

J. W. HACKWORTH.

Valve-Gearing for Steam-Engines.

No. 133,529.

Patented Dec. 3, 1872.

Fig. 1.

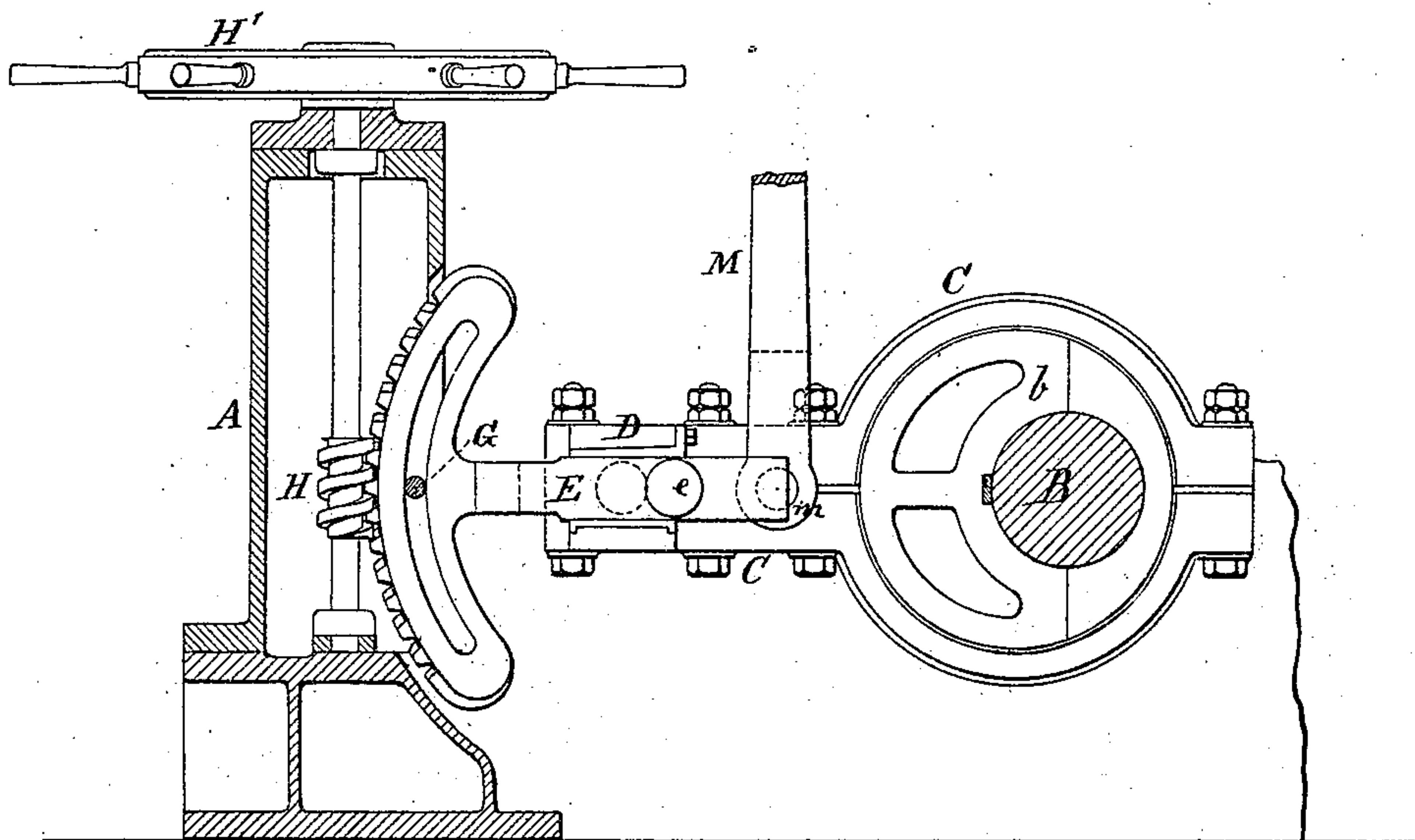
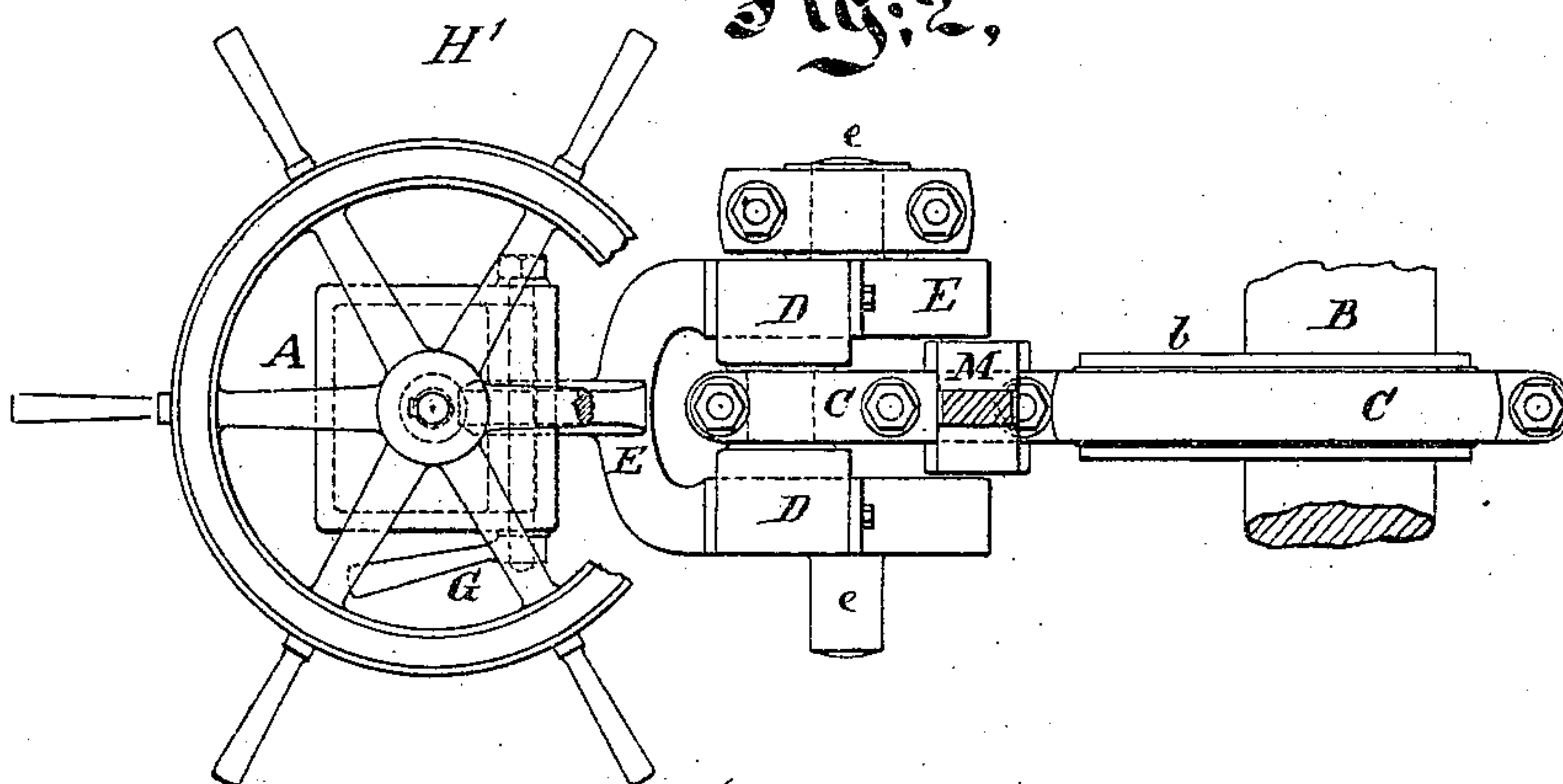


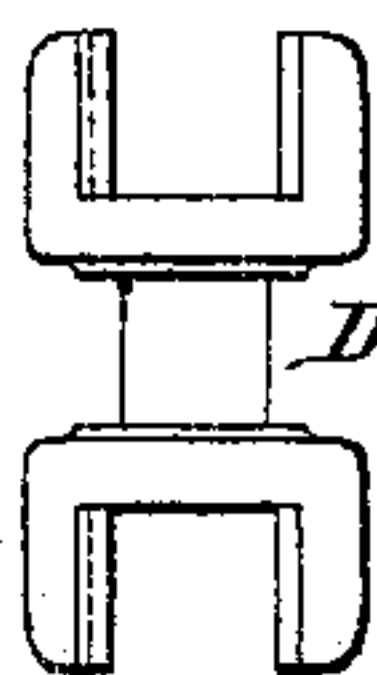
Fig. 2.



Witnesses;

*Arnold Hermann.*  
*Alfred Westbrook*

Fig. 3.



Inventor;

*J. W. Hackworth,*  
by his attorney *J. D. Stetson*



# UNITED STATES PATENT OFFICE.

JOHN W. HACKWORTH, OF DARLINGTON, ENGLAND.

## IMPROVEMENT IN VALVE-GEARING FOR STEAM-ENGINES.

Specification forming part of Letters Patent No. 133,529, dated December 3, 1872.

*To all whom it may concern:*

Be it known that I, JOHN W. HACKWORTH, of Darlington, Durham county, England, temporarily residing in Jersey City, in the State of New Jersey, have invented certain Improvements relating to the Valve-Gearing of Steam-Engines, of which the following is a specification:

It consists in the construction and combination of mechanism for working the valves of locomotive, marine, and other engines, whereby any desirable amount of lead or advance, variable expansion or cut off, and reverse action may be obtained from one eccentric crank or radial pin by two motions at right angles to each other, the rod or rods which are attached to the eccentric crank or radial pin maintaining, for both back and forward motion, one general and uniform center line, only deviating therefrom by an equal oscillatory movement on each side of the center line of action, from which oscillatory movement the motion of the valve or valves is derived.

The following is a description of what I consider the best means of carrying out the invention: I employ an eccentric rod of moderate length, one end of which is formed into straps or clasps, which embrace an eccentric pulley secured to the main or driving shaft of the engine, the other end of the said eccentric rod being hinged, jointed, or attached by suitable arrangements to the pin of a sliding block fitted to move freely the full throw of the eccentric pulley in a path, which may be changed to various angles. In one position it lies in a plane, the axis of which falls through the center of the main or driving shaft. At about two-thirds of the length of the eccentric rod from the center of the straps, or one-third from the end of the eccentric rod attached to the sliding block, or any other proportion suitable for lap and lead, I attach, laterally and at right angles with the axis of the before-described plane, one end of the valve-rod, the other end of the said valve-rod being connected to the valve strap or spindle. It follows that when a rotary action is imparted to the eccentric, the eccentric rod performs the functions of a lever, the fulcrum of which is the block moving in the before-named plane, thereby communicating a certain proportion of oscillatory action of the eccentric rod which

is derived from the throw of the eccentric pulley to the valve. This amount is equal to the lap and lead. It constitutes that which is termed the lead motion of the valve. As the extremes of this movement occur when the engine is on the center, it determines the relative position of eccentric and main crank, and is suitable for either back or forward working. The plane has hitherto been treated as fixed in a position central to that it will now be assigned to move in. This plane may take the form of a slot-hole cut through a shaft, or various other forms or modifications. The said shaft on which the before-named plane is formed is supported in bearings, the centers of which are placed at a distance from the main or driving shaft of the engine equal to the extreme centers of the eccentric rod. Further, this said shaft with the before-named plane formed on or attached thereto, may, with suitable rods and levers, be thrown to an angle of about forty degrees on each side of the previously-assigned center line, or any other intermediate angular position, imparting through the medium of such angular variation a variable and reverse lateral movement to that end of the eccentric rod moving in the hereinbefore-described plane, and thereby a proportionate increased movement to the valve.

This, then, is that part of my said invention which I designate variable, traverse, and reverse motion, the greatest extremes of which are produced when the lead motion is in the center of its action, the two movements being at right angles each to each.

The accompanying drawing forms a part of this specification, representing the novel parts, with so much of the other parts as is necessary to indicate their relation thereto.

Figure 1 is a side elevation, partly in section. Fig. 2 is a plan view, and Fig. 3 is a view of one of the parts detached.

Similar letters of reference indicate corresponding parts in all the figures.

B is the main shaft, and *b* the single eccentric required for my invention. C is an eccentric strap and rod, having the valve-rod connected at the point *m*. A is a portion of the stationary framing. One end of the eccentric rod has, necessarily, the motion of the eccentric *b*. The other end may be variously directed. It



is provided with a pin, D, which is formed with jaws on each side. These jaws embrace the two arms of an adjustable yoke or forked piece, E, which, being mounted on fixed trunnions e, is capable of being adjusted at various inclinations to induce a corresponding motion of the adjacent end of the eccentric rod. The pin D is necessarily compelled to reciprocate in different paths, according as the piece E stands in a central position or is inclined in one direction or the other. When the piece E is adjusted in the position represented, so that the line of travel of that end of the eccentric rod, if extended, would pass through the main shaft B, the rod M leading to the valve-spindle, not represented, has a certain amount of motion equal to the lap and lead. This may be proportioned to any extent, according to the judgment of the engineer. If it be desired to increase the motion, when so conditioned, the pin *m* should be placed nearer the eccentric; but wherever it is placed it is kept permanent. Now, if the piece E be inclined in one direction or the other, so that the pin D shall have any up-and-down motion, the engine will receive more steam at each stroke, and it will follow the piston to a greater or less distance, according as the inclination of the piece E is increased or diminished. The inclination of the piece E in one direction causes the engine to go ahead. Inclining it in the other direction causes it to go backward. The lead-and-lap motion will be the same in amount and hold the same relative time in both directions. The piece E may be held firmly in any position in which it may be adjusted by means of the pinching-screw G standing in a curved slot in the piece E. On slackening this screw G the piece E may be changed into any different position required. This change can be effected by means of the worm H, operated by the hand-wheel H', and taking in a curved rack or segment-teeth formed on the piece E, as shown. For locomotives and other small engines a link, operated by a hand-lever, may be connected directly to the piece E so as to allow it to be thrown instantly into various inclinations. For heavy engines it is better to employ a worm, as shown. There

may be various other modes or forms for constructing the piece E. The trunnions may be enlarged to form wheels, and the pin D may be provided with rollers traversing in grooves in such wheels instead of the jaws and bars represented. In some cases one such wheel with a deep groove and corresponding roller, or one such bar with strong jaws, taking hold of it might suffice. The friction is considerably less with rollers than with jaws. The friction can be reduced still lower by providing long links pivoted on centers mounted on the adjustable piece E, and if the links are made sufficiently long so that the path of the pin D does not differ sensibly from a right line the device will operate successfully. Any of the complex arrangements of links termed parallel motions may be used. The pinching-screw G may be dispensed with, but it is preferable to employ it, as it gives a desirable firmness to the entire work. The proportions of all the parts may be varied, but it will be found that the yoke E, or equivalent guide-way, should never be inclined more than about forty degrees from the position represented. It is essential that the valve-connection M stand at right angles to the mean or central position of the eccentric rod, and that the throw of the eccentric be always greater than is ever required for the greatest throw of the valve.

I claim as my improvement in valve-gear—

The rod C operated by a crank or eccentric at one end, and reciprocating at the other end in a changeable path, having the valve-connection at an intermediate point, substantially as described, for producing two motions from one eccentric crank or radial pin—one motion for working that which is termed the "lead" of the valve, and the other motion at an angle with the former, whereby a variable expansion and reverse motion is obtained, substantially as herein specified.

In testimony whereof I have hereunto set my hand this 16th day of November, 1872, in the presence of two subscribing witnesses.

JOHN W. HACKWORTH.

Witnesses:

WM. C. DEY,

ALF. C. WESTBROOK.