

(No Model.)

2 Sheets—Sheet 1.

L. W. HARDY.
STEAM ENGINE.

No. 335,191.

Patented Feb. 2, 1886.

Fig. 1.

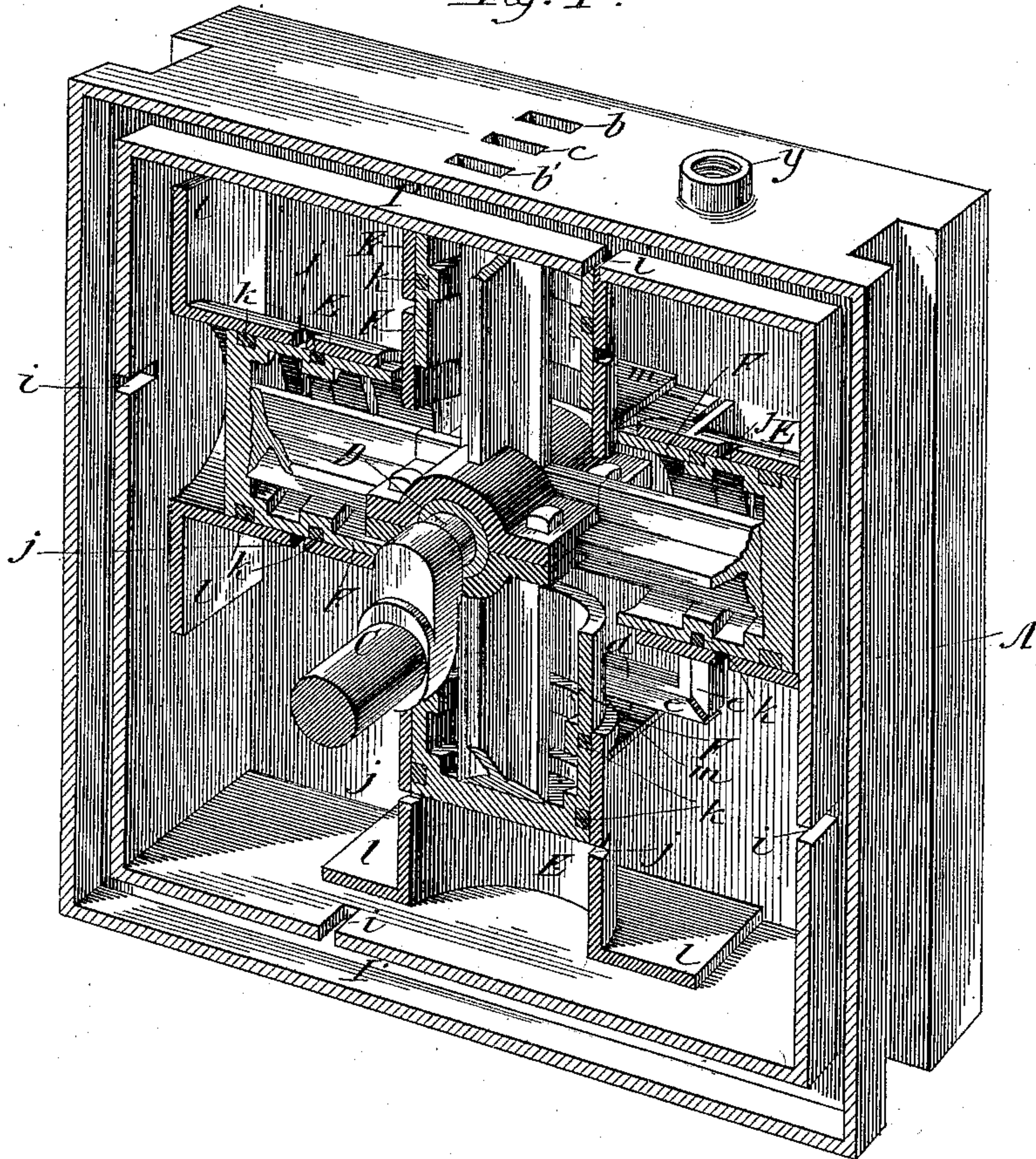
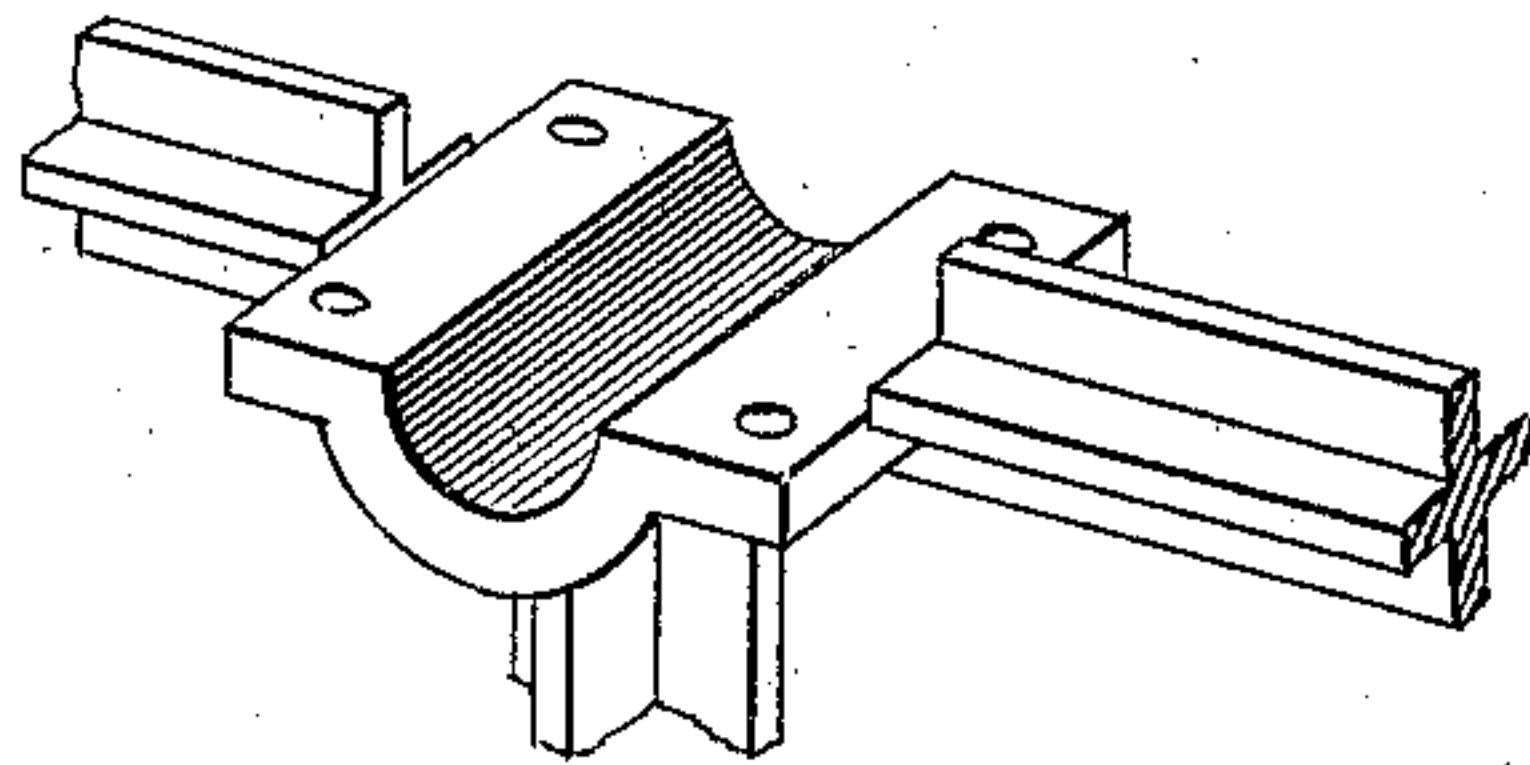
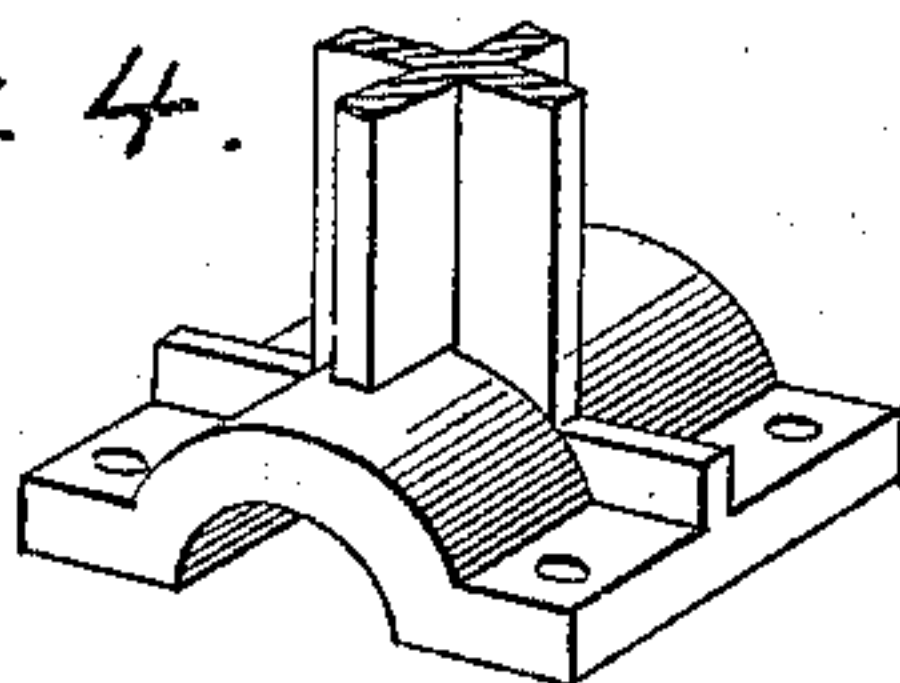


Fig. 4.



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2 Sheets—Sheet 2.

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Fig. 2.

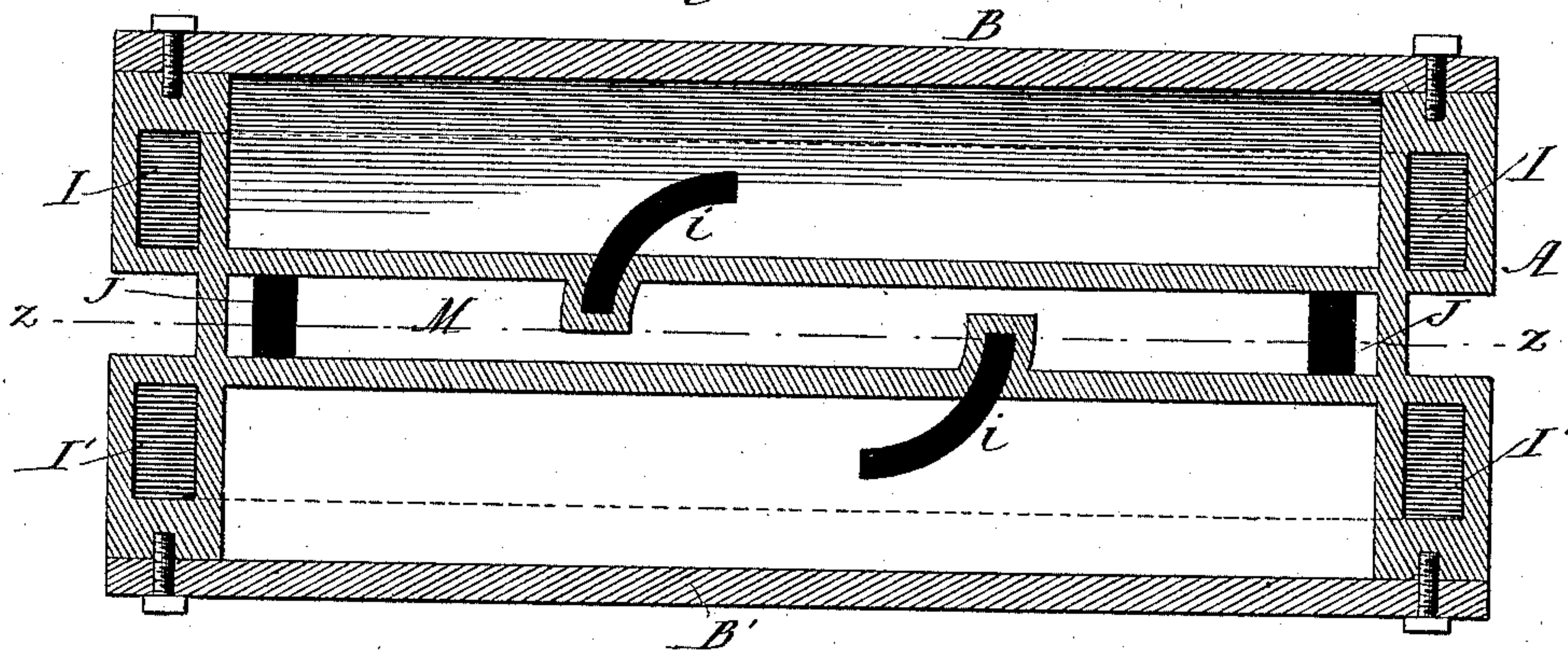
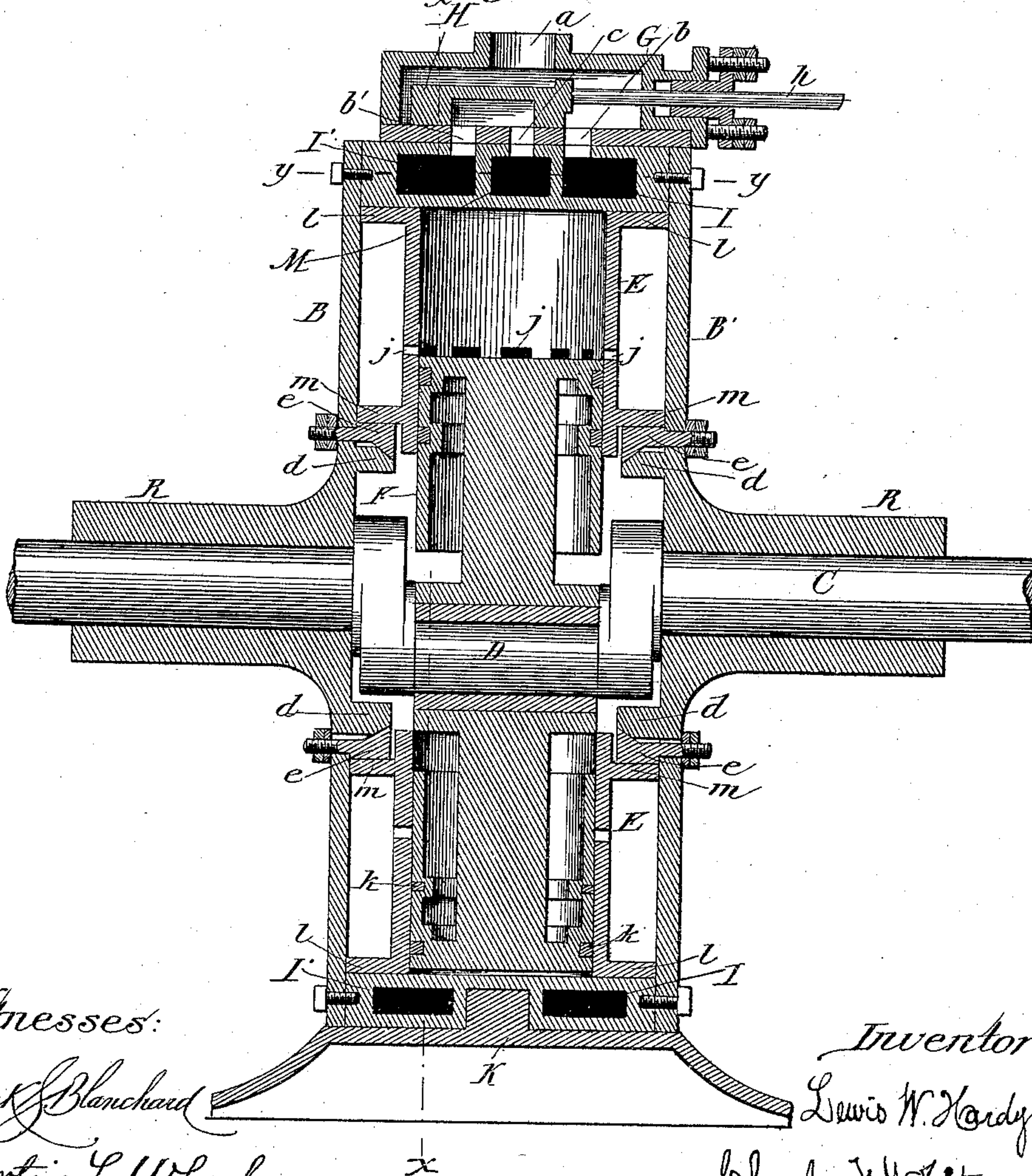


Fig. 3.



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UNITED STATES PATENT OFFICE.

LEWIS W. HARDY, OF CHICAGO, ILLINOIS, ASSIGNOR TO WALTER C. GUNN,
OF SAME PLACE.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 335,191, dated February 2, 1886.

Application filed April 25, 1885. Serial No. 163,464. (No model.)

To all whom it may concern:

Be it known that I, LEWIS W. HARDY, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Steam-Engines; and I do hereby declare that the following specification contains a full, clear, and exact description of my said invention, reference being had to the accompanying drawings, illustrative thereof, and which form a part of said specification.

My invention has relation to an improved steam-engine, in which the essential features consist of an outside shell or box, with smooth straight interior surfaces, on which the open ends of the cylinders slide, said smooth surfaces also acting as abutments for the steam within said cylinders. Said outside shell or box is provided with side plates or heads having suitable bearings in which the crank-shaft works, the crank being inside of said plates and shell. The pistons, of which there may be two or more, are placed upon or around the crank-pin, and are rigidly connected together. The cylinders, within which said pistons work, are made free to move laterally back and forth, their outer ends being open and provided with projecting flanges adapted to slide on the straight inner surfaces of the outside shell of said engine, and also perform the office of a valve in opening and closing the ports. Said cylinders are kept in contact at their outer ends with said straight surfaces on the interior side of the shell by adjustable slide-bars, placed parallel with said straight surfaces on the inside of said shell and on the side plates or heads on which the inner ends of said cylinders slide. The inlet and exhaust ports are contained in the outside shell, as shown in the drawings. The steam is admitted into the outer ends of the cylinders through ports from the steam-chamber, opening through the straight inner surfaces of the shell on which the cylinders slide, said ports being so arranged as to be opened and covered at the proper times by the flanges on the ends of the sliding cylinders. The cylinders are provided with central exhaust-ports, which are opened and closed by the moving

pistons, and also with relief exhaust-ports, which are opened and closed by the outer ends of the sliding cylinders. The crank-shaft may extend at each side through the bearings, to receive a counterbalanced pulley of sufficient counter-weight to equal one-half of the unequal balance caused by the pistons being placed on the crank-pin, the combined counter-weights in the two pulleys being sufficient to produce a running balance.

In the drawings, Figure 1 is a sectional view through the shell A on the line *xx*, and through the cylinders and piston-heads on the central line, Fig. 3, and illustrates a four-piston engine constructed in accordance with my invention. Fig. 2 is a longitudinal section through the shell A and heads B B' on the line *yy*, Fig. 3, showing the location and arrangement of the steam-ports. Fig. 3 is a vertical cross-section through the base K and the shell A and heads B B', and through two of the cylinders E E and pistons F F on the line *vv*, Fig. 1, and also through the steam-chest G and reverse-valve H. (Not shown in Fig. 1.) Fig. 4 is a perspective view of the piston-rod ends.

Referring now to said drawings, A is a square shell inclosing the working parts of the engine. This shell is provided with two steam passages or chambers, I I', extending entirely around it, with which the steam-ports *i i'* and *b b'* communicate, and is provided also with the exhaust-passage M, extending along its top, with which the exhaust-ports J J, *c c'*, and *y* communicate. The interior surfaces on the four sides of said shell are made straight and smooth, in order that the cylinders may slide thereon. Said shell is provided with the side plates or heads, B B', having therein the bearings R R, to receive the crank-shaft C.

d d are the supports for the adjustable slide-bars *e e*. These supports are attached to the heads, and extend in the form of a square around the shaft-bearing, the upper edge of said supports being beveled to correspond with the beveled edges of the slide-bars *e e*. Said slide-bars are made with their outer surfaces flat and their inner surfaces beveled, as shown in the drawings, and are held in position by means of one or more bolts extending through

slotted holes in the heads, and provided with suitable nuts. By tightening or loosening the nuts the slide-bars will be raised or lowered.

D is the crank-pin to which the four pistons 5 F F F F are attached. These pistons are rigidly connected together, and, as shown in Figs. 1 and 4 of the drawings, three of said pistons are of one piece, the fourth with one-half the box around the crank-pin forming a separate 10 piece, the two being bolted together. The piston-heads are hollow and open at one end, and are preferably made somewhat longer than the length of the stroke.

k k are packing-rings in the piston-heads.

15 E E E E are the cylinders. These are open at both ends, and are made free to move back and forth laterally, the outer ends being provided with the flanges l l, having smooth flat surfaces adapted to slide upon the inner surface of the shell A. Near the inner ends of 20 each cylinder, on the sides next to the heads, are two lugs, m m. These lugs have their inner surfaces smooth and parallel with the outer surfaces of the flanges l l, and are intended to slide upon the slide-bars e e.

G is the steam-chest, and a is the inlet-port into the steam-chest, and b is an inlet-port from the steam-chest into the steam-chamber I, when the reverse-valve H is in the position 30 indicated in the drawings, while b' is an exhaust-port opening from the chamber I' under the valve-seat, whence the exhaust-steam passes through the port c into the exhaust-chamber M.

35 y is the exhaust-port through which the exhaust-steam passes from said exhaust-chamber M. By reversing the valve H, b' becomes the inlet-port, and b the exhaust-port.

i i' are ports opening from the steam-chambers I I', respectively, i being an inlet-port 40 and i' a relief exhaust-port when the engine runs in one direction, and vice versa when the engine is reversed and runs in the opposite direction. These ports, where they open into the cylinders, are elongated, as shown in 45 Fig. 2.

J J are openings from the interior part of the engine into the exhaust-chamber M, through which the exhaust-steam admitted 50 through the central exhaust-ports, j j, passes.

If desired, the ports j j may be dispensed with and the steam exhausted through the ports i i', in which case the openings J J may be closed.

55 It is evident that the sole office of the steam-chest G and valve H is to make the engine reversible, and where a non-reversible engine only is required such steam-chest and valve may be dispensed with and a direct connection made between the steam-boiler and steam-chamber I through the steam-pipe. 60

The operation of my engine is as follows: The steam is admitted through a pipe from the boiler into the steam-chest G through the 65 inlet-port a, and thence passes through the port b into the steam-chamber I, extending around the engine. The ports i i i i, opening from

said steam-chamber, are so arranged that they will alternately be opened and closed by the reciprocating or sliding motion of the cylinders, the flanges l l of said cylinders, during 70 half of the revolution of the crank, covering two of said ports in succession, while the other two are open into the outer ends of two of said cylinders. The exhaust-ports i' i' i' i' are also 75 arranged in a corresponding manner; but their positions are reversed, so that the two cylinders open to exhaust are always on opposite sides of the engine from those open to receive steam. 80

In Fig. 1 the crank-pin is shown at the end of the upstroke of the piston of the lower cylinder. In this position said lower cylinder has just opened to exhaust through the central exhaust-ports, j j, while the piston of the 85 upper cylinder has reached the end of its stroke. The steam-port i is now open into the left-hand cylinder, while the exhaust-port i' is open into the opposite right-hand cylinder. The movement from this position is as follows: The steam acting on the outer end of 90 the piston F in said left-hand cylinder carries said piston forward to the end of its stroke, moving the crank through about one-quarter of a revolution, all the other pistons 95 at the same time moving in like manner and an equal distance. The movement of said pistons, it will be observed, is a compound or gyratory movement, the center lines of said pistons and their cylinders always maintain- 100 ing a position radial to the crank-pin. The cylinders, being confined between the flat sides of the shell A and the slide-bars e e e e, are made to slide along said bars in the direction of said vertical or lateral movement of 105 the pistons, respectively. From the position indicated in the drawings the direction of the piston movement is to the right and downward. This will carry the cylinders working on the vertical sides of the engine downward, 110 closing the steam-port i and exhaust-port i' just before the end of the quarter-stroke, and opening the central ports, j j, on the left-hand cylinder to exhaust. At the same time 115 the cylinders working on the upper and lower sides of the engine will be carried to the right, opening the steam-port i and the exhaust-port i' at the commencement of the movement, so that the steam is acting continuously on two of the four cylinders in said engine, and always at the best point of leverage 120 on the crank. The steam exhausts through the ports j j in the several cylinders into the inside of the shell, and thence passes through the openings J J into the chamber M, and out 125 through an exhaust-pipe at y.

The ports i' i' i' i' are designed as relief exhaust-ports, to remove the compression of the air in the cylinders that would otherwise occur on the back-stroke of the pistons, although 130 these parts may be used, as hereinbefore stated, as exhaust-steam ports, and the ports j j dispensed with. In that case the exhaust-steam would pass into the chamber I and

thence through the port *b*, under the valve-seat, and through the port *c* into the exhaust-chamber *M*; or the exhaust-pipe may be connected directly with the chamber *I*.

5 Instead of four cylinders, as shown in the drawings, my engine may, by a mere mechanical change in the form of construction, be made with only two or three cylinders; but the best results, it is believed, will be ob-
10 tained from four cylinders.

Having now fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. An improved steam-engine, consisting in
15 its essential principle of an outside shell or box, *A*, having the steam-chambers *I I'*, exhaust-chamber *M*, steam-ports *b b* and *b' b'*, *i i* and *i' i'*, and exhaust-ports *c* and *y*, or their equivalents, and having straight interior sur-
20 faces, on which the outer ends of the cylinders of the engine reciprocate, and being provided with heads or side plates, *B B*, having the bearings *R R* for the shaft *C*, the pistons *F F*, rigidly connected together and centrally
25 swung on the crank-pin *D* within said shell *A*, the center lines of said pistons always being radial to the crank-pin, and the cylinders *E E*, having the flanges *l l*, made to slide upon the inner surfaces of the shell *A*, and the lugs *m m*,
30 made to slide upon the slide-bars *e e*, said cylinders being confined between said slide-bars and said interior surfaces of the shell, and having a reciprocating motion parallel with said slide-bars and interior surfaces and at
35 right angles to the bore of said cylinders, caused by the compound or gyratory motion of the pistons, all constructed and arranged in manner substantially as and for the uses and purposes specified.

40 2. In a steam-engine, the cylinders *E E*, having a reciprocating motion at right angles to

the bore of said cylinders, the central lines of which are always radial to the crank-pin.

3. In a steam-engine, the cylinders *E E*, open at both ends, and having the terminal exhaust-
45 ports *j j*, and provided at their outer ends with flanges *l l*, having smooth sliding surfaces adapted to reciprocate on the straight interior surfaces of the shell *A* and operate as valves in opening and closing the ports *i i* and *i' i'*. 50

4. In a steam-engine, the pistons *F F*, rigidly connected together and centrally swung on the crank-pin *D*, when used in connection with the reciprocating cylinders *E E*, and shell *A*, having smooth interior surfaces, sub-
55 stantially as and for the uses and purposes specified.

5. In a steam-engine, the outside shell or box, *A*, having smooth interior surfaces, on which the outer ends of the cylinders recipro-
60 cate, said shell being provided with heads or side plates, *B B*, steam-chamber *I I*, exhaust-chamber *M*, and ports *i i i i*, *i' i' i' i'*, *b b'*, and *c*, substantially as and for the uses and purposes
65 specified.

6. In a steam-engine, the combination of the cylinders *E E*, having a reciprocating motion at right angles to the bore of said cylinders, with the pistons *F F*, swung upon the crank-pin and having a compound or gyratory mo-
70 tion caused by the movement of the crank, substantially as specified.

7. In a steam-engine having reciprocating cylinders and pistons therein centrally swung on a crank-pin and operating thereon within
75 an outside shell, the adjustable slide-bars *e e*, for the uses and purposes specified.

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Witnesses:

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