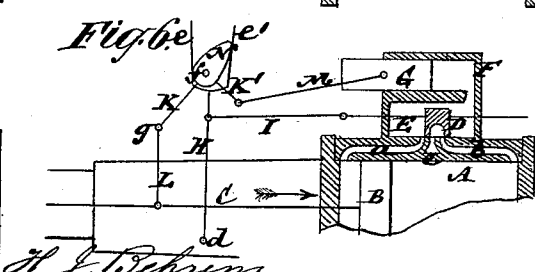
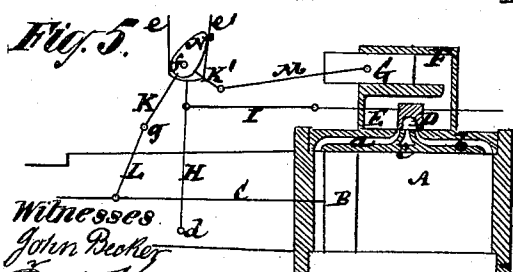
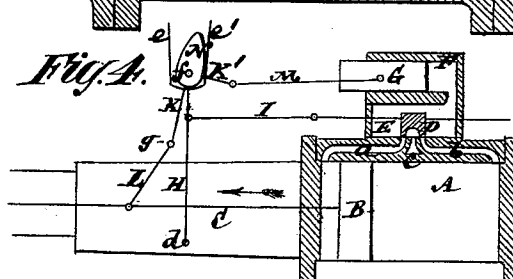
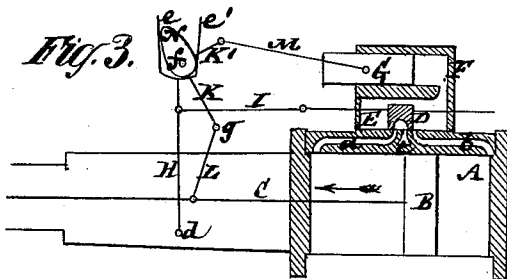
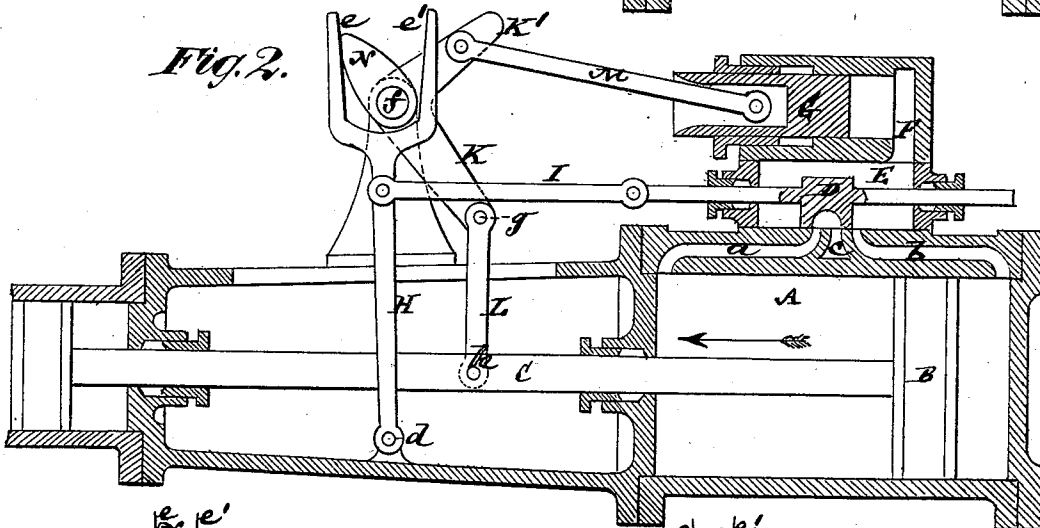
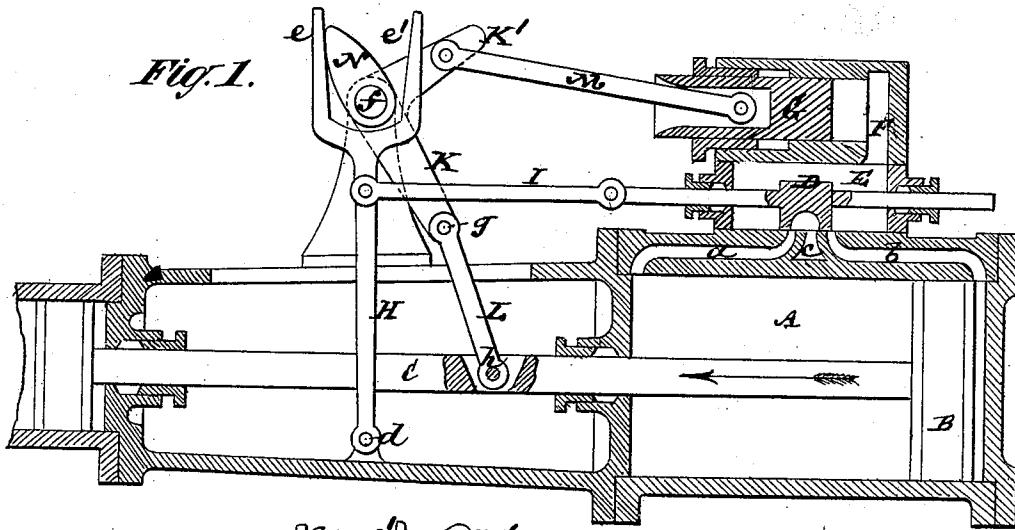


H. J. BEHRENS.

VALVE-GEAR FOR DIRECT-ACTING ENGINES.

No. 178,714.

Patented June 13, 1876.



Witnesses.
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HENRY J. BEHRENS, OF TREMONT, NEW YORK, N. Y.

IMPROVEMENT IN VALVE-GEARS FOR DIRECT-ACTING ENGINES.

Specification forming part of Letters Patent No. **178,714**, dated June 13, 1876; application filed April 11, 1876.

To all whom it may concern:

Be it known that I, HENRY J. BEHRENS, of Tremont, in the city, county, and State of New York, have invented certain new and useful Improvements in Valve-Gear for Direct-Acting Engines; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawing, which forms part of this specification.

This invention relates to valve motions for direct-acting engines, in which the valve-gear that derives its motion from the engine-piston has combined with it an independent plunger, constantly exposed on its one end to the steam or other motive gas or fluid, and operating to reverse the valve at the close of the piston's stroke in either direction, whereby an auxiliary valve, to control the action of the main valve, is dispensed with, no steam is wasted to effect the operation of the valve, and a main slide-valve of ordinary construction may be used.

The invention consists in a combination, with the valve which controls the motion of the engine-piston, of gear or mechanism for operating the same, deriving its motion in part from the engine-piston and in part from an independent plunger, exposed at its one end to the pressure of the steam, and actuated by the piston against said pressure, but released toward the close of the piston's stroke, whereby the independent plunger only partially opens the valve a little before the piston commences its reverse stroke in either direction, and the valve-gear, as moved by the engine-piston, operates afterward to rapidly and fully open the valve during the commencement of the piston-stroke, and subsequently—that is, in the after part of the piston's stroke—to close the valve ready for the succeeding partial opening or reversing of it by the independent plunger.

The invention also consists in various novel combinations and constructions of certain details, whereby the above-specified action of the valve is obtained by a positive connection of the parts composing the valve-gear, without shock or jar, and whereby the length of the stroke of the piston is made as positive as that of a crank-engine.

In the accompanying drawing, Figure 1 represents a longitudinal section of a steam-pump in part, or it may be any other direct-acting engine, having the improved valve motion applied, and showing the valve as having been started in its reverse stroke by the independent plunger. Fig. 2 is a similar section, showing the engine-piston in a position after it has commenced its return-stroke, and the valve as fully opened by the direct action of the valve-gear. Figs. 3, 4, 5, and 6 are diagrams in further illustration of the action of the valves for or during different positions of the engine-piston.

A is the cylinder of the engine; B, its reciprocating piston; and C, the piston-rod. D is the valve, which controls said piston, and which may be an ordinary D-shaped slide-valve, arranged to reciprocate within a valve-chest, E, to which the steam is freely admitted, said valve serving to control induction and eduction passages *a b* leading to opposite ends of the engine-cylinder, and an intermediate exhaust port or passage, *c*. G is the independent plunger, exposed to the atmosphere at its outer end, and to the pressure of the steam at its inner end, said plunger working in a chamber, F, which is in free communication with the valve-chest E, or may form part of it. H is the main valve, operating lever pivoted at *d*, and connected with the stem of the valve D by a rod, I, and forked at its outer or free end, forming horns *e e'*. K K' is a bell-crank lever, or the two arms thereof, having its fulcrum or center of motion *f* within the fork or, horns *e e'* of the lever H, and connected—that is, its one arm K—with the piston-rod C by a link or rod, L, forming a sort of toggle motion, and its other arm, K', with the independent plunger G by a connecting-rod, M. Furthermore, said lever K K' has secured to its working center *f* a cam, N, arranged to work within the horns *e e'* of the lever H. This cam N is constructed or shaped, so that in being vibrated by the rocking of the bell-crank or lever K K', to which it is attached, it only acts upon the lever H at intervals—that is, when coming in contact with the horns *e e'*, sooner or later, toward the close of the engine-piston's stroke.

The operation is as follows: Supposing the

engine-piston B to be moving to the right; then as, or shortly before, it reaches the end of its stroke in that direction the valve D is partially opened or reversed, as regards its control of the passages *a b c* to act as a cushion to the piston, and to move it to the left by the independent plunger G, which previously has been worked inward against the pressure of the steam, being forced outward by the steam, and acting through the cam N on the horn *e* of the forked lever H to partially throw or reverse the valve, as shown in Fig. 1. This takes place by the flexing to the right of the toggle-joint connection, formed by the arm K of the lever K K' and link L, with the piston-rod C, so soon as the pivot *g*, which connects the link L with the arm K, reaches or passes its culminating-point—that is, when said pivot is in a straight line with the fulcrum or center *f* of the bell-crank or lever K K', and the pivot or joint *h*, by which the link L is attached to the piston-rod.

The piston B then starts to the left, and by the time it has reached the position represented in Fig. 2—that is, after it has fairly started—the valve D has its opening rapidly and fully completed, to continue the motion of the piston to the left by the action of the link-rod L on the arm K, to continue the action of the cam N on the horn *e* of the lever H till the link L assumes a right-angled position, or thereabout, in relation with the piston-rod C, after which the piston B continues to move to the left without shifting the fully-open valve, as shown in Fig. 3, by reason of the free play of the cam between the horns *e e'* of the lever H. This continues until the piston B has moved some distance in the cylinder, or is approaching the conclusion of its stroke to the left, when the cam N, as actuated by the arm K and link L, acts upon the horn *e'* of the lever H to close the valve, as shown in Fig. 4, and so that the valve is not opened again till immediately before the piston reaches the end of its stroke to the left. On the piston reaching this last-named position, however, the valve is partially opened or reversed, as shown in Fig. 5, by the independent plunger G, which previously had been worked inward against the pressure of the steam, being forced outward by the steam, and acting, through the cam N, on the horn *e'* of the forked lever H, to partially open the valve to reverse the engine, till the flexing to the left of the toggle-joint connection formed by the arm K and link L with the piston-rod

C. The piston B then starts to the right again, and as the link L approximates or reaches a position which is at right angles to the piston-rod, as shown in Fig. 6, the valve D is fully opened by the continued action of the cam N, through the piston-rod C, link L, and arm K, on the horn *e'* of the lever H, after which the cam N works free between the horns *e e'* till it is required to close the valve, when it is caused, by the motion of the piston, to act upon the horn *e* and close the valve preparatory to its being partially opened again by the independent plunger G as, or shortly before, the piston B reaches the end of its stroke to the right again, as hereinbefore described.

By varying the length of the arm K relatively with that of the link L, the point in the travel of the piston at which the valve ceases to open may be changed; and by varying the shape of the cam N, the closing of the valve may be regulated to take place at any desired point in the piston's stroke.

All the parts of this valve-gear being connected, so that the motion is positive, there need be no knocking or shock in the working of it, and the valve is operated and controlled in part by the engine-piston, and in part by the independent plunger.

I claim—

1. In direct-acting engines in which the main valve that controls the motion of the engine-piston has combined with it an independent plunger, exposed at its one end to the pressure of the steam, and operating to control said valve, the combination, with such valve, independent plunger, and engine-piston, of valve-gear or mechanism organized to only partially open the valve by the action of the independent plunger, and to subsequently complete the opening of it, and afterward to close the same by the direct or positive action of the engine-piston preparatory to the partial opening of the valve again by the independent plunger to reverse the stroke of the engine-piston, substantially as specified.

2. The combination, with the engine-piston B and its controlling-valve D, of the plunger G, the lever H, the valve-rod I, the lever K K', the link L, the rod M, and the cam N, substantially as and for the purposes herein set forth.

HENRY J. BEHRENS.

Witnesses:

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MICHAEL RYAN.