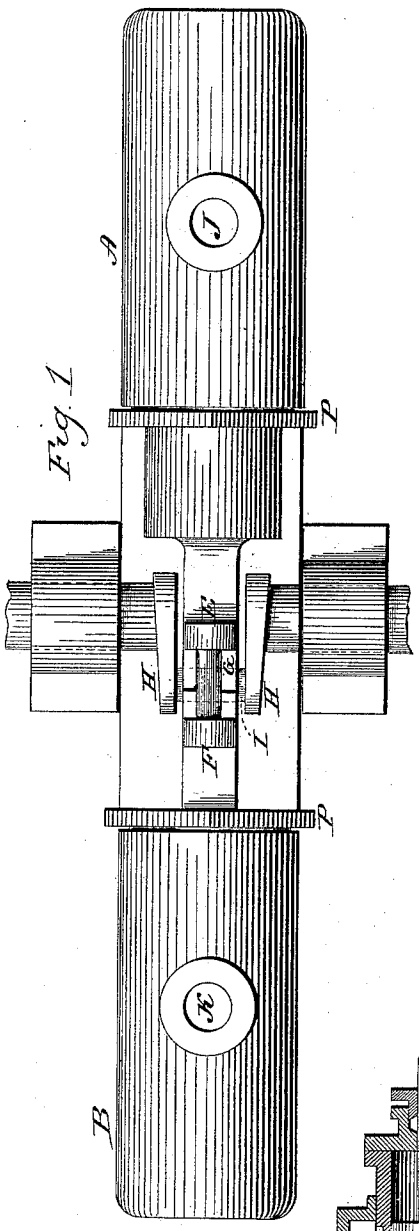
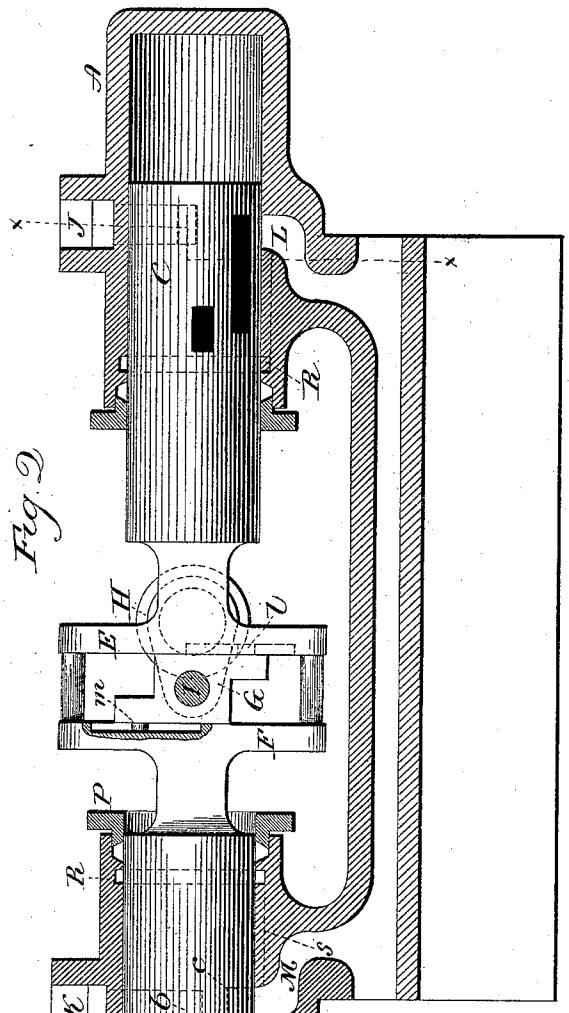
(No Model.) 2 Sheets—Sheet 1.

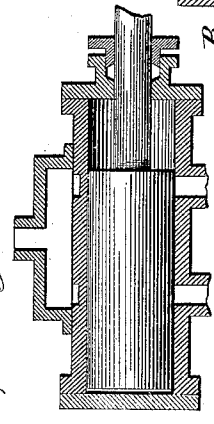
F. H. LAFORGE & H. J. BARKER.

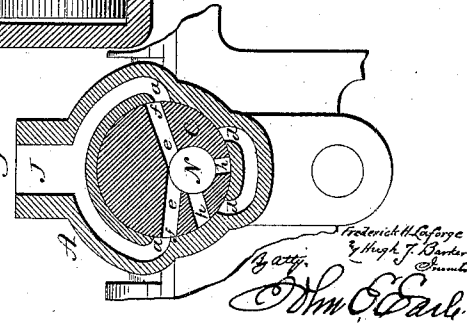
DIRECT ACTING STEAM ENGINE.

No. 398,164. Patented Feb. 19, 1889.









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(No Model.) 2 Sheets—Sheet 2.

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Fig. 6

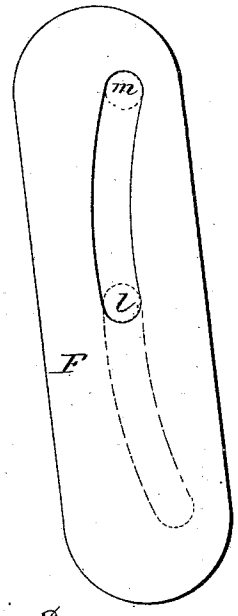


Fig. 5

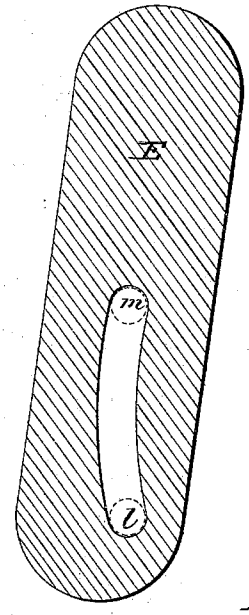


Fig. 8

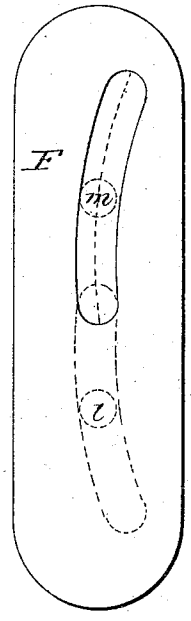
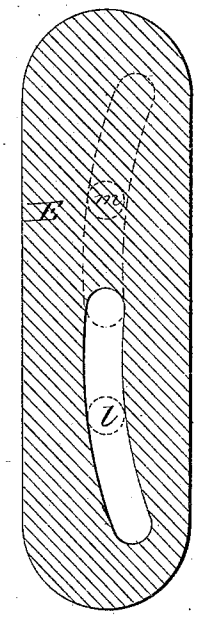


Fig. 7



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UNITED STATES PATENT OFFICE.

FREDERICK H. LAFORGE, OF WATERBURY, CONNECTICUT, AND HUGH J. BARKER, OF PHILADELPHIA, PENNSYLVANIA.

DIRECT-ACTING STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 398,164, dated February 19, 1889.

Application filed October 1, 1888. Serial No. 286,871. (No model.)

To all whom it may concern:

Be it known that we, FREDERICK H. LAFORGE, of Waterbury, county of New Haven, and State of Connecticut, and HUGH J. BARKER, of Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a new Improvement in Direct-Acting Steam-Engines; and we do hereby declare the following, when taken in connection with accompanying drawings and the letters of reference marked thereon, to be a full, clear, and exact description of the same, and which said drawings constitute part of this specification, and represent, in—

Figure 1, a top or plan view of the engine complete; Fig. 2, a longitudinal vertical sectional view of the same; Fig. 3, a transverse vertical section on line *x x* of Fig. 2; Fig. 4, a modification; Fig. 5, a vertical section through the guide E, looking toward the guide F, and showing the groove, the guide being in the position of the down-quarter point; Fig. 6, a face view of the guide F, representing the position as at the up-quarter point or opposite that of Fig. 5; Figs. 7 and 8, the same figures, showing the positions as at the respective dead-centers.

This invention relates to an improvement in direct-acting piston steam-engines, and particularly to that class in which the piston itself is the valve, and in which a rotation is imparted to the piston during its travel, and whereby the ports are accordingly opened or closed, the object of the invention being to impart the rotative movement to the piston in a simple and so easy a manner that the engine is capable of running at a very high speed; and it consists in the construction, as hereinafter described and more particularly recited in the claims.

A represents one cylinder, and B a second cylinder, both substantially alike and in axial line with each other. The adjacent ends of the two cylinders are open, but the outer ends are closed. The two cylinders are supported upon a base common to both, and so as to be firmly held in alignment.

C is the piston of the cylinder A, and D the piston of the cylinder B. These pistons are of cylindrical shape, corresponding to the interior of the respective cylinders, but of a length somewhat greater than the stroke required for the piston. The two pistons are connected between the cylinders, and the connection forms a pair of parallel guides, E F, between which guides a crank-block, G, is arranged, which is free to slide in said guides at right angles to the axis of the piston. The crank H of the driving-shaft is fitted with a crank-pin, I, which works in the said block G, and so that as the pistons reciprocate the guides E F will be moved accordingly, and such reciprocating movement of the pistons and guides will, through the block G and the crank H, impart a corresponding rotary movement to the driving-shaft.

J represents the steam-inlet passage of one cylinder, A, and K represents the like steam-passage of the other cylinder, B. These steam-passages are arranged distant from the closed end of the cylinder a little greater than the stroke of the piston, and the passages open into the cylinder through ports *a a* of the cylinder A, as seen in Fig. 3, and like ports, *b*, in the cylinder B. (Indicated by broken lines, Fig. 2.) The passages in the cylinders preferably terminate in two ports upon opposite sides of the piston, as seen in Fig. 3. From the cylinder A an exhaust-passage, L, opens through, preferably, two ports, *d d*, (see Fig. 3,) and from the cylinder D a like exhaust-passage, M, opens through like ports, *c*. The exhaust-ports are also distant from the closed end of the cylinder greater than the length of the stroke, and the length of the piston is equal to the length of the stroke plus the length of the ports of the cylinder, and a little more, so that on the reciprocating movement of the piston neither end of the piston ever reaches the respective ends of the ports.

The piston is constructed with a longitudinal chamber, N, (see Fig. 3, and also seen in broken lines, Fig. 2,) opening to the active end of the cylinder.

From the sides of the piston corresponding to the respective inlet-ports passages open from the periphery of the piston into the central chamber, N, as seen at *e* in Fig. 3. These passages form ports *f* in the piston C and *g* in the piston D, which correspond in size to

the corresponding inlet-ports of the respective cylinders. From the same chamber, N, exhaust-passages *h h* (see Fig. 3) open to the periphery of the piston, and are adapted to register with the corresponding exhaust-ports, *d d*, in the cylinder A, and like exhaust-passages, *i*, are formed in the piston D to register with the respective exhaust-ports *d d* of that cylinder. The exhaust-ports of the piston are in length little less than the stroke of the piston.

The rotary movement is imparted to the piston, so that as the pistons move from one quarter-point to the dead-center, then to the other quarter-point, a rotative movement will be imparted to the pistons in one direction. Then as the pistons continue to the other dead-center, and hence to point of starting, the return rotative movement will be imparted to the pistons.

The arrangement of the respective pistons with relation to the ports of the cylinder is such that as the piston of one cylinder starts on its outward movement the inlet-ports of that piston will register with the inlet-ports of its cylinder for the admission of steam at the same time that the exhaust-ports of the piston of the other cylinder will register with the exhaust-ports of its cylinder for the escape of steam.

To impart the required rotation to the pistons, and so that it may be so easy as to produce no jar or concussion, we construct the guides E F with grooves on the face of one or the other of cam shape, and into which a stud on the crank-block works as it moves up and down between the guides E F, and the stud of the crank-block, always traveling in a direct straight path, will impart to the guides E F an oscillatory or rotative movement corresponding to the shape of the grooves in the said guide or guides, and in which grooves the said stud or studs work, and the rotative movement thus imparted to the guides E F will be communicated to the pistons. The shape of the cam groove or grooves in the guides E F is therefore of a shape which will impart the required rotative movement to the piston, that the several ports may properly register for the admission, cut-off, and exhaust of steam.

Preferably we make the cam-grooves in both slides, as seen in Figs. 5 and 6, that in the guide E running from the center downward and to the right, while that in the guide F runs from the center upward and to the right, and on the crank-block we provide corresponding studs, *l m*, for the respective grooves in the guide E, and as seen in Fig. 2. These studs are equidistant from the central line of the crank-pin, and, as shown, each stud is distant from the center of the piston equal to the length of the crank; hence when the crank is at the quarter one of the studs will always stand in the central line of the pistons. The two grooves therefore both run to the center, and so that together they would form a continuous groove, as indicated in broken lines, Fig. 6; but both grooves curve in the same direction from the center outward.

In operation, when the cranks stand upon the quarter, say, upward, the lower stud, *l*, will stand in a central position, as indicated in Fig. 6, at which time the upper stud, *m*, will have reached its highest position, as also seen in Fig. 6, the result of which is by the upward movement of the stud *m* in the curved groove the guide has been thrown to the extreme left, as seen in Fig. 6. As the crank now passes to its dead-center, the studs travel down the respective grooves until they arrive at the central or dead-center position indicated in Fig. 8, at which time the slides stand vertical; but the crank now continues its movement and the studs continue their descent until the next quarter-point is reached, when the stud *m* will have arrived at the center and the stud *l* will be at the extreme down position, as indicated in Fig. 5, which continues the rotative movement of the slides to the opposite extreme, the crank continuing its movement on the return, and when the dead-center is reached the studs will have arrived at the central or opposite dead-center position, as seen in Fig. 7, when the studs will be at points equidistant from the center. Thus as the crank revolves a vibratory movement is imparted to the slide, which gives a corresponding rotative movement to the pistons, sufficient to open and close the ports for the admission or exhaust of steam. The shape of the grooves is a segment drawn through the three points for each stud—to wit, the central line of the piston, the dead-center point of the studs, and the extreme throw of the studs—the dead-center points being in a vertical line through the center of the pistons and the extreme point being at one side of that line equal to one-half the rotation required, and as clearly indicated in Fig. 8. The grooves may be both in one guide—say as indicated in broken lines in Figs. 7 and 8—or grooves may be formed alike in both guides and studs formed upon or attached to the crank-block accordingly; but we find that the groove for one side formed in one guide and the groove for the other stud formed in the other guide produces the most satisfactory result. This construction of grooves and studs makes the rotative movement of the piston correspondingly easy, and the change from one direction to the other is so gradual that there is no abrupt termination of the stroke. Consequently no jar is produced, and the result is that there is no limit to the velocity at which the engine may be successfully run further than the action of the steam is concerned, the machine itself offering no impediment to such high velocity.

We have represented the studs as distant from each other equal to the throw of the crank and equidistant from the center line of the crank; but the distance of the studs

from the center line of the crank-pin is immaterial, it only being essential that they be equidistant from the center of the crank-pin, and that when the cranks stand upon the dead-centers the studs shall be equidistant from the center line of the pistons.

The grooves are in length corresponding to the movement required for the studs, and the shape of the grooves is a segment starting from the center of the piston through the center of the studs at the dead-center position, thence to the point where the studs will stand at the quarter position.

In describing the grooves in the guides E F we have stated that the curve is to the right. This term "right" is used as looking toward the face of the guide F; but it will be understood that it is immaterial whether the grooves turn to the right or left.

The wear of the machine, owing to this easy movement, is extremely light, and the construction affords great facilities for lubrication.

We have illustrated two inlet-passages in the pistons and two exhaust-passages with corresponding ports and passages in the cylinder; but it will be understood that the two inlet-ports and the two exhaust-ports act substantially as one, and that therefore either may be dipensed with, it only reducing the area of the inlet or outlet, or more ports may be added.

While we prefer to make the pistons to employ two open-ended cylinders and two corresponding pistons acting directly, the two pistons may be combined in one and work in a single cylinder, as represented in Fig. 4; but the crank will still work between the guides, and so that the rotation of the piston will be imparted as described.

As a packing for the piston at the open end of the cylinder we introduce a stuffing-box, P, around the piston, and to avoid the full pressure of steam upon the stuffing-box construct the cylinder with an annular groove, R, near the stuffing-box, and from that groove in the bottom of the cylinder a channel, S, leads to the exhaust, so that steam or water passing along the cylinder toward the stuffing-box will necessarily enter the groove *r* and be conducted therefrom to the exhaust; hence no greater pressure can be brought upon the stuffing-box than the exhaust. This packing for the piston at the open end of the cylinder, while specially applicable to engines of this character, is equally applicable to all open-end cylinders.

We claim—

1. In a steam-engine, the combination of a cylinder, a reciprocating piston, the cylinder constructed with inlet and exhaust passages terminating in ports into the cylinder distant from that end of the cylinder with which they are adapted to communicate greater than the stroke of the piston, a piston greater in length than its stroke, with inlet and exhaust ports opening through its periphery to the cylinder through the active end of the piston, the said piston extending outside the cylinder and provided with two guides parallel to each other at right angles to the axis of the piston, a crank, a crank-pin extending between said guides, a crank-block on said crank-pin working between and guided by said guides, grooves in the face of one or both of said guides, and studs on the said crank-block corresponding to said grooves, the said studs equidistant from the central line of the crank-pin, and the said grooves curved from the center, substantially as and for the purpose described.

2. In a steam-engine in which the cylinder is constructed with inlet and exhaust passages opening through ports into the cylinder, and in which one end of the cylinder is open, and in which the piston works through the said open end of the cylinder, and having a stuffing-box in the said open end of the cylinder around the said piston, the cylinder constructed with an annular groove upon its inner surface and inside the said stuffing-box, with an outlet from said annular groove directly to the steam-exhaust passage of the cylinder, substantially as described, and whereby the water arising from condensation in the said annular groove may flow directly to the steam-exhaust passage and there escape.

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