No. 659,927. Patented Oct. 16, 1900.

H. JENSENIUS.

STEAM ENGINE.

(Application filed Sept. 19, 1899.)

(No Model.) 3 Sheets—Sheet 1.

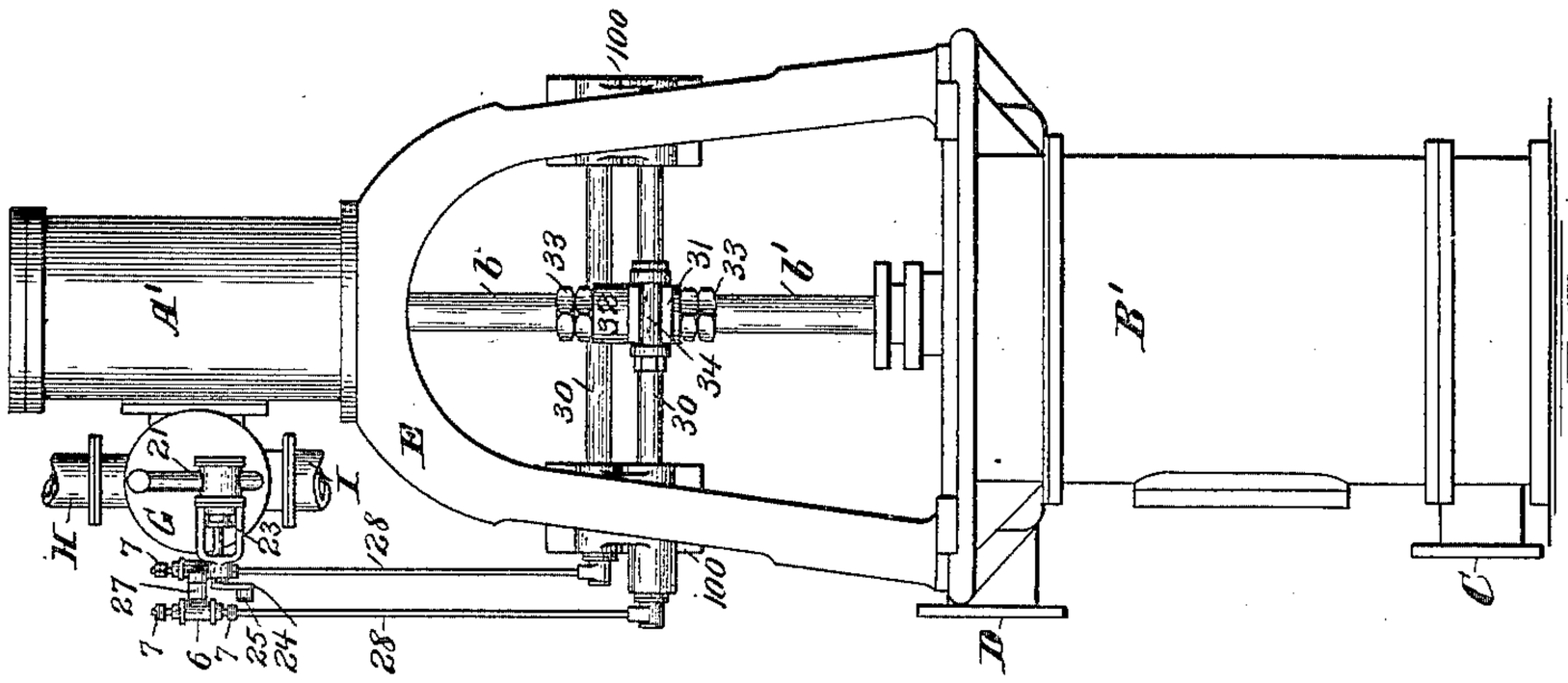

Fig. 2.

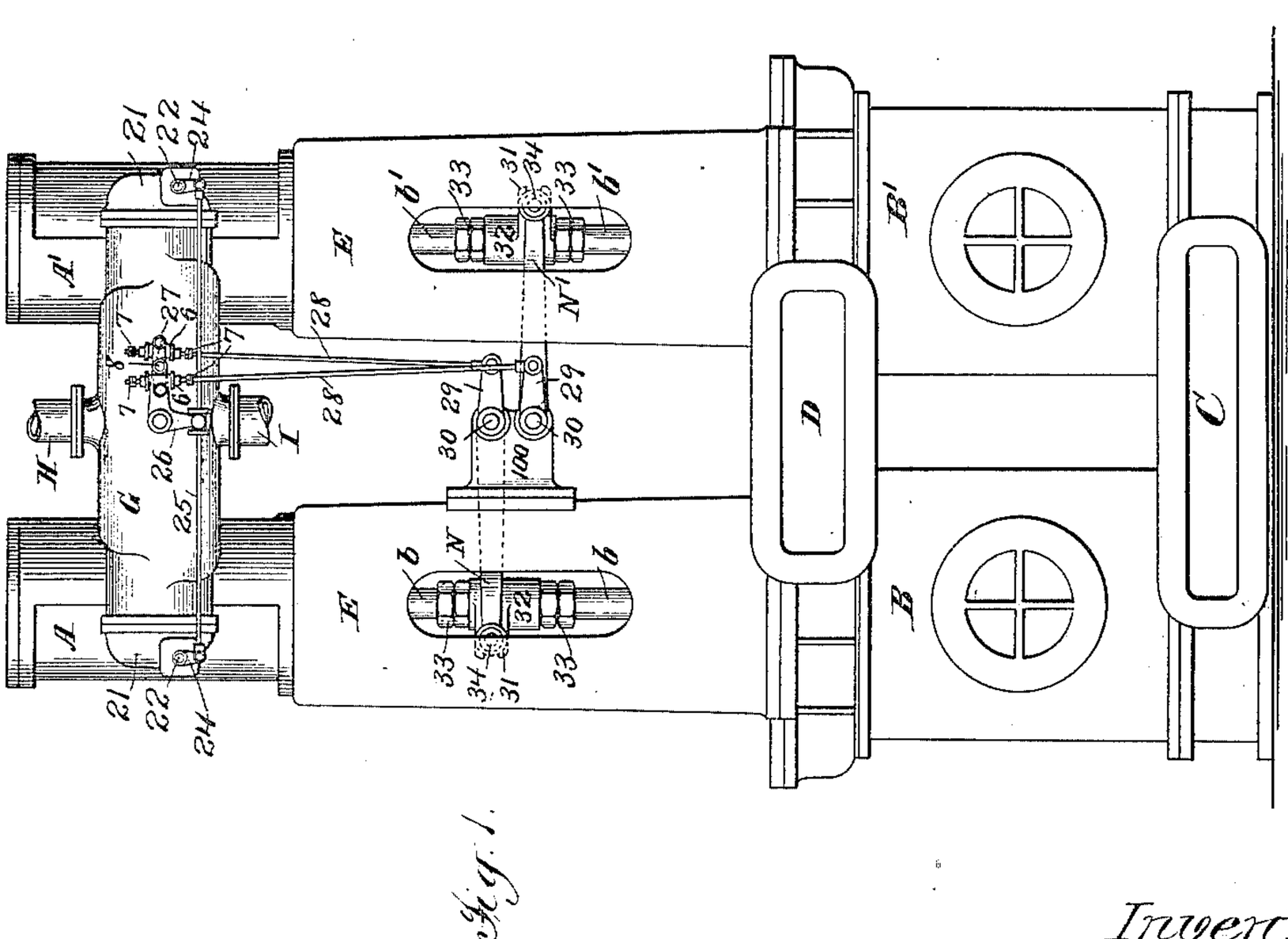

Fig. 1.

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Fig. 3.

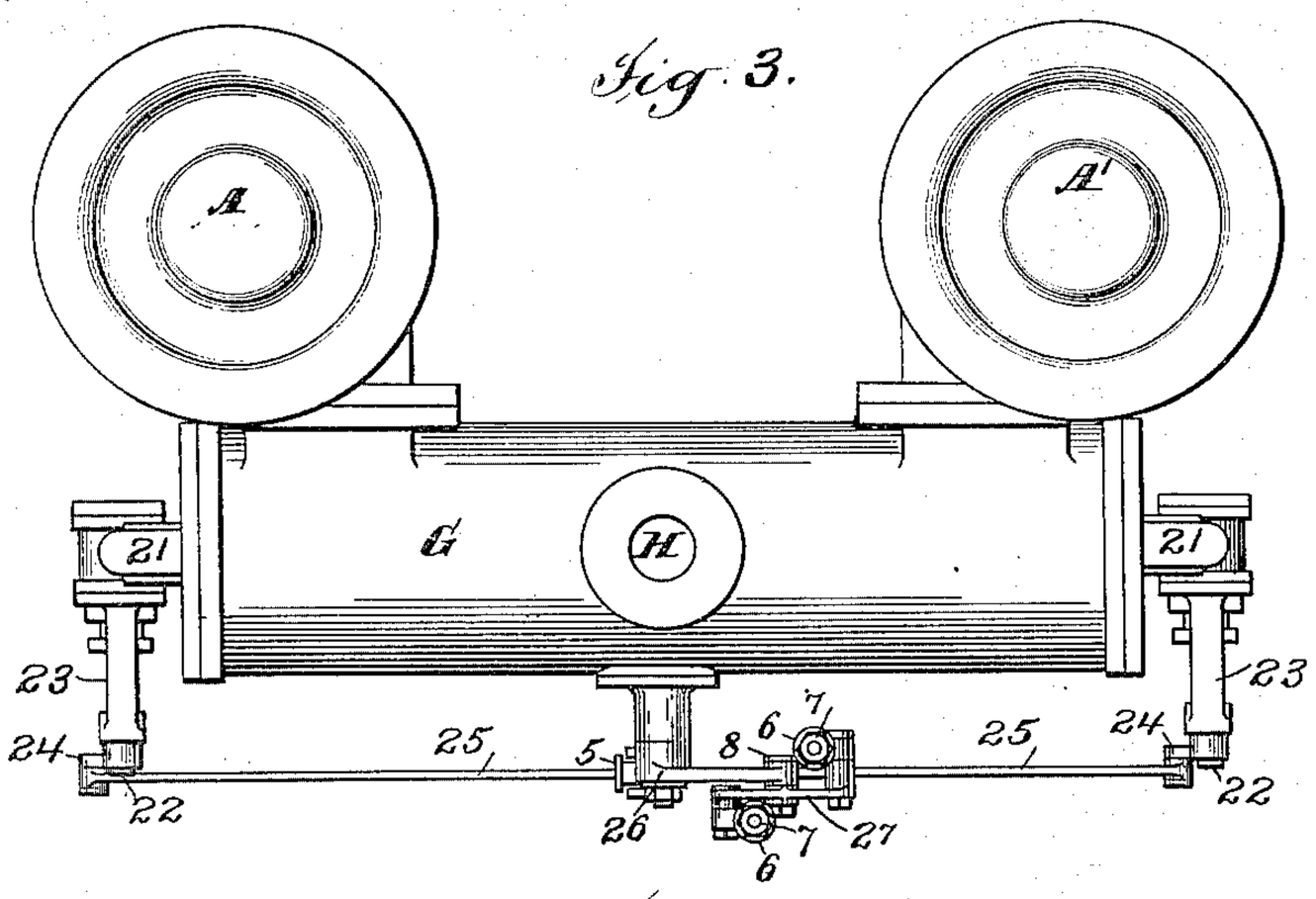

Fig. 4.

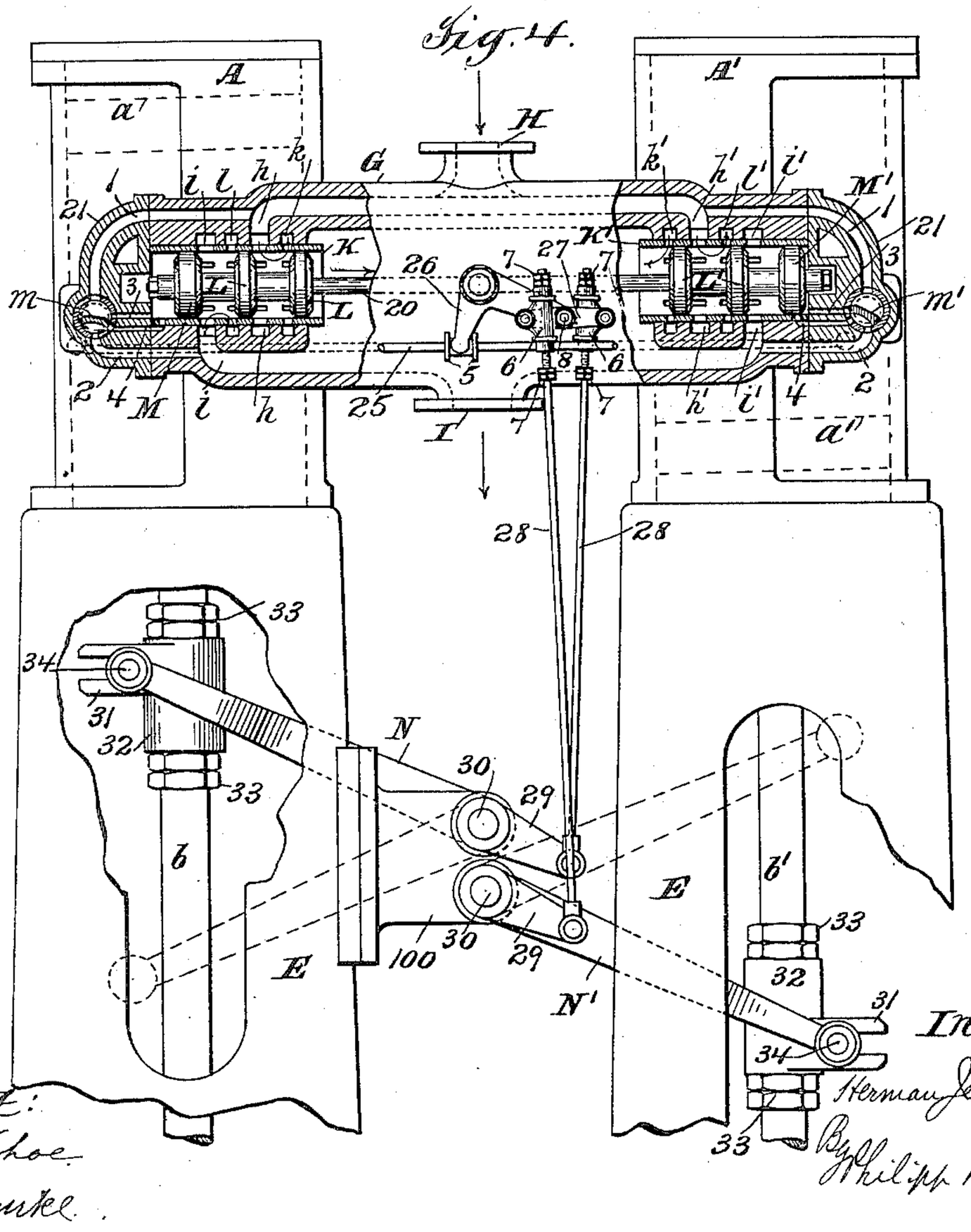

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Fig. 5.

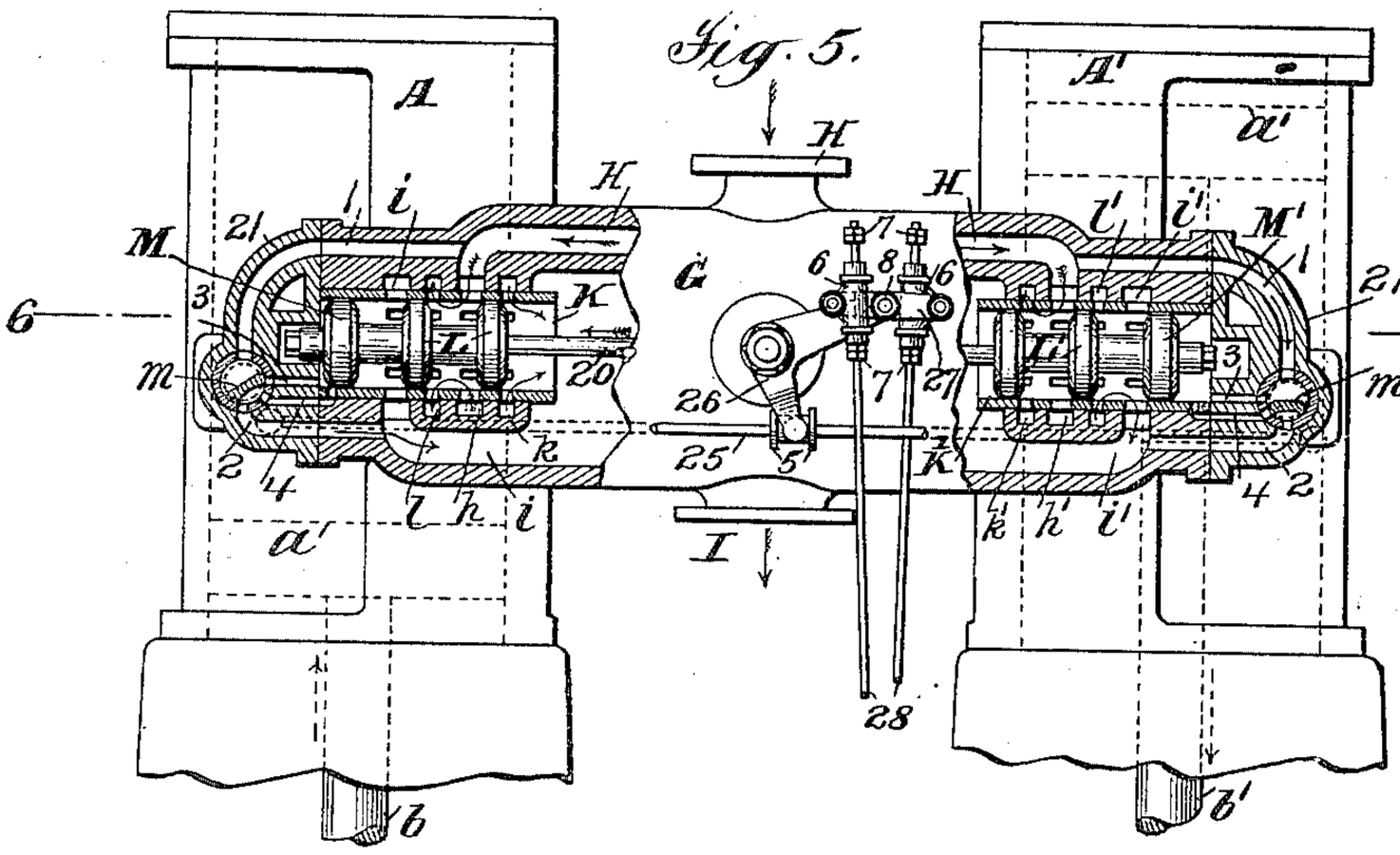


Fig. 6

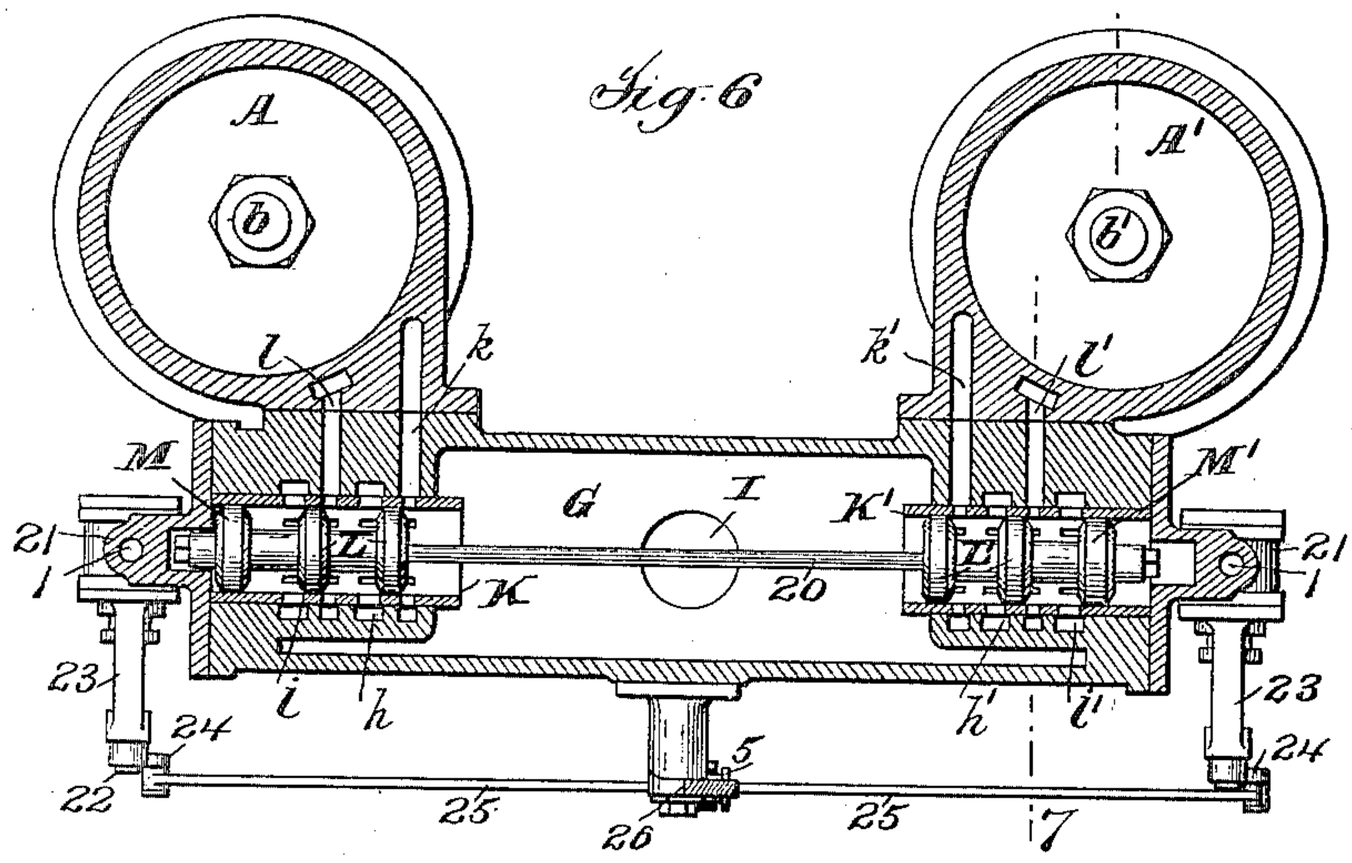
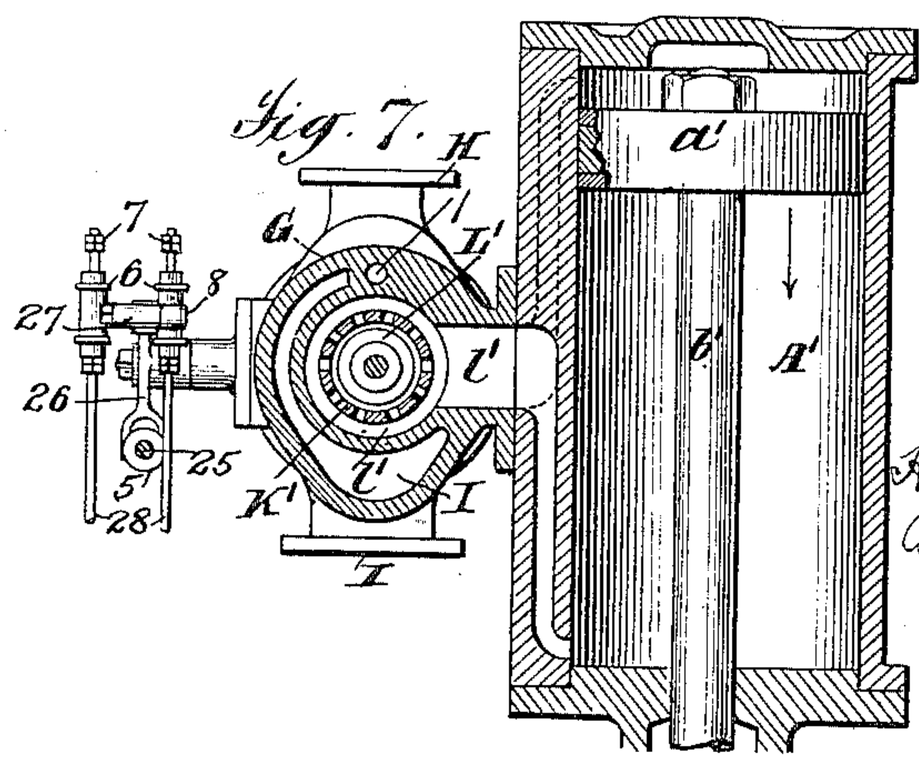


Fig. 7.



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UNITED STATES PATENT OFFICE.

HERMAN JENSENIUS, OF NEW YORK, N. Y., ASSIGNOR TO THE HENRY R. WORTHINGTON, OF ELIZABETH, NEW JERSEY.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 659,927, dated October 16, 1900.

Application filed September 19, 1899. Serial No. 730,988. (No model.)

To all whom it may concern:

Be it known that I, HERMAN JENSENIUS, a citizen of the United States, residing in the borough of Brooklyn, city of New York, county of Kings, and State of New York, 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 with corresponding pump-cylinders and the pistons moved simultaneously in opposite directions, the special object of the present invention being to provide an improved vertical pump of that 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 form of connections between the pistons and the valve or valves controlling the admission and exhaust of steam for the two cylinders or between the pistons and the auxiliary or control valve or valves of steam-thrown valve movements, by which the movement or movements of such valve or valves is or are controlled by the two pistons in such a manner 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 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 steam or other motor fluid, and the admission and exhaust of the motor fluid is controlled by valve mechanism actuated from the pistons through my improved connections 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 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 cross compound cylinders may be used, if desired. Fig. 2 is a side elevation of the engine. Fig. 3 is a plan view of the engine. Fig. 4 is an enlarged elevation of the upper part of the engine with the steam-chest sectioned centrally at opposite ends to show the valve construction and the supporting-frame partly broken away. Fig. 5 is a view similar to Fig. 4, showing the steam-cylinders and valves with the parts in a different position from Fig. 4. Fig. 6 is a horizontal section on the line 6 of Fig. 5. Fig. 7 is a vertical section on the line 7 of Fig. 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 the force or 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, the invention is illustrated as applied in connection with a single steam-chest and

piston-valve construction in which separate piston-valves are employed for the two cylinders A A′, but connected so as to move together, and these valves are actuated by steam controlled by two auxiliary or control valves, these control-valves being actuated so as to secure the admission and exhaust of steam for shifting the piston-valves as required for the control of the steam-ports to actuate the pistons *a a′* in opposite directions. These control-valves are connected so as to be moved together, and the member by which they are moved is actuated from the pistons *a a′* by connections such that this member is moved for shifting the control-valves so as to throw the main valves for the reversal of the pistons *a a′* only when both these pistons have reached their proper position—that is, the end of their full strokes for which the engine is adjusted. It will be understood, however, that the present invention does not depend upon any particular form of valve mechanism whether employing steam-thrown valves or otherwise, and in steam-thrown valve mechanisms either one or more control-valves may be used, the present invention consisting in the connections between the pistons and a member by which the main valves may be shifted or controlled directly or by steam or other motor fluid controlled through one or more valves by said member.

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, which is closed to the space within the valve-chest, directly to the valves, and thus to the steam-cylinders, while the low-pressure steam is exhausted into the space within the steam-chest, 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 the main exhaust-port I. Ports *k k′* are the cylinder admission and exhaust ports extending from the valve-casing to the upper ends of the cylinders, 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 rod may be divided or 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 their 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 open 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 casings 21 are valve-chambers which communicate by ports 1 with the admission-port H and by ports 2 with the space within the valve-casing and 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′, these valves being shown as a common form of oscillating valves. The stems 22 of these control-valves *m m′* extend outside the valve-chambers, where they are supported in brackets 23 and are actuated through crank-arms 24 by a connecting-rod 25, which extends between the crank-arms of the two control-valves *m m′* at opposite ends of the steam-chest, so that these valves move together, and this rod 25 is actuated to oscillate the control-valves *m m′* as required by one arm of a bell-crank lever 26, mounted on the steam-chest and moving between collars 5 on the rod 25, so as to throw the rod 25 in opposite directions as it engages one or the other of the collars 5 in its movement in either direction. This bell-crank lever is actuated by the following means, so that it will be moved to shift the valves *m m′* only when both pistons *a a′* have

reached the proper position and both are just at the end of their strokes, or if one has reached the end of its stroke ahead of the other the lever will not be moved until just as the other piston reaches the end of its stroke. The other arm of the bell-crank lever 26 has pivoted thereon a lever 27, and this lever carries at its opposite ends and at opposite sides of its pivot to the lever 26 sleeves 6, which are pivotally mounted on the lever 27. Through these sleeves 6 pass the upper ends of connecting-rods 28, adjustable lost motion between the connecting-rods and the sleeves being secured by nuts 7 on the threaded ends of the connecting-rods above and below the sleeves 6, so that by the adjustment of these nuts the amount of lost motion may be varied and the time of engagement of the nuts 7 with the sleeves 6 determined as desired. The lower ends of these connecting-rods 28 are pivoted to crank-arms 29 on rock-shafts 30, mounted in the frame E in any suitable manner and shown as carried by brackets 100 thereon, and these rock-shafts 30, with the crank-arms 29, are actuated from the piston-rods *b b'* by levers N N', which are actuated from the respective piston-rods *b b'* by forks 31, carried by sleeves 32 on the piston-rods *b b'* and secured in position by nuts 33, these forks 31 engaging pins 34, carried by the forked ends of the levers N N'. It will be understood that the piston-rods *b b'* may be divided and the two parts secured together by the sleeves 32, if desired.

The operation of the construction will be understood from the preceding with a brief general description. As shown in Figs. 1 and 2 the pistons are on center, this position being selected simply for the purpose of illustrating the outside working parts of the engine. In Figs. 4 to 7, however, the steam end is shown with the steam-valves thrown to different positions, Fig. 4 showing the steam-valves thrown to the right for starting the piston *a* on its downstroke and the piston *a'* on its upstroke, and Figs. 5 to 7 showing the valves thrown to the left for starting the piston *a* on its upstroke and the piston *a'* on its downstroke. In the position of Fig. 4 piston *a* has moved up and the piston *a'* down from the central position of Fig. 1, and the movement of the levers N N' transmitted through the rock-shafts 30, crank-arms 29, connecting-rod 28, moving downward, and lever 27, the lost motion between the connecting-rods 28 and sleeves 6 having been taken up, has moved to the left the arm of bell-crank 26, engaging collar 5, and thus moved the connecting-rod 25 to the left and, through crank-arms 24 and valve-stems 22, oscillated the control-valves *m m'* into the position shown in Fig. 4, in which the valve *m* opens the connection between ports 1 and 3 at the M piston end of steam-chest G, so as to admit steam outside piston M, and opens the connection between ports 2 and 4 at the piston M' end of steam-chest G, so as to exhaust steam from outside the piston M'. By thus admitting steam outside the piston M and exhausting outside piston M' the pistons, with the rod 20 and valves L L', are moved to the right in the drawings and into the position shown in Fig. 4, the piston M' covering the exhaust-port 4 near the end of the piston-stroke, so as to prevent further exhaust and cushion the piston, the pistons and valves then being held in the position shown in Fig. 4 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. This movement of the pistons M M' and valves L L' reverses the admission and exhaust in the cylinders A A', so as to start the piston *a* on its downstroke and piston *a'* on its upstroke from the position shown in Fig. 4. As the piston *a* moves down and piston *a'* moves up the connecting-rods 28, actuated by the levers N N', connected to these pistons, are moved upward, the movement of one of these rods being reversed relatively to its piston and the other rod moving in the same direction as its piston on account of the different forms of the levers employed formed by the levers N N', crank-shafts 30, and cranks 29. The connecting-rods thus move upward through sleeves 6 until the lost motion between the rods and sleeves is taken up, when the nuts 7 strike the under sides of the sleeves 6, which occurs just as the pistons are approaching the ends of their strokes, and the simultaneous upward movement of the connecting-rods 28, if the pistons are moving together when the lost motion on the two connecting-rods has been taken up, moves the lever 27 upward bodily, and thus rocks the lever 26 upon its pivot to the steam-chest, raising the arm on which the lever 27 is mounted and throwing the other arm to the right from the position shown in Fig. 4 to that shown in Fig. 5, thus moving the connecting-rod 25 to the right and shifting the control-valves *m m'* from the position shown in Fig. 4 to that shown in Fig. 5, which movement of the control-valves *m m'* reverses the connection of the admission and exhaust ports 1 2 3 4 at opposite ends of the steam-chest G, thus admitting steam outside the piston M' and exhausting from outside the piston M, so that the pistons M M', with the valves L L', are moved to the left by the steam-pressure from the position shown in Fig. 4 to that shown in Fig. 5, in which the valves L L' reverse the admission and exhaust of steam in the cylinders A A', so as to start the piston *a* on its next upstroke and the piston *a'* on its next downstroke from the position shown in Fig. 5. The above is the action of the lever 27 if both pistons reach the end of their stroke at the same time, so that the lost motion between the two connecting-rods 28 and the sleeves 6 is taken up and the sleeves moved by the engagement of nuts 7 simultaneously. If, however, one of the pistons runs ahead of the

other, so that the lost motion between the connecting-rod 28 actuated by it and the corresponding sleeve 6 is taken up before the lost motion between the other connecting-rod 28 as actuated by the other piston and its corresponding sleeve 6 is taken up, it will be seen that the lever 27 will not be raised bodily so as to actuate the lever 26, but that the lever 27 will be rocked upon the pivot 8, by which it is mounted on the lever 26, and this rocking movement of the lever 27 upon the lever 26 will continue until the lost motion thus provided for is taken up and both sleeves 6 are in engagement with the nuts 7 on the connecting-rods 28. If neither piston has then completed its stroke, the lever 27 will then be raised bodily by the joint action of the connecting-rods 28 until the advance piston has reached the end of its stroke and will then be moved by the other connecting-rod actuated by the other piston, rocking upon its pivot to the sleeve 6, now held stationary by the stopping of the piston that has completed its stroke until the stroke of the moving piston is completed and the valves *m m'* thus shifted. The lever 27 thus forms a lost-motion device common to both pistons between them and the lever 26, by which the valve mechanism is actuated, and the lost motion thus provided for must be taken up by the proper movement of both pistons before the valve mechanism will be actuated to reverse the movement of the steam-pistons. If one piston should run during a stroke so far ahead of the other that it reaches the end of its stroke before the lost motion between the other connecting-rod 28 and the sleeve 6 has been taken up by the movement of lever 27 upon its pivot 8 and the movement of the other piston-rod, then it is obvious that the shifting of the lever 26 will be effected wholly by the movement of the other piston rocking the lever 27 on its pivot to the sleeve 6 that is held stationary by the piston which has completed its stroke. In either case the piston that completes its stroke in advance of the other piston will wait at the end of its stroke until the stroke of the other piston is completed before commencing its reverse stroke, as the valves L L' are shifted to reverse the pistons only when both pistons have completed their stroke. On the next stroke the action is the same with the connecting-rods 28 moving downward, and the parts are thus returned to the position shown in Fig. 4.

The control of the steam-cylinder ports by the valves L L' will be understood readily from Figs. 5 to 7 with a brief description. In the position shown in Fig. 5 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-port 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*, while valve L' connects induction-port H to the cylinder-port *k'* through the port *h'* and the valve-casing, so as to admit steam above the piston *a'*. In the position shown in Fig. 4 the connection of the ports for cylinder A is the same as the connection for cylinder A' in Fig. 5, as just described, and the connection of the ports for cylinder A' is the same as those for cylinder A in Fig. 5.

It will be understood that the invention is not to be limited to the construction of valve mechanism illustrated nor to constructions in which the pistons are connected to and actuate auxiliary or control valves instead of the main steam-valves, and the main valves are actuated by steam or other motor fluid, as my means for operating a valve or valves from two pistons is generally applicable for this purpose. Such valve movements as that shown, however, in which the pistons control the steam-valves indirectly through a control valve or valves actuated by the pistons, is very efficient and requires only very light connections with the steam-pistons, while a quick throw of the valves at the end of the piston-stroke is secured with a small movement of the parts actuated by the pistons. It will be understood, also, that I am not to be limited to the form of connections shown between the pistons and the valves actuated thereby, as modifications may be made therein without departing from the invention, and the invention, considered broadly, includes other suitable forms of lost-motion devices common to the two pistons that may be substituted for the lever 27 to secure the desired result.

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 means for controlling said valve mechanism including an actuating member and connections between said member and each of said pistons comprising lost-motion devices whereby the lost motion is taken up and the actuating member moved for the operation of the valve mechanism 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 valve mechanism controlling the motor fluid for actuating said pistons, and means for controlling said valve mechanism including an actuating member, a lever pivoted on said member, and connections between said lever and each of the pistons whereby the lever will be rocked by the motor-pistons on its pivot on the actuating member, or moved with the actuating member for the operation of the valve mechanism according to the position of the two pistons, 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 means for controlling said valve mechanism including an actuating member, a lever pivoted on said member, and separate connections between said lever on opposite sides of its pivot on the actuating member and each of the pistons whereby the lever will be rocked on the actuating member by the movement of either of the pistons in advance of the other until the other reaches a determined position, or the lever will be moved with the actuating member for the operation of the valve mechanism by one or both of the pistons 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 means for controlling said valve mechanism including an actuating member, a lever pivoted on said member, and separate connections between said lever on opposite sides of its pivot on the actuating member and each of the pistons including lost-motion devices between the pistons and said lever whereby the lever will be rocked on the actuating member by the movement of either of the pistons after the lost motion between said piston and the lever has been taken up until the lost motion between the lever and the other piston has been taken up, or the lever will be moved with the actuating member for the operation of the valve mechanism by one or both of the pistons after the lost motion between both of the pistons and the lever has been taken up, substantially as described.

5. 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, auxiliary valve mechanism controlling the fluid operating said main valve mechanism, means for controlling said auxiliary valve mechanism including an actuating member and connections between said member and each of said pistons comprising lost-motion devices whereby the lost motion is taken up and the actuating member moved for the operation of the auxiliary valve mechanism only when both pistons have reached a determined position, substantially as described.

6. 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, auxiliary valve mechanism controlling the fluid operating said main valve mechanism and means for controlling said auxiliary valve mechanism including an actuating member, a lever pivoted on said member, and connections between said lever and each of the pistons whereby the lever will be rocked by the motor-pistons on its pivot on the actuating member, or moved with the actuating member for the operation of the auxiliary valve mechanism according to the position of the two pistons, substantially as described.

7. 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, an actuating member connected to both of the auxiliary valves, a lever pivoted on said member, and connections between said lever and each of the pistons whereby the lever will be rocked by the motor-pistons on its pivot on the actuating member or moved with the actuating member for the operation of the auxiliary valves according to the position of the two pistons, 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 in opposite directions simultaneously, and means for controlling said valve mechanism including an actuating member, and connections between said member and each of said pistons comprising lost-motion devices whereby the lost motion is taken up and the actuating member moved for the operation of the valve mechanism only when both pistons have reached a determined position, 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 in opposite directions simultaneously, and means for controlling said valve mechanism including an actuating member, a lever pivoted on said member, and connections between said lever and each of the pistons whereby the lever will be rocked by the motor-pistons on the actuating member, or moved with the actuating member for the operation of the valve mechanism according to the position of the two 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 fluid-operated main valve mechanism controlling the motor fluid for actuating said pistons in

opposite directions simultaneously, auxiliary valve mechanism controlling the fluid operating said main valve mechanism, and means for controlling said auxiliary valve mechanism including an actuating member and connections between said member and each of said pistons comprising lost-motion devices whereby the lost motion is taken up and the actuating member moved for the operation of the auxiliary valve mechanism only when both pistons have reached a determined position, substantially as described.

11. 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 in opposite directions simultaneously, auxiliary valve mechanism controlling the fluid operating said main valve mechanism including an actuating member, a lever pivoted on said member, and connections between said lever and each of the pistons whereby the lever will be rocked by the motor-pistons on the actuating member, or moved with the actuating member for the operation of the auxiliary valve mechanism according to the position of the two pistons, substantially as described.

12. 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 in opposite directions simultaneously, auxiliary valve mechanism controlling the fluid operating said main valve mechanism including an actuating member, a lever pivoted on said member, and separate connections between said lever on opposite sides of its pivot on the actuating member and each of the pistons including lost-motion devices between the pistons and said lever whereby the lever will be rocked on the actuating member by the movement of either of the pistons after the lost motion between said piston and the lever has been taken up until the lost motion between the lever and the other piston has been taken up, or the lever will be moved with the actuating member for the operation of the auxiliary valve mechanism by one or both of the pistons after the lost motion between both of the pistons and the lever has been taken up, substantially as described.

13. The combination with pistons a,a' and a valve mechanism, of an actuating member connected to said valve mechanism, lever 27 pivoted on said member, connecting-rods 28 having a pivotal connection with said lever on opposite sides of its pivot, connections between said rods 28 and the pistons for operating the connecting-rods and reversing the movement of one of the connecting-rods relatively to the piston by which it is operated, and lost-motion devices between the lever and pistons, substantially as described.

14. The combination with pistons a, a', and a valve mechanism, of an actuating member connected to said valve mechanism, lever 27 pivoted on said member, and connections between said lever on opposite sides of its pivot and the respective pistons with lost motion between each piston and the lever, substantially as described.

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

HERMAN JENSENIUS.

Witnesses:
B. W. PIERSON,
LOUIS R. ALBERGER.