2 Sheets—Sheet 1.

R. HARDIE, J. JAMES & J. G. COOPER.

Valve-Gear for Engines.

No. 209,474. **Patented Oct. 29, 1878.**

Fig. 2.

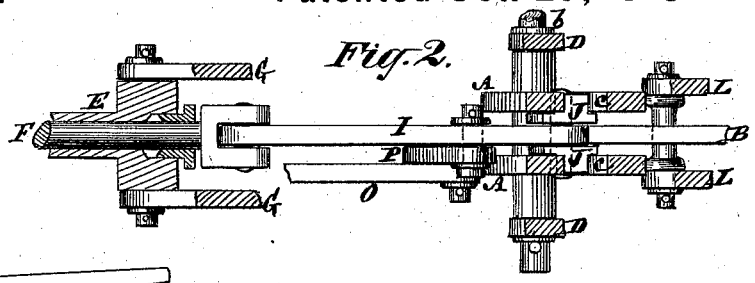


Fig. 1.

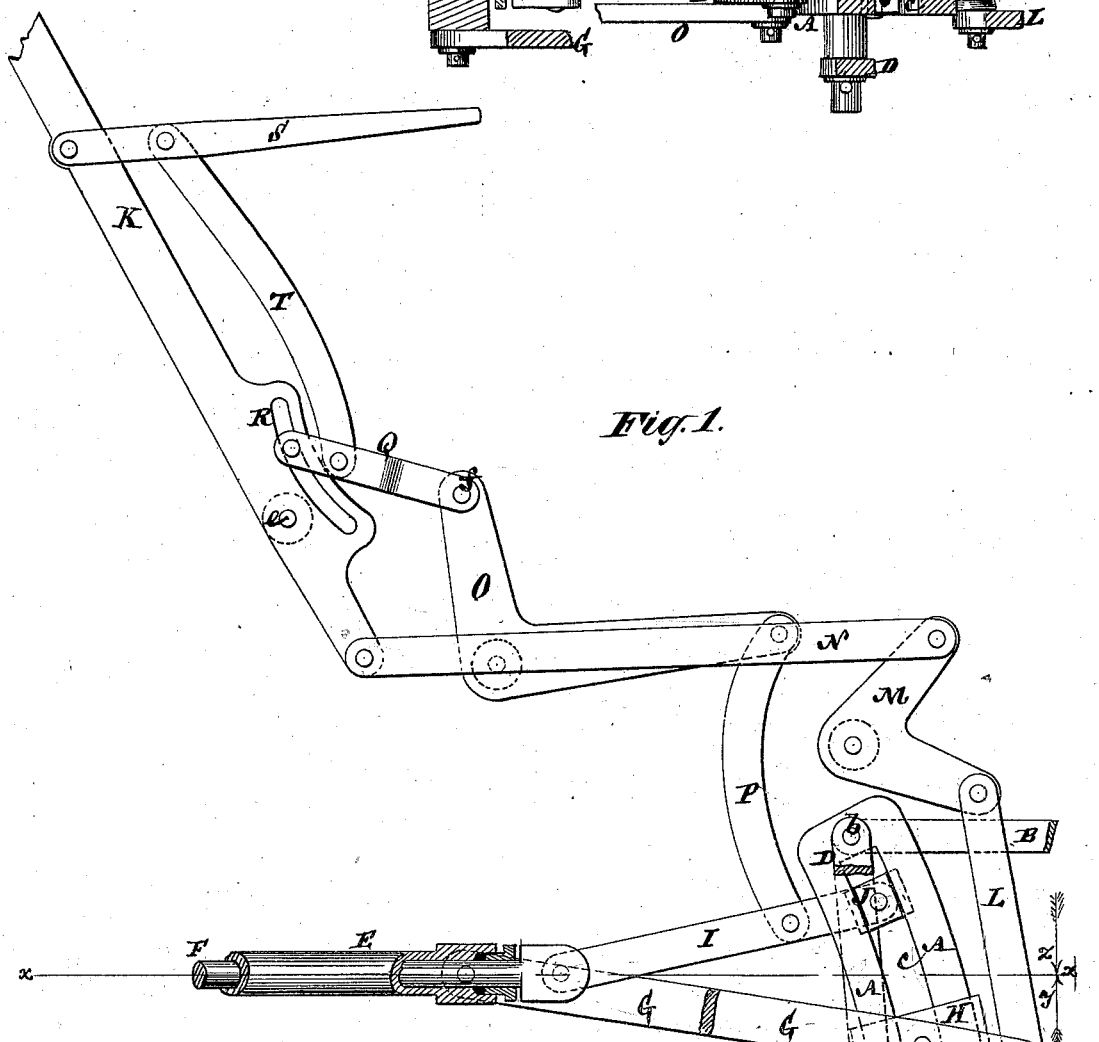
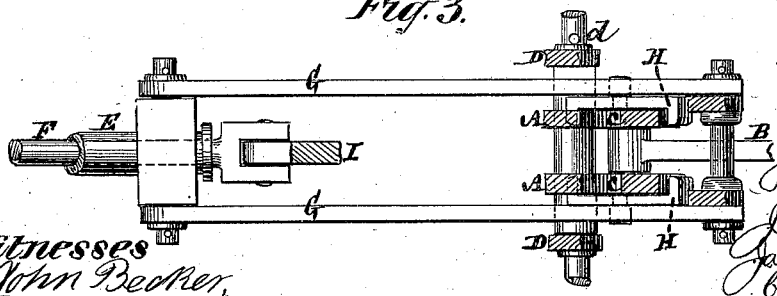


Fig. 3.



Witnesses
John Becker,
Benjamin W. Hoffmann.

Inventors
Robert Hardie,
John James,
James G. Cooper,
by their attorneys,
Brown & Allen

2 Sheets—Sheet 2.

R. HARDIE, J. JAMES & J. G. COOPER.

Valve-Gear for Engines.

No. 209,474. Patented Oct. 29, 1878.

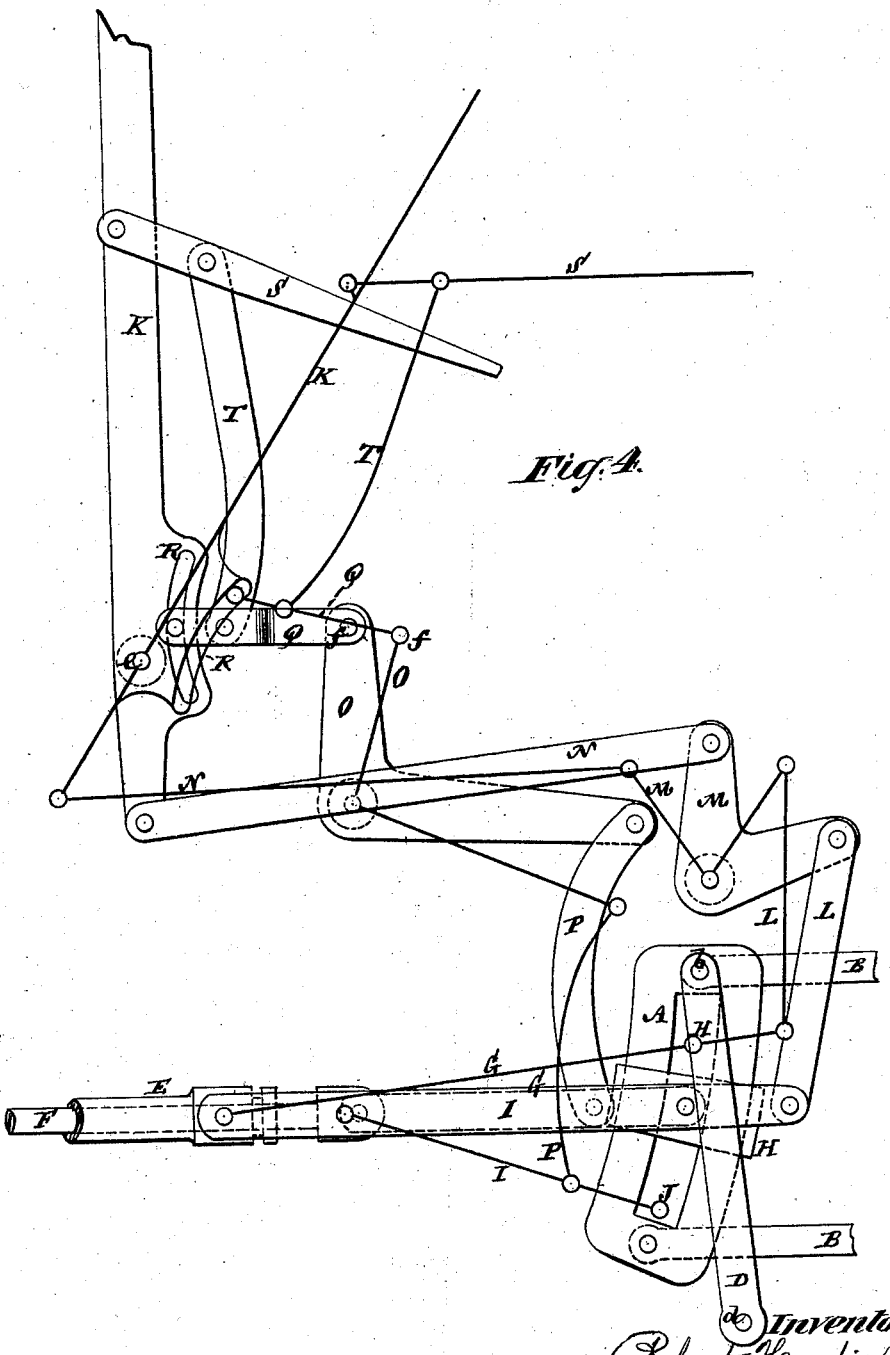


Fig. 4.

Witnesses
John Becker.
Benjamin M. Hoffmann

Inventors
Robert Hardie,
John James,
James J. Cooper,
by their attorneys,
Brown & Allen

UNITED STATES PATENT OFFICE.

ROBERT HARDIE, OF GOVAN, AND JOHN JAMES, OF EDINBURGH, NORTH BRITAIN, AND JAMES G. COOPER, OF BROOKLYN, ASSIGNORS TO THE PNEUMATIC TRAMWAY ENGINE COMPANY, OF NEW YORK, N. Y.

IMPROVEMENT IN VALVE-GEARS FOR ENGINES.

Specification forming part of Letters Patent No. **209,474**, dated October 29, 1878; application filed March 25, 1878.

To all whom it may concern:

Be it known that we, ROBERT HARDIE, of Govan, in the county of Lanark, North Britain, JOHN JAMES, of Edinburgh, in the county of Mid-Lothian, North Britain, and JAMES G. COOPER, of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Valve-Gears, of which the following is a description, reference being had to the accompanying drawing, forming part of this specification.

This invention relates to valve-gears for steam, air, and other engines of various kinds, including locomotive-engines, in which a link-motion is used to control both the throw of the main valve and of a cut-off valve, which regulates the admission of the impelling-fluid through the main valve, and in which provision is made for reversing or stopping the motion of the engine without stopping the link-motion.

The invention consists in a novel combination of devices, including a separate hand-lever attached to the main hand-lever of the valve-gear, for varying the amount of cut-off, or for stopping all cut-off action, and certain devices, including an arc on or in said main hand-lever, a connection between said hand-lever, and a rod connecting said arc with a bell-crank, and a connection between said bell-crank and the sliding or adjustable block which controls the cut-off valve, the whole being applied to a reversing link-motion or gear for controlling both the main valve and the cut-off valve of an engine, and in which provision is made for reversing or stopping the motion of the engine without stopping the link-motion, and, preferably, in which independently-sliding blocks adjustable along the same rocking link are respectively connected with the main valve and cut-off valve of the engine.

By this combination increased facilities are afforded for controlling the cut-off valve independently of and while manipulating the main valve.

Figure 1 represents a partly broken or sectional side elevation of a valve-gear having our invention applied; Fig. 2, a horizontal section on the line *x x*, looking in direction of the arrow *y*; Fig. 3, a further horizontal section on the same line *x x*, looking in direction of the arrow *z*; and Fig. 4, a side elevation and diagram combined, showing the valve-gear in different positions to that illustrated for it in Fig. 1.

A A is the valve operating and reversing link, made in two parallel parts or halves, but virtually a single piece, and forming but one link, said two parts or halves being connected at their opposite ends by pins or studs *b b'*. Said link, which has a slot or slots, *c*, in it, and is of curvilinear form in direction of its length, as in other valve link-motions or gears, is arranged to rock upon or about the axis of its stud or pin *b* as a center of motion by means of its opposite end eccentric-rods B B, connecting the link with oppositely-set eccentrics on the shaft of the engine. The pin *b* also forms the connection of said link with the usual swinging frame or bars D D, the center of motion of which is at *d*.

E is the stem of the main valve, and F the stem of the cut-off valve passing through it. G G is the connecting device between the main-valve stem E and the sliding block H H on the valve operating and reversing link A A. Said block H H, though made in two pieces, is virtually but a single block, by reason of the pivoted attachment to said parts of the connection G G. This block H H is constructed to embrace, and in its sliding adjustment along the link A A is guided by, the exterior of said link.

I is the connection or pivoted bar between the stem F of the cut-off valve and the sliding block J of the valve operating and reversing link A A. This block occupies an inside position in relation to the block H H, and is fitted to have a sliding adjustment within the slots *c* of the link A A, so that it is free to pass the block H H.

Thus one and the same link, A A, serves to receive and actuate both block H H and block J, one of which—viz., H H—constitutes an outer block, and the other, J, of which constitutes an inner block. Accordingly as the block H H is shifted to one end or the other of the link

A A will the main valve be set or reversed to move the engine backward or forward, as the case may be, and an adjustment in a reverse direction of the block J relatively to the block H H toward either end of the link will cause the cut-off valve to be operated and to cut off sooner or later in the stroke, according to the distance of said block from the end of the link toward which it is adjusted.

When block H H and block J are adjusted to occupy a central position along the link A A, both valves move in unison. Such is the position of the blocks, and corresponding position of the valve-gear generally, shown in full or by double lines in Fig. 4. The single lines or diagram in the same figure represent the blocks and valve-gear in a reverse working position to that shown for them in Fig. 1.

K is the stopping or starting and reversing lever of the valve-gear. This lever controls the main valve by its adjustment of the block H H along the link A A; and to this end said lever, which works on a fulcrum, *e*, is connected with said block, through its connection G G, by one or more rods, L, a bell-crank, M, and a rod, N, connecting said bell-crank with the hand-lever K. O is a bell-crank, used in controlling the reversal or stationary position of the cut-off valve by or through the block J in the slot *c* of the working-link A A. To this end one arm or leg of said bell-crank is connected with the sliding or adjustable block J, through its connecting-bar I, by a rod, P. The other leg or arm of said bell-crank O has pivoted to it at *f* a rod, Q, which is free to work on or from the pivot *f* as a center of motion, and the opposite or free end of which is in sliding gear or connection by a slotted arc, R, with the lever K, said arc being struck from the pivot *f* as a center. This rod Q has the position of its free end in the arc R controlled by an independent lever, S, pivoted to the lever K, and within easy reach of the hand applied to the latter. The lever S is connected with the rod Q by a rod, T.

When the parts are in the position represented in Fig. 1 of the drawing, then the engine is made to run in a given direction, the block J, which controls the cut-off valve, being at or near one end of the link A A, and the block H H, which controls the main valve, being at the opposite end of said link, and the cut-off valve being made capable of independent adjustment to vary the time of cutting off the impelling-fluid in the stroke of the engine by the separate manipulation of the lever S and movement of the rod Q in the slotted arc R, which changes the position of the block J in the link A A. When the parts are in the position represented in full or by double lines in Fig. 4, then the blocks J and H H are midway of the link A A. This stops the engine, or, rather, prevents any further admission of impelling-fluid to the working-cylinder, and any separate manipulation of the lever S has no effect upon the cut-off valve, as the rod Q, if worked up and down within the slotted arc R, has no effect upon the bell-crank O to move it one way or the other. When the parts are in the position represented by diagram or single lines in Fig. 4, then the engine is reversed.

Although provision is here made, by separate manipulation of the lever S, for varying the amount of cut-off, it does not necessarily follow that any variation should take place when reversing the engine, as by simply fixing the lever S relatively to the lever K when the free end of the rod Q is at top of the arc R, the movement of the lever K alone in either direction to the full extent of its stroke causes the blocks J and H H to be moved to opposite ends of the link A A, and effects the reversal of the engine.

To facilitate variation of the cut-off valve, the lever S should have combined with it a graduated arc and set-screw.

We claim—

The combination of the separate hand-lever S, the main hand-lever K of the valve-gear, having said lever S attached to it, the arc R, the connection T, the rod Q, the bell-crank O, the connection P, and the sliding or adjustable block J, which controls the cut-off valve, essentially as specified.

ROBERT HARDIE.
JOHN JAMES.
JAMES G. COOPER.

Witnesses:
FRED. HAYNES,
VERNON H. HARRIS.