder C, and constituting the steam-piston, while the lower portion of this plunger is made of a smaller diameter, in the shape of a metal shell open at its lower end, and having a solid filling of wood or other non-conductor of heat, which prevents condensation of steam and lightens the plunger. This lower section of the plunger is made to fit the bore of the pump-cylinder a^3 in the base B, and between the base and a contracted flange, t^3, of the upper cylinder there is left a recess, which is filled with the packing-rings *t t*, between which is an orifice communicating with the vent-passage *v*, Fig. 4, which, it will be seen, communicates with the passage *a*, which is on the suction side of the pump. The object of this arrangement is to prevent the great hydrostatic pressure (which exists on the downward movement of the plunger) from forcing the water up beside the plunger and into the steam-cylinder; and this is accomplished by connecting the space between the rings *t* with the suction side of the pump, so that if any water is forced up by the downward movement it is immediately sucked back again by the upward stroke of the piston, and never reaches the interior of the steam-cylinder, where its presence would be objectionable.

For closing in the top of the cylinder C, I employ a cylinder-head, D, Figs. 3 and 7, of a peculiar form, upon the top of which is bolted through to the flange of the cylinder a valve-chest, E, and in the top of which chest is screwed a cap, F.

In constructing the upper cylinder-head, D, it is formed with a central downward projection, (see Figs. 4 and 5,) which is tapered, and through the lower end of which steam is admitted to and exhausted from the top of the main piston. The piston is recessed with straight walls to receive this projection, so that when the top of the piston rises above the level of the lower end of the projection on the cylinder-head the steam is cushioned in the annular space and all shock upon this cylinder-head avoided.

G is the main valve, which is constructed with a piston, G', at its lower end, working in a chamber, *b*, and a hollow stem rising centrally and fitting within the valve-chest. This valve is guided or prevented from turning about its vertical center by the guide-pin *b'*, Fig. 4, and steam is received into its hollow stem from one or both of the inlets H through openings b^2 in the side of the hollow stem, (see Fig. 4,) and passes thence alternately through openings b^3 b^4, Fig. 3, into either the port b^8 and the outside pipe, H, leading to the under side of the steam-piston, or to the port b^5, leading to the upper side of the piston. This port b^5 opens into the top of the cylinder through a registering port, b^6, in the top cylinder-head, Figs. 3 and 7, which communicates with vertical channels b^7, extending vertically about the periphery of a fixed bushing, *c*, and opening at the lower end of the projection into the cylinder.

I is the main exhaust-port, which connects with the exhaust-pipe arranged at right angles to the inlet-pipe. This exhaust-port is arranged to be alternately connected with the two induction-ports b^8 b^5 by a recess, c^2, Fig. 3, in the main valve, so that the main valve G, with its recess c^2 and openings b^3 b^4, plays over the ports b^8, I, and b^5, in a well-known manner, to admit and exhaust steam alternately from opposite sides of the piston O. The movement given to the valve G for controlling the flow of steam to and from the steam-cylinder is determined by the depth of the valve-chamber *b*, in which its piston G' moves. This valve I arrange, as will be seen, to be worked from its lower end, and as the steam-area of the bottom side of its piston is greater than the steam-area above it, I utilize this differential pressure to lift the valve, steam being during this stroke on both sides of the valve-piston, and the valve rising with a force equal to the difference in the up and down pressure. For the downward movement of this valve I simply exhaust steam from the under side of its piston and allow the steam-pressure on its upper side to exert its full power, which is equal to about the differential margin of power which raises it. For controlling the admission and exhaust of steam for thus working the main steam-valve it is necessary only to admit and exhaust steam from the chamber *b* beneath the valve-piston, the

space above the piston being always connected with the main steam-port b^5 at b^9, Fig. 3, and being supplied with steam by the same. For controlling the flow of steam, then, to and from the said chamber b, a port, d, Fig. 4, is formed in the valve-chest E, and this connects with a port, d', in the cylinder-head, which communicates with a recess, d^2, in the inner periphery of the bushing c at its lower end, which ports together constitute a special induction-passage. Near the top of the bushing c, and on the inner periphery, is another recess, d^3, connecting with a port, d^4, in the cylinder-head, which opens (see Fig. 7) into the main exhaust and forms a special exhaust-passage for the chamber b.

Within the valve G, and concentrically in its vertical hollow stem, is arranged (fixedly to the valve so as to move with it) a tube, e, whose upper end is closed when the valve is at its highest point by a plug, e^2, on the lower end of the spring-pressed rod f. Within this tube, but not fitting closely in it, is a stem, f^2, having the appearance and function somewhat of a piston-rod. The space between this stem f^2 and the hollow tube e is such that this hollow tube is always in direct communication with the space b below the valve-piston. This stem f^2 slides tightly through the bushing c, and is attached to the top of the main steam-piston. This stem I make hollow, with lateral openings g at the top and h at the bottom. (See Fig. 4.) Its upper end, h', I also make to fit tightly in the upper end of the tube e whenever said stem f^2 is at its highest point, and upon two sides, below the end, the tube is made flat, as at f^3 in Fig. 11, for the purpose hereinafter explained. Now, supposing the main valve G to have just moved down, this causes the main steam-piston to rise by introducing steam through pipe H to the lower side of piston. As then the piston rises stem f^2 rises, and as soon as opening h in stem f^2 reaches the opening d^2 in the bushing c (see Fig. 4) steam flows through d to d' and d^2, and there enters the stem at h, flows up through the stem to g, and the upper end, h', of stem being now in the end of tube e, and closing it, the steam, issuing at g, passes down outside stem g^2 to the space b, raising the main valve and sending the main steam-piston down again. Then as the piston goes down, opening h, which took its first steam through special ports d d' d^2, continues to take steam from the inside of the cylinder containing live steam, so that the flow of steam to the chamber b under the valve G is continued after opening h passes below d^2, so that the full and complete upward movement is given to valve G, whose central tube, e, closes on plug e^2 as soon as the end h' of stem f^2 is withdrawn from it. The main valve G is now at its highest adjustment and the steam-piston and stem f^2 going down. Just as or a little before the piston reaches the end of its downstroke the flat sides f^3 of the stem f^2 open a communication between chamber b and recess d^3 leading to the special exhaust d^4, (see Fig. 4,) and the steam in b then passes out beside the flat sides of stem f^2 to d^3, and through d^4 to the main exhaust, (shown in Fig. 7,) and the result is that the pressure of steam on the upper side of the valve-piston G′ forces the valve down, and by changing the flow of steam through the main ports sends the piston up again for a repetition of the same action. The exhaust from the chamber b around the flat sides of stem f^2 to port d^4 corresponds to the special induction in being only an initial action—*i. e.*, after steam commences to be exhausted from this chamber b through this special exhaust the rod f^2 rises and soon destroys this initial exhaust, and the exhaust from chamber b then continues by passing up around stem f^2 into the tube e, and from e to the chamber e' above, and thence out e (shown in dotted lines in Fig. 3) to the main exhaust. It will thus be seen that the upper end of tube e is successively closed by the plug e^2, is then open and in communication with chamber e', and then closed by the end h' of the stem f'.

In connecting the stem f^2 to the piston it is provided with a head, g^2, at its lower end, which is detachably inserted endwise into an opening in the piston-surface, (see Fig. 8,) and then slipped laterally into central position beneath an undercut edge, this loose connection serving to prevent any undue cramping, binding, and wear on the stem.

In arranging the main valve G with respect to its case it is made to cushion on both the up and down stroke. Thus for the downstroke the lower end of tube e is allowed to project below the bottom of the piston of the valve, and a recess, e^3, is made in the top of the bushing c, into which this end of tube e projects and tightly fits to form a steam-cushion, while a cushion of steam is formed in the chamber e' for the upward movement whenever the top of the valve passes the opening e^3 leading to the exhaust.

When the lower end of tube e is tightly closed in the recess in top of bushing c it will be seen that as steam is fed to chamber b through the lower end of tube e it cannot get into the chamber b when in this position to exert sufficient power to start the valve up, and I therefore make a lateral opening through the tube e opening down through the piston, as at i, Fig. 4, and over the mouth of this opening I place a spring-valve, k, (see Fig. 9,) so that while steam can pass down into chamber b through this opening it cannot pass back.

The object of the spring-plunger f is to allow the engineer to depress the same and shift the main valve in case it stops in a position in which the ports are out of registration.

Having thus described my invention, what I claim as new is—

1. The main steam-valve composed of a piston, G′, and a hollow stem, G, provided with inlets b^2 b^2 to said hollow stem, and outlets b^3 b^4, and recess c^2, combined with the valve-chest having ports, as described, and a chamber, b, for the valve-piston, with mechanism for regu-

lating the admission of steam to and its exhaust from said valve, substantially as described.

2. The main valve having a hollow stem and a piston at its lower end, combined with the valve-chest, and mechanism, substantially as described, whereby steam is applied to both sides of the piston on the upward stroke and raised by the different areas of steam-pressure, and mechanism for exhausting the steam from the lower side of the piston for moving the valve on the downstroke, substantially as described.

3. In a direct-acting steam-pump, the combination, with the pump proper, of the steam cylinder and piston, a steam-valve for regulating the flow of steam to the cylinder, and a rod or stem attached directly to the piston for equal movement therewith, and provided with passage-ways for controlling the flow of steam to and from the steam-valve for giving it its necessary movement, as set forth.

4. The steam-cylinder having a head with a central tapering boss, with ports in the same, combined with a piston having a straight walled recess therein for forming an annular cushion, substantially as described.

5. The combination, in a direct-acting pump, with the steam-cylinder and the water-cylinder having less diameter than the steam-cylinder, of a plunger composed of a piston, O, fitting the steam-cylinder and having cast in one piece therewith a shell of less diameter than the steam-piston, adapted to fit the water-cylinder, and having a filling of wood or other non-conducting material, substantially as and for the purposes described.

6. In a pumping-engine, the steam and water pistons made in one, combined with the steam and water cylinders, having a vent-passage between the two connected with the suction side of the pump, as and for the purpose described.

7. The combination, with an engine constructed substantially as described, of the cylinder C, having the water-valves u u' formed at its lower edges, the water-valves arranged therein, and the detachable base B, having passages a a' a^3 a^4 a^5 a^6, substantially as and for the purpose described.

8. The combination, with an engine constructed substantially as described, of the cylinder C, formed with valve-chambers u u', the valves w w', detachable caps u^2, and bails r, and set-screw q for holding the same, as shown and described.

9. The combination, with the valve G, having tube e, and its chest having chamber b, of the bushing c, having opening d^2 connected with a supply-port, d d', and the rod f^2, made hollow and having openings h and g, and connected with the piston, for the purpose of supplying steam to the main valve, as described.

10. The combination, with the valve G, having tube e, and its chest having chamber b, of the bushing c, having opening d^3 connected with the exhaust-port d^4, and the rod f^2, having a flattened end, adapted to connect the chamber b with the port d^4, for exhausting steam from the main valve and bringing it down, as described.

11. The combination, with the main valve G, having central tube, e, of the hollow stem f^2, having an upper end, h', and the plug e^2, arranged to fit alternately into the end of tube e, as and for the purpose described.

12. The combination, with the bushing c, having a recess in its upper end, of the main valve G, having its central tube, e, extended below its piston and adapted to fit in this recess to form a cushion, and having also an independent downwardly-opening port and valve, i, as and for the purpose described.

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