(No Model.) 4 Sheets—Sheet 1.

E. E. CLARK.

DUPLEX ENGINE.

No. 513,303. Patented Jan. 23, 1894.

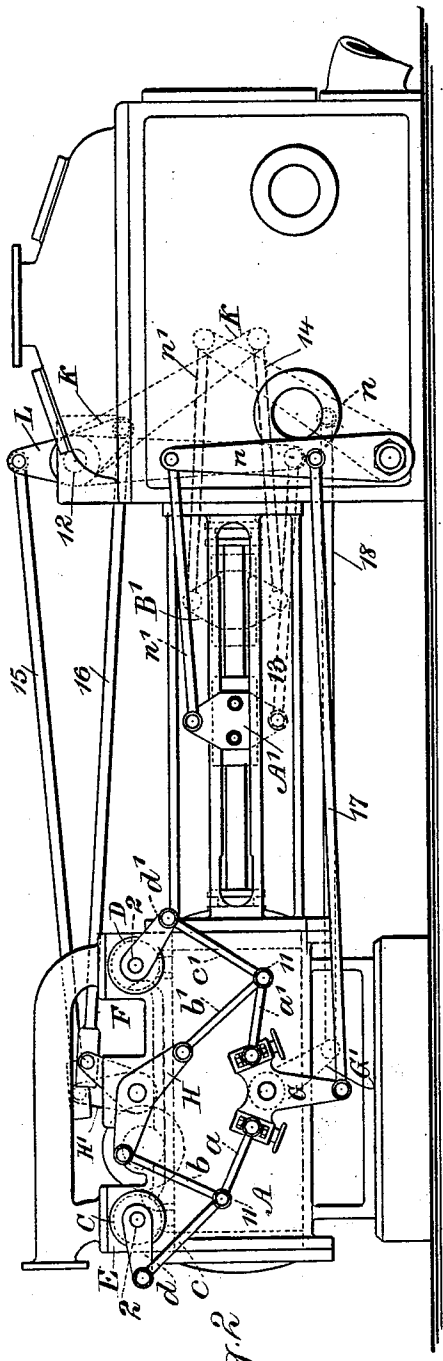

Fig. 2.

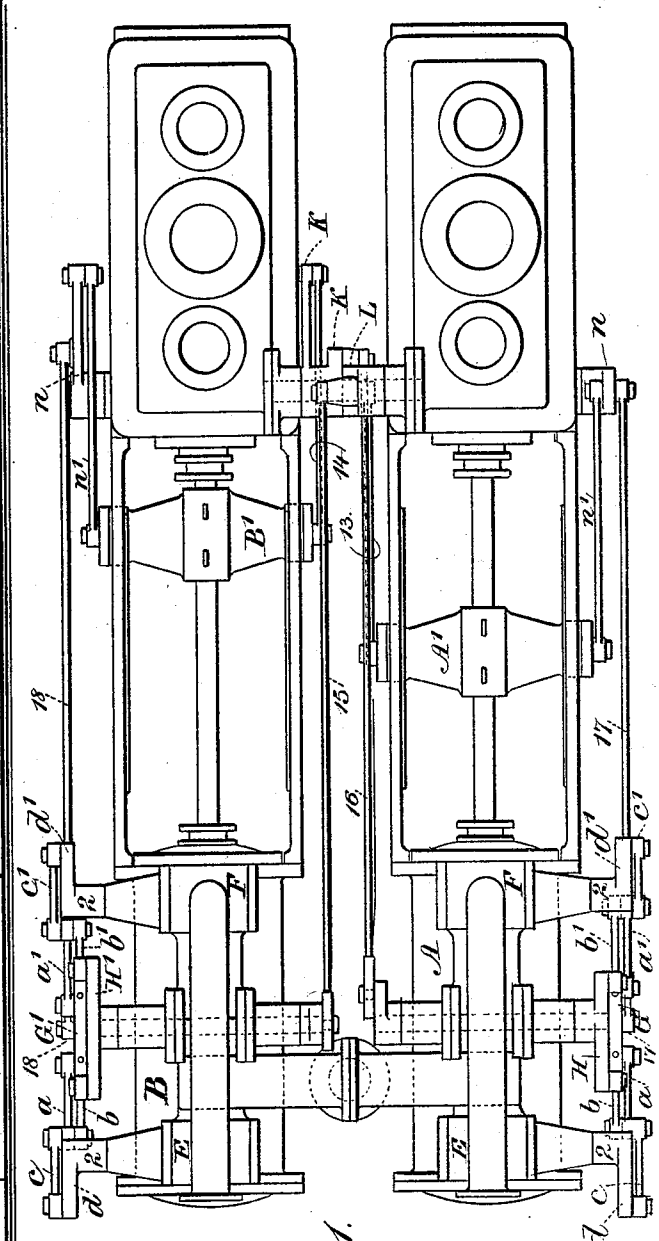

Fig. 1.

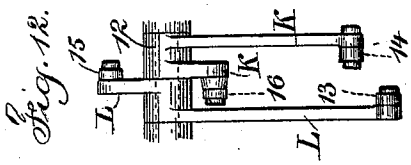

Fig. 12.

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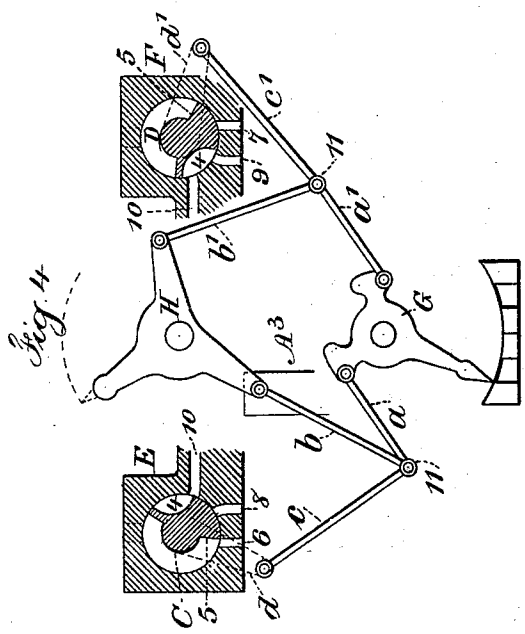

Fig. 4.

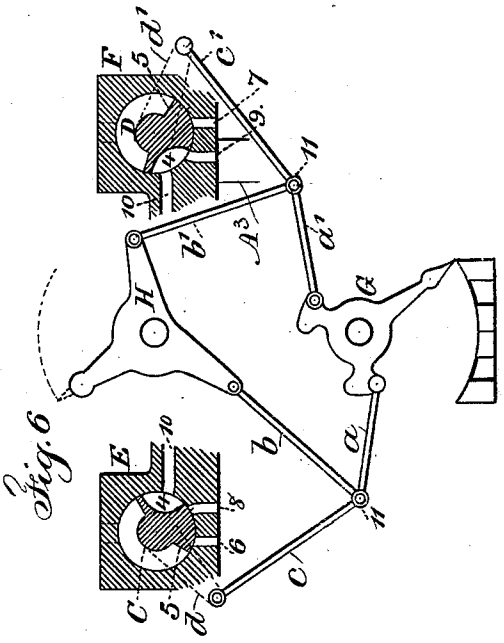

Fig. 6.

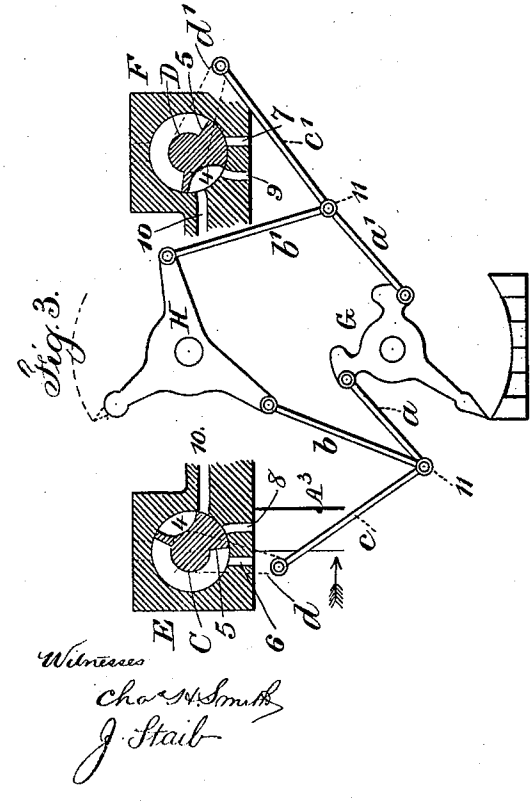

Fig. 3.

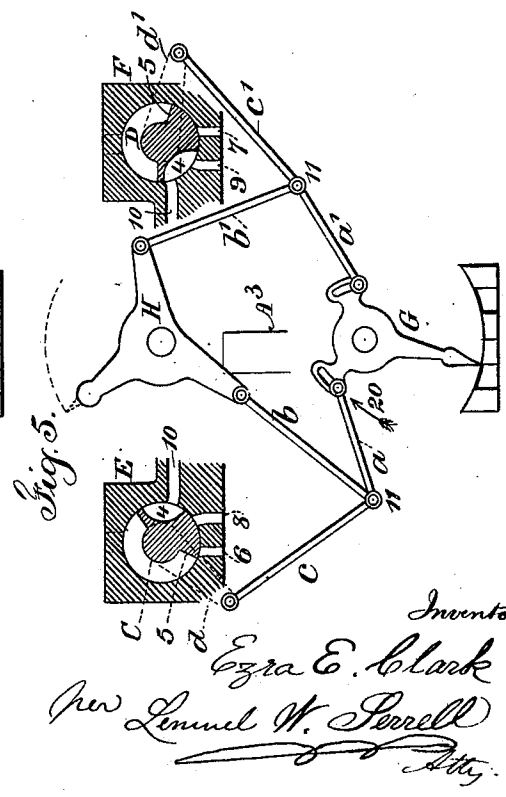

Fig. 5.

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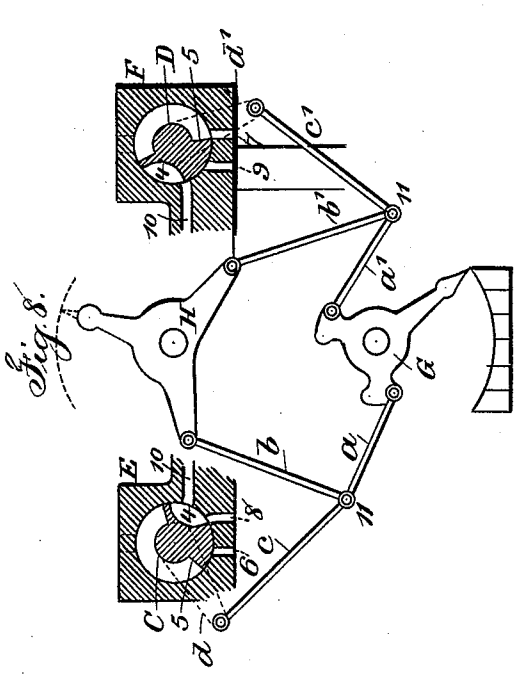

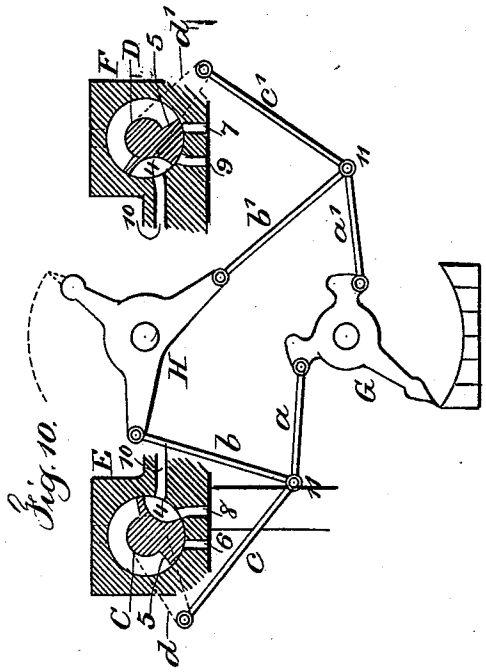

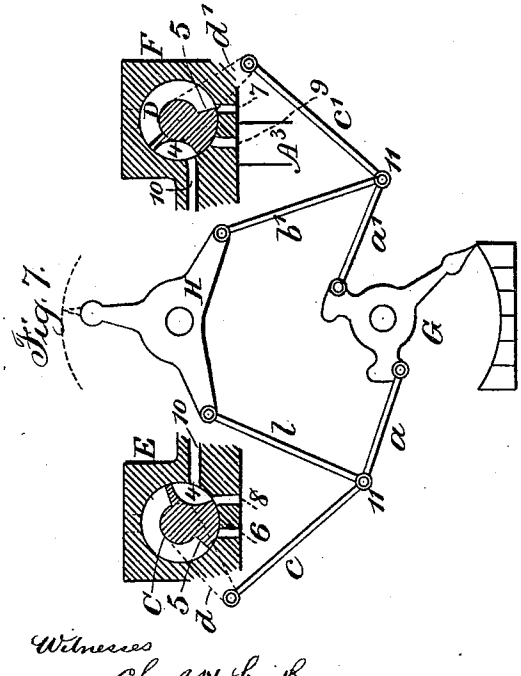

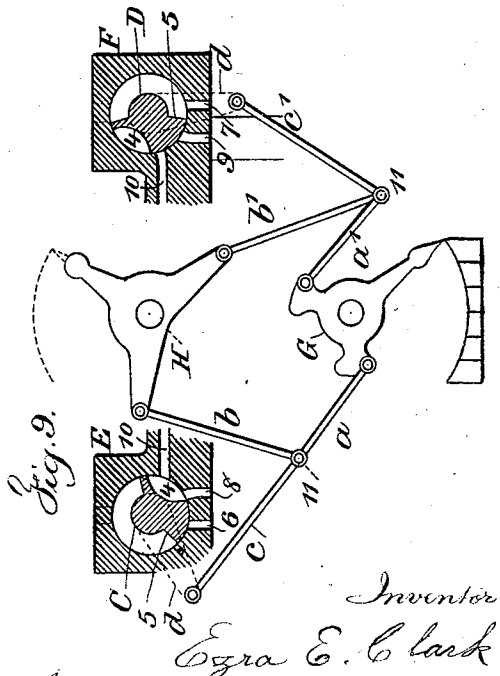

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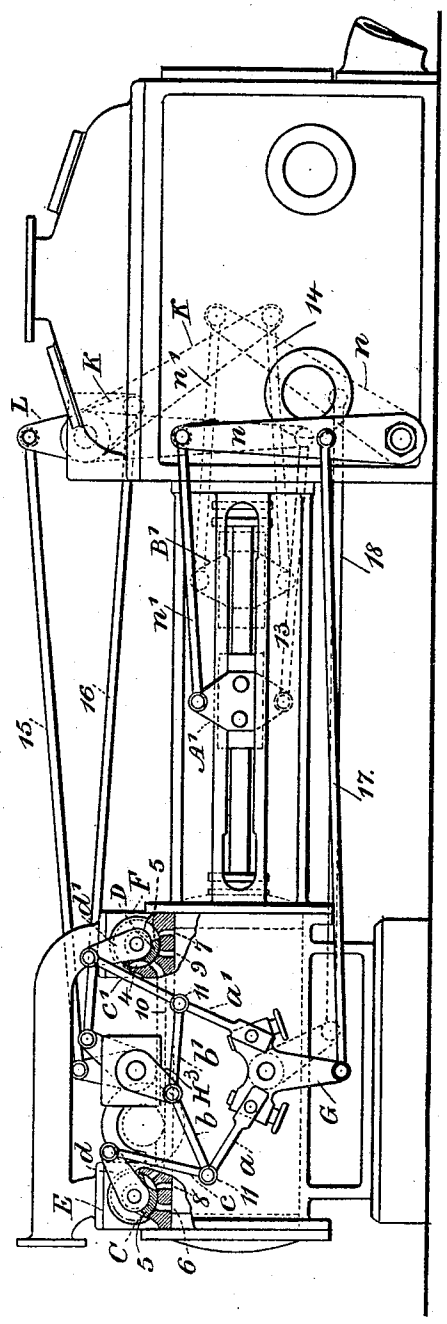
Fig. 11.



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UNITED STATES PATENT OFFICE.

EZRA E. CLARK, OF NORTHAMPTON, MASSACHUSETTS.

DUPLEX ENGINE.

SPECIFICATION forming part of Letters Patent No. 513,303, dated January 23, 1894.

Application filed February 2, 1893. Serial No. 460,801. (No model.)

To all whom it may concern:

Be it known that I, EZRA E. CLARK, a citizen of the United States, residing at Northampton, in the county of Hampshire and State of Massachusetts, have invented an Improvement in Duplex Engines, of which the following is a specification.

This engine is especially adapted for use with direct acting pumps, but it is available for other purposes.

By my improvement each valve performs the functions heretofore effected by two valves, that is to say, each valve acts to admit the steam, to cut off the same, allow the exhaust, and to retain vapor that by compression acts as a cushion to the direct acting piston.

In the present invention the valves receive their motions from connections at the cross heads, and a primary movement is given to the valve by the cross head of the cylinder in which the steam is acting, and this primary movement operates the valve to effect a cut-off, and a secondary movement is given by a connection to the cross head of the adjacent cylinder. Hence with this improvement when the steam is admitted, the piston of cylinder A commences to move, and by a direct connection its valves are so moved as to cut off the live steam and allow the exhaust to remain open. As the piston of cylinder A completes its movement it acts on the valves of cylinder B, the piston of which has been quiescent at the end of the stroke, and the piston of cylinder B commences its movement and by direct connection cuts off the steam at the proper place, and the piston in continuing its movement, with the steam acting expansively, gives motion to the valve of cylinder A, the piston of which has been standing still, to admit steam to move the piston of cylinder A in the opposite direction, and these movements are continued, the cut-off being effected by a direct connection, and the admission of steam being effected by the movement of the piston of the opposite cylinder.

In the drawings, Figure 1 is a plan view illustrating the positions of two cylinders. Fig. 2 is a side elevation representing the relative positions of the two sets of connections. Figs. 3 to 10 illustrate the relative positions of the valves and the valve moving devices. Fig. 11 is an elevation with part of the valve chests in section showing the devices adapted to cut off at a different point to those in the other figures, and Fig. 12 is a detached edge view of the levers for the cross connections.

A represents one cylinder and B the other; A′ and B′ the respective cross heads, and C and D show the valves. The valves are near the ends of the respective cylinders and they are cylindrical segments within cylindrical valve chests E F to which steam is admitted, and each valve is upon a spindle or stem 2 and an oscillating motion is given to the spindles or stems by crank arms *d d′*, so that the valves are moved by the oscillating motion of the spindle or stem and slide around upon the interior surfaces of the cylindrical valve chests, and each valve is made with an exhaust port 4 and a cut-off edge 5, and there are ports 6 and 7 leading into the cylinder, and exhaust ports 8 and 9 leading to the exhaust port of the valve, and the passage 10 leads to the exhaust pipe of any usual character.

To each engine there is a primary rocker and a secondary rocker, the primary rocker for the cylinder A being marked G and the secondary rocker H, and for the cylinder B, G′ and H′ respectively, and from the primary rocker G to the crank arms *d d′* there are links *a c* and *a′ c′*, and to the joints 11 between the respective pairs of links there are secondary links *b b′* from the arms of the secondary rocker H.

It is to be understood that the primary rocker G receives its motion from the cross head A′ of the cylinder A, and the secondary rocker H receives its motion from the cross head B′ of the cylinder B, and that the primary rocker G′ of the cylinder B receives its motion from the cross head B′, and that the secondary rocker H′ of the cylinder B receives its motion from the cross head A′ of the cylinder A. These motions can be given in any suitable manner, but I have represented an axis 12 for the two levers K and L, and the lever L is connected by the link 13 to the cross head A′ and the lever K is connected by the link 14 to the cross head B′, and there is a link 15 from the lever L to the crank arm of the rocker H′, and a link 16 from the lever K

to the crank arm of the rocker H, and there is a connection from the cross head A′ to the rocker G through link n', lever n and link 17 and a connection from the cross head B′ to the rocker G′, through link n', lever n and link 18, and in consequence of the connections for the links 15 and 16 being on the respective levers, one below and the other above the axis 12, the movements to the respective rockers are given in the correct direction.

As the movements of the respective valves are the same, I have only represented in Figs. 3 to 10 the movements of the valves to the cylinder A:

Let it now be presumed that the parts are in the position indicated in Fig. 3. The steam enters from the valve chest by the port 6 and moves the piston A^3 and cross head A′ in the direction of the arrow, and as the piston and cross head A′ move, the rocker G is moved by the connections 17 and when the rocker G reaches the position indicated in Fig. 4, the edge 5 of the valve commences to act as a cut-off, and by the time the rocker G has reached the position shown in Fig. 5, the steam is cut off, and it so continues when the piston A^3 has reached its extreme movement and stops, as illustrated in Fig. 6, in which the ports 6 and 8 remain closed, but the exhaust has remained open during all this movement through the ports 9 and 4 to the passage 10. When this point of movement has been reached, the piston A^3 remains quiescent, and the piston in the cylinder B has commenced its stroke in consequence of the movement of the cross head A′ having acted through 13, L and 15 upon the rocker H′ of the cylinder B in the manner as is next described with reference to the cylinder A; that is to say, as the piston of the cylinder B moves in consequence of the steam having been admitted to it, it moves its own primary rocker G′ by the connection 18 in the manner which has before been described with reference to the rocker G and its connection 17, and at the same time the piston and cross head B′ moves the secondary rocker H of the cylinder A by the link 14, lever K and link 16, so that when the link 16 has moved the rocker H into the position shown in Fig. 7, the exhaust commences for the cylinder A through the port 8, and then the exhaust is opened fully as the parts reach the position shown in Fig. 8, and steam is also admitted by the port 7 to act upon the piston A^3 to move the same in the opposite direction, and Fig. 9 illustrates the fact that as the piston of the cylinder B′ reaches the end of its stroke and moves the rocker H to its extreme position Fig. 9 the port 7 is open fully for the admission of the steam and the port 8 for the exhaust, but as soon as the steam is admitted to the cylinder A, the rocker G commences to move by the links n and 17 and the cut-off takes place at the same point at which the cut-off had been effected when the piston A^3 was moving in the other direction, and the parts assume the position represented in Fig. 10, in which the exhaust 8 remains open and the steam is cut off at 7 and acts expansively to the end of the stroke of the piston A^3, but before the termination of the stroke of the piston A^3 its cross head A′ has acted by the link 13, lever L and link 15 to move the rocker H′ of the cylinder B and admit steam to the cylinder B in the same manner as is indicated by the diagrams 7, 8 and 9, as before explained with reference to the cylinder A. Hence it is impossible for one piston to get out of time with the other piston, because as the piston completes its stroke it remains stationary until its valve is moved by the movement of the piston in the other cylinder.

A scale is shown in Figs. 3 to 10 and the rocker G is represented as having a point so that the positions of the parts can be understood, the scale representing the stroke as divided up into six parts.

It will be noticed that in Figs. 1 and 2 the connections between the links a a' and the rocker G or G′ are adjustable, so that by varying the positions of the connections the cut-off can be effected at an earlier or later point. This will be more readily appreciated by reference to Fig. 5, where it will be seen that the port 6 has been entirely closed. If now the connection between the link a and the rocker G was moved along farther in the direction of the arrow 20, the valve would be thereby moved to uncover the port 6 to a greater or less extent. Hence an adjustment of the connections between the links a and a' with the rocker G in the direction indicated, will delay the time of closing the port 6, and thereby lessen the expansion of the steam in the cylinder. This adjustment can be effected in any suitable manner. I have represented in Fig. 2, slots for the joint pin connections, and screws for moving such joint pins along in the slots of the rocker G.

In the diagram Fig. 11 the same parts as before described are represented, but they are proportioned and positioned in such a manner that the cut-off occurs at a different point. In this figure 11 the valve chests are shown as broken open to exhibit the valves and ports in section, and the links b b' are brought to one pivotal connection on the rocker H^3 instead of being connected by the two pivots to the rocker H, Fig. 2. In this Fig. 11 the operations take place in the order and in the manner before set forth, but the time at which the cut-off takes place is about three quarters, while in Figs. 3 to 10 it takes place at about one third of the stroke.

The vapors cushion the piston after the same passes the port 8 or 9, the port 6 or 7 being closed.

It will be apparent that the valves, rockers and connections herein described are adapted to operate with a single engine as well as with a duplex engine, so long as the rockers receive

substantially the movements herein specified from any source; such for instance as from cams and connecting rods on a main shaft where a fly wheel is employed.

I claim as my invention—

1. The combination with two direct acting cylinders, of separate valves at the respective ends of each cylinder, primary and secondary rockers to each cylinder and links connecting each valve to two rockers, substantially as specified, and a connection from the primary rocker of each cylinder to the cross head of that cylinder, and a connection from the secondary rocker of one cylinder to the cross head of the other cylinder, substantially as set forth, whereby the cut-off is operated by a connection to the cross head of the piston that is being moved and the admission and exhaust of steam is regulated by the secondary rocker and a connection to the cross head of the other cylinder, as specified.

2. The combination with the cylinder, piston, piston rod and cross head, of two rocking valves and their cylindrical valve chests, each valve having a cut-off surface and an exhaust port, there being inlet and exhaust ports in the cylinder, two rockers and connections to the respective valves, and means for moving the two rockers, substantially as specified, for giving motion to the respective valves for admitting, cutting off and exhausting the steam, substantially as set forth.

Signed by me this 20th day of January, 1893.

EZRA E. CLARK.

Witnesses:
GEORGE W. BURT,
THOMAS CARY.