A. VILE.

Compound Steam-Engine.

No. 205,817. Patented July 9, 1878.

Fig 1

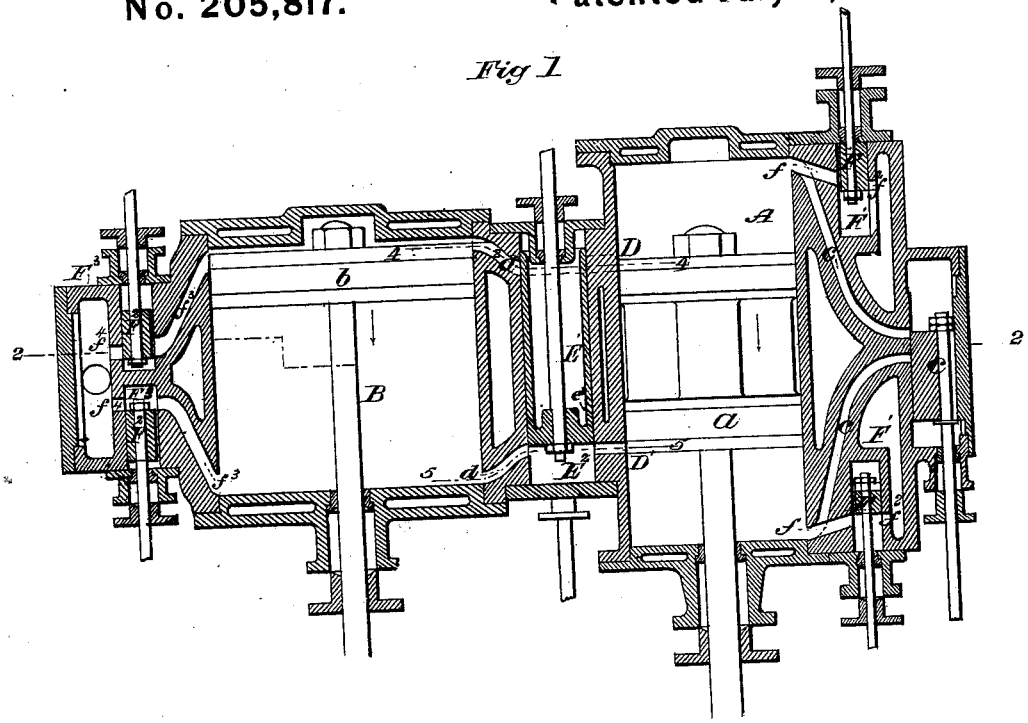

Fig 2

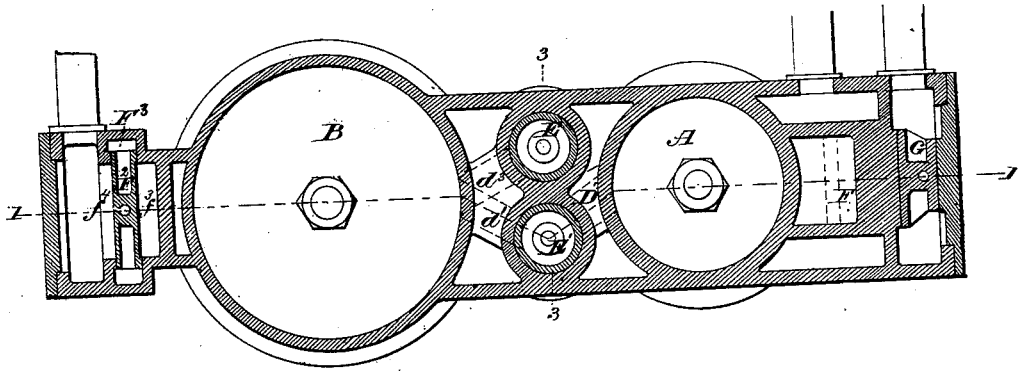

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Fig 7

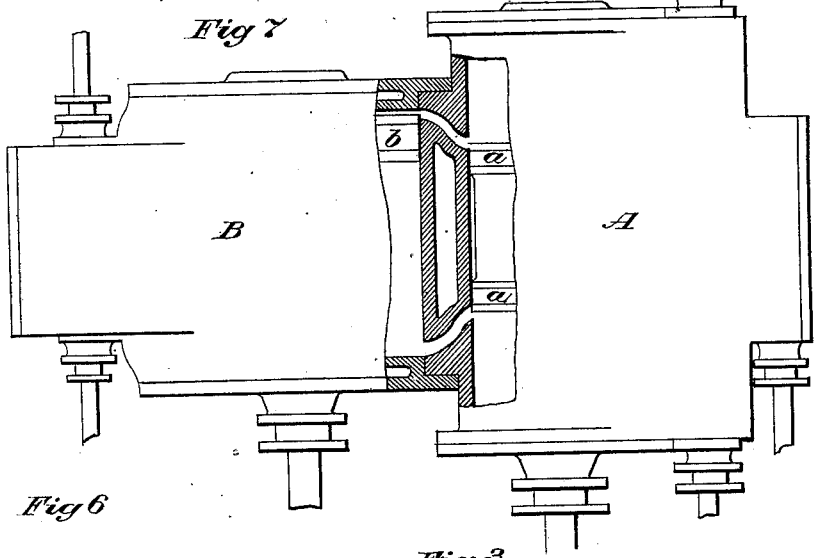


Fig 6

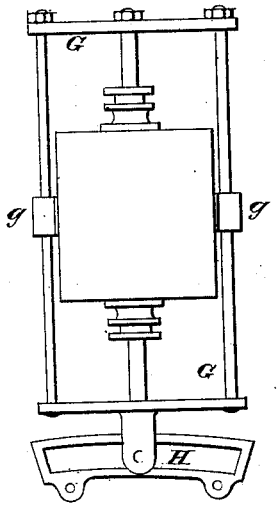


Fig 3

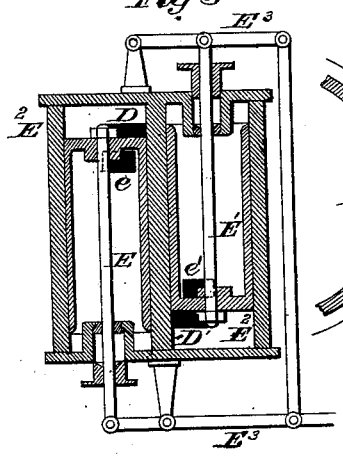


Fig 4

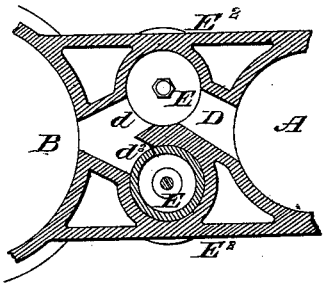
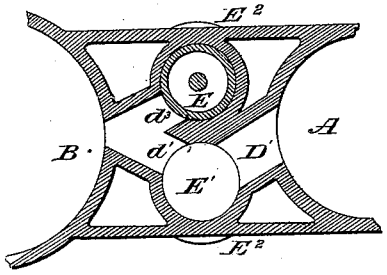


Fig 5



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UNITED STATES PATENT OFFICE.

ALBION VILE, OF SOUTHAMPTON, ENGLAND.

IMPROVEMENT IN COMPOUND STEAM-ENGINES.

Specification forming part of Letters Patent No. **205,817**, dated July 9, 1878; application filed May 13, 1878; patented in England, October 13, 1877.

To all whom it may concern:

Be it known that I, ALBION VILE, of the town and county of Southampton, England, have invented a new and Improved Compound Steam-Engine; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming part of this specification.

My invention relates to improvements in compound engines of that kind in which the piston of the high-pressure cylinder is made to act as the valve to open and close the ports leading from the high-pressure to the low-pressure cylinder or cylinders for controlling the passage of the steam from the one to the other. The steam, after it has acted on the piston of the high-pressure cylinder, is passed directly into the low-pressure cylinder or cylinders without the intervention of any slide-valve between the cylinders, and without exhausting into jackets or receivers of any kind; and my invention consists more particularly in exhausting in such an engine directly from the ends of the high-pressure cylinder to the condenser or atmosphere, in order to avoid compression or back-pressure in the said cylinder. For this purpose I provide exhaust-valves in connection with ports leading from the ends of the cylinder, the valves being connected together and worked through a link-motion, or directly by eccentrics or otherwise in engines which do not require reversing. These valves are preferably blank valves—that is to say, solid plates or pistons, without any exhaust cavity or passage in them. I also provide a similar arrangement of valves for the low-pressure cylinder. Between the cylinders I provide reversing-valves, which, as well as the ports they control, are arranged in a peculiar manner, and so as to leave no vacant spaces in which the steam can expand uselessly in passing from the one cylinder to the other. Each consists of a hollow cylinder closed at one end, and fitting like a piston in a stationary cylinder or cylindrical casing, made longer than the valve-cylinder, the steam, when the engine is going ahead, passing from the high-pressure cylinder to the corresponding ends of the low-pressure cylinder over the ends of the valve. When the engine is reversed by shifting the valves the steam passes through the interior of the valves, which then place the opposite ends of the cylinders in communication. The slide-valve which controls the admission of steam to the high-pressure engine is an equilibrium-valve.

In the drawing, Figure 1 is a vertical section of compound-engine cylinders and valves, as described, the section being taken on a line passing through the axis of reversing-valve E^1, as at 1 1, Fig. 2. Fig. 2 is a horizontal section of the same, taken on a line, 2 2, Fig. 1. Fig. 3 is a vertical section of the reversing-valves on line 3 3, Fig. 2, looking toward the cylinder A; and Figs. 4 and 5 are horizontal sections of the reversing-valves and the ports in connection therewith, taken on the lines 4 4 5 5, Fig. 1, respectively. Fig. 6 shows one arrangement of gear that may be used in connection with the exhaust-valves of the low-pressure cylinder, that for the same valves of the high-pressure cylinder being similar. Fig. 7 is a part-sectional elevation of compound cylinders without reversing-valves.

A *a* are the high-pressure cylinder and piston, and B *b* are the low-pressure cylinder and piston. C is the steam-valve, controlling the admission of steam through the ports *c* to the high-pressure cylinder. D D′ are the ports leading from cylinder A to the reversing-valves E E^1, and *d* d^1 d^2 d^3 are ports leading from the latter to the cylinder B. F and F^2 are the exhaust-valves of both cylinders.

The steam-valve C is an equilibrium-valve, being fitted to work between its seat and an accurately-planed surface at its back on the cover of the valve-chest, as shown, and it is also a blank valve—that is to say, without any exhaust cavity or passage in it. Its weight and size are thus reduced to less than one-half of the weight and size of the slide-valves commonly in use, and, having no exhaust-passage, it can be linked up to any required degree of expansion without causing compression, as the exhaust takes place when the separate exhaust-valves F open. The piston *a* is of considerable thickness, being preferably equal to the length of its stroke, and therefore equal to half the length of its cylinder A, and it acts as a valve for controlling the admission of

steam to cylinder B. The piston *a* is preferably of the same weight as the piston *b*, so that the pistons are balanced.

The ports and reversing-valves connecting cylinder A to cylinder B are arranged as follows: From the upper end of cylinder A a port, D, leads directly into the adjacent end of the casing of the reversing-valve E, as shown in Figs. 3 and 4, and from the lower end of cylinder A another port, D′, leads similarly into the casing of the other reversing-valve, E¹, as shown in Figs. 1 and 5. *d d*², Figs. 1 and 4, are ports leading from the upper ends of the two reversing-valve casings into the upper end of the cylinder B, where they meet in a single orifice; and *d*¹ *d*³, Figs. 1 and 5, are similar ports connecting the lower ends of the two reversing-valve casings with the lower end of cylinder B. The valves E E¹ are of cylindrical or other form in cross-section, and are fitted steam-tight in corresponding cylinders or chambers E², constructed integral with the cylinders A B, or made of a separate piece joined thereto. These chambers E² are rather longer than the valves E E¹, so as to leave a passage for the steam past the ends of the valves, which, when the engines are working ahead, are in the position shown at Fig. 3, the valve E being at the bottom, and valve E¹ at the top, of its chamber. Each valve is hollow or tubular, and open at one end and closed at the other, the valve E being open at bottom and closed at top, and the valve E¹ closed at bottom and open at top. At the side, and near the closed end of each valve, there is a port, *e*, which, when the position of the valves is reversed, coincides with the corresponding port leading from the cylinder A, and the steam, instead of passing the ends of the valves, then passes through the hollow valves to the opposite ends of the cylinder B. The valves E E¹ are attached to rods passing through stuffing-boxes in the covers of the chambers and connected to rock-levers E³, Fig. 3, so that the two valves are moved simultaneously in opposite directions when the engine is reversed, these rock-levers being operated by hand, or connected to the same shaft that gives movement to the exhaust-valves, hereinafter referred to.

F are the exhaust-valves, one for the high-pressure end of each cylinder; and *f* are the exhaust-ports, entering the cylinder at the same orifices as the steam-ports *e*. F² are the exhaust-valves of the low-pressure cylinder. These valves are blank valves—that is to say, without any exhaust-cavity in them, the exhaust-steam passing the end of the valve on its way to the exhaust-pipe.

The valves F and F² are shown as being flat plates; but they might be cylindrical pistons. In either case they are fitted to work in chambers of corresponding form against a suitable seat, provided with a port leading to a receiver, to which the exhaust-pipe is attached, as shown.

The chambers of the exhaust-valves of the high-pressure cylinder and the inlet and outlet ports thereof are designated by the letters F¹, *f*, and *f*², and the corresponding parts of the low-pressure cylinder are denoted by the letters F³, *f*³, and *f*⁴, as is shown in Fig. 1 of drawing.

By the use of blank exhaust-valves separate from the steam-valve and from one another, the friction of the exhaust-valves against their seats is greatly reduced, thereby admitting of a greater pressure of steam than is at present practicable with the ordinary arrangement of valves. These valves are attached to valve-rods passing through stuffing-boxes, and are preferably coupled in pairs by being attached to cross-heads connected by rods, forming a frame, G, as shown in Fig. 6, sliding in guides *g*, connected to the frame, and operated by a link-motion, H, connected to eccentrics on the crank-shaft in the usual manner.

The links of both pairs of exhaust-valves are also preferably connected to the same shaft as the reversing-valves E, as above mentioned, so that all these valves are shifted at once when the motion of the engine is to be reversed.

The working of the engine is as follows: The ports in the position shown, and the pistons moving in the direction of the arrows, steam is admitted to the top sides and exhausted from the bottom sides of both pistons. The steam having at first acted on the top side of piston *a* only, when the latter arrived at the middle of its stroke it uncovered the port D and admitted the steam directly through that port over the end of the valve E, and through port *d* to the top side of piston *b*. On or before the closing of port D′ by the other side of piston *a*, the exhaust-valves opened at the lower ends of both cylinders. Similarly, on the return-stroke, when the piston *a* has been raised by the steam acting on its lower face to the same position, (the piston *b* being now at the bottom of its cylinder,) thereby uncovering the port D′, the steam passes directly under the valve F¹, through port *d*¹, to the lower side of piston *b*. The steam admitted to cylinder A thus acts as motive power in both cylinders in the same direction, there being no exhaust-jackets, receivers, or spaces where steam can expand uselessly.

When the valves E E¹ are reversed, as above described, the steam passes from the top side of piston *a* through port D, port *e* of valve E, down through the valve E itself, and through port *d*³ to the lower side of piston *b*, and on the return-stroke from the lower side of piston *a* through the port D′, through the port *e*′ of valve E¹, up through the valve E¹ itself, and through port *d*² to the top side of piston *b*.

Fig. 7 represents an engine that does not require to be reversed, and the reversing-valves are according omitted, the ports leading directly from the one cylinder to the other, as shown. The steam and exhaust valves are the same as before, and the working of the engine is the same, but in one direction only.

I do not claim as my invention the control-

ling the admission of steam to the low-pressure cylinder by means of the high-pressure piston; but

What I claim is—

1. A compound engine the high-pressure piston of which controls the admission of steam to the low-pressure cylinder, in which the steam is exhausted from either end of the high-pressure cylinder directly to the condenser or atmosphere on the closing by the high-pressure piston of the port connecting the two cylinders, in order to avoid compression in the high-pressure cylinder, substantially as herein set forth.

2. The combination, with a compound engine in which the high-pressure cylinder controls the steam to the low-pressure cylinder, of separate exhaust valves and ports for each end of both cylinders, substantially as shown and described.

3. The combination, with a compound engine in which the high-pressure cylinder controls the steam to the low-pressure cylinder, of a blank equilibrium-valve for controlling the admission of steam to the high-pressure cylinder, substantially as set forth.

4. The combination, in a compound engine, of blank exhaust-valves, substantially as shown and described.

5. The combination, with a compound engine in which the high-pressure cylinder controls the steam to the low-pressure cylinder, of two reversing-valves, as described, fitted in corresponding cylinders or chambers communicating with the two cylinders by ports, the said valves and ports being arranged to control the passage for the steam from the high to the low pressure cylinder, as specified.

The above specification of my invention signed by me this 10th day of January, 1878.

ALBION VILE.

Witnesses:

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T. W. KENNARD.