No. 750,377. PATENTED JAN. 26, 1904.

G. DE LAVAL & G. P. ABORN.

ENGINE.

APPLICATION FILED JULY 10, 1903.

NO MODEL. 2 SHEETS—SHEET 1.

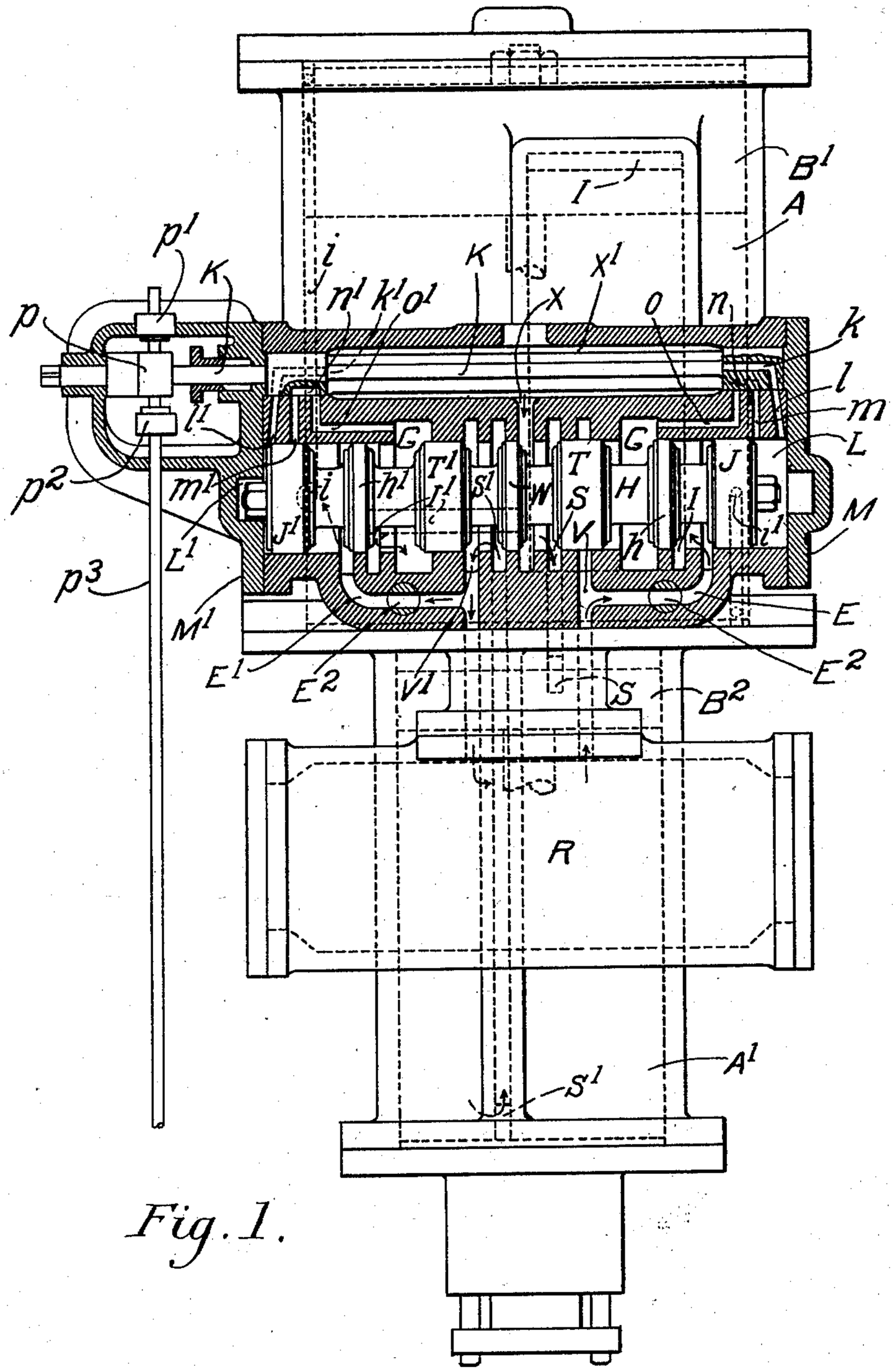

Fig. 1.

WITNESSES
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NO MODEL. 2 SHEETS—SHEET 2.

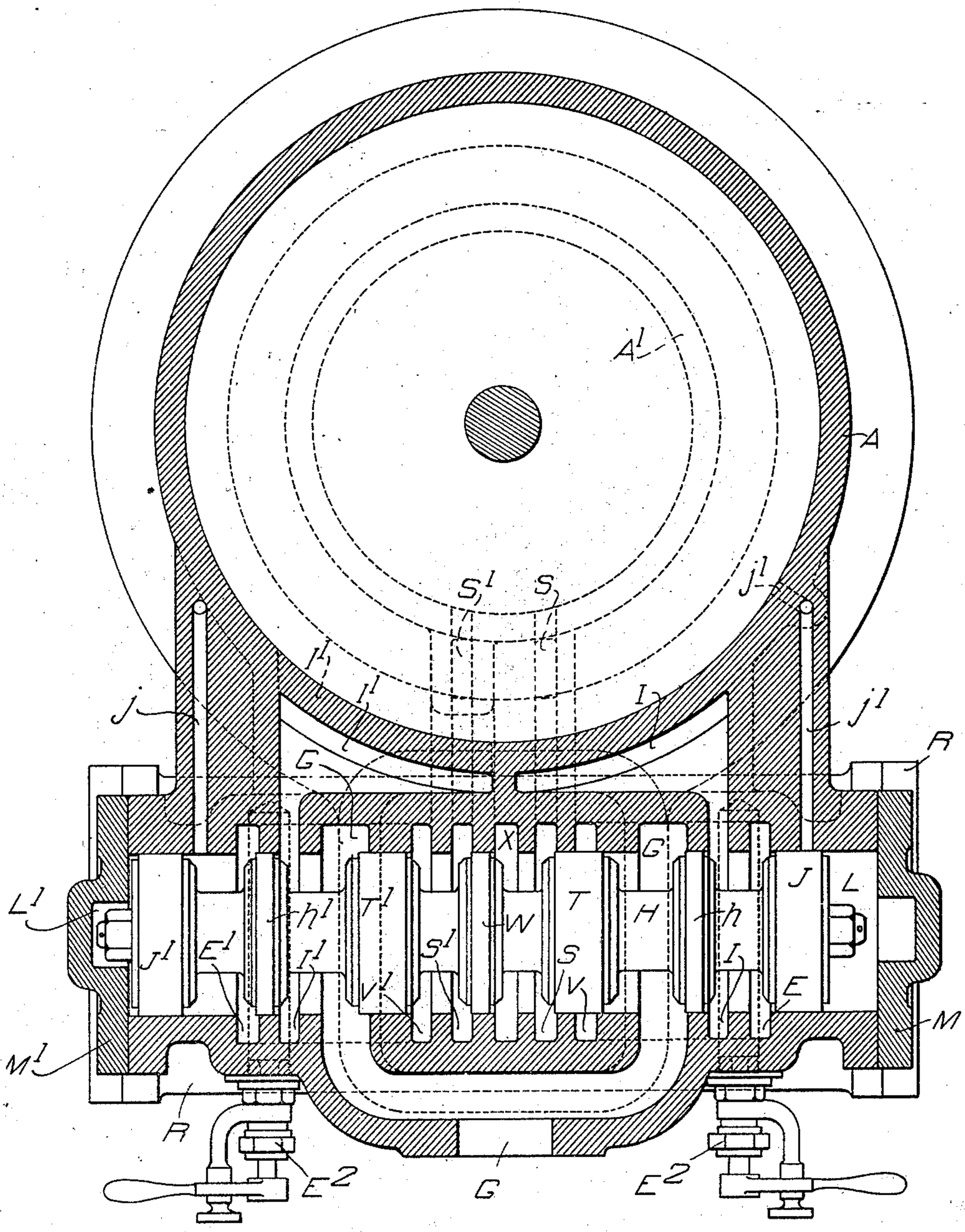

FIG. 2.

WITNESSES
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No. 750,377. Patented January 26, 1904.

UNITED STATES PATENT OFFICE.

GEORGE DE LAVAL, OF CAMBRIDGE, AND GEORGE P. ABORN, OF BOSTON, MASSACHUSETTS, ASSIGNORS TO INTERNATIONAL STEAM PUMP COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

ENGINE.

SPECIFICATION forming part of Letters Patent No. 750,377, dated January 26, 1904.

Application filed July 10, 1903. Serial No. 164,994. (No model.)

To all whom it may concern:

Be it known that we, GEORGE DE LAVAL, of Cambridge, county of Middlesex, and GEORGE P. ABORN, of Boston, county of Suffolk, respectively, and State of Massachusetts, have invented certain new and useful Improvements in Engines, of which the following is a specification.

The invention relates to means for controlling the distribution of steam or other motor fluid to the cylinder of a direct-acting compound engine, and resides more particularly in a piston-valve provided with pistons for controlling the admission and exhaust of steam through the main ports of the cylinders and the admission of steam through the starting-ports of one of the cylinders.

In an engine embodying the features of the invention one of the cylinders, preferably the low-pressure cylinder, is provided with main ports for the admission and exhaust of steam, which open into the cylinder at some distance from the ends, so that these ports are closed by the piston before it reaches the limit of its movement, thereby cutting off the exhaust from that end of the cylinder, so that the confined steam will act to effectively cushion the piston.

In order to give the piston a gradual initial movement when it starts in the opposite direction, starting-ports are provided, which enter the ends of the cylinder and supply steam to gradually start the piston forward until the main port is uncovered, after which steam is supplied through both the main and starting ports to advance the piston. The admission and exhaust of steam through the main ports of both cylinders and the admission of the steam to the starting-ports are controlled by a single piston-valve provided with pistons arranged to alternately bring the main ports into communication with the supply and exhaust passages and to alternately bring the starting-ports into and cut them off from communication with the supply-passage. By thus controlling the distribution of the steam through the main and starting ports a simple and efficient valve mechanism is provided which admits of the use of superheated steam or steam at high pressures and without wear upon the valve and valve-casing, and also admits of the use of such steam without the introduction of oil into the steam for lubricating the valve. With this construction also the pressures upon the valve are balanced, and the valve may be readily and quickly shifted to effect the efficient and proper distribution of steam through the ports.

The various features of the invention will be best understood from a detailed description of the engine illustrated in the accompanying drawings, in which—

Figure 1 shows a vertical elevation of the steam end of a direct-acting steam-pump embodying the invention, the valve-casing being shown in section. Fig. 2 shows a horizontal section through a valve on a larger scale.

In the construction shown in the drawings, A indicates the low-pressure cylinder, and A′ the high-pressure cylinder, of a vertical compound pumping-engine, the motor-pistons being indicated at B′ B². The main ports S S′ of the high-pressure cylinder lead from the valve-casing to the opposite ends of the cylinder, the port S leading to the upper end and the port S′ to the lower end of the cylinder. Steam is supplied to the ports S S′ through the supply-passage X, which leads from the steam-chamber X′ of the steam-chest to the valve-casing and is arranged between the ports S S′. The exhaust-passages V V′ for the high-pressure cylinder communicate with the valve-casing on opposite sides of the ports S S′ and lead from the valve-casing to a receiver R.

Steam is supplied to the low-pressure cylinder A through supply-passages E E′, which communicate with the receiver, so that the steam exhausted from the high-pressure cylinder is supplied to the low-pressure cylinder. In the construction shown the supply-passage E leads from the exhaust-passage V to the valve-casing and the supply-passage E′ leads from the exhaust-passage V′ to the valve-casing. The main port I of the low-pressure cylinder A leads from the valve-casing to the up-

per end of the low-pressure cylinder and is arranged adjacent to the supply-passage E and between it and the exhaust-passage G, which communicates with the valve-casing outside of the exhaust-passage V for the high-pressure cylinder. The main port I′ for the low-pressure cylinder leads from the valve-casing to the lower end of the low-pressure cylinder and is similarly arranged between the supply-passage E′ and the exhaust-passage G, which communicates with the valve-chamber outside of the exhaust-passage V′ for the high-pressure cylinder.

The starting-port *i* leads from the valve-casing outside of the supply-passage E′ to the upper end of the low-pressure cylinder and is arranged to communicate with the supply-passage E′, through which steam is supplied to the main port leading to the lower end of the low-pressure cylinder. The starting-port *i*′, which leads from the valve-casing to the lower end of the low-pressure cylinder, is similarly arranged with relation to the supply-passage E, through which steam is supplied to the main port I for the upper end of the low-pressure cylinder.

The distribution of steam through the main ports for both the high and low pressure cylinders and through the starting-ports for the low-pressure cylinder is controlled by a series of pistons in the form of rings formed on a valve-stem H and fitting a cylindrical bore of the valve-casing. The valve is provided with pistons W T T′ for controlling the distribution of steam to the high-pressure cylinder and with pistons *h h*′ J J′ for controlling the distribution of steam through the main ports and starting-ports of the low-pressure cylinder. When the valve is in the position indicated in the drawings, the port S is in communication with the supply-passage X and the port S′ is in communication with the exhaust-passage V′. The main port I of the low-pressure cylinder is in communication with the supply-passage E and the main port I′ is in communication with the exhaust-passage G, while the starting-port *i* is in communication with the supply-passage E′ and the starting-port *i*′ is closed by the piston J. With the valve in this position the steam from the steam-supply passage X passes through port S to the upper end of the high-pressure cylinder A′, while the exhaust-steam from below the piston B^2 in the high-pressure cylinder passes up through port S′ and through the exhaust-passage V′ to the receiver. From the passage V′ the steam also passes through the supply-passage E′ at the left to the starting-port I. From the receiver the steam passes through the passage V to the supply-passage E, and thence up through the port I to the upper end of the low-pressure cylinder A. The steam supplied through the port S to the high-pressure cylinder and through the starting-port *i* to the low-pressure cylinder will start the pistons B′ B^2 gradually downward until the port I is uncovered by the piston B′, after which steam will also be supplied through this main port to force the pistons downward. When the motor-piston B′ covers the main port I′ in the low-pressure cylinder, the steam confined in the lower end of this cylinder will act to cushion the pistons. When the motor-pistons reach the limit of their downward stroke, the piston-valve is shifted to the right. When the valve is thus shifted, the piston W shuts off the port S from the supply-passage X and opens the port S′ to said passage, while the piston T opens port S to the exhaust-passage V and piston T′ closes the port S′ to the exhaust-passage V′. At the same time the piston *h*′ closes communication between the port I′ and the exhaust-passage G and opens said port to the supply-passage E′, while piston *h* opens communication between the port I and the exhaust-passage G and closes said port to the supply-passage E. The starting-port *i* is also cut off from the supply-passage E′ by the piston J′, while starting-port *i*′ is opened to the supply-passage E by the movement of the piston J. Now steam is supplied to the lower end of the high-pressure cylinder through port S′ and is supplied to the lower end of the low-pressure cylinder through the starting-port *i*′, while the exhaust-steam from above the piston B^2 passes through port S and exhaust-passage V to the receiver, and thence through passage V′ and supply-passage E′ to the port I of the low-pressure cylinder.

While the communication between the port S′ of the high-pressure cylinder and the port I of the low-pressure cylinder and the communication between the port S of the high-pressure cylinder and the port I′ of the low-pressure cylinder are through a receiver in the construction shown, this is not essential, and the receiver may be omitted, if desired. It is preferred, however, to employ a receiver and to arrange the receiver as shown, so that it forms a part of the communicating passages between the ports of the high and low pressure cylinders, thus compelling the exhaust-steam from the high-pressure cylinder to pass through the receiver before it is supplied to the main ports of the low-pressure cylinder. It is also preferred to arrange the supply-passages E E′ so that they lead from the exhaust-passages V V′ for the high-pressure cylinder, although this is not essential, and the passages may be arranged to communicate with the receiver R directly, if desired.

The action of the engine may be regulated, if desired, by valves E^2, arranged in the supply-passages E E′, so that by adjusting the valves the supply of steam may be throttled to a greater or less extent, and this arrangement of valves forms a feature of the invention.

In order to shift the piston-valve quickly and surely at each end of the stroke of the

motor-pistons, the piston-valve is operated by steam acting upon the pistons J J′ at the ends of the valve and controlled by a controlling or auxiliary valve K, mounted in valve-chambers formed in the steam-chest at opposite ends of the steam-chamber X′. The pistons J J′ work in steam-chambers L L′, formed at the ends of the piston-valve casing by closing said ends with heads M M′, secured to the ends of the steam-chest. Admission-ports *l l′* and exhaust-ports *m m′* lead from the steam-chambers L L′ to the auxiliary valve-chambers at the ends of the steam-chamber X′. The admission of steam through the steam-ports *l l′* is controlled by ports *k k′*, formed in the valve K and having their inner ends in constant communication with the steam-chamber X′. The exhaust of steam through ports *m m′* is controlled by ports *n n′*, formed in the valve K and arranged to connect the ports *m m′* with ports *o o′*, which lead from the auxiliary valve-chambers to the exhaust-passages G.

The valve K is rocked to control the movements of the piston-valve H by means of tappets p' p^2, arranged to engage opposite sides of an arm *p*, secured to the shaft K′ of the valve K. The tappets p' p^2 are secured upon a rod p^3, which is connected in any suitable or usual way with the motor-pistons, so that it is shifted at each end of the stroke of the pistons.

As the motor-pistons reach the end of their upward stroke the valve K is moved into the position shown in the drawings. This brings port *k* into communication with port *l*, closes ports *l′ m*, and connects ports *m′* and *o′*. Steam is therefore admitted to chamber L and quickly throws the piston-valve into the position shown, the steam in chamber L passing out through exhaust-port *l′* until this port is closed by the piston J′, when the steam remaining in the chamber L′ and port *l′* acts as a cushion for cushioning the piston-valve. When the motor-pistons reach the end of their downward stroke, the valve K will be rocked so that port *k′* will connect port *l′* with the steam-chamber, ports *l m′* will be closed, and port *m* will be connected with port *o*. Steam will now enter chamber L′ and throw the piston-valve to the right, the steam in chamber L exhausting through port *m* until the piston J closes said port.

What we claim, and desire to secure by Letters Patent, is—

1. In a direct-acting compound engine the combination with high and low pressure cylinders, and motor-pistons therein, of main ports for said cylinders, starting-ports for one of said cylinders, and a piston-valve provided with pistons for controlling the admission and exhaust of the motor fluid through the main ports of both cylinders and the admission of the motor fluid to the starting-ports.

2. In a direct-acting compound engine the combination with high and low pressure cylinders, and motor-pistons therein, of main ports for said cylinders, starting-ports for the low-pressure cylinder, and a piston-valve provided with pistons for controlling the admission and exhaust of the motor fluid through the main ports of both cylinders and the admission of the motor fluid to the starting-ports of the low-pressure cylinder.

3. In a direct-acting compound engine the combination with high and low pressure cylinders and motor-pistons therein, of main ports for said cylinders, starting-ports for one of said cylinders, a piston-valve provided with pistons for controlling the admission and exhaust of the motor fluid through the main ports and the admission of steam to the starting-ports, and an auxiliary valve for distributing the motor fluid to reciprocate the piston-valve.

4. In a direct-acting compound engine the combination with high and low pressure cylinders and motor-pistons therein, of main ports for said cylinders, a receiver forming a part of the communication between the ports of the high and low pressure cylinders, starting-ports for the low-pressure cylinder, and a valve for controlling the distribution of the motor fluid through the main and starting ports.

5. In a direct-acting compound engine the combination with high and low pressure cylinders and motor-pistons therein, of main ports for said cylinders, starting-ports for the low-pressure cylinder, a receiver forming a part of the communication between the main ports of the high and low pressure cylinders, and a piston-valve provided with pistons for controlling the distribution of the motor fluid through the main and starting ports.

6. In a direct-acting compound engine the combination with high and low pressure cylinders, passages between the exhaust-ports of the high-pressure cylinder and the supply-ports of the low-pressure cylinder, a throttling-valve in each passage, and separate exhaust-passages for the low-pressure cylinder, substantially as described.

7. In a direct-acting compound engine the combination with high and low pressure cylinders, a communication between the exhaust-ports of the high-pressure cylinder and the supply-ports of the low-pressure cylinder, a receiver forming part of said communication, and throttling-valves between the receiver and the ports of the low-pressure cylinders, substantially as described.

8. In a direct-acting compound engine the combination with the high and low pressure cylinders and motor-pistons therein, of supply and exhaust passages for the high-pressure cylinder, main ports for said cylinder between said supply and exhaust passages, supply-passages for the low-pressure cylinder communicating with the exhaust for the high-pressure cylinder, exhaust-passages for the low-pressure cylinder, main ports for said cyl-

inder between the supply and exhaust passages, starting-ports for the low-pressure cylinder, and a piston-valve having a series of pistons for controlling the communication between the main ports and the supply and exhaust passages and between the starting-ports and the supply-passages of the low-pressure cylinder.

9. In a direct-acting compound engine the combination with high and low pressure cylinders and motor-pistons therein, of main ports for said cylinders, starting-ports for the low-pressure cylinder and a single valve for controlling the admission and exhaust of motor fluid through the main ports and the admission of motor fluid to the starting-ports.

10. In a direct-acting compound engine the combination with high and low pressure cylinders and motor-pistons therein, of main ports S, S′ for the high-pressure cylinder, exhaust-passages V, V′, a receiver to which said exhaust-passages lead, supply-passages E, E′ for the low-pressure cylinder communicating with the receiver, main ports I, I′, for low-pressure cylinder, starting-ports *i*, *i*′ for the low-pressure cylinder, a supply-passage for the high-pressure cylinder, exhaust-passages for the low-pressure cylinder, and a piston-valve having pistons W, T, T′ for controlling the supply and exhaust through the ports S, S′ and pistons *h*, *h*′, J, J′, for controlling the supply and exhaust through ports I, I and the supply to ports *i*, *i*′.

In testimony whereof we have affixed our signatures in presence of two witnesses.

GEORGE DE LAVAL.
GEORGE P. ABORN.

Witnesses:
JOHN J. FINLEY,
HERBERT S. HAMBLETT.