No. 659,947. Patented Oct. 16, 1900.

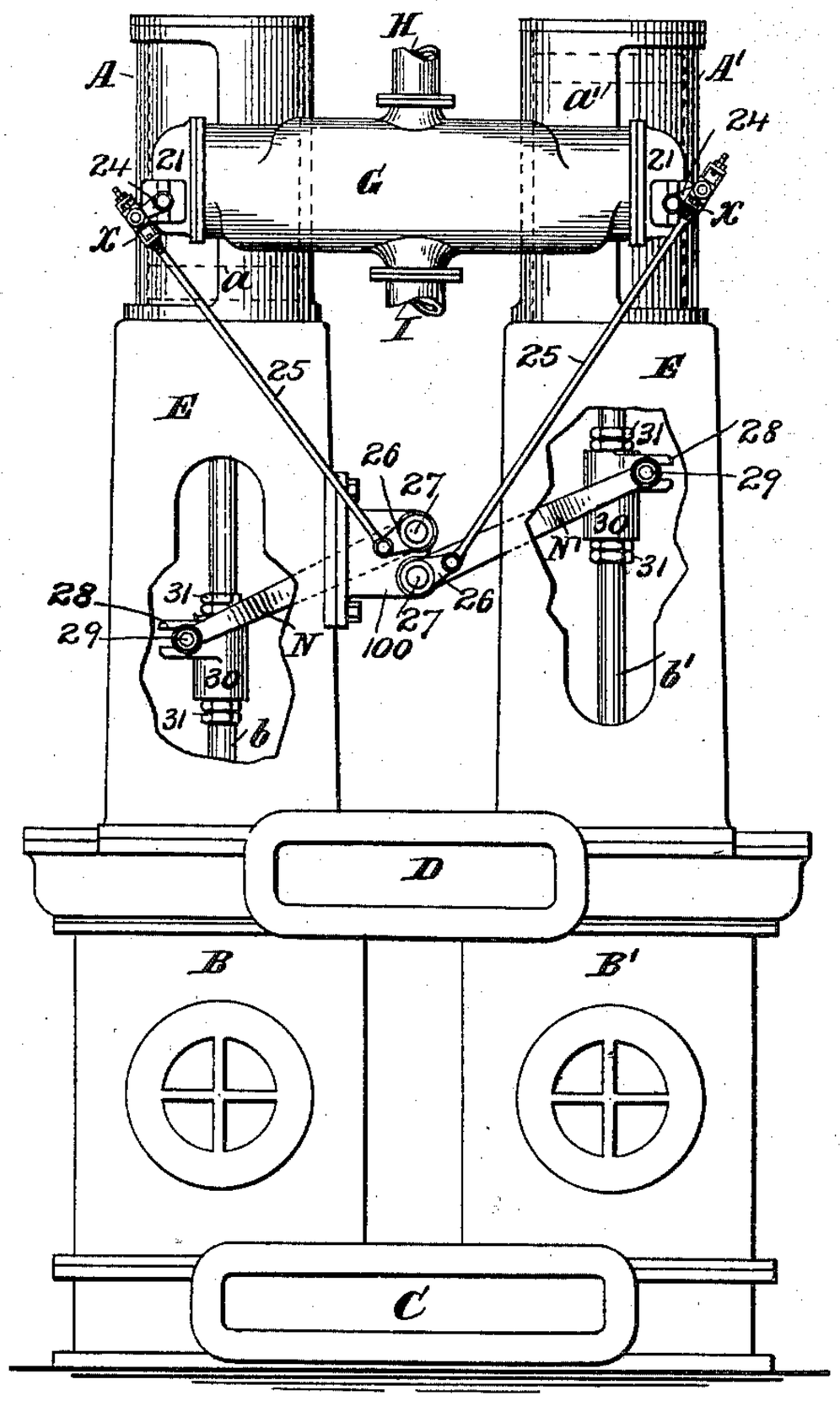
C. C. WORTHINGTON.

STEAM ENGINE.

(Application filed Sept. 19, 1899.)

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.



Witnesses:
T. G. Hoboe
A. D. Bourke

Inventor:
Charles C. Worthington
By Philipp Phelps & Sawyer
Attys

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Fig. 3.

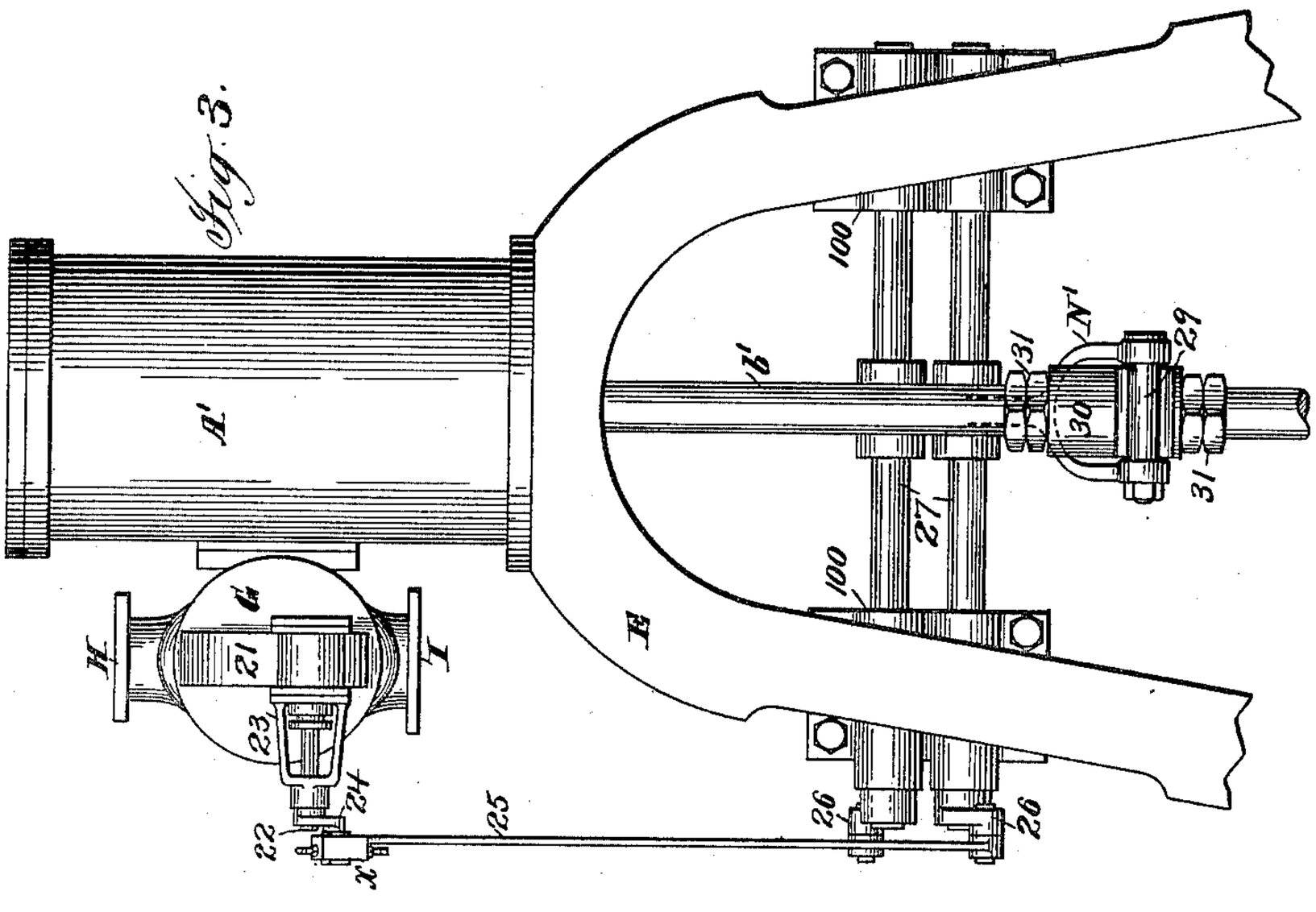
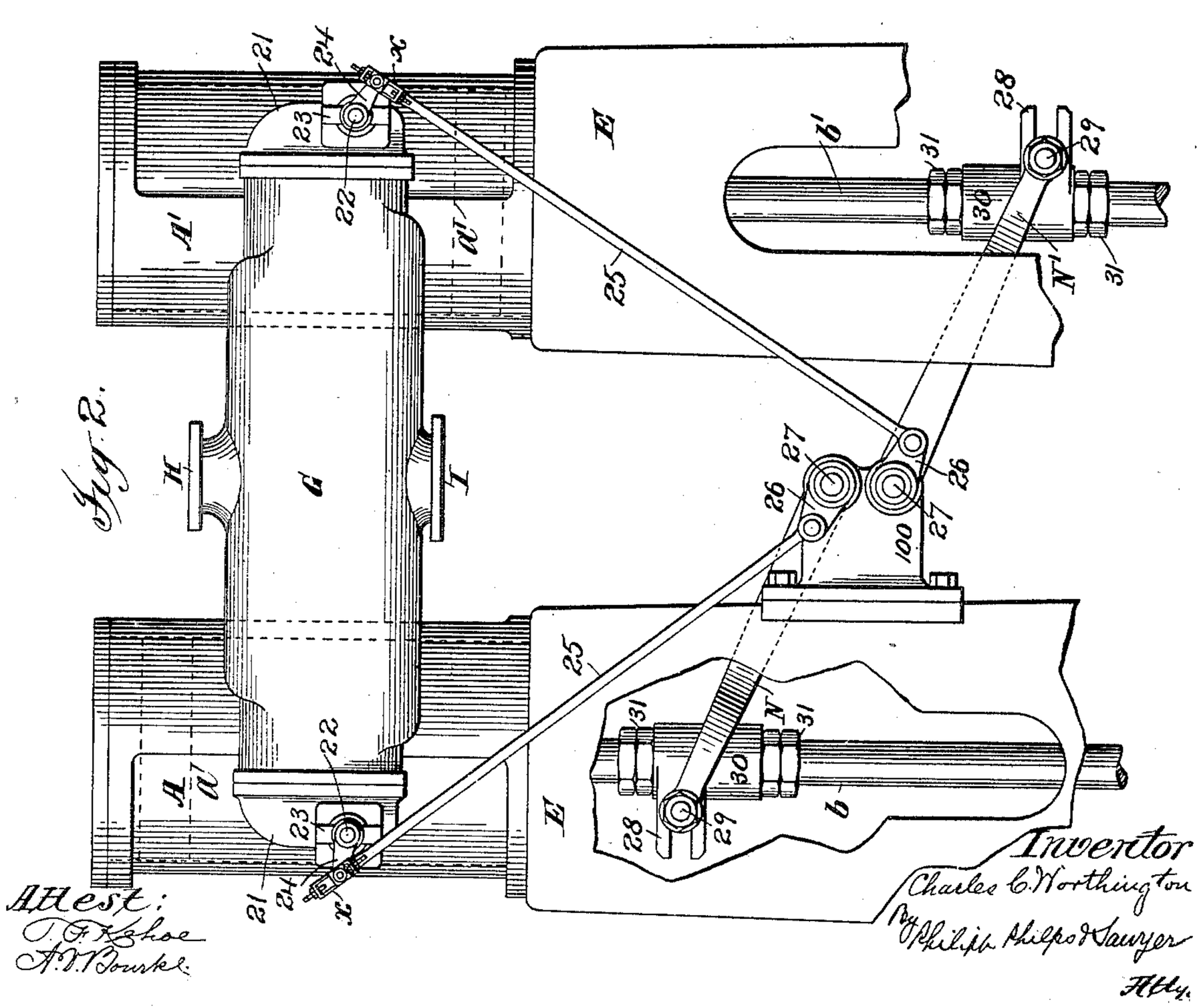


Fig. 2.



Attest:
T. F. Kehoe
A. V. Bourke.

Inventor
Charles C. Worthington
By Philip A. Philps & Sawyer
Atty.

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C. C. WORTHINGTON.

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Fig. 4.

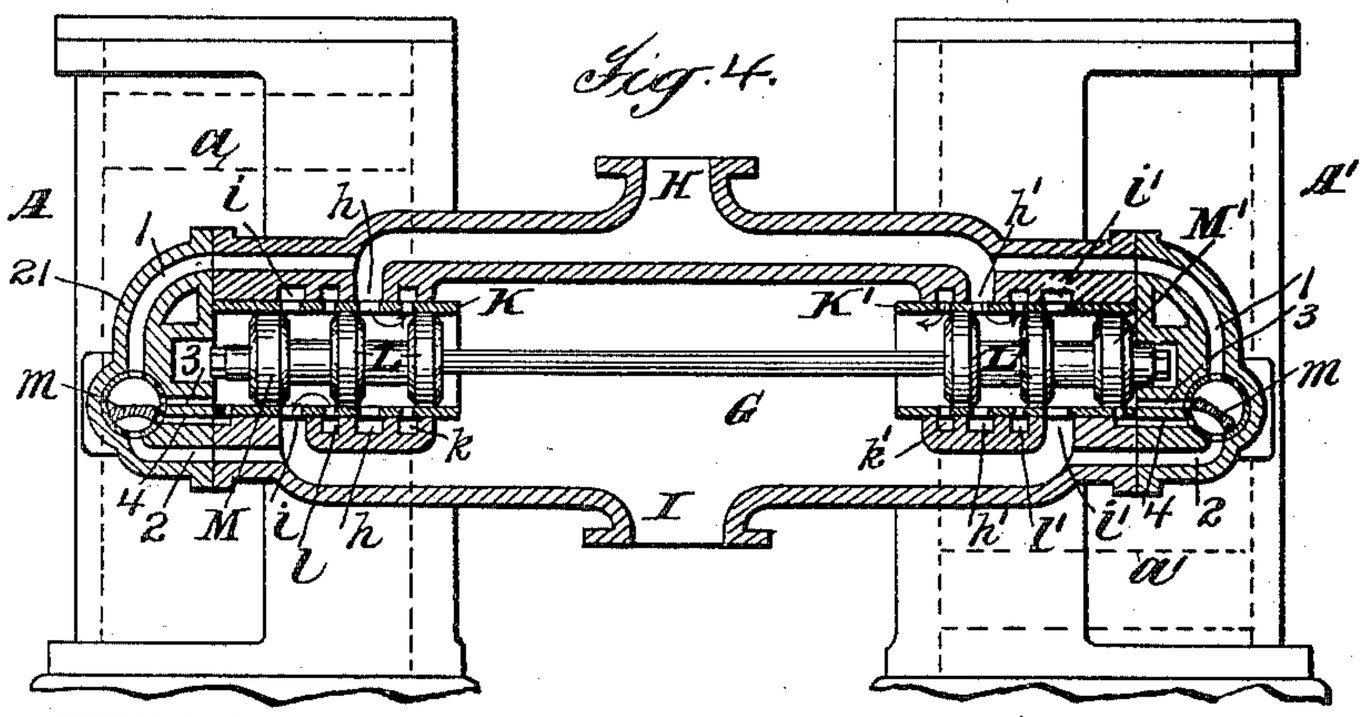


Fig. 5.

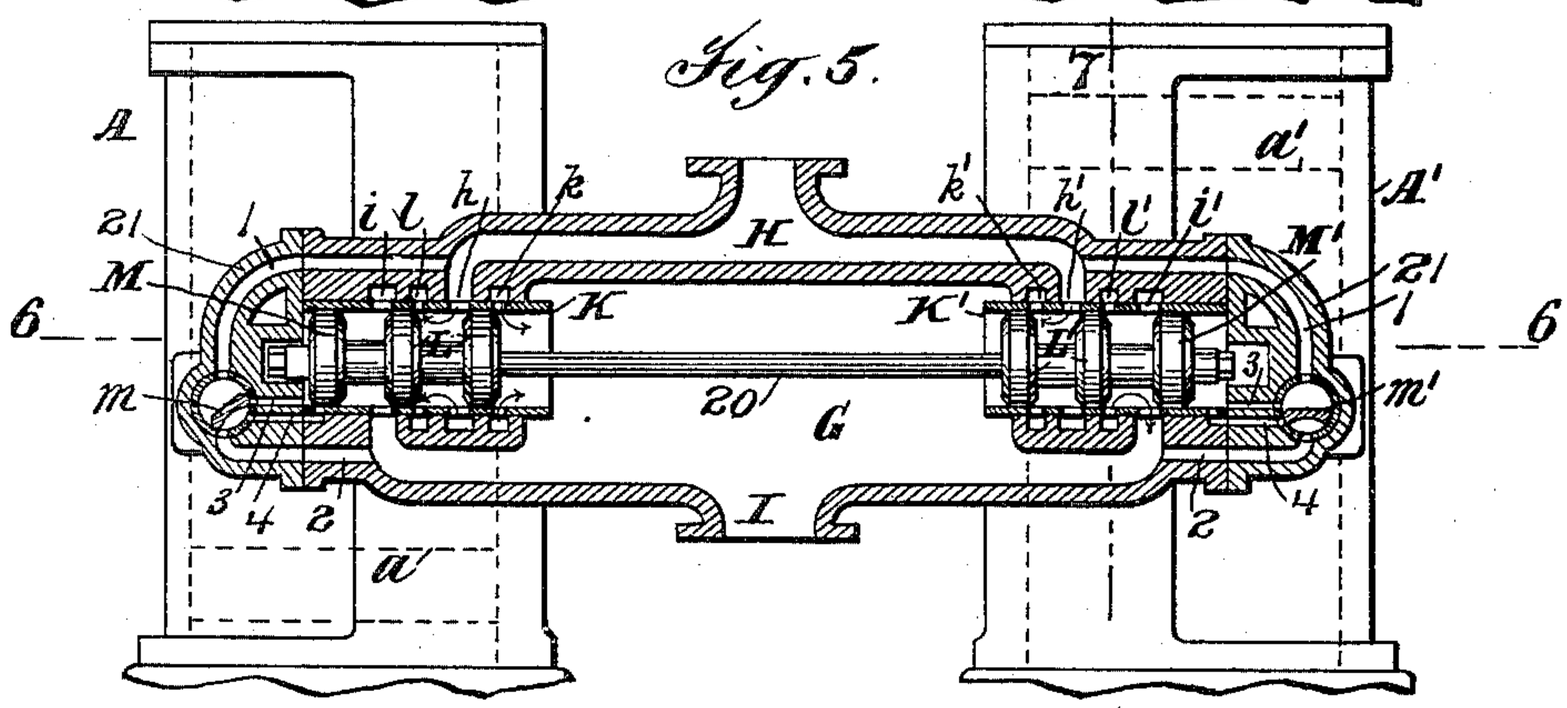


Fig. 6.

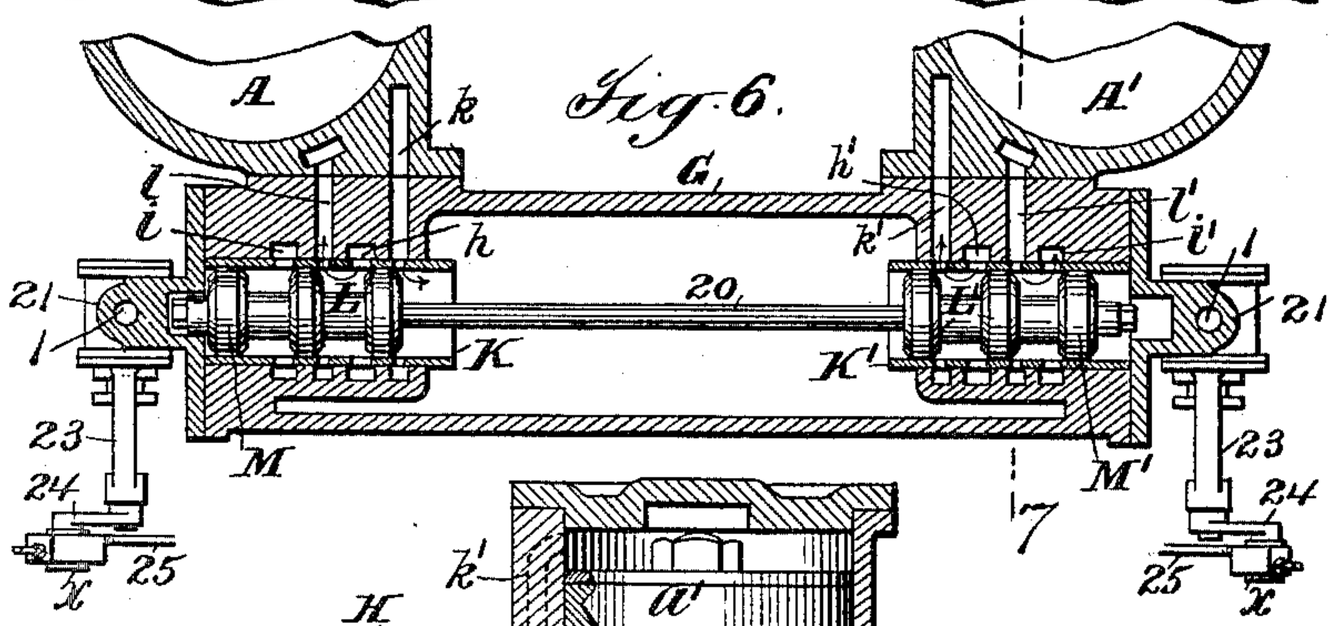
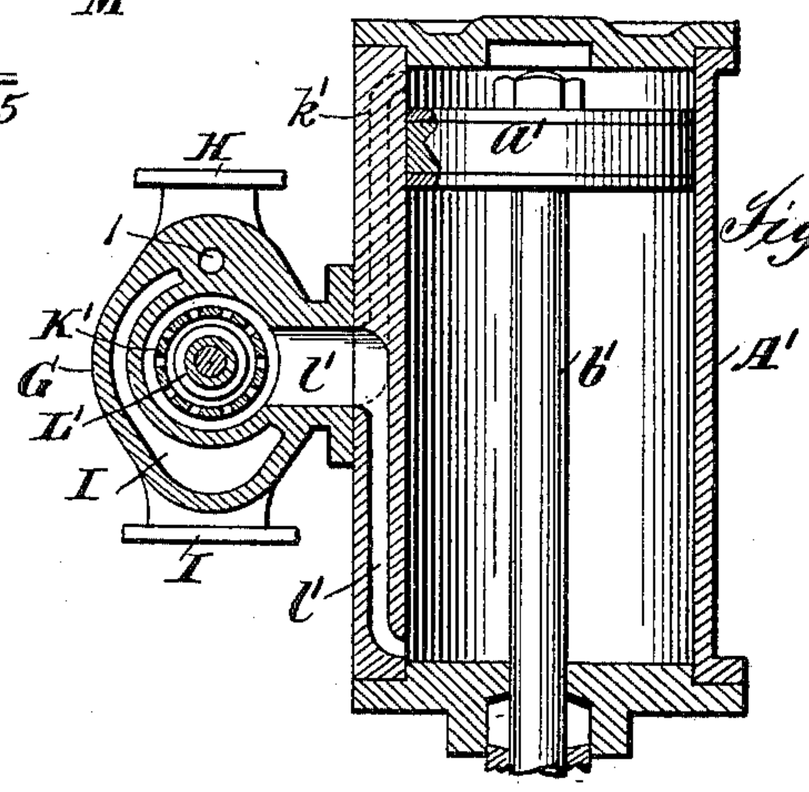


Fig. 7.



Attest:
T. F. Hoge
A. V. Bourke

Inventor:
Charles C. Worthington
By Philipp Phillips & Lawyer
Attys

UNITED STATES PATENT OFFICE.

CHARLES C. WORTHINGTON, OF DUNNFIELD, NEW JERSEY.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 659,947, dated October 16, 1900.

Application filed September 19, 1899. Serial No. 730,996. (No model.)

To all whom it may concern:

Be it known that I, CHARLES C. WORTHINGTON, a citizen of the United States, residing at Dunnfield, county of Warren, and State of New Jersey, have invented certain new and useful Improvements in Steam-Engines, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates particularly to that class of direct-acting steam-pumps in which two steam-cylinders are arranged side by side and the steam-pistons move simultaneously in opposite directions, the especial object of the present invention being to provide an improved vertical pump of this class in which the proper timing and synchronous movement of the pistons and their full stroke shall be secured without tying the two piston-rods together by a beam, as usual in such constructions.

The invention consists in an improved valve-movement in which the valve or valves controlling the admission and exhaust of steam for the cylinders on opposite sides of the engine is or are controlled or actuated by both the steam-pistons, so that the steam valve or valves are operated to reverse the pistons only when both pistons have reached the proper point in their strokes, and if either of the pistons completes its stroke before the other piston the steam valve or valves will not be operated to reverse the piston in advance until the other has completed its stroke. I am thus enabled to secure the proper timing and full stroke of both sides of the engine, although the piston-rods are not tied together. I preferably use a valve-movement in which the valve or valves controlling the admission and exhaust of steam for the cylinders on the opposite sides of the engine is or are controlled or actuated by a motor fluid and the admission and exhaust of the motor fluid are controlled by valve mechanism actuated from the pistons in such a manner that both pistons must be in proper position before the motor fluid can operate to actuate the valve or valves for the reversal of the pistons, and such a movement forms a part of the invention, which, however, broadly considered, includes valve-movements not employing steam-thrown or steam-controlled valves.

For a full understanding of the invention a detailed description of a construction embodying the same as applied in its preferred form to a vertical air-pump or similar pumping-engine will now be given in connection with the accompanying drawings, and the features forming the invention will then be specifically pointed out in the claims.

In the drawings, Figure 1 is a front elevation of the pumping-engine with two high-pressure cylinders, although it will be understood that high and low pressure cylinders for cross compound use of the steam may be employed if desired. Fig. 2 is a front elevation of the upper part of the engine, on a larger scale, showing the parts in a different position. Fig. 3 is a side elevation of Fig. 2. Fig. 4 is a sectional elevation of the steam end of the engine, the section being taken centrally through the steam-chest and showing the parts in the position they occupy in Fig. 2. Fig. 5 is a similar view with the parts shown in the position they occupy in Fig. 1. Fig. 6 is a horizontal section on the line 6 of Fig. 5. Fig. 7 is a vertical section on the line 7 of Figs. 5 and 6.

In the drawings, A A′ are the steam-cylinders, B B′ the corresponding pump-cylinders, and *a a′* the steam-pistons, having piston-rods *b b′*, which are connected to the corresponding pump-plungers in the pump-cylinders B B′, so that the pistons *a a′* operate directly the plungers or buckets in the pump-cylinders B B′, all of which may be of any common or suitable construction. The pump-cylinders B B′ are shown as having suction-main C connecting with the suction-chamber at the lower end of the cylinders and force and delivery main D connecting with the force-chamber at the upper end of the cylinders, as usual in such constructions. The steam-cylinders A A′ are shown as supported by an open frame E, rising from the top of the pump-cylinders; but it will be understood that the framework of the pumping-engine may be of any suitable form.

Referring now to the steam-valve movement, I have shown the invention as embodied in a construction employing a piston valve mechanism and a single steam-chest for controlling the admission and exhaust of steam for the two cylinders A A′, two piston-valves being used, which are connected so as to move

together and actuated by steam which is controlled by the pistons on the opposite sides, so as to secure the results desired. It will be understood, however, that any other suitable form of valve mechanism employing either slide or piston valves and either steam or mechanically thrown valves may be used in carrying out the present invention, broadly considered, the essential feature of the broad invention being the control of valve mechanism of some suitable form by the pistons, as hereinafter described and claimed. In the construction shown a single steam-chest G is mounted upon one side of the cylinders A A', extending across the space between the cylinders, and is provided with a steam-admission port H, entering at the top and branching to the opposite ends of the steam-chest, and with the exhaust-port I at the bottom of the steam-chest communicating directly with the space within the latter, the high-pressure steam passing through the admission-port H directly to the valves, and thus to the steam-cylinders, while the low-pressure steam is exhausted into the space within the steam-chest below the admission-port, and thus to the exhaust-pipe through port I.

The construction of the valves and valve-casings and the cylinder steam-ports is as follows: At opposite ends of the steam-chest G are valve-casings K K', in which move piston-valves L L', which control the admission and exhaust of steam to and from the respective cylinders A A' through ports, as follows: The ports *h h'* are the continuations of the main induction-port H. Ports *i i'* are the exhaust-ports, opening from the valve-casing to the space within the steam-chest G and to the main exhaust-port I. Ports *k k'* are the cylinder admission and exhaust ports, extending from the valve-casings to the upper ends of the cylinders A A', and ports *l l'* are the corresponding admission and exhaust ports for the lower ends of the cylinders. All these ports are preferably sectional ports extending entirely about the valve-casings, as usual in such piston-valve constructions. The valve-casings K K' are open at their inner ends to the space within the steam-chest G, so that the exhaust from each cylinder is in turn through the exhaust-port *i* or *i'* and through the open end of the valve-casing K or K' into the space within the steam-chest, as fully described hereinafter.

The piston-valves L L' are tied together by a valve-rod 20, extending centrally through the space within the steam-chest, this rod being shown as a single rod and unjointed. It will be understood, however, that the rod may be jointed to permit the valves to be somewhat out of line, if desired, and that the valves may be connected in any other suitable manner so as to secure the desired movement of both valves by the motor-pistons now to be described. Outside each of the respective piston-valves L L' is an actuating-piston M M', connected rigidly to the valves, so that the valves and their actuating-pistons, with connecting-rod 20, move together in both directions and pressure upon each of the actuating-pistons M M' is transmitted to both the piston-valves, the valves thus being actuated by the difference in pressure upon the two pistons M M'. These pistons M M' are actuated by steam supplied and controlled as follows: The opposite ends of the steam-chest G are provided with heads 21, which are preferably formed separately from the steam-chest and secured thereto, as shown, so that the outer ends of the valve-casings K K' are closed by these heads when secured in place and steam-chambers thus formed outside the pistons M M'. In these heads 21 are valve-chambers which communicate by ports 1 with the admission-port H and by ports 2 with exhaust-port I and which communicate with the steam-chambers at the outer ends of the valve-casings K K', outside of the pistons M M', by admission-ports 3 and exhaust-ports 4, these ports 1 2 3 4 being controlled by the auxiliary or control valves *m m'* at the respective ends of the steam-chest corresponding to the cylinders A A', which valves are shown as a common form of oscillating valves.

It will be seen that with this construction both the control-valves *m m'* must be in proper position to secure the movement of the motor-pistons M M' with the piston-valves L L' in either direction, as not only must the admission-port 3 outside one of these pistons M M' be opened for the admission of steam outside said piston, but the exhaust-port 4 at the other end of the valve-chest must be opened for the exhaust of steam from outside the other piston M or M', or the pressure upon the two pistons M M' will be balanced and the pistons and valves remain stationary. By controlling the position of the valves *m m'* by or in accordance with the position of the pistons on the opposite sides of the engine, therefore, it may be assured that the valves L L' will not be thrown for the reversal of the pistons *a a'* until both the pistons have reached the full limit of their strokes, and as the valves L L' are connected together so as to move simultaneously the admission and exhaust of steam in the two cylinders A A' for the simultaneous reversal of the pistons *a a'* are assured, so that both pistons *a a'* will start their strokes at the same moment. Thus both pistons will be in exact time at the beginning of each stroke, so that their synchronous movement in opposite directions is assured, and both pistons must complete their full stroke before the valves are shifted for reversal of either piston.

Connections of different form may be used for actuating or controlling the auxiliary or control valves *m m'* by the pistons, and each of these valves may be actuated or controlled by the piston on its own side of the engine or by the piston on the opposite side, or such connections may be used that both pistons will coact in actuating or controlling both valves,

the only essential feature being that the control-valves *m m'* are actuated or controlled by the pistons in such a manner that these valves will not be shifted for the movement of the main valves L L' until both pistons are in the proper position.

I have shown a simple form of connections by which each of the auxiliary or control valves *m m'* is actuated by the piston on its own side of the engine, this form of connections being as follows: The stems 22 of the control-valves *m m'* extend outside the valve-chambers, where they are supported in brackets 23 and are actuated through crank-arms 24 by connecting-rods 25 through suitable lost-motion devices *x*, which may be of any desired form. These connecting-rods 25 connect the crank-arms 24 to crank-arms 26 on rock-shafts 27, mounted in any suitable manner in the frame E, being shown as mounted in brackets 100 thereon, and these rock-shafts 27 are actuated from the piston-rods *b b'* by levers N N', corresponding to the respective piston-rods, so that the lever N actuated by piston-rod *b* operates the auxiliary valve *m* and the lever N' actuated by piston *b'* operates the auxiliary valve *m'*. The levers N N' are actuated from the piston-rods *b b'* by forks 28, engaging pins 29, carried by the forked ends of the levers N N', the forks 28 being carried by sleeves 30, adjustable on the piston-rods *b b'* and held in adjusted position by nuts 31. It will be understood that the piston-rods *b b'* may be divided and the two parts connected together by the sleeves 30, if desired.

The operation of the construction will be understood from the preceding with a brief general description. As shown in Figs. 1 and 5 to 7, the piston *a* is at the end of its downstroke and the piston *a'* at the end of its upstroke and the control-valves *m m'* have just been shifted by the levers N N', acting through the rock-shafts 27, crank-arms 26, connecting-rods 25, and crank-arms 24, so as to open the connection between ports 2 and 4 at the piston M end of the steam-chest G for the exhaust of steam from outside the piston M and to open the connection between the ports 1 3 at the M' piston end of the steam-chest G, so as to admit steam outside piston M', thus moving the pistons M M', with the valves L L', into the position shown in Figs. 5 to 7, the piston M covering the exhaust-port 4 near the end of the piston movement, so as to prevent further exhaust and cushion the piston, the piston and valves then being held in the position shown in these figures by the balanced steam-pressure outside the two pistons M M' until the control-valves *m m'* are shifted to reverse the movement of the pistons. As will be clear from an examination of Figs. 5 to 7, this movement of the valve L connects induction-port H through port *h* and the valve-casing K to the cylinder-port *l*, so as to admit steam below the piston *a*, and the cylinder-port *k* to the exhaust I through the open inner end of the valve-casing K and the space within the steam-chest G, so as to exhaust from above the piston *a*. This movement also by valve L' connects the admission-port H to the cylinder-port *k'* through the port *h'* and the valve-casing, so as to admit steam above the piston *a'* through the cylinder-port *k'*, and the cylinder-port *l'* is connected to the exhaust I through the valve-casing and port *i'* and the space within the steam-chest G, so as to exhaust from below the piston *a'*. The piston *a* of cylinder A now moves up and the piston *a'* of the cylinder A' down for the next stroke, and as these pistons move in opposite directions the levers N N' are moved from the position shown in Fig. 1 toward that shown in Fig. 2, thus, through the rock-shafts 27 and crank-arms 26, moving the connecting-rods 25. This movement of the connecting-rods 25 continues without operation of the crank-arms 24 of the control-valves *m m'* until the lost motion in the devices *x* is taken up, and then the control-valves *m m'* are moved by the connecting-rods 25 acting on crank-arms 24, so that just as both pistons *a a'* reach the end of their stroke these control-valves *m m'* are shifted from the position shown in Figs. 5 to 7 to that shown in Fig. 4, in which position of the valves the pistons and their connections to the control-valves *m m'* are in the position shown in Figs. 2 and 3. This movement of the valves *m m'* from the position shown in Fig. 5 to that shown in Fig. 4 reverses the connections to the ports controlled by the valves *m m'* at the opposite ends of the steam-chest G, so as to admit steam outside piston M and exhaust steam from outside the piston M', with the result that these pistons M M', with the valves L L', are moved by the excess pressure on the piston M to the right from the position shown in Fig. 5 into the position shown in Fig. 4, thus reversing the connections of the admission and exhaust ports for the cylinders A A', controlled by the valves L L', so as to admit steam above the piston *a* and exhaust from below piston *a* and admit steam below the piston *a'* and exhaust from above the piston *a'*, thus reversing the movement of the pistons *a a'* for the next stroke. At the completion of this next downstroke of the piston *a* and upstroke of the piston *a'* the control and main valves are again shifted into the position shown in Fig. 5, and thus the operation is continued.

It will be understood that the invention is not limited to the construction illustrated either as to the valve mechanism or as to the connections by which the valve mechanism is controlled from the steam-pistons, but that the valve mechanism and form of connections illustrated are a very convenient and efficient embodiment of my broad invention, which may be embodied in constructions differing widely in form and arrangement of parts. The form of valve-movement shown, however, is very desirable, as it requires but light

operating connections with the steam-pistons, as only the auxiliary valves *m m'* are mechanically actuated and the steam-valves are thrown quickly at the end of the stroke of the pistons with a very short movement of the valves actuated by the pistons, and such a steam-thrown valve-movement is preferably employed in carrying out the invention.

What is claimed is—

1. The combination with two motor-cylinders and motor-pistons therein movable independently of each other, of valve mechanism controlling the motor fluid for actuating said pistons, and connections between each of said pistons and the valve mechanism for controlling said valve mechanism by both said pistons and constructed and arranged to secure the reversal of the admission and exhaust in either of said cylinders only when both pistons have reached a determined position, substantially as described.

2. The combination with two motor-cylinders and motor-pistons therein movable independently of each other, of fluid-operated main valve mechanism controlling the motor fluid for actuating said pistons, and auxiliary valve mechanism controlling the fluid operating said main valve mechanism, and connections between each of said pistons and the auxiliary valve mechanism for controlling said auxiliary valve mechanism by both said pistons, said valve mechanisms and connections being constructed and arranged to secure the reversal of the admission and exhaust in either of said cylinders only when both pistons have reached a determined position, substantially as described.

3. The combination with two motor-cylinders and motor-pistons therein movable independently of each other, of valve mechanism controlling the motor fluid for actuating said pistons and comprising separate fluid-operated main valves for the two cylinders connected to move together, auxiliary valve mechanism controlling the fluid operating said main valves, and connections between each of said pistons and the auxiliary valve mechanism for controlling said auxiliary valve mechanism by both said pistons to secure the reversal of the admission and exhaust in either of said cylinders only when both pistons have reached a determined position, substantially as described.

4. The combination with two motor-cylinders and motor-pistons therein movable independently of each other, of valve mechanism controlling the motor fluid for actuating said pistons and comprising separate fluid-operated main valves for the two cylinders connected to move together, auxiliary valve mechanism having separate valves for admitting the fluid operating the main valves for the movement of the valves in opposite directions, whereby the main valves are moved in opposite directions by the admission movement of one auxiliary valve and the exhaust movement of the other auxiliary valve, and connections between said auxiliary valve mechanism and both said motor-pistons whereby the admission and exhaust of motor fluid for each of said cylinders are controlled by the movement of both motor-pistons, substantially as described.

5. The combination with two motor-cylinders and motor-pistons therein movable independently of each other, of valve mechanism controlling the motor fluid for actuating said pistons and comprising separate fluid-operated main valves for the two cylinders connected to move together, auxiliary valve mechanism having separate valves for admitting the fluid operating the main valves for the movement of the valves in opposite directions, whereby the main valves are moved in opposite directions by the admission movement of one auxiliary valve and the exhaust movement of the other auxiliary valve, and independent connections between each of said auxiliary valves and one of the pistons, substantially as described.

6. In a direct-acting pumping-engine, the combination with two motor-cylinders and motor-pistons therein connected to their corresponding pumping devices and each movable independently of the other, of valve mechanism controlling the motor fluid for actuating said pistons, and connections between each of said pistons and the valve mechanism for controlling said valve mechanism by both said pistons and constructed and arranged to secure the reversal of the admission and exhaust in said cylinders simultaneously when both pistons have reached a determined position to move the pistons simultaneously in opposite directions, substantially as described.

7. In a direct-acting pumping-engine, the combination with two motor-cylinders and motor-pistons therein connected to their corresponding pumping devices and each movable independently of the other, of fluid-operated main valve mechanism controlling the motor fluid for actuating said pistons, and auxiliary valve mechanism controlling the fluid operating said main valve mechanism, and connections between each of said pistons and the auxiliary valve mechanism for controlling said auxiliary valve mechanism by both said pistons, said valve mechanisms and connections being constructed and arranged to secure the reversal of the admission and exhaust in said cylinders simultaneously when both pistons have reached a determined position to move the pistons simultaneously in opposite directions, substantially as described.

8. In a direct-acting pumping-engine, the combination with two motor-cylinders and motor-pistons therein connected to their corresponding pumping devices and each movable independently of the other, of valve mechanism controlling the motor fluid for actuating said pistons and comprising separate fluid-operated main valves for the two cylinders connected to move together, auxil-

iary valve mechanism controlling the fluid operating said main valves, and connections between each of said pistons and the auxiliary valve mechanism for controlling said auxiliary valve mechanism by both pistons, said valve mechanisms and connections being constructed and arranged to secure the reversal of the admission and exhaust in said cylinders simultaneously when both pistons have reached a determined position to move the pistons simultaneously in opposite directions, substantially as described.

9. In a direct-acting pumping-engine, the combination with two motor-cylinders and motor-pistons therein connected to their corresponding pumping devices and each movable independently of the other, of valve mechanism controlling the motor fluid for actuating said pistons and comprising separate fluid-operated main valves for the two cylinders connected to move together, auxiliary valve mechanism having separate valves for admitting the fluid operating the main valves for the movement of the valves in opposite directions, whereby the main valves are moved in opposite directions by the admission movement of one auxiliary valve and the exhaust movement of the other auxiliary valve, and connections between said auxiliary valve mechanism and both said motor-pistons whereby the admission and exhaust of motor fluid for each of said cylinders are controlled by the movement of both motor-pistons, substantially as described.

10. In a direct-acting pumping-engine, the combination with two motor-cylinders and motor-pistons therein connected to their corresponding pumping devices and each movable independently of the other, of valve mechanism controlling the motor fluid for actuating said pistons and comprising separate fluid-operated main valves for the two cylinders connected to move together, auxiliary valve mechanism having separate valves for admitting the fluid operating the main valves for the movement of the valves in opposite directions, whereby the main valves are moved in opposite directions by the admission movement of one auxiliary valve and the exhaust movement of the other auxiliary valve, and independent connections between each of said auxiliary valves and one of the pistons, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

CHARLES C. WORTHINGTON.

Witnesses:

B. W. PIERSON,

LOUIS R. ALBERGER.