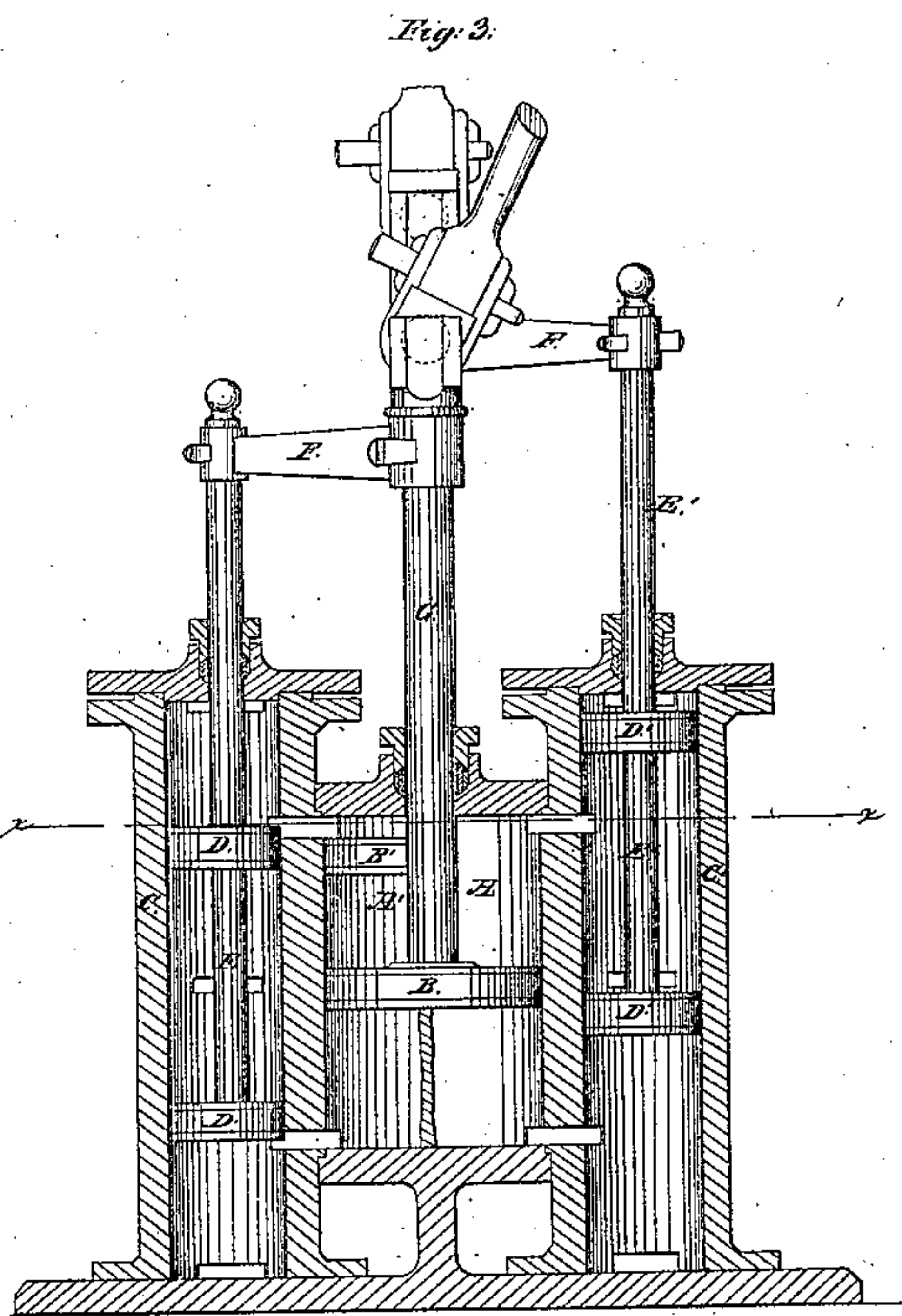
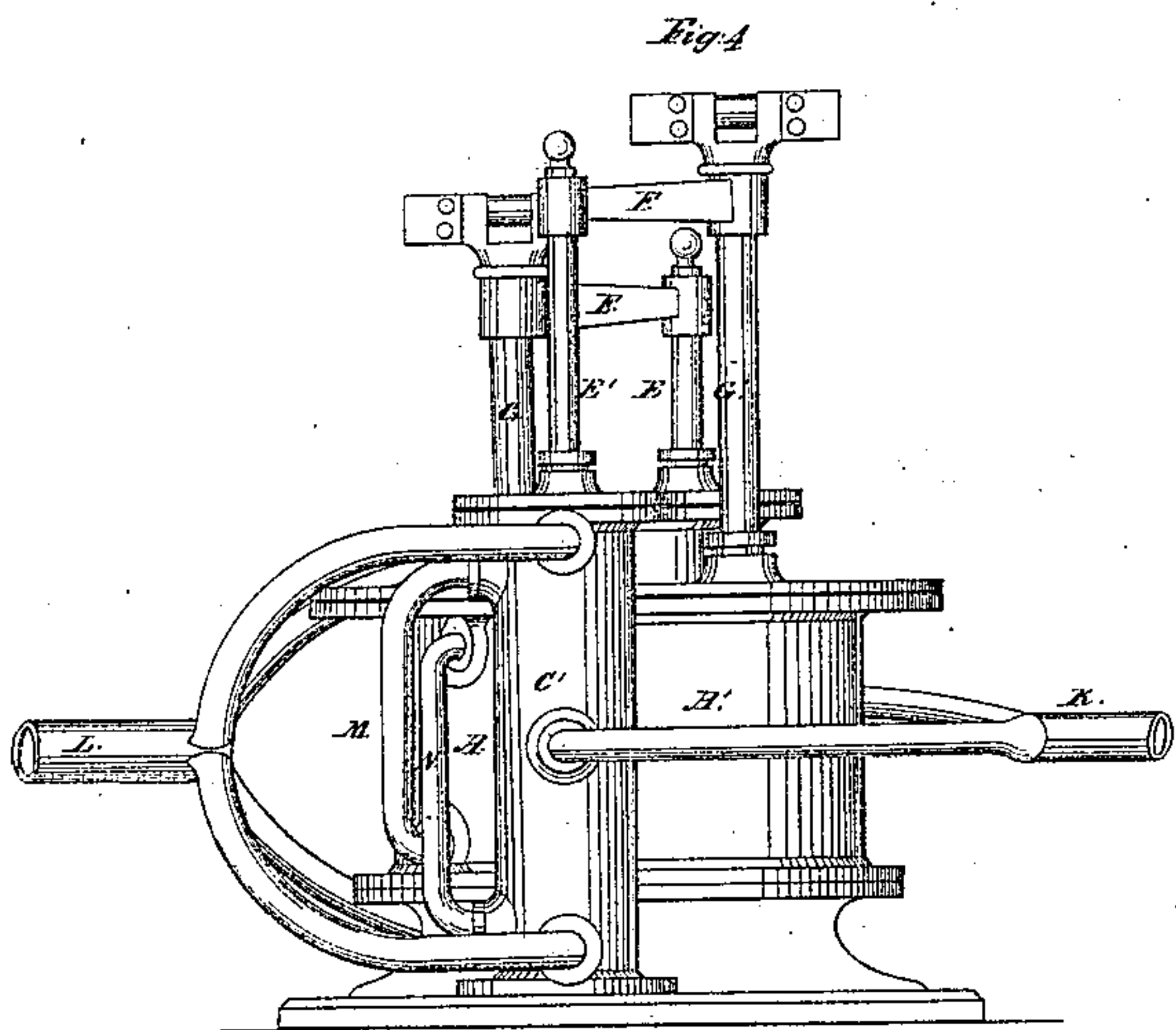
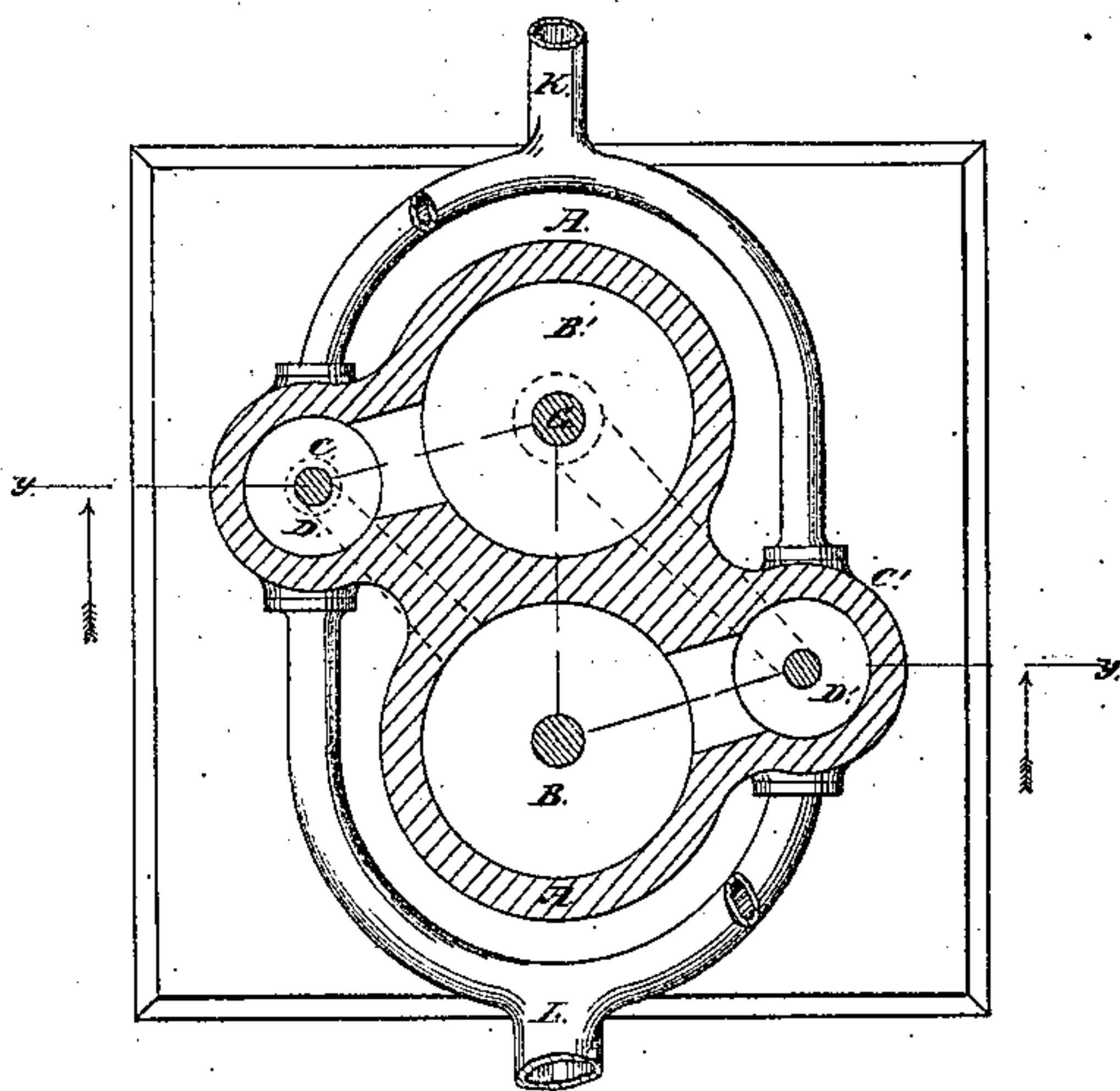
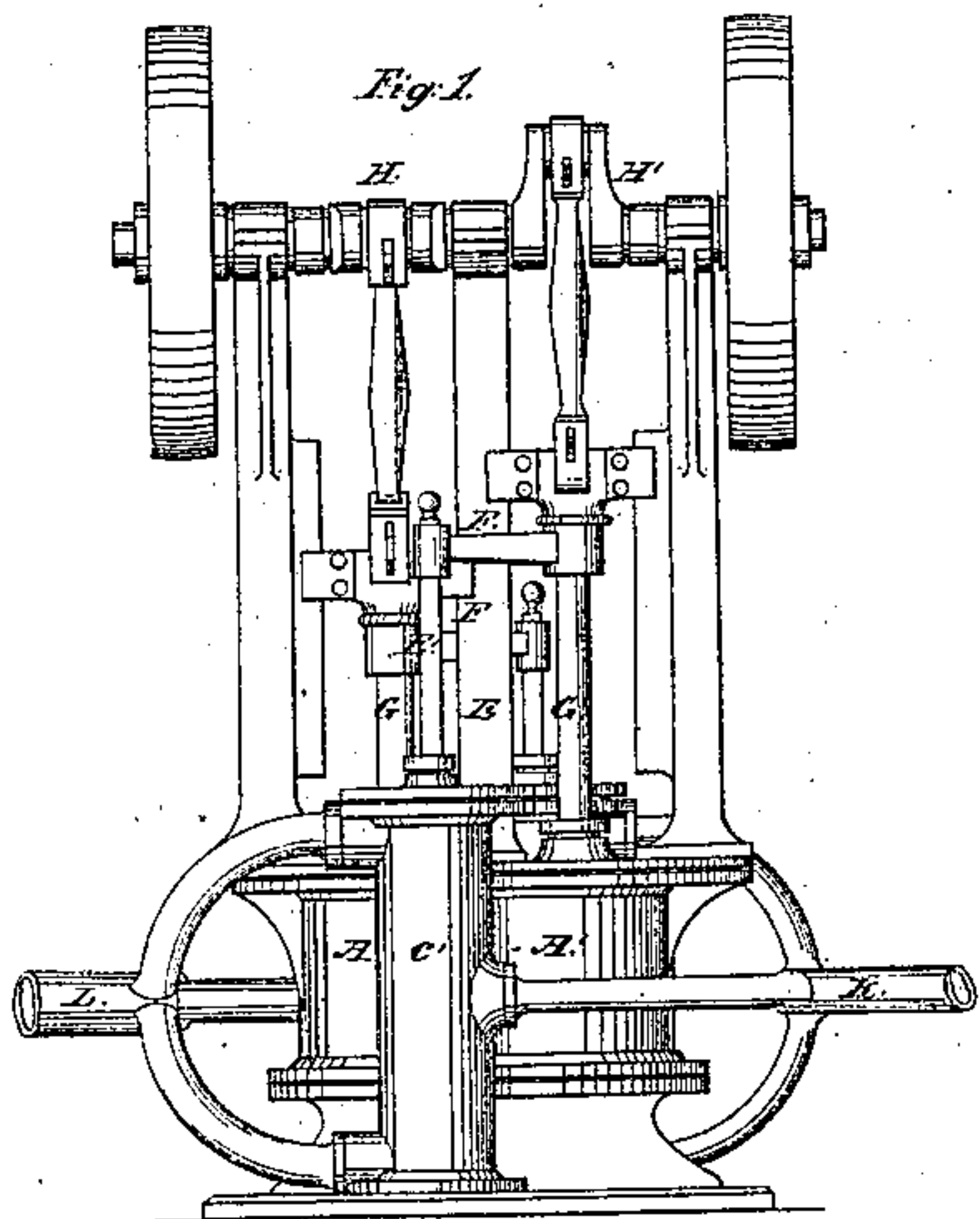


*G. I. Washburn,
Reciprocating Steam Engine,*

No 54,983

Patented May 22, 1866.

Fig. 2.



Witnesses:
Edward H. Knight,
James S. Green.

Inventor:
George I. Washburn
per *Alvin H. Cook*
Attorney.

UNITED STATES PATENT OFFICE.

GEORGE I. WASHBURN, OF WORCESTER, MASSACHUSETTS.

IMPROVEMENT IN STEAM-ENGINES.

Specification forming part of Letters Patent No. 54,983, dated May 22, 1866.

To all whom it may concern:

Be it known that I, GEORGE ICHABOD WASHBURN, of the city and county of Worcester, and State of Massachusetts, have made new and useful Improvements in Steam-Engines; and I do hereby declare the following to be a full, clear, and exact description of the nature, construction, and operation of the same, sufficient to enable one skilled in the art to which my invention is allied to construct and use the same, reference being had to the accompanying drawings, which are made part of this specification, and in which similar letters refer to corresponding parts in the different figures.

Figure 1 is an elevation of the steam-engine with slides, shaft, cranks, and fly-wheels attached. Fig. 2 is a horizontal section on the line *x x*, Fig. 3. Fig. 3 is a vertical section on the line *y y*, Fig. 2. Fig. 4 is an elevation of an engine similar in general character to the engine represented in the other figures, but varying to some extent in the arrangement of the steam-passages.

This invention consists of a double engine having two or more pistons attached to a common crank-shaft, each piston working in a separate cylinder, and each cylinder having its own valve and valve-chest outside the cylinder. The valve which governs the action of the steam upon a given piston is moved precisely with and by direct attachment to the other piston. This motion is of the same extent as that of the piston which actuates it, the two passing through the corresponding portions of their strokes at the same time and rate.

The cranks to which the pistons are attached are set at an angle with each other of ninety degrees, and consequently one of them is one-half stroke or one-quarter of a revolution ahead of the other when the shaft is running in a given direction. Owing to the connection between the pistons and the cranks, each valve is passing ports while the piston to which it is attached is about the middle of its motion and at the point of greatest speed, while the piston which is governed by the valve is moving at its slowest speed, being at the end of its stroke.

In the drawings, A A' represent the two cylinders, and B B' the respective pistons. At-

tached to the cylinders are valve-chambers C C', occupied by valves D D', which are respectively formed of two disks on a rod, E E'. The upper end of the rod E' is attached by cross-head F to the piston-rod G', and the upper end of the valve-rod E is attached by cross-head F to the upper end of the piston-rod G.

It will thus be perceived that each valve is attached to one piston, and is the means of actuating the other by the opening and closing of the steam-passages leading thereto and therefrom.

Each valve-chamber is an appendage to a given cylinder, and the valve therein is made the means of opening and closing the steam-passage of said cylinder and thus actuating the piston therein; but the motions of the valve are derived from the piston of another cylinder, and the required relation is preserved in this form of my engine by means of their common connection to a shaft, by means of cranks H H' set at an angle of ninety degrees with each other.

In the form of engine illustrated in the drawings the pistons are double-acting; but it is possible to make each piston, in a sense, single-acting by placing two upon the same rod, so that the steam acts upon them alternately.

The steam is admitted to the valve-chambers by means of the feed-pipe K, and exhausted through exhaust-pipe L.

It is necessary, either by means of the constructions of the valves or by the construction of the ports or channels which lead the steam from a given valve-chest to its cylinder, to cause them to work the steam, that if one valve, when at the top of its stroke, gives the steam to the upper side of its piston, the other valve, when at the top of its stroke, shall give steam to the under side of its piston. The same is true of exhausting the steam. This may be done either by the construction of the valves, as shown in Fig. 1, in which the middle space is an exhaust-space in one valve and a steam-space in the other; or, as in Fig. 4, by causing the steam-passage from the upper side of one of the valves to lead to the under side of the piston, as by pipe M, while the corresponding passage N in the other valve leads to the upper side of its piston. The reversal of the action may be obtained in either

way. I do not limit myself to any particular mode of obtaining it.

In consequence of the action or operation of the crank-shaft and the method of moving the valves above explained, when the valve passes the ports and reverses the steam-pressure in a given cylinder the maximum rate of vertical motion of one crank is given to the valve, while the minimum vertical motion of the other crank is given to the piston upon which steam is reversed by said valve. The effect of this is a great reduction of the back-pressure of the steam in the cylinder and an increased efficiency of the steam on the receiving side of the piston. This is due to the fact that the valve has reversed the steam-pressure upon its piston, fully opening all the ports before the piston has moved to any considerable extent, the full pressure being thrown at once upon the receiving side of the piston and the exhaust side being fully opened to the passage of steam therefrom.

The foregoing description refers to a double engine used with cranks connected upon a single shaft; but when used in connection with a hammer or pumping-piston and without the cranks the pistons will move in a given direction until they meet some opposing object—as, for instance, the anvil, or the end of the steam or pump cylinder, or an elastic device or material provided for that purpose; but when used with the double crank the motions are modified in the manner so well known and understood as not to require special description. In either case—whether used with the crank

or without it—the valve which regulates the flow of steam to and from a given cylinder is actuated by the piston of the other cylinder, the use or disuse of the crank being determined by its purpose and application.

For a steam-hammer the hammer-face may be connected directly to the piston-rod, while for a steam-pump for air or water a duplicate machine is placed opposite, with continuous piston-rods, upon the respective ends of which are steam and pumping pistons, the cylinders of pump and engine having corresponding valve-connections.

A number of cranks may be used upon one shaft, each being connected to a separate cylinder, with valves corresponding to those described and bearing the same relation.

When desired to attach an adjustable cut-off to the engine, the valves shown in the drawings can be used as exhaust-valves and two more valves be placed upon each cylinder to control the inlet of steam thereto, according to the position of the governor.

Having described my invention, what I claim as new, and desire to secure by Letters Patent, is—

The arrangement of the pistons B B' and valves D D', the latter being respectively actuated by one piston, and the means of actuating the other piston, substantially as described.

GEO. I. WASHBURN.

Witnesses:

S. P. MORSE,

WM. F. BARNEY.