J. B. WARING.

DIRECT-ACTING ENGINE.

No. 185,805. Patented Dec. 26, 1876.

Fig. 2.

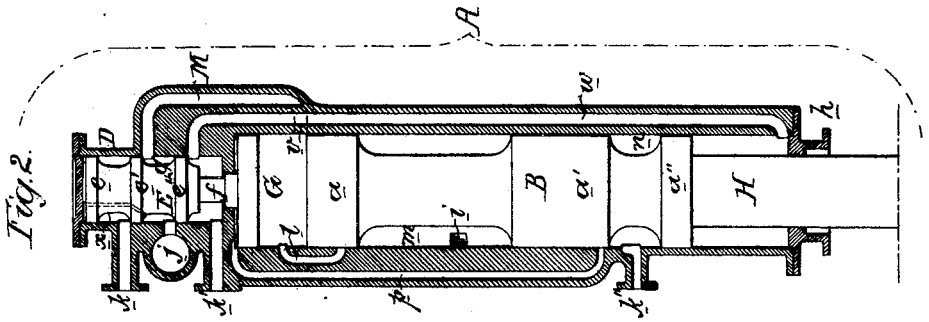


Fig. 1.

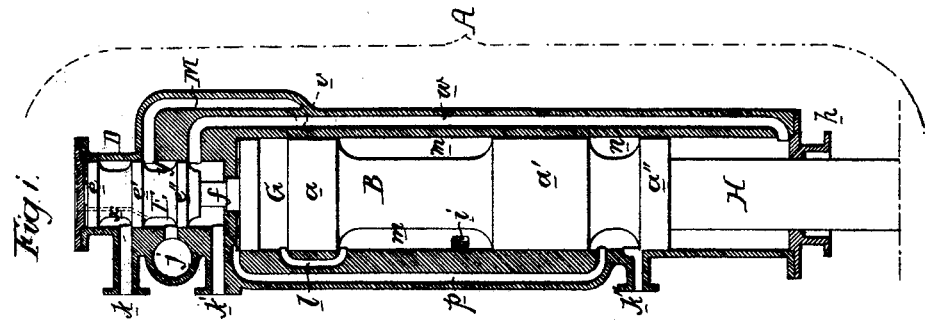
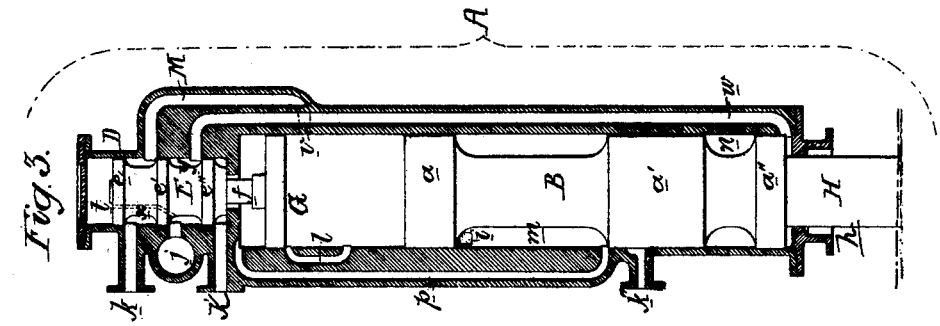


Fig. 3.



Witnesses
Hermann Moessner
Harry Smith

John B. Waring
by his Attorneys
Howson and Sons

UNITED STATES PATENT OFFICE.

JOHN B. WARING, OF STAMFORD, CONN., ASSIGNOR OF ONE-HALF OF HIS RIGHT TO JOSEPH B. WILSON, OF PHILADELPHIA, PA.

IMPROVEMENT IN DIRECT-ACTING ENGINES.

Specification forming part of Letters Patent No. **185,805**, dated December 26, 1876; application filed November 23, 1876.

To all whom it may concern:

Be it known that I, JOHN B. WARING, of Stamford, Connecticut, have invented a new and useful Improvement in Direct-Acting Steam-Engines, of which the following is a specification:

The object of my invention is to construct a simple and economical direct-action steam-engine, the valve of which shall be automatically operated by the steam alone, without the aid of external appliances usually employed for operating the valves of engines of this class.

In the accompanying drawing, Figures 1, 2, and 3 are vertical sections of the engine, showing the operating parts in different positions.

A is the cylinder and B the main piston, the latter being reduced in diameter at two places, so as to form with the cylinder the two annular chambers or passages *m* and *n*, as described hereafter, the piston being thus composed of three united sections, *a*, *a'*, and *a''*, fitting snugly to the interior of the cylinder. On the top of the main cylinder A is the cylindrical valve-chest D, containing the cylindrical valve E, which is composed of three sections, *e*, *e'*, and *e''*, fitting snugly in the chest, and which is reduced in diameter at two points, so as to form, with the said chest, two annular chambers or passages, *x* and *y*. At the lower end of the valve is a piston, G, adapted to the interior of the main cylinder, the piston and valve being connected together by a rod, *f*, part of which is less in diameter than the opening in the top of the cylinder through which the said rod passes, for a purpose explained hereafter. The rod or plunger H attached to or forming part of the main piston passes through a stuffing-box, *h*, at the bottom of the cylinder. There are a number of channels or passages, all of which will be referred to in the following description of the operation of the engine.

It may be stated in the outset that there are two inlets, *i* and *j*, for live steam; that the annular chamber *m* of the main piston and the annular chamber *y* of the piston-valve are always exposed to the live steam; that there is a communication, *t*, (shown by dotted lines,) Fig. 3, between the annular chamber *y* and the space above the piston-valve, on which there is consequently a constant live-steam pressure, and that there are three outlets, *k*, *k'*, and *k''*, for the exhaust steam.

In Fig. 1 the main piston has reached, or nearly reached, the limit of its upward movement, live steam from the annular chamber *m* having passed through the channel *l* to the space above the piston, and the pressure of this steam having forced the piston G and its valve E upward to the position shown, (*e*,) the steam above this piston G having escaped through the channel *p* into the annular chamber *n*, and thence through the outlet *k''*. The piston now commences to descend, owing to the pressure of steam from the channel *l*, which is comparatively small, so that the commencement of the downward movement of the piston is slow, and free from sudden shocks. It should here be understood that while the piston descends the steam below it is being exhausted through the passage *w*, through the small cylinder D, below its piston-valve, and thence through the exhaust-passage *k'*. As the main piston descends it closes the passage *l*, but before the latter is quite closed the piston exposes the port *v* communicating with the inlet *j* through a channel, M, and through the annular chamber *y*, so that the piston continues its descent under a full head of live steam.

When the piston B has reached the position, Fig. 3, the exhaust-port *k''* has been closed and the channel *p* has formed a communication between the annular steam-chamber *m* and the space above the valve-piston G, and the consequence of this has been the sudden descent of the said piston and valve. By this movement the annular chamber *y* of the valve is made to communicate with the inlet *j* and also with the channel *w* through which the live steam passes to the space beneath the main piston. At the same time there is an open communication through the port *v*, passage M, and annular chamber *x* of the valve between the exhaust-outlet *k* and the space above the piston B. The consequence of this will be the rising or return movement of the piston.

Turning back to the arrival of the piston in its descent to the position, Fig. 3, and to the downward movement of the valve and its piston, it will be understood that the latter in its descent is acting against steam above the main piston. This, however, is not sufficent to prevent the downward movement of the valve, for there is the pressure of live steam above the piston G, plus the pressure of live steam on the top of the valve, and the combined areas of the two are greater than the area of the main piston. The main piston continues its upward movement until it uncovers the lower port of the channel *l*, when the live steam from the chamber *m* gains access to the space above the main piston; then the under side of the valve-piston G is exposed to the full pressure of live steam, is opposed by the pressure of steam on the lesser area of the valve, and, as the main piston is supported below by a pressure of steam on an annular surface of greater area that of the valve, the instant rising of the said valve and its piston must take place, after which there is a repetition of the above-described movements.

As before remarked, a portion of the rod *f* which connects the valve with the piston G is somewhat less in diameter than the hole in the top of the cylinder through which the said rod passes. In other words, there is an annular space around a portion of the rod, through which space the steam above the piston G can escape to the outlet *k'*, during the rapid upward movement of the said piston. The lower portion of the rod *f*, however, is arranged to fit snugly in the hole in the top of the cylinder, so that a small quantity of steam may be trapped between the piston and cover, to serve as a cushion for the former.

It will be seen without further description that a reciprocating motion is imparted to the main piston without the usual valve-operating appliances common to other direct-action engines, and that the engine may be used in connection with a pump, or may form part of a steam-hammer or of a rock-drilling machine, or other machines of like character. It will also be evident to those familiar with engines of this class that the passages and ports may be arranged in different ways without departing from the main features of the invention.

The chamber *n* and outlet *k''* may be dispensed with, but I prefer to use them.

An important feature of my invention is the arrangement of the valve-chest at the top of and in line with the cylinder, a plan which facilitates construction, for reasons which will be familiar to those practically familiar with the construction of steam-engines.

I claim as my invention—

1. The combination, in a direct-action engine of a main piston, B, cylindrical valve E, and its piston G, adapted to the main cylinder of the engine, with inlets and outlets and ports and passages, arranged substantially as described, for the purpose specified.

2. An opening in the top of the main cylinder, communicating with an exhaust-outlet, in combination with the rod *f* of the valve and its piston, the upper portion of said rod being less than the opening, and the lower portion being made to fit the same, all as set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses.

JOHN B. WARING.

Witnesses:

HERMANN MOESSNER,

HARRY SMITH.