(No Model.) 3 Sheets—Sheet 1.

E. W. HARDEN.

STEAM ENGINE.

No. 490,349. Patented Jan. 24, 1893.

Fig. 1.

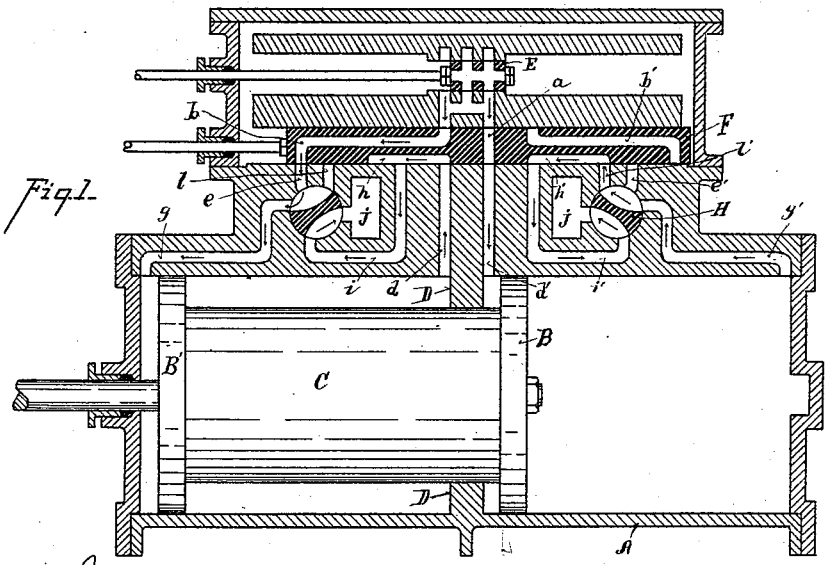


Fig. 2.

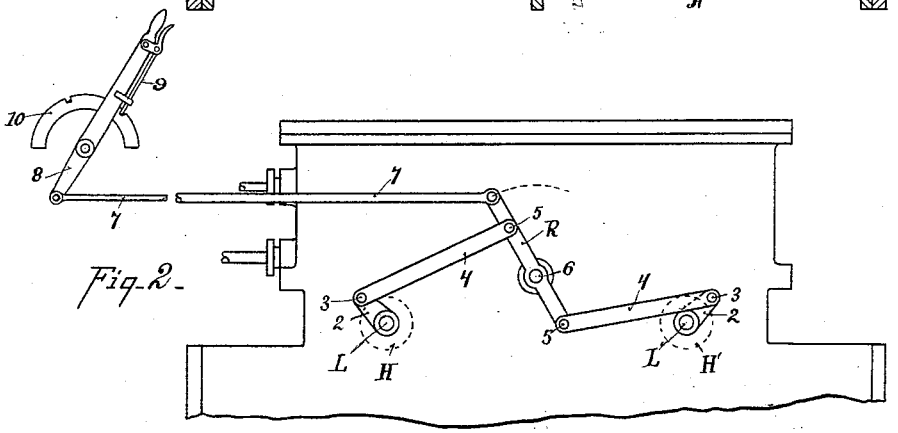
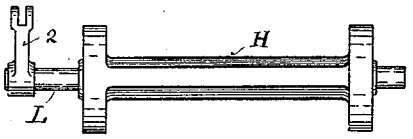


Fig. 3.



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(No Model.) 3 Sheets—Sheet 2.

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Fig. 4.

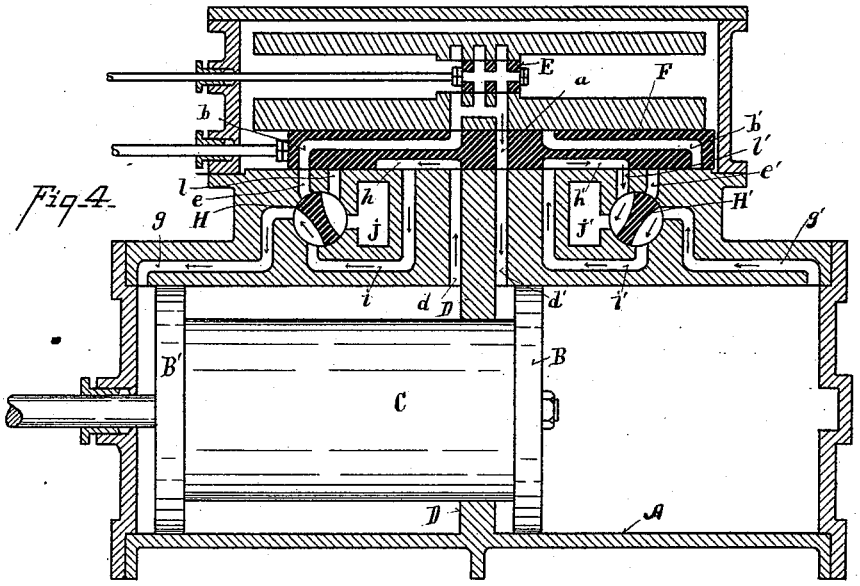
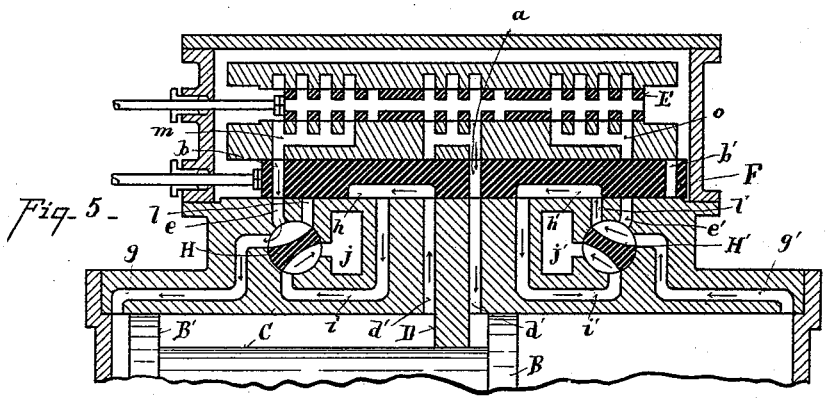


Fig. 5.



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(No Model.)

3 Sheets—Sheet 3.

E. W. HARDEN.

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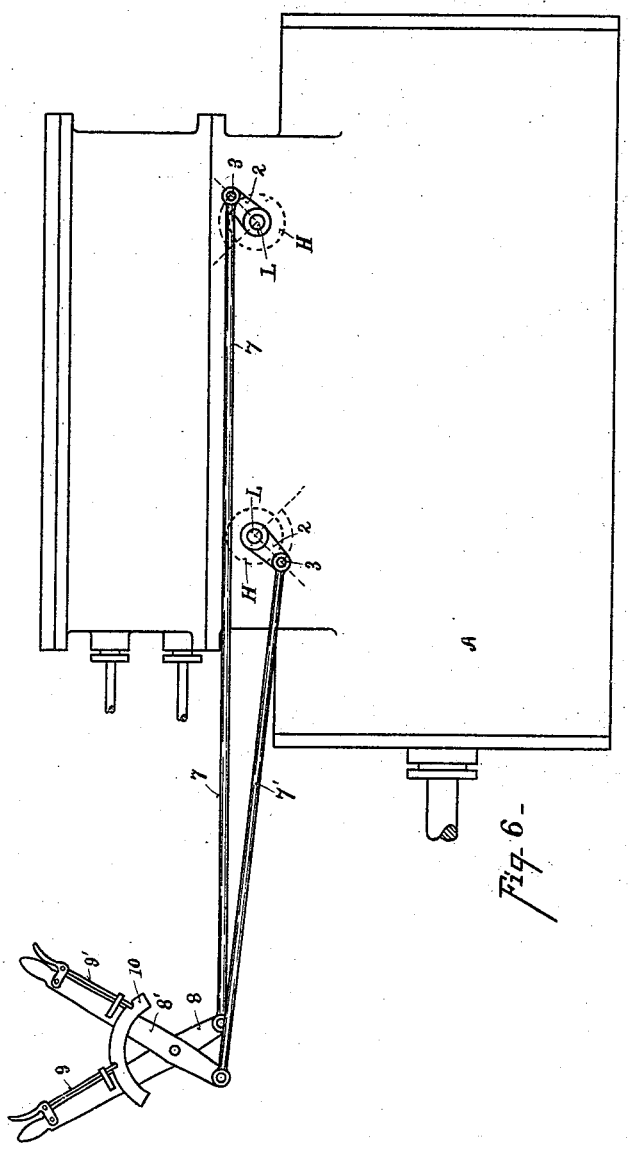

Fig. 6.

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UNITED STATES PATENT OFFICE.

EDWARD W. HARDEN, OF CINCINNATI, OHIO, ASSIGNOR TO FREDERIC C. WEIR, OF SAME PLACE.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 490,349, dated January 24, 1893.

Application filed July 14, 1892. Serial No. 440,026. (No model.)

To all whom it may concern:

Be it known that I, EDWARD W. HARDEN, a citizen of the United States, residing at Cincinnati, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Steam-Engines, of which the following is a specification.

My invention relates to means for converting a compound into a direct acting engine. I have shown it applied to a quadruplex form of engine shown in my application Serial No. 421,034, filed February 10, 1892, but it is obvious that it can be applied to a single piston compound engine.

The various features of my invention are fully set forth in the description of the accompanying drawings making a part of this specification, in which—

Figure 1 is a central, longitudinal, vertical section of my improvement showing the parts in position for working as a simple engine. Fig. 2 is a side elevation of the same. Fig. 3 is a perspective view of an improved two-way valve. Fig. 4 is a similar view of the construction exhibited by Fig. 1, and Fig. 6, is a side elevation showing a modification of the construction exhibited by Fig. 2 showing the parts in position for a compound engine. Fig. 5 is a modification of Fig. 1.

A represents the cylinder. B one of the larger area pistons. B′ the other large area piston.

C represents a cylinder connecting the two pistons B B′ together to form the smaller area pistons.

D represents the central partition in the cylinder A.

E represents the cut-off valve which is of the same construction as shown in my said former application.

F represents the main valve, which is constructed to make a full throw at all times, and when used with the quadruplex engine it is provided with three ports *a*, *b*, *b′*; port *a* through the valve communicates with the steam passages *d* and *d′* alternately for supplying steam to the smaller area pistons.

e represents a steam passage for supplying live steam to the larger area piston when used as a simple engine. *e′* represents a similar passage for the opposite piston.

H represents a two-way valve tapping the steam passages between the valve seat and cylinder. It is rotated on its axis and is employed to convert the engine from compound to a direct acting, and vice versa, and operates in the following manner: When set in position shown in Fig. 1 it admits the live steam through port *a* and passage *d′* onto the smaller area piston and from port *b* and passage *e* into the passage *g*, and thence to the larger area piston; the two-way valve also cuts off the passage *i* for exhausting the smaller area piston through the same passage *g* on to the large area as when compound. *h′* and *g′* represent similar ports for the opposite end of the piston.

Steam is being exhausted from the smaller area piston through the passage *d*, port *h*, passage *i*, and two-way valve H, into the exhaust chamber *j*, and from the larger area through the passage *g′* passage *l′*, port *h′* and passage *i′* into the exhaust chamber *j′*. When the valve F is reversed in position of course live steam is received through ports *b′ e′* and *g′* on the larger area and *a*, *d*, on the smaller area and exhaust through steam passages *g*, *l*, *h*, *i*, and *d′ h′ i′*. When the engine is to be used as a compound engine the two valves H H′ are turned on their axis in position shown in Fig. 4. Live steam will then be admitted alternately on to the smaller area pistons through the passages *d*, *d′*, and compounded by the passage of the steam from the smaller area on to the larger by exhausting say, from the left hand piston through the passage *d*, port *h*, steam passage *i*, the two-way valve H, directing it through the passage *g* on to the larger area piston; and the opposite end of the piston B is receiving live steam through the steam passage *d′* on to the smaller area, and exhausting from the larger area through passage *g′*, the two-way valve H′ directing steam through the passage *i′* port *h′*, steam passage *l* into the exhaust *j′*. When the valve F is reversed the operation takes place at the opposite end in the same manner.

In order that the engineer may easily and readily convert the engine from a compound to a simple, or vice versa, I provide the following instrumentalities: LL′ represent shafts for the two-way valve H H′; 2 represents

cranks, 3 crank-pins; 4 links hinged to the crank-pins 3 and to the oscillating lever R by the stud pins 5; said lever oscillates on the center 6. 7 represents a connecting rod hinging said lever to the setting lever 8, which lever is provided with the latch 9 so as to fasten it to the segment 10. When the lever is in position shown in Fig. 3 the parts are in position for a simple acting engine; when the lever is reversed it is turned into a compound engine. By this means the engine is quickly converted from a compound to a simple without interfering with the operation of the valves, and this may be readily and easily done whether the engine is idle or working.

In the modification shown in Fig. 5 I provide the auxiliary or cut-off valve with two live steam ports *m*, *o*, in addition to the two live steam ports shown in Figs. 1 and 4, and the ports *b*, *b'* in the main valve F pass directly through the valve and connect with the ports *m* and *o* instead of with the central port as shown in Figs. 1 and 4.

The cut-off valve is provided with three sets of grid-iron openings for supplying each port respectively.

In Fig. 2 I have shown the two-way valves H H' linked together for being moved simultaneously so as to convert both ends of the piston simultaneously from the compound to the direct, or vice versa. But it is obvious that only one of these two-way valves might be turned, and one used as a direct and the other end as a compound engine as illustrated in Fig. 6, as each piston B B' receives and discharges the steam independent of the other, or, one-half of the engine might be used alone.

As shown in Fig. 6, the valves H are operated independently by means of the setting levers 8, 8' through the medium of connecting rods 7, 7' secured directly to the crank pins 3.

Having described my invention what I claim is—

1. In a compound engine, in combination with the supply valve a two-way valve, located between the valve seat and the cylinder and interposed between ports one of which is cut in or cut out by the rotation of the valve, whereby the action of the engine is changed from a compound to a simple and vice versa, substantially as described.

2. In a compound engine, the combination of the main valve with two or more live steam ports, with the steam cylinder provided with connecting ports and a two-way valve located between the valve seat and cylinder and interposed between the supply and exhaust ports, whereby the oscillation of said valve will direct the live steam on to one or both of said piston faces, substantially as specified.

3. In combination with the differential piston B, C, a supply valve F provided with steam ports *a*, *b*, with the valve seat provided with the ports *g*, *i*, and the valve H interposed between said ports, and the exhaust *j*, whereby the port *g* may be employed as a steam supply or a compounding port as desired, substantially as described.

4. In combination with a differential piston B, C, a supply valve F provided with steam ports *a*, *b*, with the valve seat provided with the ports *g*, *i*, and the valve H interposed between said ports and the exhaust *j*, whereby port *i* may be employed as an exhaust port or brought into connection with the port *g* for compounding, substantially as specified.

5. In combination with the differential piston B, C, the steam valve F having two supply passages *a*, *b*, communicating with two sets of ports in the valve seat, and the two-way valve H interposed between the ports *g* and *i* and *e*, *i* and *l*, whereby by the turning of said valve H the engine is converted from a compound to a simple acting, or vice versa, substantially as described.

6. In combination with the differential pistons B B' and C, the supply valve F provided with the supply ports *a*, *b*, *b'* the valve seat having two sets of supply and exhaust ports, one of which is brought into operation or cut out by the turning of the valve H, whereby one of said valves may be turned to use on end of the engine as a simple and the other as a compound, substantially as described.

7. In a steam engine, in combination with the differential pistons B B' C, the valve F provided with the supply ports *a*, *b*, *b'*, and the ports *h*, *h'* communicating with two sets of ports in the valve seat, and the two-way valves H H' interposed between the supply and exhaust ports, and mechanism connecting the said valves H together, and to the setting lever, whereby they may be simultaneously turned to convert the engine from a simple to a compound, or vice versa, substantially as specified.

In testimony whereof I have hereunto set my hand.

EDWARD W. HARDEN.

Witnesses:
T. SIMMONS,
C. W. MILES.