Sheet 1-2 Sheets.

G. I. Washburn,

Reciprocating Steam Engine,

No. 62,713, Patented Mar. 5, 1867.

Fig. 3

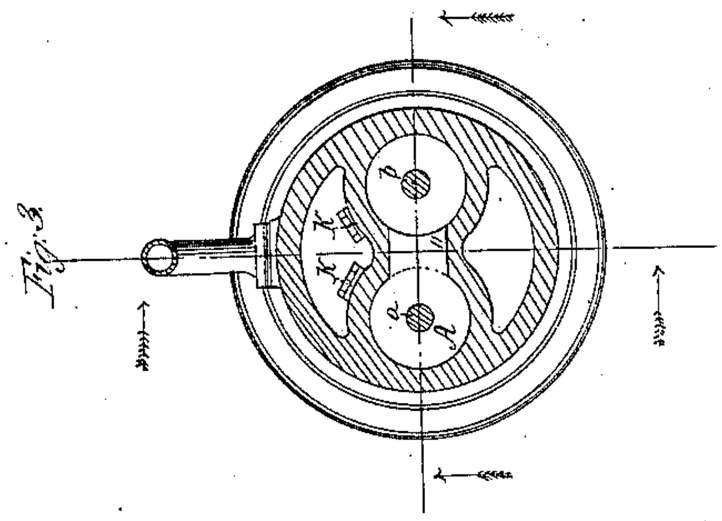

Fig. 2

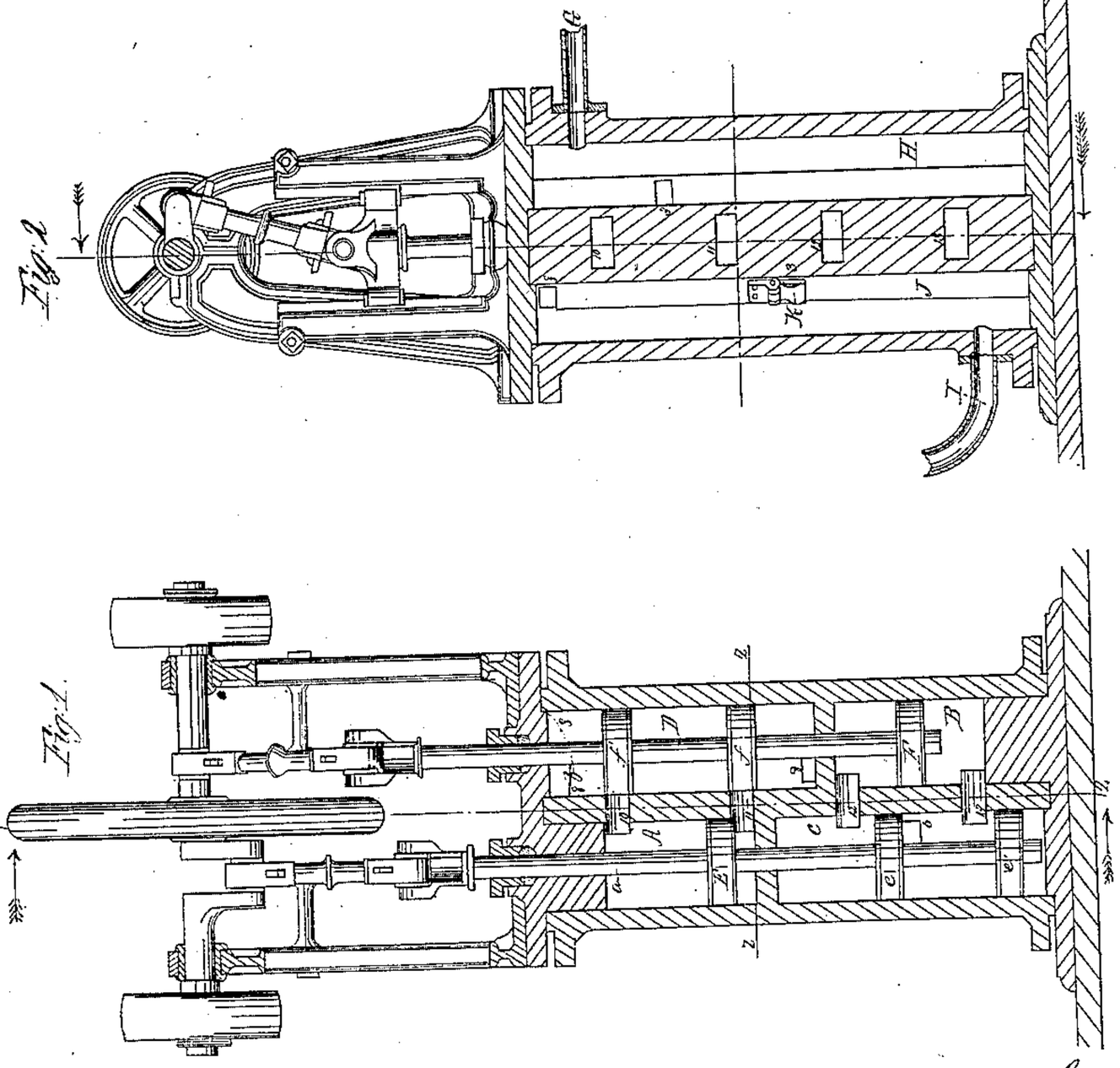

Fig. 1

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Geo. W. Rothwell

Inventor:
George I. Washburn
by Attorneys
Munn & Co.

Sheet 2-2 Sheets.

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Fig. 5.

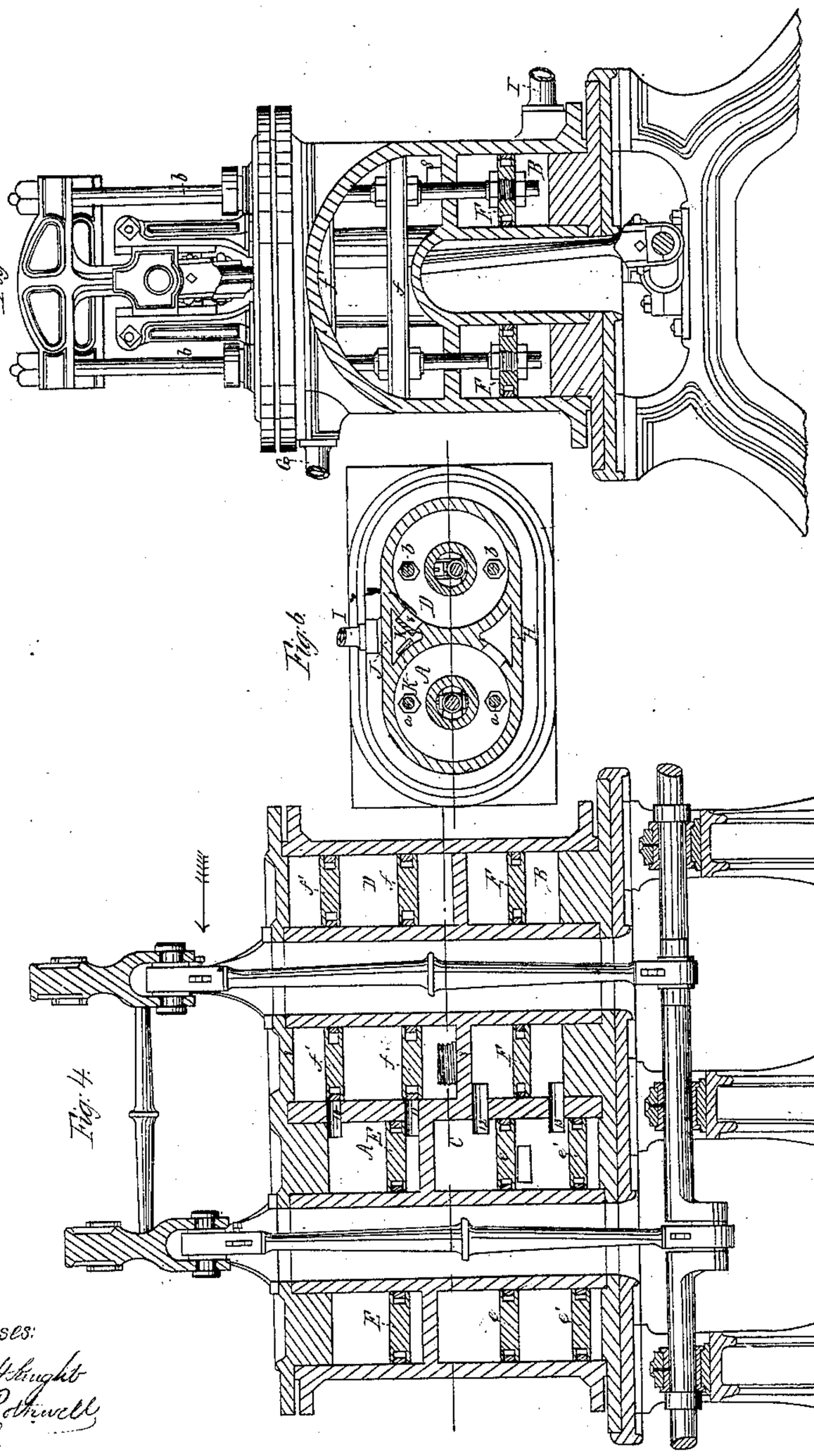

Fig. 6.

Fig. 4.

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United States Patent Office.

GEORGE I. WASHBURN, OF WORCESTER, MASSACHUSETTS.

Letters Patent No. 62,713, *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 the city and 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 section on the line *x x*, fig. 2.

Figure 2 is a vertical section on the line *y y*, fig. 1.

Figure 3 is a horizontal section on the line *z z*, fig. 1.

Figures 4, 5, and 6 show the same application of steam to an engine in which the pistons are annular, have two piston-rods, and the rod connecting the cross-head with the crank passes through the centre of the cylinder.

This engine has two double-acting pistons, each operating by itself in its steam cylinder, and attached to a piston-rod which carries a valve of any suitable construction, operating in its own chamber. Each valve controls the action of the steam upon the double-acting piston in the opposite cylinder, and not that piston to which it is attached. A valve upon the eduction port, or in the exhaust pipe, opening outwardly, closes the aperture against the reflux of exhaust steam. The piston-rods may be attached each to its own crank on a double crank-shaft, as in the drawings, or may both be attached to the same crank, provided that in all cases they are so located in reference to each other that, when one piston is at the end of its stroke, the valve governing the action of steam thereupon may be in the proper position for reversing the said motion. Thus, if the cylinders are placed parallel to each other, as in the drawings, it will be necessary to have a double crank-shaft in order to maintain the above relation between the valve and piston, but if the cylinders are placed in the same plane, and at an angle of ninety degrees with each other, the rods may be attached to the same crank, and a proper valve motion preserved. In the first-mentioned instance a benefit will result from shortening the steam passages, and in the second I use but one crank. An angle of ninety degrees is found between the two cranks or the two cylinders. If the two cylinders be placed at an angle of ninety degrees, and both pistons operate upon a single crank, the pipes which convey the steam from the valves to the pistons may be flexible or jointed, each cylinder hanging upon trunnions, and dispensing with cross-head ways and connecting-rods. The two piston-rods may be attached directly to the crank, the valve action remaining the same as before. The steam may be taken either through flexible or jointed pipe, or through the hollow trunnions; and exhausted likewise. Also the connecting pipes may be enclosed in a chamber and heated by any suitable means, as steam, or the products of combustion as they pass from the boiler to prevent condensation of steam in the connecting passages. In this form the engine will have two oscillating cylinders, but the mutual action of the valves and pistons is designed to be the same as in the drawings, when the cylinders are stationary and parallel, the valve on a given piston-rod controlling the action of the steam on the piston of the other rod.

While I do not confine myself to a disk-valve, it is a necessary feature of my invention that the valve shall be attached to the piston-rod and move with the piston to which it is attached, though its effective action is upon the other piston in the other cylinder. The valve-chamber and piston-chamber, traversed by a common piston-rod, are separated by a cylinder head, which entirely divides them so far as any association of coaction is concerned, the valve action, though, isochronous with the piston motion, having no immediate effect upon it. I do not rely upon any extraneous condenser for obtaining a partial vacuum before the piston, but afford the exhaust steam the means of escaping with the maximum liberty and freedom, and provide a check-valve over the ports in the exhaust-chamber to admit the efflux but prevent the reflux of steam therethrough.

The steam as it rushes out will drive the atmosphere before it until its momentum is overcome, at which time the pressure behind it and against the exhaust side of the piston will be less than the atmospheric pressure outside, thereby obtaining a partial vacuum on the exhaust side of the piston. The steam passing freely out will expend its momentum in driving the air before it through the exhaust port, and, at the instant the momentum is expended, the minimum pressure upon the exhaust side of the piston is attained. This check-valve on the exhaust port, or in the exhaust pipe, is not designed to constitute the space intervening between it and the

cylinder as a condenser in any respect or degree, but to prevent the reflux of the exhaust steam into the cylinder. The automatic check-valve thus placed in the exhaus passage or on the exhaust port is opened by the flow outward of the exhaust steam, and closed by the reflux of the same, or by its gravity, or a spring, as soon as the force of the outgoing steam is insufficient to keep it open. It is not designed to prevent the escape of the steam, and is only operative when the exhaust port is open. Its object is to utilize the partial exhaust produced by the rapid emptying of the exhaust end of the cylinder. That a partial vacuum is thus produced in certain contingencies is recognized by high expert authority, and it is a reasonable deduction from the nature of the case.

In some cases, where an engine has but a short stroke and rapid revolution of the crank, the valve may not be necessary to make the momentary partial vacuum available, as the period during which the air and steam is held at bay preparatory to the reflux may be sufficient to enable the piston to complete its motion when the steam is reversed and the exhaust passage closed by mechanical means preparatory to the admission of live steam to that side of the piston which was lately in contact with the exhaust steam referred to. The rate of motion of the piston being known, and the rapidity with which the exhaust steam will pass from the cylinder being calculable, it is reasonable to suppose that the speed of the steam being so far in excess of that of the piston which is following, a partial vacuum will, at a certain time, be formed before the momentum of the outgoing exhaust steam is perfectly conterpoised by the resistance of the atmosphere. In some cases, as I have said, this period may be sufficient for the purpose in short-stroke engines; but in others. which move more slowly, it is, or may be, useful to place upon the port or in the exhaust pipe a valve to prevent the reflux, and make the partial vacuum thus pr duced more distinctly and certainly utilizable, and to prolong it for a longer period. To make this partial vacuum fully available, the port should be comparatively large, and the pipe of such a shape as to offer the least possible resistance to the passage of the steam, and also of such length that the steam may exert its momentum against the atmosphere before it leaves the pipe.

In the drawings, A is one steam cylinder, and B a second cylinder, their axes being parallel in the drawings, but capable of other arrangement, as I have before stated. At the end of cylinder A is a valve-chamber, C, and at the end of cylinder B is a valve-chamber, D. Traversing longitudinally in cylinder A and valve-chamber C is a piston-rod, *a*, having upon it a piston, E, and valve-disks *e e'*. Similarly the piston-rod *b* traverses in cylinder B and valve-chamber D, carrying the piston F and valve-disks *f f'*. The cylinder and valve-chambers thus arranged in line with each other, are separated by a partition or cylinder-head through a steam-tight opening, in which the piston-rod passes. Each piston-rod is connected by a pitman and crank to the main shaft, on which is a fly-wheel and two belt pulleys, as represented, the main shaft being supported on standards, and the cross-head at each connection of piston-rod and pitman having guides, as usual under such conditions. G is the induction pipe to the induction-chamber H, and I is the eduction pipe from the exhaust-chamber J, K being check-valves to prevent the reflux of exhaust steam back into the cylinder, as has been before referred to. Live steam from the boiler is constantly present in the induction-chamber H, and communicates by ports with the chamber C to the outer faces of the disks *e e'*, respectively, and communicates with chamber D by a single port, 3, between the two disks *f f'*. The exhaust-chamber J receives steam from chamber C through a single port, 6, between the valves *e e'*, and from chamber D, through two ports, 8, above and below the disks *f' f*, respectively. The cylinder A receives and discharges steam through the ports 10 and 11 alternately from chamber D, and the cylinder B receives and discharges steam through ports 12 and 13, alternately, from chamber C, the ports being alternately induction and eduction ports, and the pistons in each case double-acting. Piston-rod *a* being down, and *b* at half stroke descending, steam is admitted above disk *e* from chamber H, and passes through port 12 above piston F, the exhaust steam below piston F passing out through port 13 to valve-chamber C between disks *e e'*, and thence through port 6 to the exhaust-chamber J. Steam admitted below disk *e'* serves to balance its pressure on the valve in the chamber C. While this is being effected in cylinder B, steam is admitted from chamber H through port 3 into valve-chamber D, between the disks *f f'*, and will pass thence through port 11 under piston E, as soon as the port 11 is uncovered by the disk *f*, passing its mid stroke, the point of reversal of the steam on piston E. As soon as this reversal occurs, the port 10 will be open for the exhaust steam from above piston E, to pass out into chamber D above disks *f'*, and thence through port 8 into exhaust-chamber K. The exhaust-chamber K connects by two ports with chamber D, and by one with chamber C, and the steam chamber connects by two ports with chamber *c*, and by one with chamber D. In each case the duplicate ports are respectively above and below the disks in the valve-chamber and the single port between the said disks. The steam admitted between the disks is thereby balanced in its action on them as a valve, and the same is true of the admission of it to the outer faces of the two disks on a given piston-rod. In the cylinders it is admitted to the upper and lower faces alternately, and the reciprocating action thereby obtained.

The description having been given at length of the action in one direction, the order and means for induction and eduction, while executing the return motion, will be readily understood by experts, to whom this specification is addressed. The engine may be reversed by reversing the functions of the steam and exhaust-chambers H J, except when using the check-valves K. The cylinders may be vertical or horizontal, inclined or oscillating the connections their minimum length, as in the drawings, or longer if the cylinders are not so closely associated. Several may be associated around a common shaft with a common crank or cranks, H, disconnected, except as to their common shaft. Each valve, in the arrangement to secure the minimum length of ports, is opposite to the piston, whose motion it regulates, so that (as shown) the piston E is above the valve *e e'*, and the piston F below the valve *f f'*. Figs. 4, 5, and 6 illustrate the same application of steam in an engine whose pistons are annular, having two piston-rods and the connecting-rods, which extend from the cross-heads to the cranks passing through the centres of the cylinders. This admits of a certain compactness of arrangement not readily attained in any other way.

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

1. I claim the arrangement, upon one piston-rod, of the double-acting, operating piston in its own cylinder, and a valve or valves attached to said piston-rod, and operating within a valve-chamber in line with said cylinder, substantially as described.

2. I claim the combination with each other of two such arrangements, (as expressed in the above claim,) the valves attached to a given piston-rod in each case governing the induction and eduction ports of the opposite steam cylinder, in which reciprocates the other piston-rod, substantially as described.

3. I claim a valve, operating in connection with an exhaust port or pipe to permit the egress of steam, and prevent reflux thereof, for the purpose described.

GEO. I. WASHBURN.

Witnesses:

A. D. HOBART,

EDWARD MELLEN.