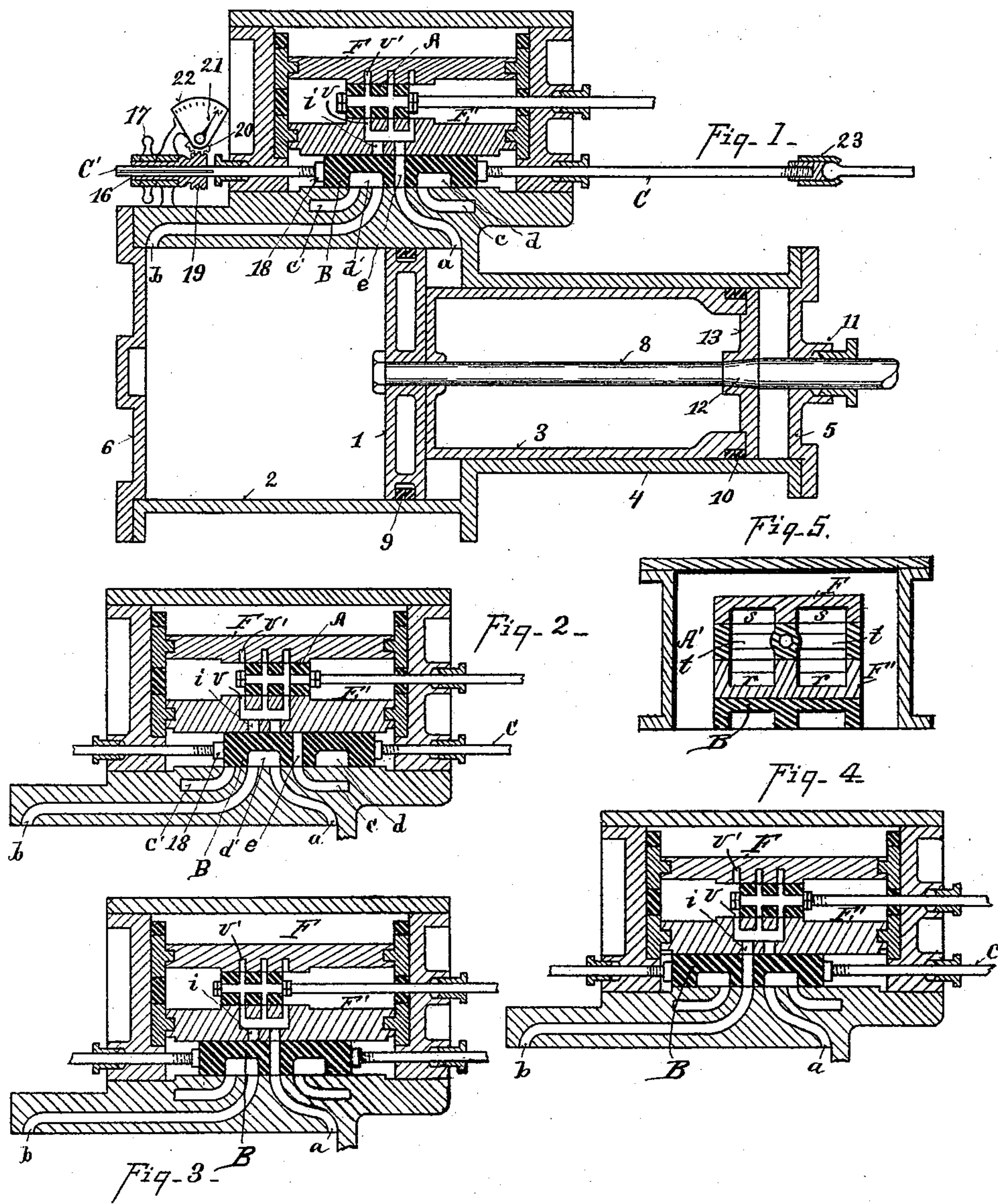


(No Model.)

E. W. HARDEN.
DIRECT ACTING AND COMPOUND ENGINE.

No. 490,348.

Patented Jan. 24, 1893.



Attest—
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UNITED STATES PATENT OFFICE.

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

DIRECT-ACTING AND COMPOUND ENGINE.

SPECIFICATION forming part of Letters Patent No. 490,348, dated January 24, 1893.

Application filed February 10, 1892. Serial No. 421,035. (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 Direct-Acting and Compound Engines, of which the following is a specification.

My invention relates to a compound engine. The object of my invention is, first, to employ a differential piston inclosed in a differential cylinder with the valves so arranged that the steam can be used either as a double acting direct engine, or as a single acting compound engine, by simply changing the position of the valve so as to bring the different ports into a new operation.

My invention relates further to details of construction which will be fully set forth in the description of the accompanying drawings making a part of this specification, in which—

Figure 1 is a central sectional elevation of the piston, cylinder, and steam valve. Fig. 2 is a similar view of the steam chest and ports showing the position of the valves when compounding the steam. Fig. 3 is a similar view showing the position of the valves for directing the steam on to the smaller piston while it is exhausting from the piston side. Fig. 4 shows the opposite position of the valve for directing steam on to the larger piston and exhausting from the opposite side. Fig. 5, represents an end section of the steam chamber and auxiliary valve.

In the accompanying drawings, 1 represents the steam piston, 2 the cylinder in which the said piston travels. 3 represents a cylindrical extension of said piston 1, and 4 the cylinder in which said cylinder 3 reciprocates.

5 represents a head closing the end of the smaller cylinder.

6 represents the opposite head for closing the front end of the cylinder. The said piston 1 and the cylinder 3 are preferably made of two pieces and mounted upon piston rod 8.

9 represents the packing rings on the main piston.

10 represents the packing rings on the cylindrical extension of said piston.

11 represents a stuffing box for the piston rod 8; this rod is shown tapered at 12 and engaging with the hub of the inside end 13 of the extension cylinder 3.

B represents the main valve which in the construction here shown makes its full throw, the amount of steam being controlled by the auxiliary valve A hereinafter described. But it is obvious that this main valve may be used to operate automatically and cut off without the use of the auxiliary valve.

a represents the steam port leading to the smaller piston area.

b represents a steam port leading to the larger piston area.

c, c' represent ports leading to the ordinary exhaust chamber on one side of the steam chest.

e represents the live steam port of the main valve; this valve is provided with ports d, d', on each side of the live steam port e. Port d is for exhausting steam into port c and is only used when the engine is working as a double acting simple engine. It is shown in proper position for exhausting in Fig. 4. The port d' is used for exhausting the steam compounded; it is also used for connecting port a with port b for directing steam from the smaller piston on to the larger area for being compounded. It is also used for exhausting steam from the larger piston when it works only as double acting simple engine. It is shown in Fig. 1 in position for exhausting the steam which has been compounded on the larger piston. In Fig. 2 it is shown in position for receiving the steam from the port a, and directing it through port b for compounding.

When the valve B is in position shown in Fig. 1 it is directing live steam on to the smaller piston in one stroke, and the opposite operation is shown in Fig. 2, the steam being conveyed to the opposite end or larger area for compounding. Now, if it is desired to change the engine from a compound to a simple acting engine this valve B is moved

longitudinally forward on its stem so that in its forward position the live steam port *e* will be under the port *i* in the valve seat *F'*, as shown in Fig. 4. This is the forward position of the valve *b* when it is acting as a simple engine. And Fig. 3 shows the rear position of the valve. Fig. 1 shows the forward position of the valve when it is acting as a compound engine, and Fig. 2 shows the rear position of the valve when it is working compound. So that this engine is converted from a compound into a direct acting engine by simply adjusting the valve B forward on its seat. To accomplish this result I preferably mount the valve on the stem C, which projects forward through the steam chest. In order that the position of this valve may be readily seen at a glance, and also readily adjusted, I provide the following instrumentalities: The forward end of the valve rod C' reciprocates in the sleeve journal 16 to which it is splined. 17 represents a hand wheel rigidly secured to this journal 16; when said hand wheel is turned it revolves the journal 16 and the valve rod C' being feathered thereto turns with it, and the inner part is screw threaded and taps through the nut 18 secured to the valve; thereby drawing the valve forward on the valve rod C C', and this movement may be made while the valve is in motion. And when the auxiliary valve is employed this is more readily accomplished as the valve is making its full throw all the time. 19 represents a worm on the hub of said journal 16 which meshes with the segment gear 20 on the shaft of which is an indicator 21 moving over the quadrant disk 22; thus the indicator finger will show the position of the valve to the engineer. As this main valve is moved preferably by an eccentric rod 40 jointed to the valve stem C C'. I prefer to employ a ball joint 23 for connecting the valve rod to the eccentric rod.

As shown in Fig. 5, the letter A' represents the steam chamber, and A, the auxiliary valve arranged therein. *t, t*, represent the openings into the shell of the valve. *s, s*, represent recess ports in the upper seat *F*, for balancing the valve; *F'*, represents the lower seat, *r, r*, represent the lower ports with which the parts *i* and *e* communicate. *v, v*, represent the upper and lower ports through the shell of the valve A.

The advantages of the construction shown herein are numerous. The differential piston is inclosed at all times and in this respect an improvement over the ordinary trunk cylinders and pistons. The engine can be readily converted from a direct acting to a compound and vice-versa by simply shifting the position of the main valve B. And I believe I am the first to accomplish this result with one and the same valve.

Having described my invention, what I claim is—

1. In combination with a differential cylinder having the ports *a, b, c'*, and a piston, of the main valve B provided with the live steam port *e*, and the port *d'*, for co-operating with the ports *a, b, c'* in the steam chest, whereby direct steam is admitted to the lesser piston area, and compounded upon the larger piston area, and then exhausted, substantially as specified.

2. In combination with the differential cylinder of an engine, provided with the ports *a, b*, and the exhaust ports *c, c'* on each side of the said ports *a, b*, the main valve B provided with live steam port *e*, and the ports *d, d'* on either side thereof, substantially as specified.

3. In combination with the differential cylinder of an engine, provided with the ports *a, b*, and the ports *c, c'*, the main valve B provided with live steam port *e*, and the ports *d, d'*, on either side thereof, and mechanism for adjusting said valve longitudinally on its seat, whereby the engine may be converted from a compound to a simple engine, and vice-versa, substantially as specified.

4. In combination with the differential cylinder of an engine, the valve B provided with the ports *e, d* and *d'*, the upper valve seat provided with two live steam ports with which the ports *e*, of the valve are pleasantly connected by the valve adjusting mechanism, substantially as specified.

5. In combination with the differential piston of a steam engine, the valve B provided with the live steam port *e*, and the ports *d, d'*, formed in the under face of the valve, and with two cut-offs formed between said ports, whereby live steam is admitted on to the smaller piston and compounded on the larger piston, substantially as specified.

6. In a steam engine, the combination with a cylinder having ports, of steam port *e*, and the ports *d, d'*, in front and rear of the cut-offs for port *a*, and mounted upon the valve stem C projecting through the steam chest, and mechanism for revolving said piston rod to adjust the valve on its seat, and an indicator connected to said adjusting device, whereby the position of the valve is at all times indicated, substantially as specified.

7. In combination with the differential cylinder having ports, of the main valve B, provided with the ports *e, d, d'*, and mechanism for adjusting said valves to either of the live steam ports on the upper valve seat, and the auxiliary cut-off valve A for supplying the main valve with its requisite amount of steam, substantially as specified.

8. In combination with a steam engine having the steam ports *a, b*, and the exhaust ports *c, c'*, of the valve B having a single live steam port *e*, and two connecting and exhaust ports *d, d'*, and an upper valve seat having two ports whereby steam is admitted alternately to the ports *a* and *b*, or interchange-

ably to the port *a* alone, substantially as specified.

5 9. In a steam engine the combination of a cylinder provided with ports, a main valve having ports to communicate with the ports in the cylinder, a valve A of hollow shell grid-iron form, said valve reciprocating so as to open ports on its seat at each end of its stroke, and means for adjusting the said

main valve to convert said engine into a simple or compound engine, substantially as described.

In testimony whereof I have hereunto set my hand.

EDWARD W. HARDEN.

Witnesses:

T. SIMMONS,
C. W. MILES.