No. 686,482. Patented Nov. 12, 1901.

H. E. SMALLBONE.

ROTARY ENGINE.

(Application filed Feb. 11, 1901.)

(No Model.) 6 Sheets—Sheet 1.

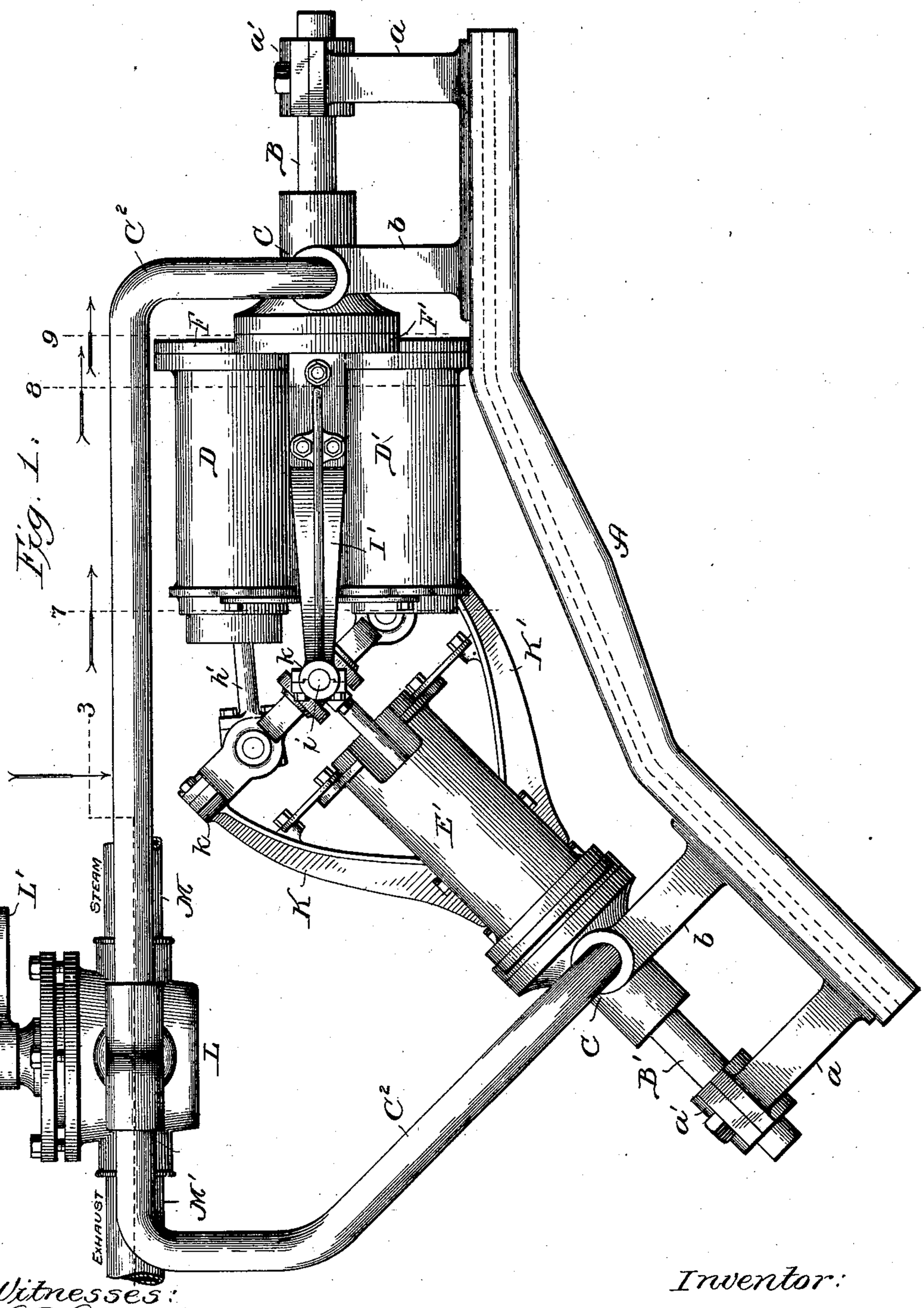

Fig. 1.

Witnesses:
Chas. E. Gaylord.
John Enders, Jr.

Inventor:
Harry E. Smallbone,
By Dyrenforth, Dyrenforth & Lee,
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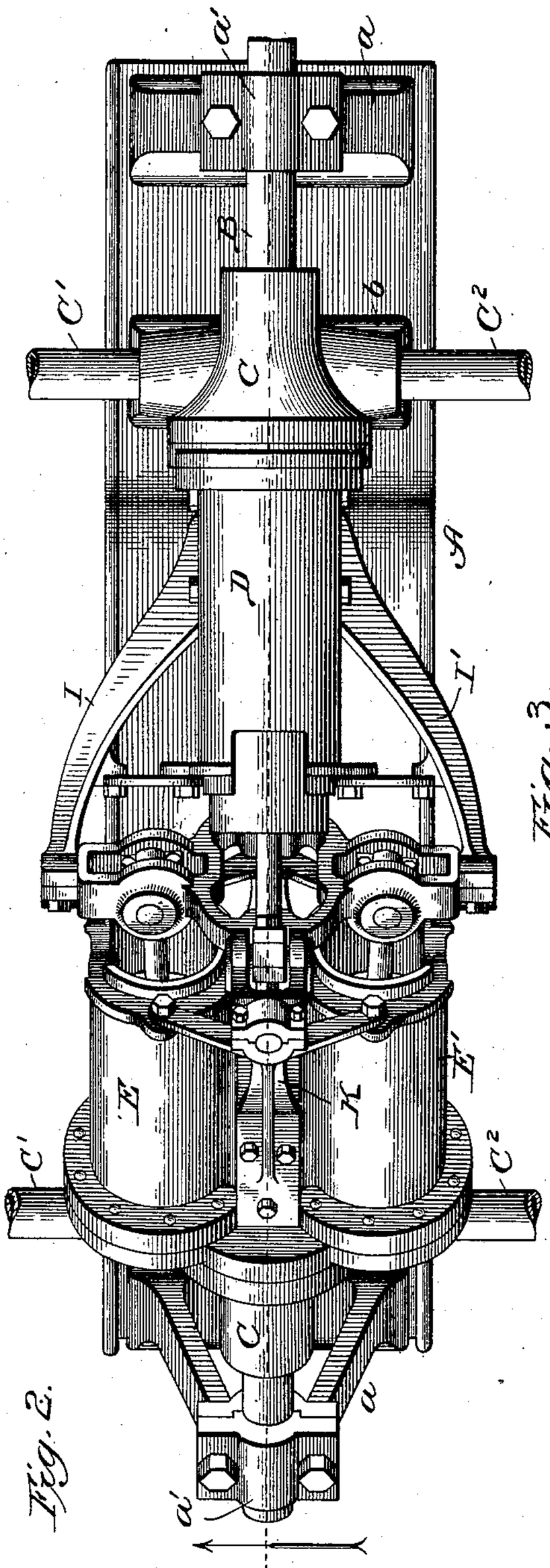

Fig. 2.

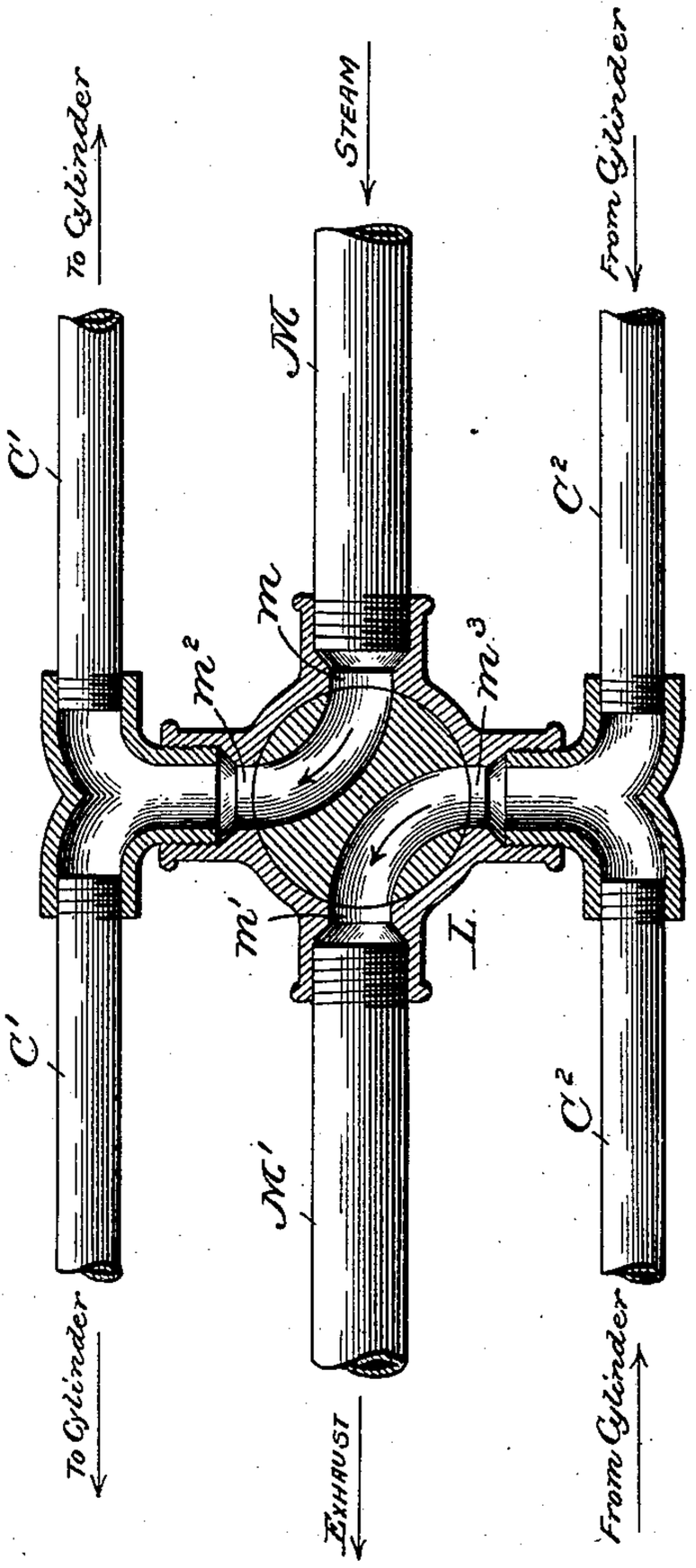

Fig. 3.

Witnesses:
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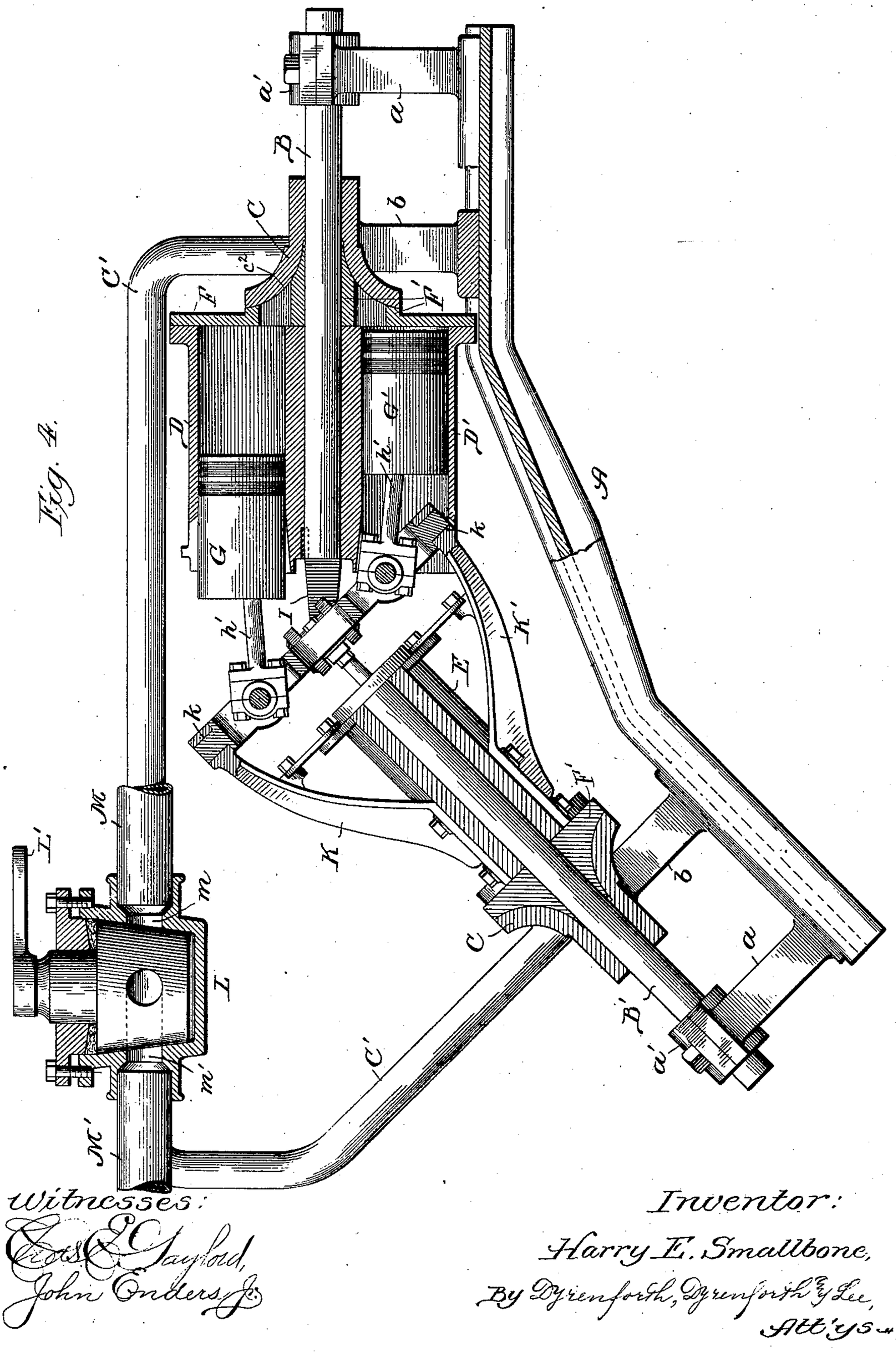
Fig. 4.



Witnesses:
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(No Model.) 6 Sheets—Sheet 4.

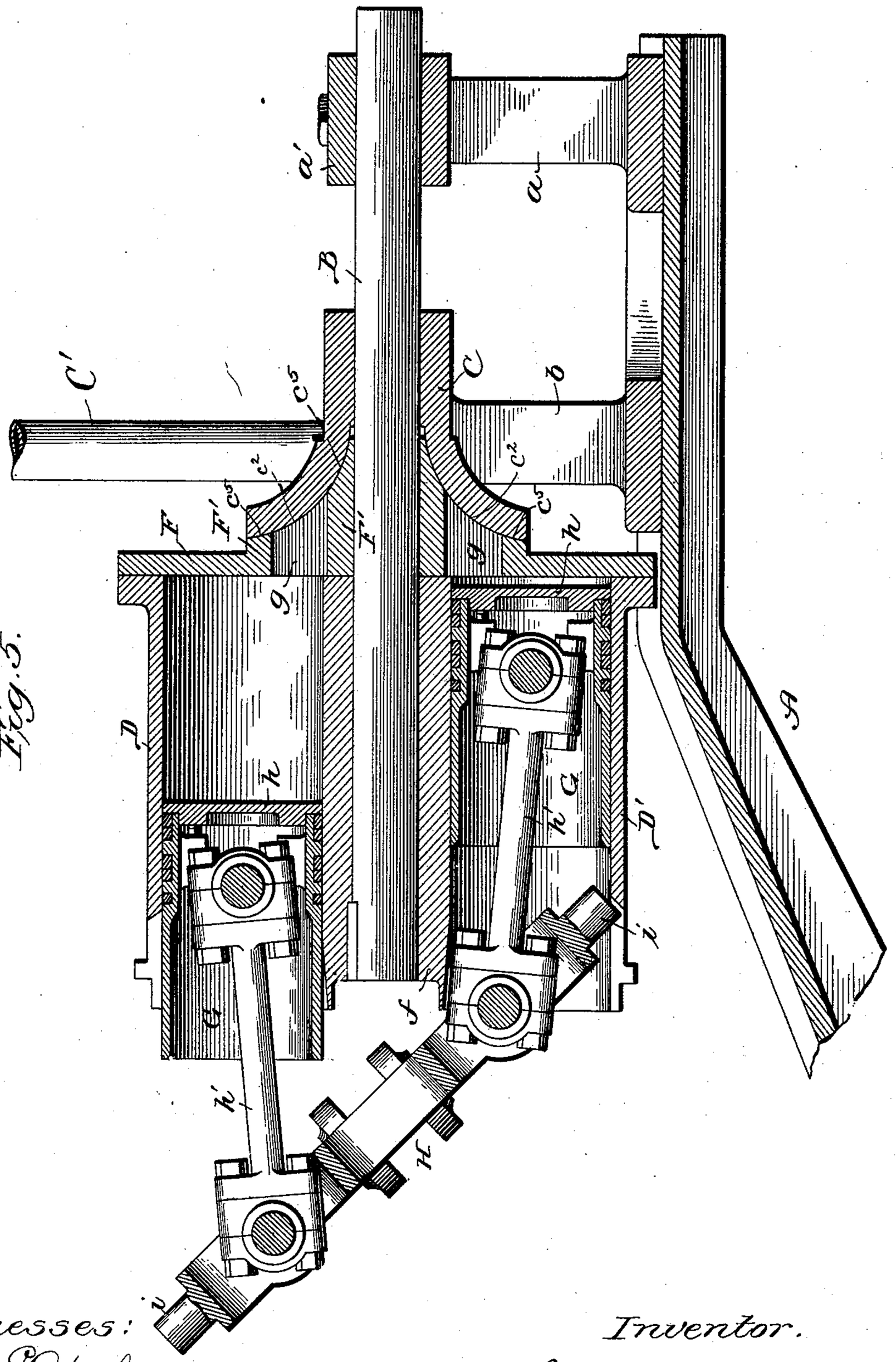

Fig. 5.

Witnesses:
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No. 686,482. Patented Nov. 12, 1901.

H. E. SMALLBONE.

ROTARY ENGINE.

(Application filed Feb. 11, 1901.)

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Fig. 6.

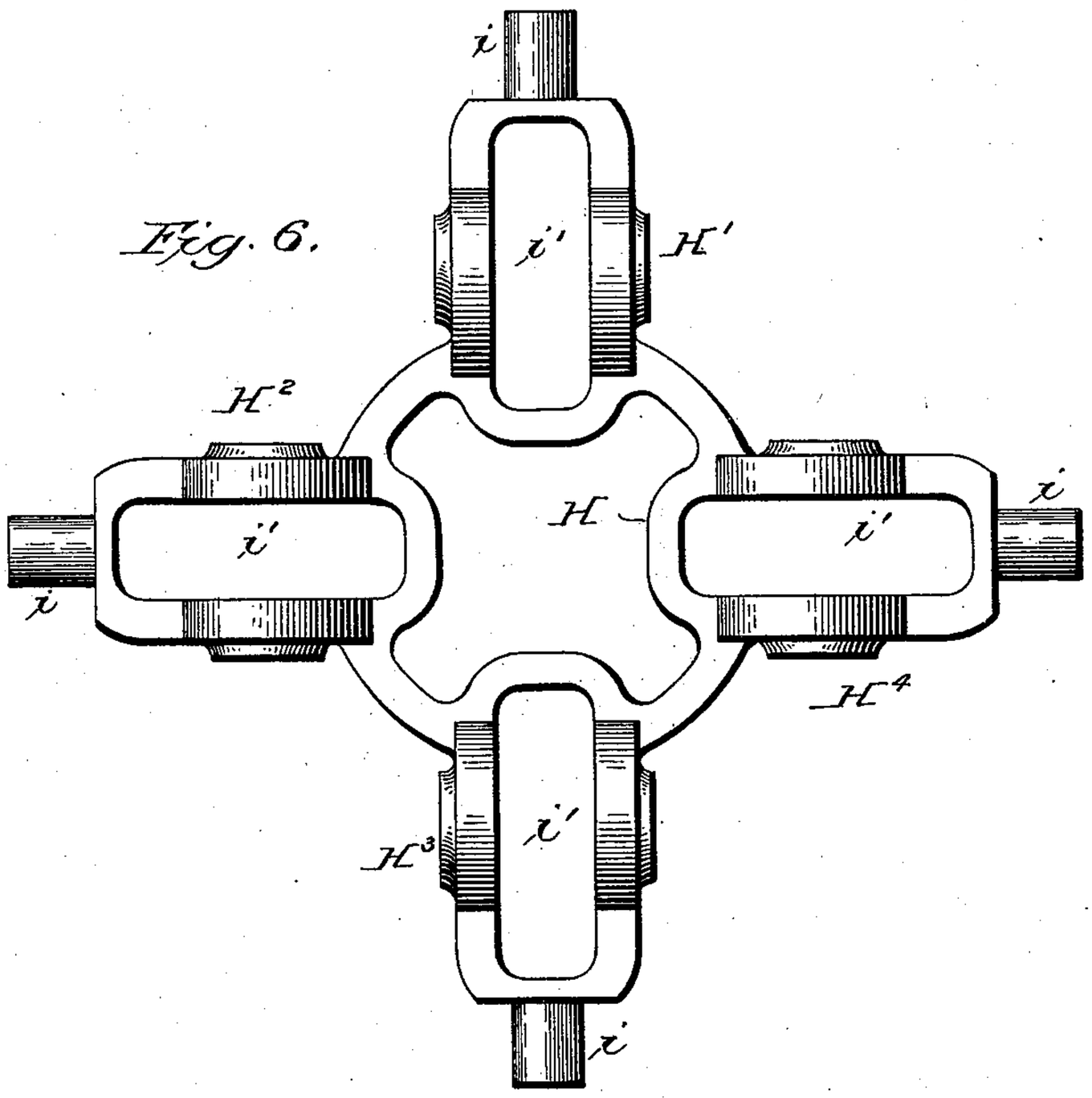
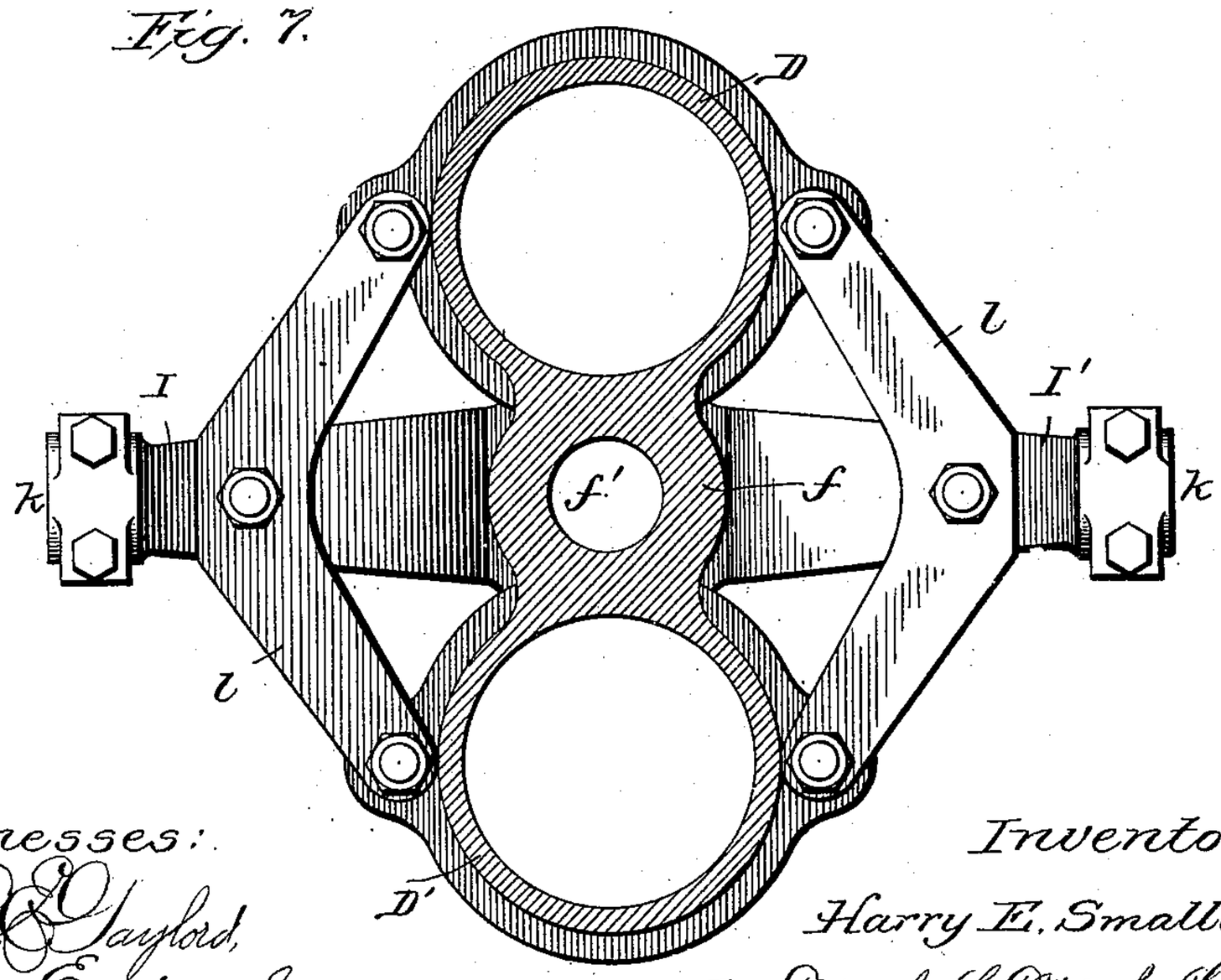


Fig. 7.



Witnesses:
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(Application filed Feb. 11, 1901.)

(No Model.) 6 Sheets—Sheet 6.

Fig. 9.

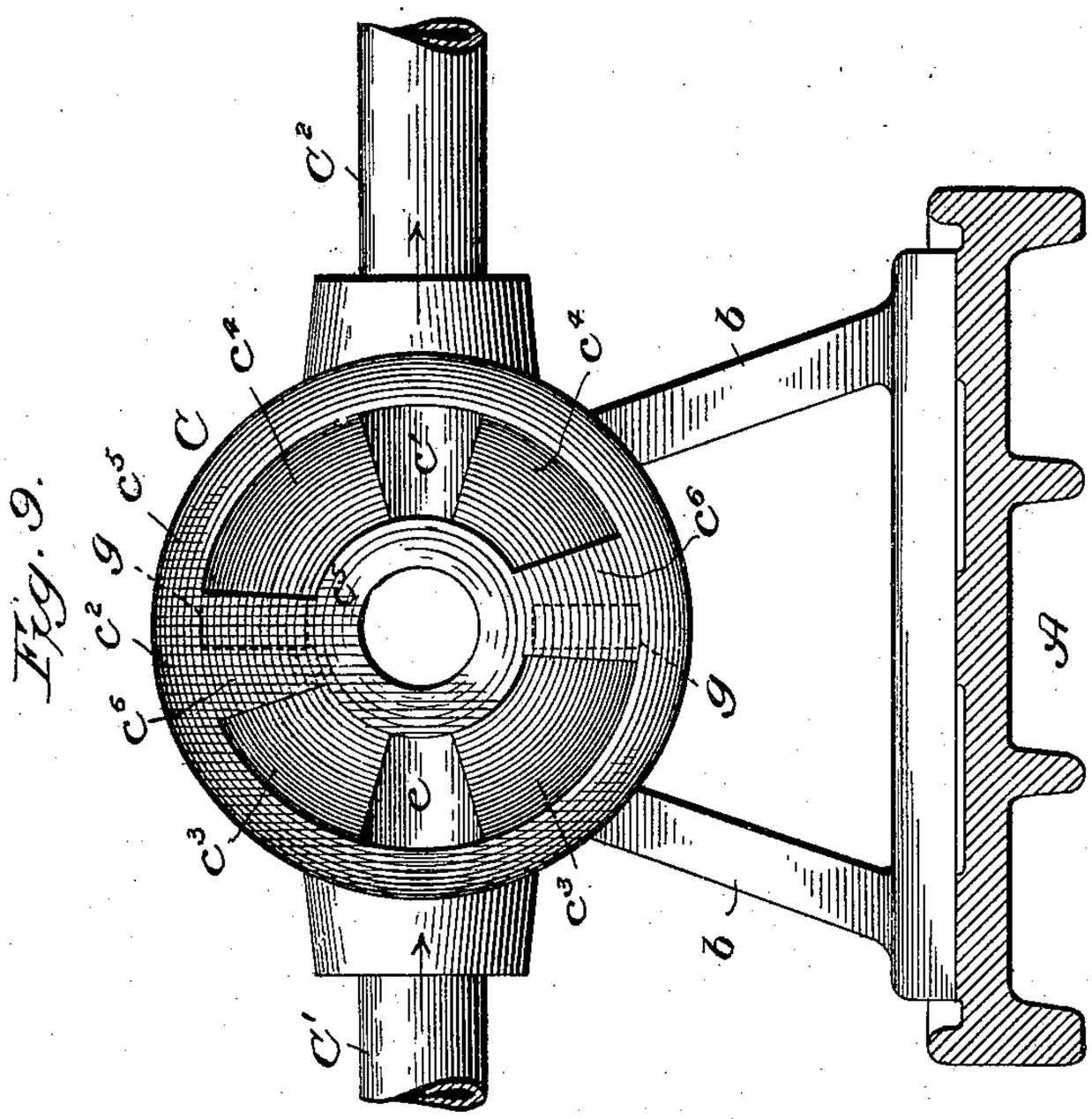

Fig. 8.

Witnesses:
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UNITED STATES PATENT OFFICE.

HARRY E. SMALLBONE, OF CHICAGO, ILLINOIS, ASSIGNOR OF ONE-FOURTH TO WILLIAM J. URQUHART AND SAMUEL E. McDOWELL, OF CHICAGO, ILLINOIS.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 686,482, dated November 12, 1901.

Application filed February 11, 1901. Serial No. 46,801. (No model.)

To all whom it may concern:

Be it known that I, HARRY E. SMALLBONE, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Rotary Engines, of which the following is a specification.

My invention relates to improvements in rotary multiple-piston engines of the type in which the steam or other motive fluid acts in cylinders against reciprocating pistons, which in turn effect rotary movement of the cylinders, from which the power is taken.

My object is to provide improvements in the construction of engines of the above general type in which the direct as well as the expansive force of steam may be utilized, in the operation of which there shall be a practically-continuous unvarying force exerted to propel the moving parts with no dead-centers to overcome, and which shall be of a construction adapting it for use upon motor-vehicles or wherever weight, dimensions, general outline, and power are matters of importance.

In the drawings, Figure 1 is a view in elevation of my improved engine; Fig. 2, a plan view of the same; Fig. 3, a section taken on irregular line 3 in Fig. 1, showing a valve for starting, stopping, and reversing the engine; Fig. 4, a section taken on line 4 in Fig. 2; Fig. 5, an enlarged broken section corresponding with the section in Fig. 4, but showing further details of construction; Fig. 6, an enlarged view in elevation of a wabbling disk or frame with which the piston-rods and both sets of cylinders are pivotally connected; and Figs. 7, 8, and 9, enlarged sections on lines 7, 8, and 9 in Fig. 1 and viewed in the direction of the arrows.

A is a base plate or frame of angular form, as indicated, and carrying toward each end outer standards a a and inner standards b b. On the standards a are journal-boxes a' for the ends of shafts B B'. The shafts B B' are in the same perpendicular plane, but extend toward a common center in planes at an angle to each other of preferably forty-five degrees. On the standards b are stationary motor-fluid or steam chests C, also forming journals for the shafts B B'. Leading into opposite sides of the steam-chests are inlet and exhaust pipes C' C^2. In the further description I will designate pipe C' as the "inlet-pipe" and pipe C^2 as the "exhaust-pipe," though in reversing the engine they will be reversed, as hereinafter explained. At each steam-chest the inlet-pipe communicates with a cored passage extending to a port c, and the exhaust-pipe communicates with a port c' through a cored passage. The ports c c' are in the tapering convex face c^2 of the steam-chest, against which the rear ends of the cylinders rotate, as hereinafter described. The port c is at the center of a recess c^3 in the face c^2, and the port c' is at the center of a recess c^4 in the said face. It will be understood that the cylinders rotate against the outer and inner ring-surfaces c^5 (see Fig. 9) of the steam-chests and also against segmental surfaces c^6, all of which together form the bearing-surfaces of the steam-chests. The segmental surfaces c^6 separate the recesses c^3 c^4 at diametrically opposite points and form stationary valves which open and close the cylinder-ports as the cylinders rotate. On shaft B is a set or pair of companion cylinders D D', and on the shaft B' is a pair of cylinders E E'. As the pairs of cylinders are of similar construction, a description of one pair will suffice for the other. The cylinders of each pair are formed integral with a connecting boss or web f between them. The web has a central opening f' to fit over the shaft which turns with and forms the axis of rotation of the cylinders. The cylinder-heads of each pair are formed by a plate F, fitting against and bolted to the cylinders and presenting at its central portion a projecting disk F' of the same diameter as the ring-surface c^5 of the steam-chest and having a frusto-conical concave bearing-face coinciding with the convex face c^2. The face of the part F' extends in the plane of the surfaces c^5 c^6 or bearing-face of the steam-chest and fits in rotating contact steam-tight against the same. Extending through the part F' into each cylinder is a port g, which may be of the relative dimensions indicated by dotted lines in Fig. 9. In the cylinders D D' are similarly-constructed pistons G G', and in the cylinders E E' are corresponding pistons. The

pistons are of a common cylindrical construction with heads h, and pivotally connected with the pistons are the piston or connecting rods h'. Between the adjacent open ends of the cylinders is a wabbling disk or frame H, which may be of the form shown in Fig. 6 and provided with four radial arms H' H^2 H^3 H^4. At the outer ends of the arms are radially-extending trunnions i, and between their ends the arms are provided with longitudinally-extending slots i'. The piston-rods h' are pivotally connected at their free ends in the slots i' of the wabbling frame. The cylinders D D' extend in a plane transversely of the machine at right angles to the cylinders E E', so that their piston-rods connect with the frame H at diametrically opposite slots i', while the piston-rods of the cylinders E E' connect with the other diametrically opposite slots i'. Firmly secured to opposite sides of the web f, between the cylinders D D', are bracket-arms I I', and firmly secured to the web between the cylinders E E' are bracket-arms K K'. The bracket-arms are all of the same length and project the same distance beyond the ends of the cylinders. In the free ends of the bracket-arms are bearing-openings k to receive the trunnions i of the wabbling frame. For additional strength the bracket-arms are connected between their ends with the end portions of the cylinders by means of brace-bars l, as shown.

L is a valve for starting, stopping, and reversing the engine. It is shown in the form of a four-way plug-valve with a handle L'. The port m of the valve communicates with a steam-supply pipe M, the port m' communicates with a steam-exhaust pipe M', and the ports m^2 m^3 communicate with the branch pipes C' C^2, which extend to the steam-chests of the engine, as before described. As indicated by the position of the valve in Fig. 3, steam from the pipe M is flowing to the pipes C', while the exhaust from the cylinders passes through the pipes C^2 to the pipe M'.

The operation is as follows: When the cylinders extend in the relation to their steam-chests indicated in Fig. 9, the ports g are blanked or closed by the stationary valves c^6. When the cylinders are revolved with their shafts so that the ports g are open to the recesses c^3 c^4, steam will enter that one of each pair of the cylinders whose port registers with the respective recess c^3 and exhaust from the other of the pair of cylinders through the recess c^4. The figures show the piston G of the cylinder D at the end of its outstroke, the piston G' of the cylinder D' at the end of its instroke, and the pistons of the cylinders E E' about midway of their strokes, one moving inward and the other outward. The opening and closing of ports g to the inlet and exhaust sides of the steam-chest is so timed that when a piston on one side has moved half a stroke in one direction the next piston of the other pair of cylinders commences its similar stroke either in or out, so that the pistons act in rotation alternately from opposite sides. In the outstroke of a piston its connecting-rod moves the arm of the frame H with which it is connected in the outer direction, which can only be accomplished, owing to the relative angles of the shafts B B', by turning the frame and both sets of cylinders axially and oscillating the frame on the pivots afforded by the bracket-arms. The outward movement of the piston of one pair, therefore, rocks the frame H in a manner to force the piston of the other cylinder of the same pair inward, producing the exhaust. This operation takes place alternately at opposite sides of the frame H, producing a continuous rotation of the frame, cylinders, and shafts B B'. Thus I produce a four-cylinder engine, two of which at respectively opposite sides are exerting power to rotate the shafts B B' while the other two cylinders are exhausting. With this construction there are no dead-centers, and no fly-wheel is necessary, while the power exerted is approximately uniform and the moving parts well balanced. As the ports g pass across the recesses c^3 and ports c the piston of the respective cylinder is subjected to the direct action of the steam entering from the port c, and while the port is passing the surface c^6 the steam admitted to the cylinder has a chance to expand and exert its expansive force, as is usual. The surfaces c^6 thus perform the function of cut-off valves. In the construction of the engine the surfaces or valves c^6 may be of any desired extent to regulate the cut-off.

When it is desired to reverse the engine, the plug-valve L is turned to bring the steam-pipe M into communication with the pipes C^2 and the pipes C' into communication with the exhaust-pipe M'. This causes steam to enter the valve-chests at the ports c' and effect the reversal in a well-known manner.

It will be understood that the valve L is shown merely as an expedient, and any other means for producing the same functions may be substituted therefor.

While I have shown a construction of my improvements adapting them for use with steam as a motive fluid, obviously it may be readily adapted with more or less slight variations for use with other motive fluids.

Pulleys or gear-wheels may be provided upon the shafts B B', from which the power may be taken. In applying my engine to a motor-vehicle one of the shafts may extend parallel with the driving-axle of the vehicle and be geared thereto with straight gears or driving-belts, while the other shaft may be geared to the axle by means of bevel-gears or the like.

The drawings show my improved engine of one desirable construction; but this construction may be changed to adapt it to different purposes, and the various details of construction may be modified without departing from the spirit of my invention as defined by the claims.

What I claim as new, and desire to secure by Letters Patent, is—

1. In a rotary engine, sets of companion cylinders at an angle to each other, pistons in said cylinders, and a wabbling frame, between the sets of cylinders, with which the pistons are connected to operate, substantially as set forth.

2. In a rotary engine, sets of companion cylinders at an angle to each other, pistons in said cylinders, and a wabbling frame, between and pivotally connected with the sets of cylinders, with which the pistons are pivotally connected to operate, substantially as set forth.

3. In a rotary engine, two shafts extending toward a common center, a pair of companion cylinders rotatably mounted on each said shaft, a piston in each cylinder, and a wabbling frame, at said common center, with which the pistons are connected to operate, substantially as set forth.

4. In a rotary engine, two shafts extending toward a common center, a pair of companion cylinders, rotatably mounted on each said shaft, a piston in each cylinder, and a wabbling frame, at said common center, pivotally connected with each set of cylinders and with which the pistons are connected to operate, substantially as set forth.

5. In a rotary engine, sets of companion cylinders at an angle to each other, pistons in said cylinders, a wabbling frame, between the sets of cylinders, with which the pistons are connected, ports in said cylinders, and a stationary motor-fluid chest, for each set of cylinders, having fluid inlet and exhaust ports across which the cylinder-ports move, substantially as and for the purpose set forth.

6. In a rotary engine, the combination of sets of companion cylinders, at an angle to each other, pistons in said cylinders, and a wabbling frame, between the sets of cylinders, provided with outer trunnions pivotally connected with the cylinders, and pivotally connected, within the trunnions, with the pistons to operate, substantially as set forth.

7. In a rotary engine, the combination of sets of companion cylinders, at an angle to each other, pistons in said cylinders provided with connecting-rods, bracket-arms on said cylinders, a wabbling frame, between the sets of cylinders, having radially-projecting trunnions pivotally connected with the bracket-arms and connecting means within the trunnions for the ends of the connecting-rods, substantially as and for the purpose set forth.

HARRY E. SMALLBONE.

In presence of—
ALBERT D. BACCI,
L. HEISLAR.