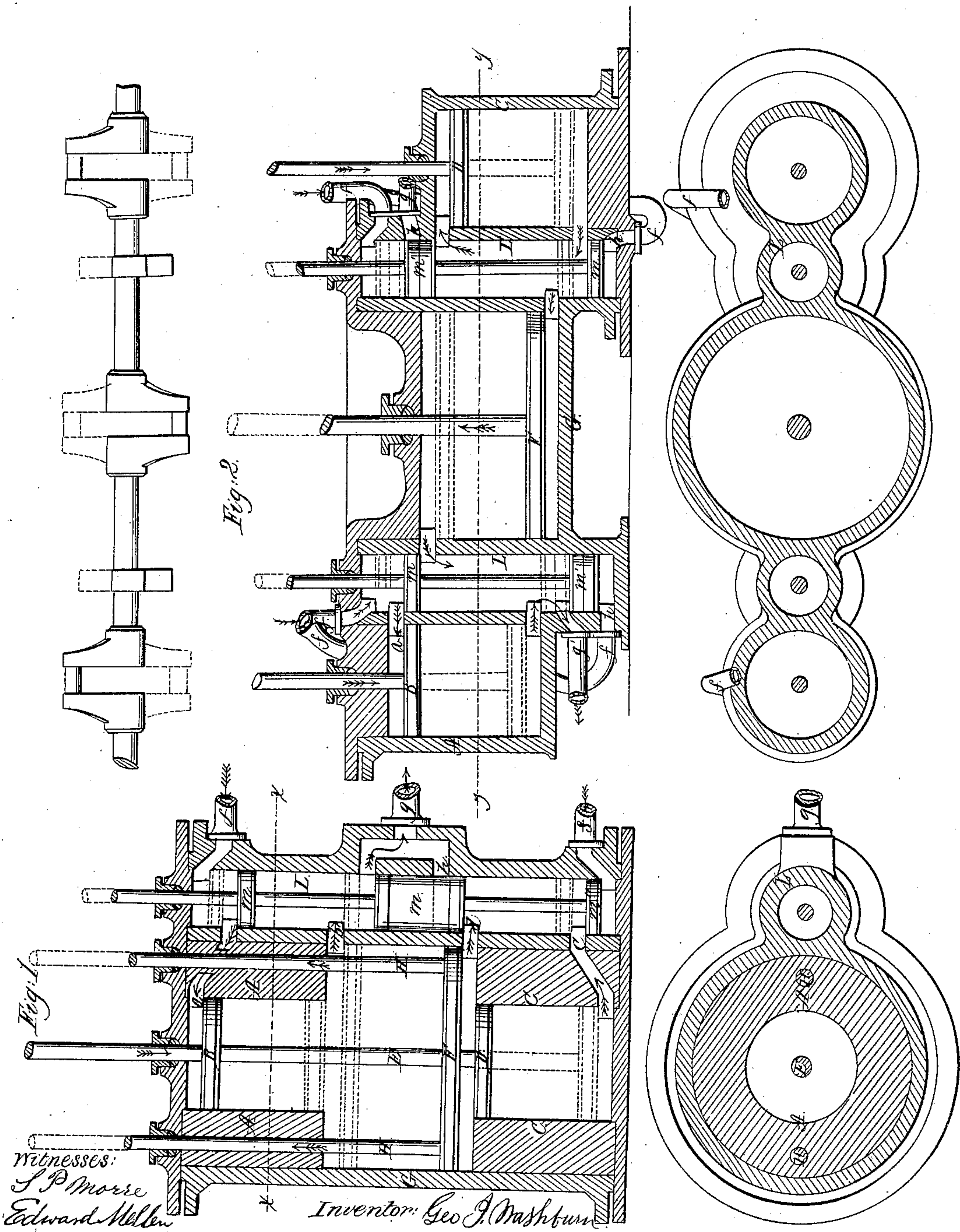


Compound Steam Engine.

N^o 62,712.

Patented Mar. 5, 1867.



United States Patent Office.

GEORGE I. WASHBURN, OF WORCESTER, MASSACHUSETTS.

Letters Patent No. 62,712, dated March 5, 1867.

IMPROVEMENT IN STEAM ENGINES.

The Schedule referred to in these Letters Patent and making part of the same.

TO ALL WHOM IT MAY CONCERN:

Be it known that I, GEORGE I. WASHBURN, of Worcester, in the county of Worcester, and State of Massachusetts, have invented a new and useful Improvement in Steam Engines; and I do hereby declare the following to be a full, clear, and exact description of the same, sufficient to enable one skilled in the art to which the invention appertains to make use of it, reference being had to the accompanying drawings, which form a part of this specification, and in which—

Figure 1 is a vertical central section with a horizontal section below it, taken on the section line *x x*, fig. 1, above.

Figure 2 is a vertical central section of a modified arrangement, with a diagram of the shaft and cranks above and a horizontal section below, taken on the section line *y y*, fig. 2, above.

This engine has two cylinders with single-acting pistons, in which steam is used directly, and one larger cylinder with a double-acting piston, on which the steam of the other and smaller cylinder is used expansively. The two smaller pistons, whether upon one rod, as in fig. 1, or upon two rods connected to a common shaft, as in fig. 2, have the effect of one double-acting piston, and the steam from these two cylinders is expanded against the upper and lower surface respectively of the piston in the larger cylinder, the action being alternate. Thus when one of the smaller pistons is making its effective stroke under the pressure of steam direct from the boiler, the piston in the larger cylinder is driven in the reverse direction by the expansion of the steam from the other smaller cylinder. The three cylinders may be arranged vertically, as in fig. 1, in which case all the steam connections may be accomplished by a single valve, or they may be arranged horizontally, as in fig. 2, in which case two valves are employed. There is a manifest propriety in placing the larger cylinder between the other two, whether vertically or horizontally arranged, as it receives steam from its smaller neighbors alternately, and it is desirable to reduce the length of the steam passages to their minimum. To prevent the back action of the steam within a given cylinder, when it passes therefrom to the larger cylinder to be used expansively, it is permitted to flow on both sides of the piston in the former cylinder, so that its action therein is balanced.

In the drawings, fig. 1, A C are two smaller cylinders, in which the pistons B D reciprocate; these are attached to the same piston-rod E which passes through the larger piston to its appropriate crank on the main shaft above. F is the piston in the larger cylinder G, and it has two piston-rods, H H, which pass to their cranks on the main shaft, being set thereon in a direction opposite to that of the crank of piston-rod E. L is a valve-chamber, the aggregate length of the cylinders, and steam from the boiler has access thereto at two places, the induction pipes *f f*, and exhaust steam from the valve-chamber is allowed to escape by ports *h h* and exhaust pipe *g*. The valve consists of three disks, *m m' m''*, upon a single stem, which connects in any proper manner with the eccentric on the main shaft, to which the cranks of the piston-rods are attached. The disks *m m''* are smaller than the middle disk *m'*, as shown in the drawing, fig. 1.

The operation of the engine, fig. 1, is as follows: Boiler steam is constantly present at the ends of the valve-chamber, above the upper disk and below the lower one, and is admitted from the valve-chamber above the disk *m*, through the port *a* above the piston B, which has the effect of depressing the latter, the exhaust steam passing from before it through the port *b* to the space between *m m'* of the valve, and is exhausted through the induction port *h* and pipe *g*. At the same time the steam in cylinder C, which had previously caused the upward motion of the piston D, is allowed to flow out of port *c* into the valve-chamber between disks *m' m''*, and through port *d* to the under side of the piston F in the larger cylinder and above the piston D. As the steam from cylinder C is prevented from escaping by way of the induction *h g*, it acts expansively against the lower side of the large piston F, and inasmuch as it is against both sides of the piston D, it exerts no back pressure thereupon, but may be considered balanced, and the piston simply descends in its cylinder under the active operation of the steam above the piston B in cylinder A. Thus it will be seen that the piston B descends by the direct pressure of steam above it, and at the same time the piston F ascends by the expansion of steam below it, the steam between the pistons B F escaping to the exhaust *h g*. This series of motions brings the parts into the position shown in red lines. The valve being raised the return motion is the counterpart of that described. The steam from the boiler is admitted by the lower induction pipe, and through port *e* to the under side of the piston D, raising it, and the steam with which cylinder A has already been filled passes by port *a*

to the valve-chamber between disks m and m' , and thence through port n , above the piston F, in the large cylinder G, acting thereon expansively, the pressure being balanced on the piston B, as it is equal on its respective sides. The steam between the pistons F D escapes through port d to the induction passage $h g$, the piston D rising by the direct force of the steam, and the piston F falling by the expansion action of the volume of steam which had previously depressed the piston B. This completes the round of motions.

The cylinders in the engine, fig. 2, are differently arranged, being in a horizontal series instead of vertical, as in fig. 1. The pistons B D F, in their respective cylinders, A C G, have their independent pistons, and on each side of the large cylinder is a valve-chamber in which a valve, M, reciprocates, under the impulse of an eccentric on the main shaft above. Each valve has two disks, $m m'$, and the steam from the boiler is constantly present at the ends of the valve-chamber and against the outer faces of the respective disks, while the space between the disks is alternately an expansion and an exhaust space. The operation, so far as the direct use of the steam in a smaller cylinder and its subsequent expansion at one end of a larger cylinder, followed by the direct use of the steam in another smaller cylinder, and its subsequent expansion in the other end of the said larger cylinder, is similar to that described in detail in reference to fig. 1. The steam is admitted at each end of the valve-chamber by induction pipes, $f f$, and educted thence through ports h leading to exhaust pipes G.

In the drawings, fig. 2, the boiler steam passes from the valve-chamber L through port a , above the piston B; and at the same time the steam collected in cylinder C expands below the large piston F, passing through the ports $e e$, and crossing the valve-chamber L' in its passage, the pressure of the expanding steam being equalized on each side of the piston D. The reverse motions of the pistons are obtained by the raising of the two valves, and the admission of boiler steam under piston D, and the expansion of the steam in cylinder A, above the piston F, in a manner so similar to that before described at length as not to require further description.

I do not claim broadly arranging the cylinders and steam ports so that the steam, after being used on one side of a given piston, is permitted to flow to the other side of the same piston and to another cylinder to be used expansively, as that is claimed in another application of even date herewith, and marked H H; but having described my invention, what I claim therein as new, and desire to secure by Letters Patent, is—

The arrangement of the two cylinders with single-acting pistons, and the larger cylinder with a double acting piston, upon whose sides the steam from the other cylinders is used expansively, substantially as described.

GEORGE I. WASHBURN.

Witnesses:

S. P. MORSE,

EDWARD MELLEN.