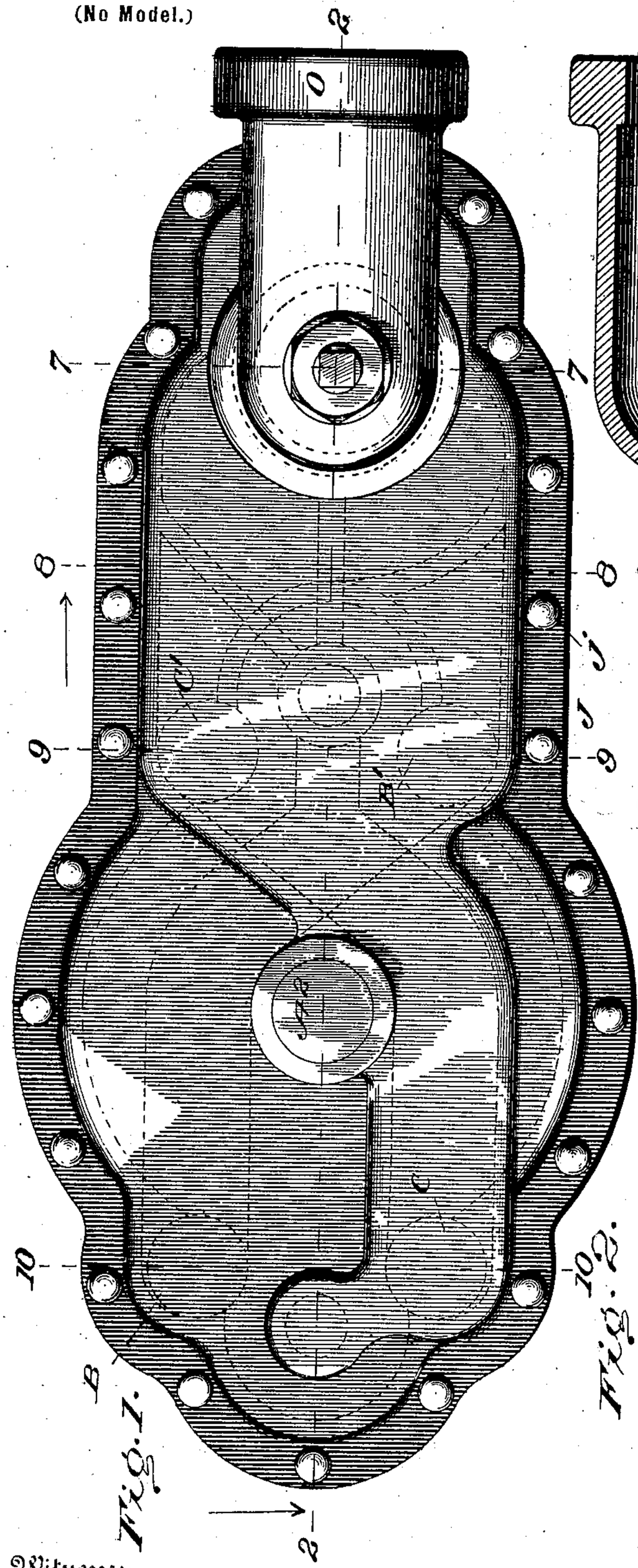
No. 690,813. Patented Jan. 7, 1902.

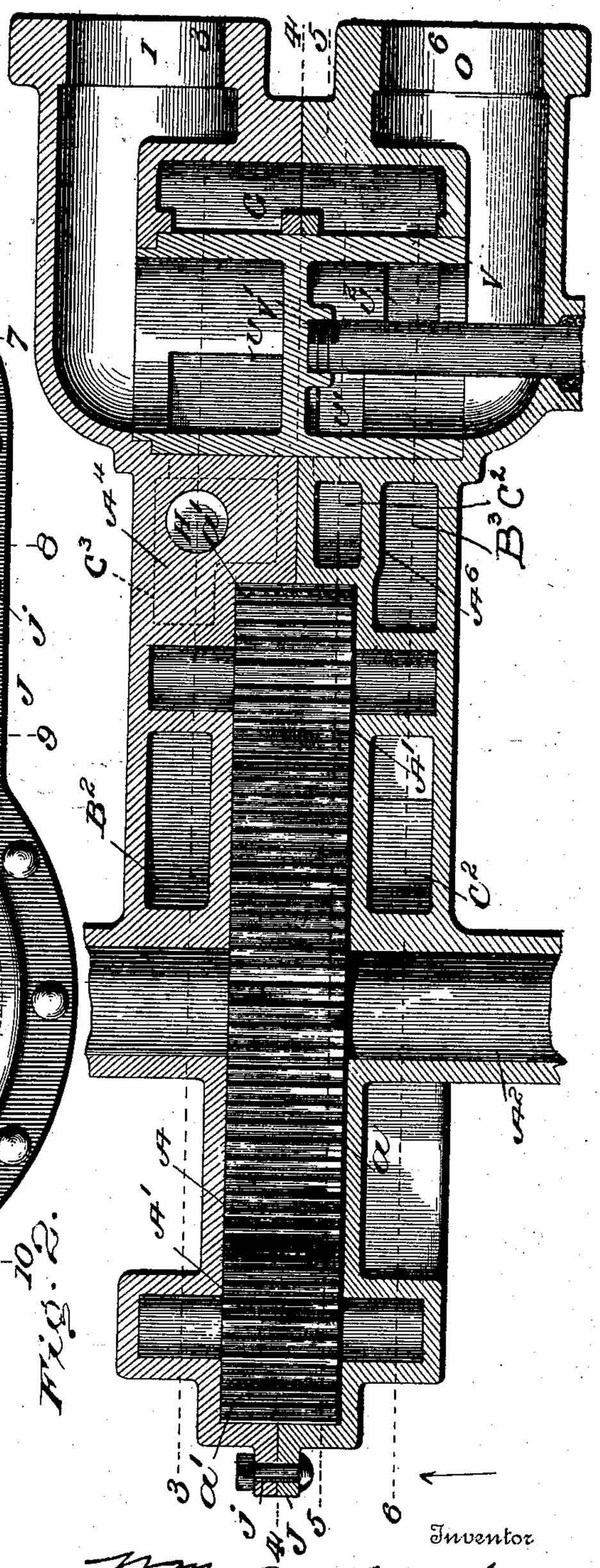
W. O. WORTH.

HYDRAULIC MOTOR OR PUMP AND REVERSING VALVE THEREFOR.

(Application filed June 9, 1899.)

(No Model.) 5 Sheets—Sheet 1.





Witnesses

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(No Model.) 5 Sheets—Sheet 2.

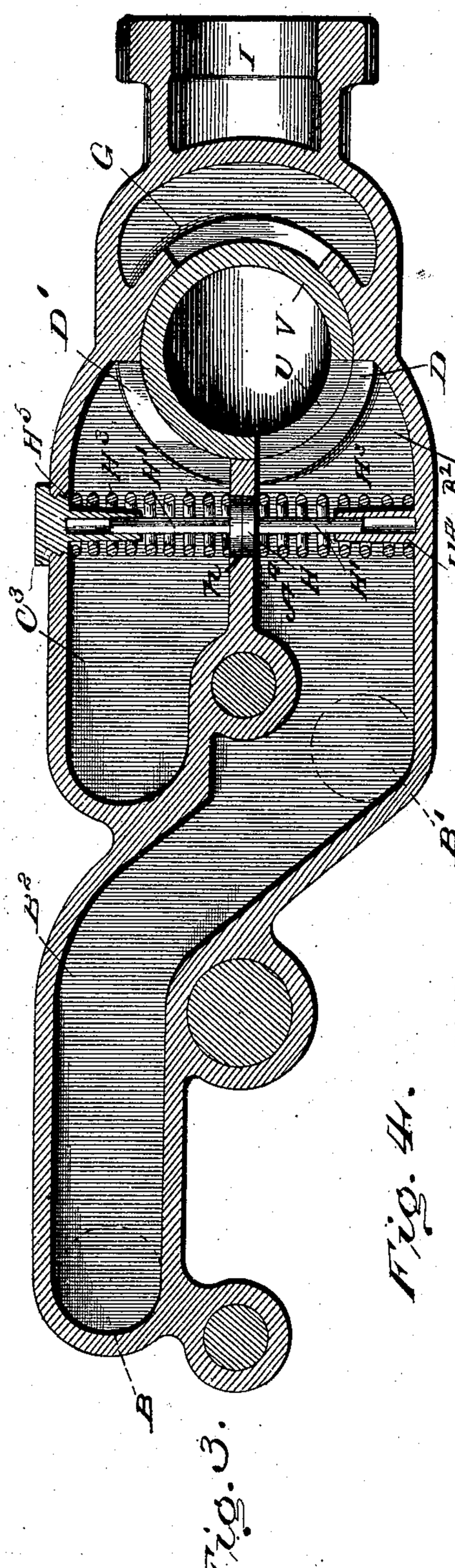

Fig. 3.

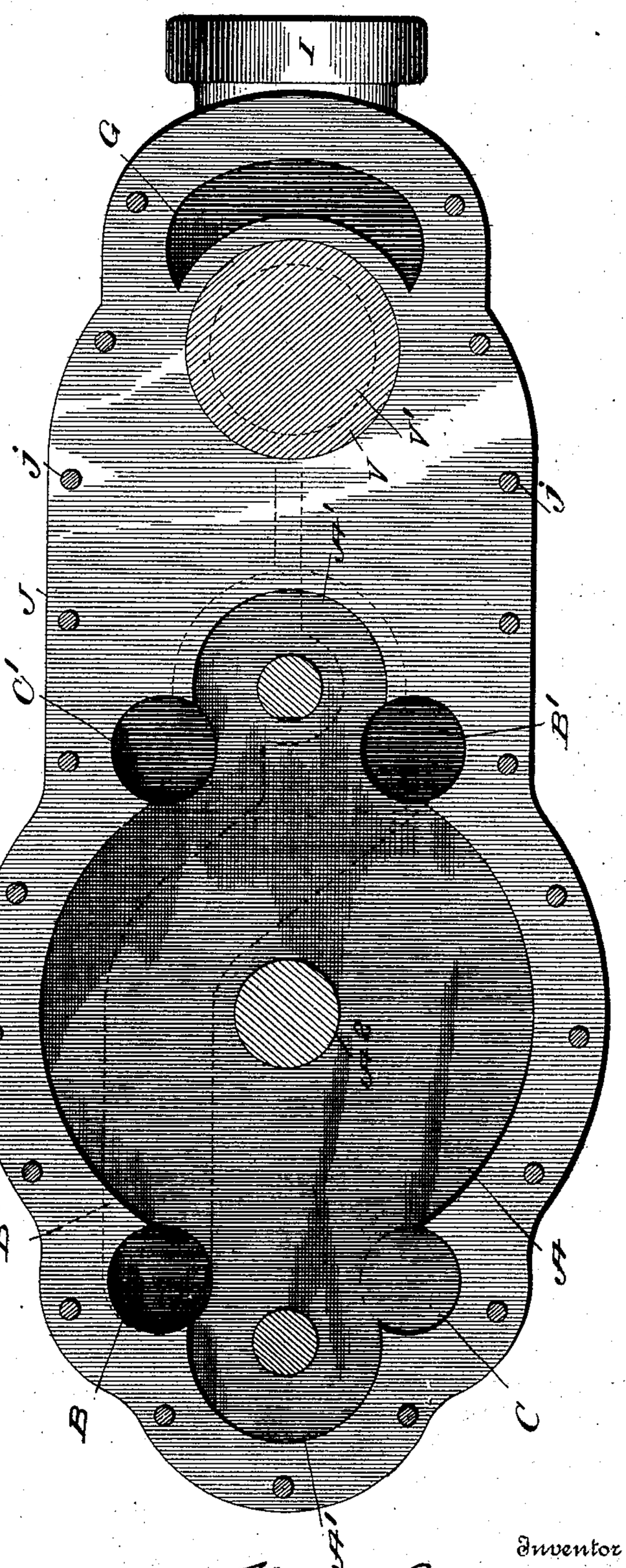

Fig. 4.

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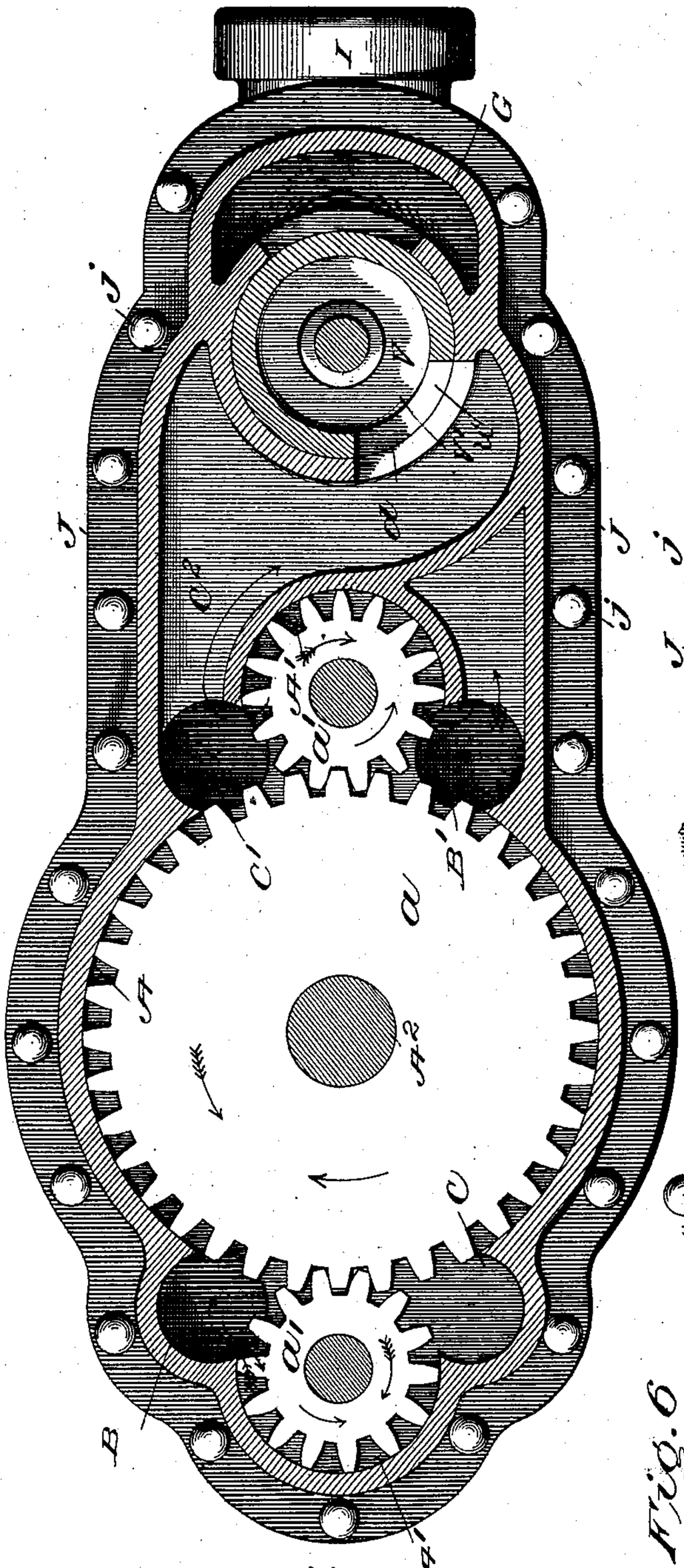
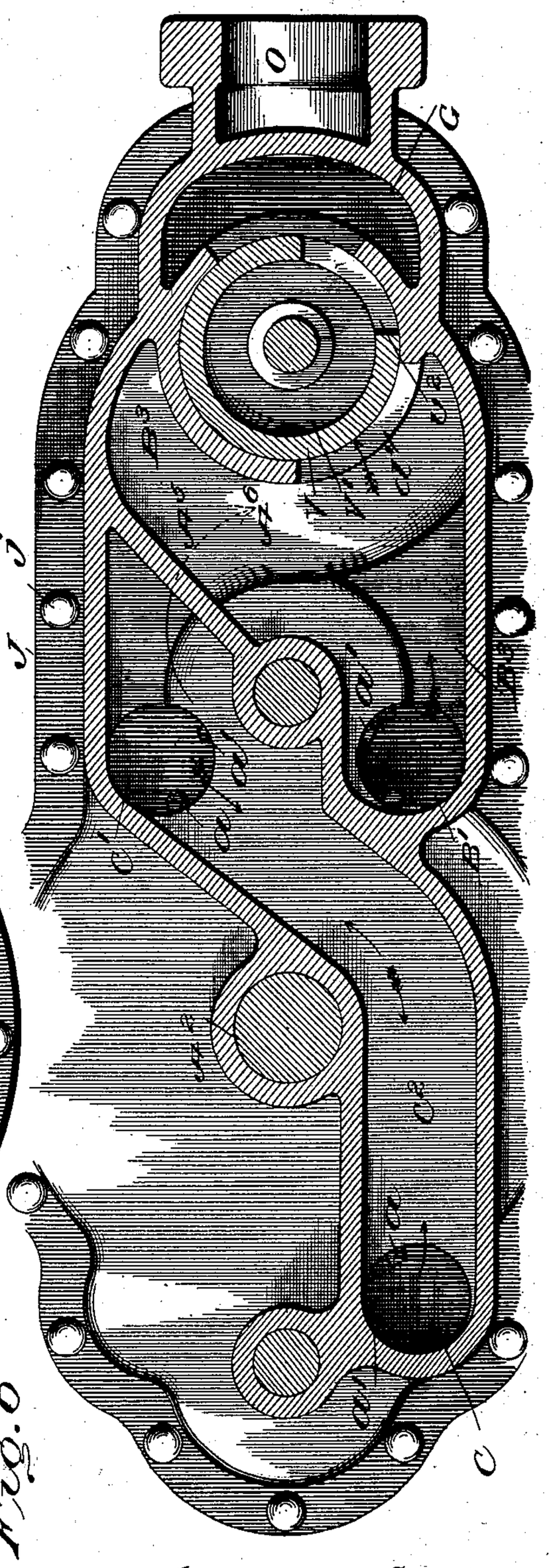
(No Model.) 5 Sheets—Sheet 3.





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(No Model.) 5 Sheets—Sheet 4.

Fig. 7.

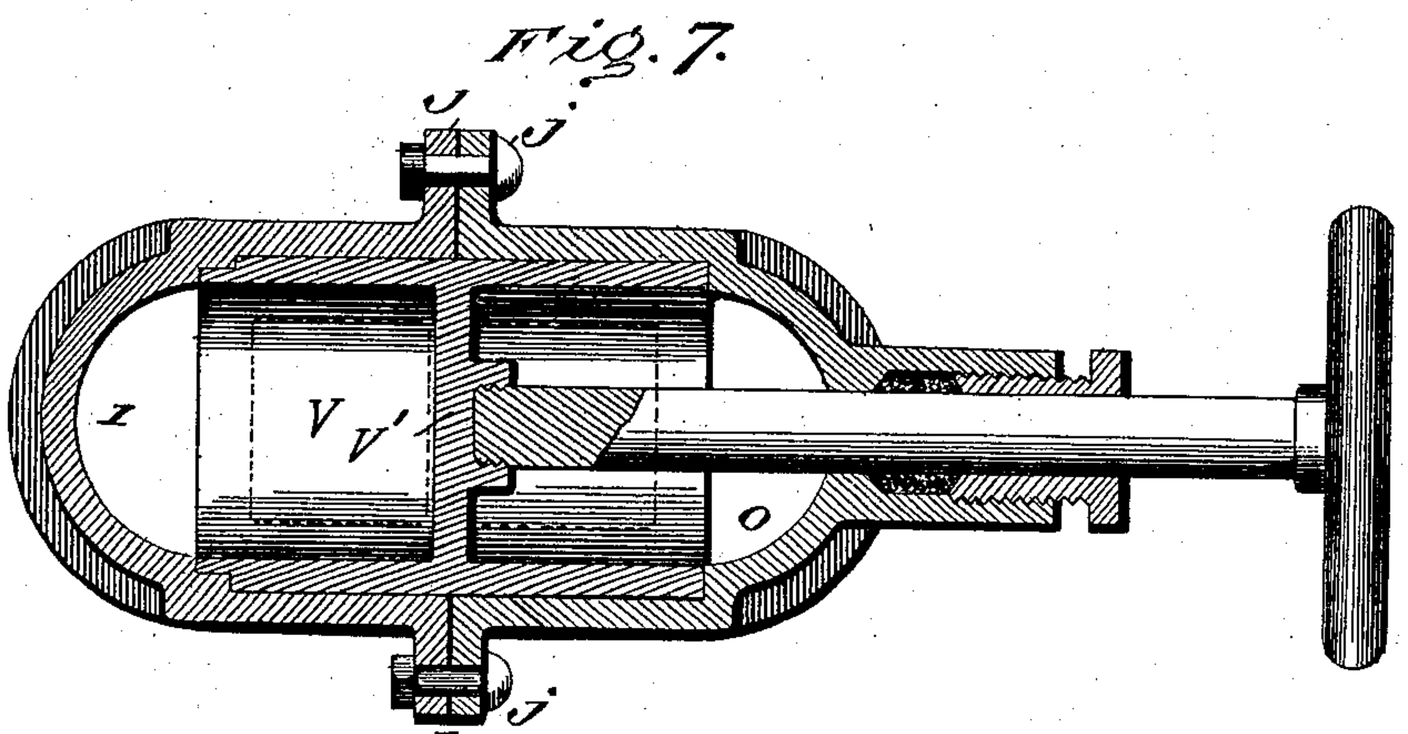


Fig. 8.

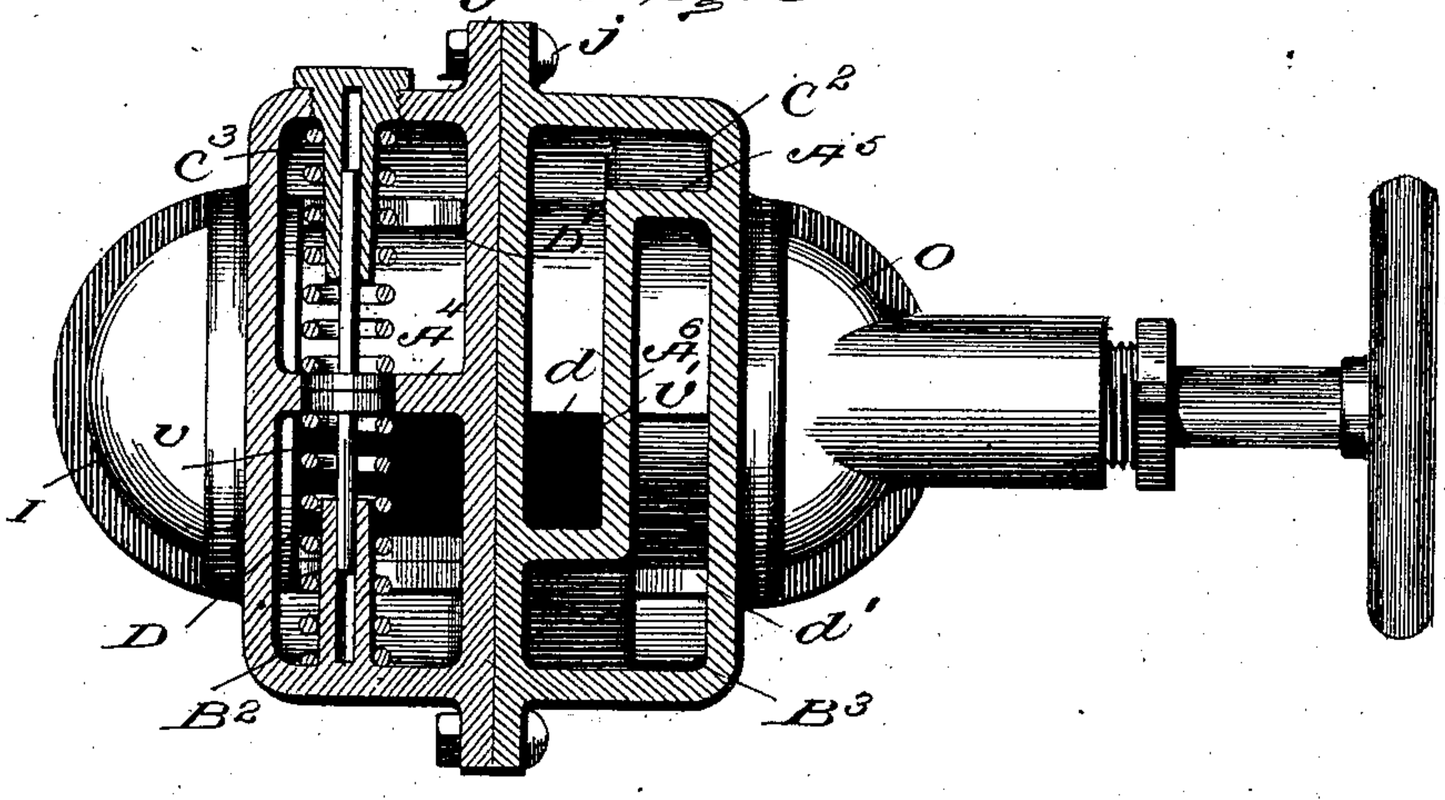
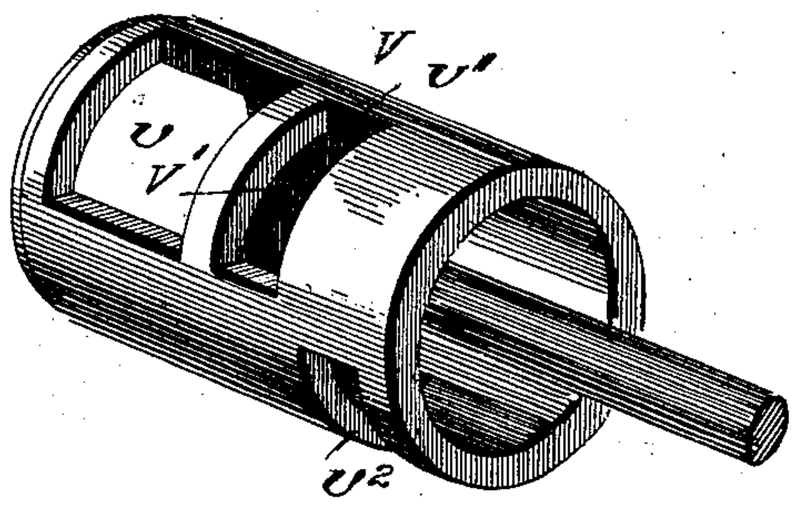


Fig. 11.



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HYDRAULIC MOTOR OR PUMP AND REVERSING VALVE THEREFOR.

(Application filed June 9, 1899.)

(No Model.) 5 Sheets—Sheet 5.

Fig. 9.

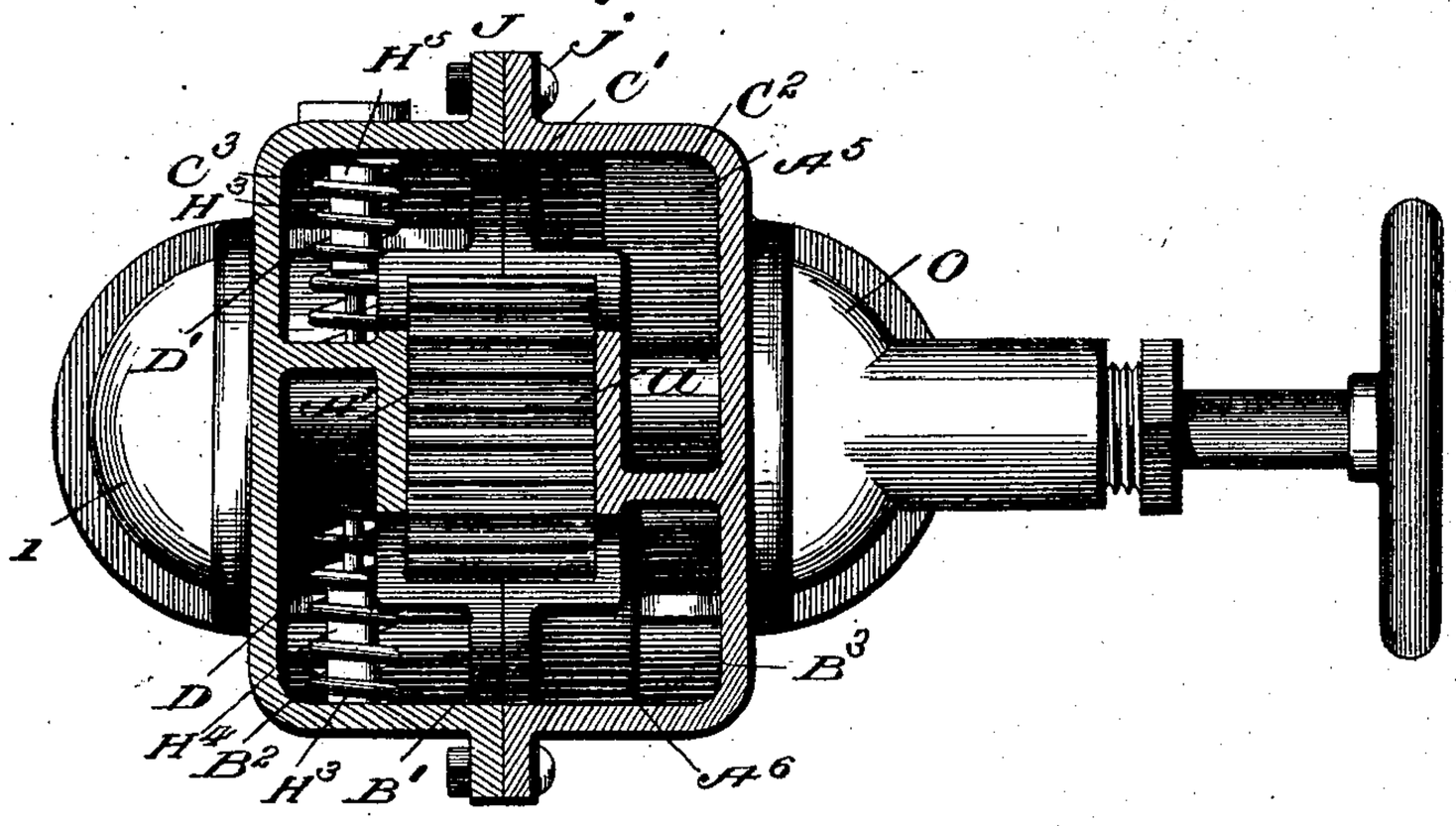
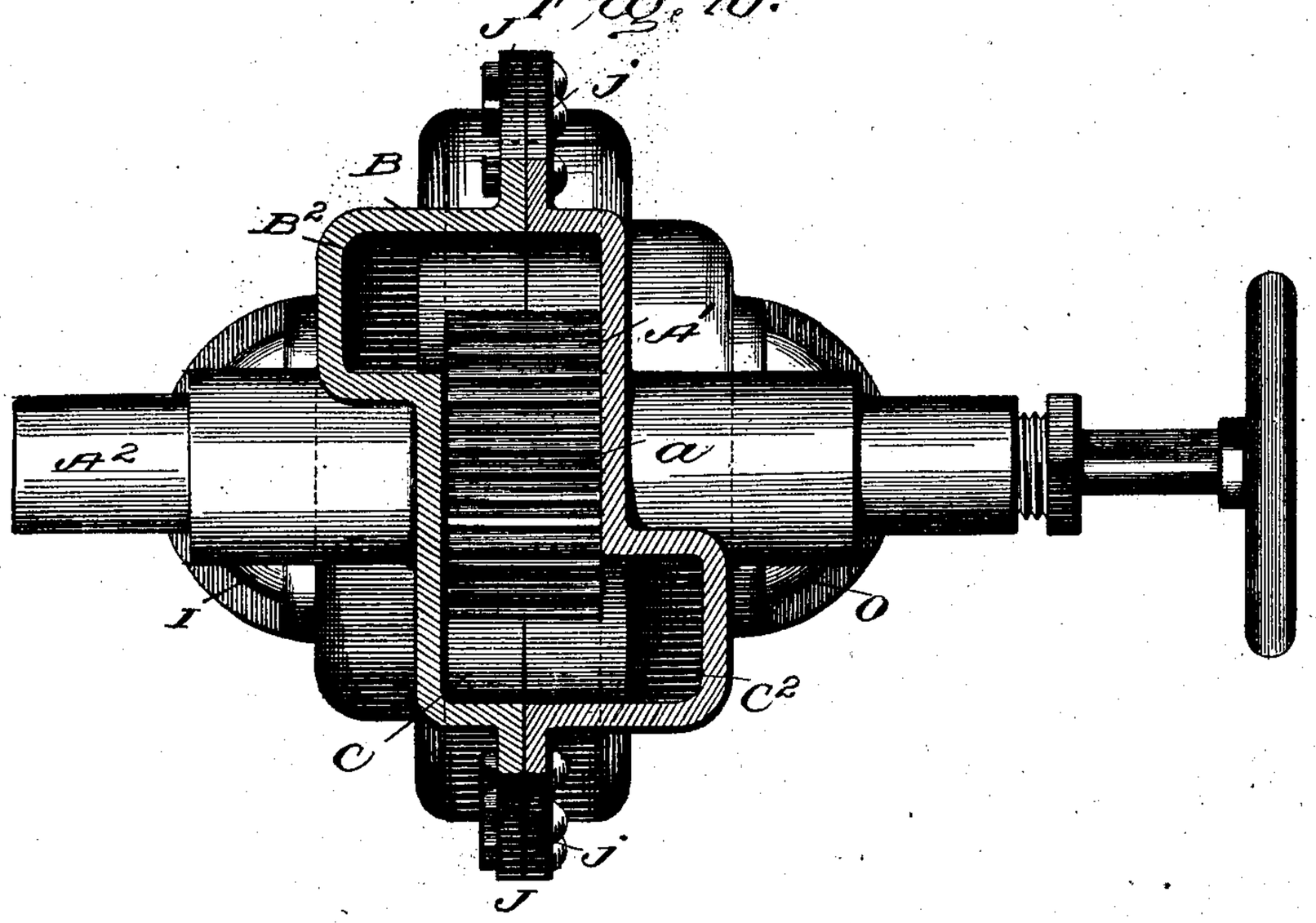


Fig. 10.



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UNITED STATES PATENT OFFICE.

WILLIAM O. WORTH, OF CHICAGO, ILLINOIS, ASSIGNOR OF TWO-THIRDS TO WILLIAM R. DONALDSON, OF LOUISVILLE, KENTUCKY, AND HENRY W. KELLOGG, OF BATTLECREEK, MICHIGAN.

HYDRAULIC MOTOR OR PUMP AND REVERSING-VALVE THEREFOR.

SPECIFICATION forming part of Letters Patent No. 690,813, dated January 7, 1902.

Application filed June 9, 1899. Serial No. 719,937. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM O. WORTH, of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Hydraulic Motors or Pumps and Reversing-Valves Therefor; and I hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, which form part of this specification.

This invention is an improvement in hydraulic motors or pumps and reversing-valve mechanism therefor, especially designed for use in systems of power transmission wherein the power is transmitted by currents of fluids preferably circulated in an endless circuit. The motor portion of the apparatus is useful when driven as a pump to circulate fluids, &c., or if the fluid be forcibly circulated therethrough it will act as a motor. For convenience I shall hereinafter refer to this part of the invention as a "motor."

The motor is designed to be operated by a current of preferably non-compressible fluid, such as oil, which is forcibly circulated therethrough from any primary source in a continuous and may be endless stream.

The second and principal part of the invention relates to the valve mechanism for controlling the flow of the fluid. This mechanism is such that it is possible to stop the motor without stopping the circulation of the propelling fluid.

Another primary and principal object of this valve mechanism is to enable the motor to be reversed without stopping or reversing the main engine or the direction of circulation of the current of driving fluid. This reversal of the motor can be accomplished without shock or jar by reason of the peculiar construction of the valve mechanism, whereby ample provision is made for the continuous circulation of the driving fluid through the valve and its casing, so that the reversal of the flow of fluid in the motor can be accomplished easily and safely without shock, as will be hereinafter more fully explained.

The invention will be fully understood from the following description and drawings, which illustrate the best form of apparatus now known to me embodying my invention, and to which reference is made by letters of reference thereon.

The claims set forth definitely what I consider the principal and essential features of my invention.

In said drawings, Figure 1 is a right-hand side elevation of the motor and valve complete. Fig. 2 is a horizontal section thereof on line 2 2, Fig. 1, looking downward. Fig. 3 is a longitudinal vertical section on line 3 3, Fig. 2, looking to the left or in the direction of the arrows. Fig. 4 is a similar vertical section on line 4 4, Fig. 2, omitting the gears and pistons. Fig. 5 is a longitudinal vertical section on line 5 5, Fig. 2, looking in the direction of the arrows. Fig. 6 is a similar section on line 6 6, Fig. 2. Fig. 7 is a transverse vertical section on line 7 7, Fig. 1, looking in the direction of the arrows. Fig. 8 is a similar view on line 8 8, Fig. 1. Fig. 9 is a transverse section on line 9 9, Fig. 1. Fig. 10 is another like section on line 10 10. Fig. 11 is a detail perspective view of the valve detached.

It will facilitate the understanding of the construction of the machine if the drawings are separated and the sheet containing Figs. 1 and 2 is placed in front of the reader, the sheet containing Figs. 3 and 4 placed at the left-hand side, (these figures being sections through the left-hand side of the machine,) and the sheet containing Figs. 5 and 6 placed at the right-hand side of the machine.

Referring to said drawings, the casing of the motor and valve is formed with a large annular chamber A, at diametrically opposite sides of which are smaller annular chambers A′, in which latter chambers are closely fitted gear-pistons a', that mesh with the large gear a in chamber A, the pistons and gear being mounted on suitable shafts extending transversely through the chambers. These gears are fitted so neatly within the chambers that they practically close communication therebetween and the gear-pistons rotate synchronously in action.

At the junction of chambers A A′ and above

pistons a' are fluid-chambers B and C', and below pistons a' at the junctions of chambers A A' are fluid-chambers C and B', the chambers B B' being diagonally opposite and so are chambers C C'.

If fluid is admitted into chambers B B' under pressure, it will tend to rotate the gear-pistons a' in the direction indicated by the tailless arrows, Fig. 5, and pass into chambers C C', and if the fluid be admitted primarily into chambers C C' it will rotate the gear-pistons in the direction indicated by the tailed arrows, Fig. 5, and escape into chambers B B'. This obvious way of reversing the motor is accomplished by means of a novel arrangement of fluid passages or ports and the novel construction of the valve, and as this construction is somewhat intricate it has been practically impossible to illustrate in a single figure the entire course of the fluid when rotating the main shaft A^2 (on which gear a is fixed) in either direction; but by careful attention to the following description of these passages and valves everything will be perfectly and fully understood.

The chambers B and B' communicate with a common passage B^2, which is formed in the exterior or left-hand wall of the gear-chambers A A' (see Fig. 3) and extends through the casing to the valve-chamber and communicates therewith through an inlet-port D, which is closed or opened by the main valve V, as hereinafter described.

The chambers C C' communicate at the right-hand side of the casing with a passage C^2, (see Fig. 6,) which leads to an exhaust-port d to the right of port D and is also closed or opened by the main valve, as hereinafter described. The chamber C', moreover, communicates at the left-hand side of the machine with a passage C^3, (Fig. 3,) which communicates with the valve-chamber through an inlet-port D', which is also closed or opened by the main valve, the said ports D D' being adapted to alternately register with but a single inlet-port v of the main valve V.

It will be observed by reference to Fig. 3 that the passage C^3 is vertically above and beside passage B^2, but is separated therefrom by a partition-wall A^4, so that there can be no short circuit of fluid between the passages B^2 and C^3, and there will be no communication between the chambers B' and C' except around through the interposed working chamber A'.

By reference to Fig. 6 it will be seen that the chamber B' also communicates at the right-hand side of the casing with a passage B^3, which lies parallel with a portion of passage C^2, but is separated therefrom by a transverse partition A^5 and a longitudinal partition A^6, passage B^3 communicating with the valve-chamber through outlet-port d', which is also closed or opened by the main valve, as hereinafter described.

It will be observed that the outlet-ports $d\,d'$ are parallel, but the main valve V has separate outlet-ports $v'\,v^2$, adapted to respectively register with ports $d\,d'$, but the ports $v'\,v^2$ are so located in the valve V that they cannot simultaneously register with ports $d\,d'$.

The main valve V is an open-ended cylinder fitted closely within the valve-chamber and having a central imperforate partition V', and at the left-hand side of said partition, within the wall of the valve, is the port v and at the right-hand side of said partition, in the wall of the valve, are the ports $v'\,v^2$.

The open left-hand end of the valve communicates with the main inlet I, to or from which the fluid may be conducted by any suitable pipes. The right-hand open end of the valve communicates with an outlet O, to or from which fluid may be conducted by any suitable system of pipes.

The ports D D' $d\,d'$ are all formed in the side of the valve-chamber nearest the working pistons, and at the opposite side of the valve-chamber is a by-pass G, which when the main valve is turned so as to close all the ports D D' $d\,d'$ will allow direct communication between the outlet and inlet ports, the fluid then passing from inlet I through port v into by-pass G, and then through ports $v'\,v^2$ into outlet O, thus cutting the engine or motor out of the circuit, while permitting the free circulation of fluid exterior to the motor.

As shown in the drawings, the main valve is turned so that the main shaft A^2 will be rotated in the direction indicated by the tailless arrow on gear a in Fig. 5. In this case the course of the current fluid is as follows: Entering at I it passes into the upper portion of the main valve through ports v and D into passage B^2, whence it enters chambers B B', and finding its way blocked imparts a rotary motion to gear-pistons a' in the direction indicated by the tailless arrows thereon, and escapes into chambers C^2, Figs. 5 and 6, then passes through to port d into the lower part of the main valve, and escapes through outlet O. The course of the currents in this position of the valve is clearly indicated by the tailless arrows on the drawings.

If it be desired to reverse the motion of the motor, it can be accomplished by turning valve V until port v registers with port D', which movement of the valve will close ports D and d and open ports D' and d', the valve-port v^2 now registering with port d'. While this movement of the valve has not affected the inflow or direction of flow of the current in the inlet and outlet pipes I and O, the course of the fluid through the motor-casing is entirely reversed, because the fluid now enters through ports v and D' into passage C^3 and flows thence through chamber C' into passage C^2, (the outlet d of which, remember, has been closed.) Part of the fluid passes through passage C^2 to chamber C, and the fluid, endeavoring to escape into chambers B and B', rotates pistons a' in the directions indicated by the tailed arrows thereon, and after entering chambers B B' it passes into passage B^2, (the

port D of which, however, has been closed,) and then the fluid passes to the right through chamber B′ into passage B^3 and escapes through ports d' v^2 into the lower part of the main valve and to the outlet O. The course of the fluid in this reverse movement is indicated by the tailed arrows in the drawings; but the main valve is not shown shifted into position to give this reverse current.

The operation may be, possibly, more readily understood if it be considered that the left-hand piston a' was omitted and only the one piston used—*i. e.*, that at the side next to the valve. In that case it will be seen that the fluid when the engine is going in the direction indicated by the tailless arrow passes through ports v and D into the left-hand passage B^2, flows into chamber B′, rises, forcing around piston a', into chamber C′, passes to the right-hand side of the casing into the passage C^2, and escapes through ports d and v' to the outlet, or if the valve V be shifted so as to register ports v and D′ the fluid passes first into the left-hand passage C^3, then to chamber C′, then flows down, turning piston a' in the directions indicated by the tailed arrows, enters chamber B′, flows to the right end thereof into passage B^3, and escapes through ports d' and v^2 into the outlet.

If it is desired to stop the motor at any time, valve V is turned until ports v v^2 or v v' register with by-pass G, when while circulation of fluid within the motor proper is stopped circulation of fluid from the inlet I to outlet O can continue uninterruptedly.

The simplicity and effectiveness of this reversing-motor will be, I think, fully comprehended from the foregoing description.

In order to prevent accidents in case the main valve should too suddenly close ports D D′ d d', thus confining a body of liquid within the casing without any outlet therefor, a safety-valve may be arranged within the partition A^4, and, if desired, a like valve may be arranged in partition A^5. I have, however, only shown such a valve in partition A^4, which is provided with a central opening h, in which is fitted a disk-valve H, the stems H′ of which extend, respectively, through passages C^3 and B^2 and are respectively guided in a socketed lug H^4 in passage B^2 and in a socket-plug H^5, tapped into an opening in the outer wall of passage C^3. Stout coiled springs H^3 are interposed between the valves and the walls of the casing, so that the valve is held within the partition A^4, preventing casual communication between the passages B^2 and C^3. If both ports D D′ should be closed and the pistons moved so as to cause any circulation of fluid within the motor, pressure would be increased on one side of the valve H, and it could yield, so as to allow some fluid to escape from the high to the low pressure side, and thus prevent damage to the motor or its casing. By means of the safety-valve, therefore, a circulation of fluid within the casing could take place independently of the circulation in the main circuit, but of course would be resisted by the springs H^3.

In practice I find it economical to form the motor-casing in longitudinal halves, as indicated in the drawings, one (the left-hand) half containing the inlet I, the passages B^2 and C^3, and ports D D′ and also half of the valve-chamber, the by-pass, the chambers A A′, and the chambers B B′ C C′, (see Figs. 2, 3, and 4,) and the other (the right-hand) half containing the outlet O, the passages C^2 and B^3, ports d d', and half of the chambers A A′ B B′ C C′ and also half of the valve-chamber and by-pass G. These castings can be provided with exterior flanges J and be united by bolts j, as indicated in the drawings, and this construction greatly simplifying the casting of the casing and facilitating the dressing up of the various chambers, ports, &c.

For convenience I will refer to the chambers B B′ and C C′ generally as "fluid-chambers" and to the chambers wherein the fluid is utilized in propelling the pistons or in which the fluid is propelled by the pistons (if the device be used as a pump) as "working chambers." I do not, however, consider my invention limited to the employment of gear-pistons, nor do I consider the invention restricted to the employment of two gear-pistons, as one or more than two might be used, if desired.

The arrangement of passages and valves for reversing the movement of the fluid may also be varied to a considerable extent within the scope of my invention.

The adaptation of the invention to other forms of fluid motors or pumps than that shown will be readily comprehended by expert mechanics familiar with this class of machinery, and the chief merit of the invention, I believe, resides in the fact of my being able to reverse the motor driven by a current of fluid entering and leaving continually by the same ports without stopping the main current or altering the inlets or outlets thereof nor reversing the prime motor by which the fluid is circulated. It will be seen, also, that this valve mechanism if applied to a pump will enable the exterior current to be directed in one direction only, whether the pump be driven forward or backward.

Having thus described my invention, what I therefore claim as new, and desire to secure by Letters Patent thereon, is—

1. In a motor, the combination of a working chamber, a rotatable piston therein, fluid-chambers on opposite sides of said working chamber, each having an inlet and an outlet, and means whereby the inlet of either chamber and the outlet of the other chamber can be opened at will, while the inlet of the latter chamber and outlet of the former chamber are closed, for the purpose of reversing the rotation of the piston substantially as described.

2. The combination of the working chamber, a rotatable piston therein, fluid-cham-

bers on opposite sides of said working chamber, an inlet and an outlet for each fluid-chamber, and valve mechanism whereby when the inlet of one chamber is opened, that of the other is closed, and whereby when the outlet of the latter is opened that of the former is closed for the purpose of reversing the rotation of the piston, substantially as and for the purpose described.

3. The combination of the working chamber, a rotatable piston therein, fluid-chambers on opposite sides of said working chamber, inlet and outlet passages communicating with opposite ends of each fluid-chamber, and means substantially as described, whereby communication may be opened between the inlet of either chamber, and a power-supply, and between the outlet of the other chamber and the exhaust; and simultaneously the inlet of the latter chamber and the outlet of the first chamber be closed, substantially as and for the purpose described.

4. The combination of a working chamber, a rotatable piston therein, fluid-chambers on opposite sides of said working chamber, inlet and outlet passages communicating with opposite ends of each fluid-chamber, and a single valve substantially as described, whereby, when the inlet of one chamber is opened, that of the other is closed, and simultaneously the outlet of the latter is opened and that of the former closed.

5. The combination of a working chamber, a rotatable piston therein, fluid-chambers at opposite sides of said working chamber, an inlet and an outlet passage for each fluid-chamber, and a main inlet and a main outlet; with valve mechanism substantially as described, whereby communication may be established between said main inlet and the inlet of either one of said chambers, and also whereby communication can be established between the outlet of the other chamber and the main outlet, while at the same time the inlet of the latter chamber and the outlet of the former chamber are closed, substantially as described.

6. In a motor, the combination of a working chamber, the rotatable piston therein, the opposite fluid-chambers at opposite sides of said working chamber, and the inlet and outlet passages for each chamber; with a valve-chamber, ports therein communicating respectively with said passages, and a valve in said chamber adapted to simultaneously open certain of said ports and close others, so that the motor can be reversed at will, substantially as and for the purpose described.

7. In a motor, the combination of the working chamber, a rotatable piston therein, the opposite fluid-chambers at opposite sides of the working chamber, a valve-chamber, a main inlet and a main outlet, separate outlet-passages leading from said main outlet to each of said fluid-chambers respectively, separate inlet-passages leading from the main inlet to each of said fluid-chambers respectively, and a valve within said valve-chamber adapted to establish communication between the main inlet and either of said inlet-passages, and between the main outlet and either of said outlet-passages, substantially as described.

8. In a motor, the combination of the working chamber, a rotatable piston therein, the fluid-chambers at opposite sides of said working chamber, a valve-chamber, a main inlet and a main outlet separated by said valve-chamber, separate outlet-passages leading from said valve-chamber to each of said fluid-chambers respectively, separate inlet-passages leading from said valve-chamber to each of said fluid-chambers respectively, and a valve within said valve-chamber adapted to prevent direct communication between the main inlet and outlet, and provided with a port adapted to establish communication between the main inlet and the inlet-passage of either of said chambers, and also provided with ports adapted to simultaneously establish communication between the main outlet and the outlet of the other of said chambers, substantially as described.

9. In a reversing-valve, the combination of the main-valve chamber, the main inlet and outlet at opposite ends thereof, two subsidiary inlet-passages and two subsidiary outlet-passages communicating with said valve-chamber, and a by-pass in the wall of said valve-chamber; with a valve in said chamber having a partition adapted to prevent direct communication between the main inlet and outlet and having ports in its walls whereby communication may be established between the main inlet and either of the subsidiary inlets, and between the main outlet and either of the subsidiary outlets, said ports being also adapted to communicate with the by-pass when the valve is properly turned, and thus establish a short circuit between the main inlet and outlet, for the purpose and substantially as described.

10. The combination of a working chamber, fluid-chambers on opposite sides thereof, an inlet and an outlet passage communicating at opposite ends of each fluid-chamber, and a safety-valve interposed between the two inlet-passages; with means substantially as described, whereby communication may be opened between the inlet of either chamber, and a fluid-supply and between the outlet of the other chamber and a fluid-exhaust, and simultaneously the inlet of the latter chamber and the outlet of the first chamber closed, substantially as and for the purpose described.

11. In a reversing-valve, the combination of the main-valve chamber, the main inlet and outlet at opposite ends thereof, two subsidiary inlet-passages and two subsidiary outlet-passages communicating with said valve-chamber, a safety-valve interposed between and closing communication between said subsidiary inlet-passages, and a by-pass in the wall of said valve-chamber; with a valve in said

chamber having a partition adapted to prevent direct communication between the main inlet and outlet and having ports in its walls whereby communication may be established between the main inlet and either of the subsidiary inlets, and between the main outlet and either of the subsidiary outlets, said ports being also adapted to communicate with the by-pass when the valve is properly turned, and thus establish a short circuit between the main inlet and outlet, substantially as and for the purpose described.

12. In a motor, the combination of the main shaft, a gear thereon, diametrically opposite gear-pistons meshing with said gear, four fluid-chambers, B, C, B′, C′, the fluid-passage connecting chambers C, C′, the fluid-passage connecting chambers B, B′; the valve-chamber, the inlet and outlet ports, separate passages connecting the inlet-ports with one end of chambers B′ and C′ respectively, and separate passages connecting the outlet-ports with the opposite ends of chambers B′ C′ respectively, and a valve whereby the fluid may be directed into either chamber B′ or C′ and withdrawn from the other, substantially as described.

13. In a motor, the combination of the main shaft, the gear thereon, the gear-pistons meshing therewith, the fluid-chambers on opposite sides of said gear-pistons, and passages establishing communication between diagonally opposite fluid-chambers; with the valve-chamber, separate inlet and outlet passages leading from the valve-chamber to each of the nearest fluid-chambers, and a valve, whereby the inlet to either fluid-chamber may be closed and the outlet to the other opened, for the purpose and substantially as described.

14. In a reversible motor or pump, the combination of a main shaft, a gear thereon, a gear-piston meshing with said gear, the upper fluid-chamber and the lower fluid-chamber at opposite sides of said gear-piston, the valve-chamber, the fluid-passage B^2 communicating with said valve-chamber and with the lower fluid-chamber, the fluid-passage C^2 communicating with the upper fluid-chamber, and the valve-chamber, the subsidiary fluid-passage B^3 communicating with the lower fluid-chamber, and the valve-chamber, and the subsidiary passage C^3 communicating with the upper fluid-chamber and the valve-chamber; with valve mechanism in said valve-chamber whereby fluid may be admitted into passages B^2 or C^3 and allowed to escape from passages C^2 or B^3, for the purpose and substantially as described.

15. The herein-described reversible motor or pump, comprising the working chambers A, A′, the gear-pistons therein, the interposed gear-chamber, the gear therein meshing with both the said pistons, the upper fluid-chambers B, C′, and the lower fluid-chambers C and B′, the valve-chamber, the fluid-passage B^2 communicating with said valve-chamber and with chambers B, B′, the fluid-passage C^2 communicating with the valve-chamber and chambers C, C′, the subsidiary fluid-passage B^3 communicating with the chamber B′ and the valve-chamber, the subsidiary passage C^3 communicating with chamber C′ and the valve-chamber, and valve mechanism in said valve-chamber, whereby fluid may be admitted into passages B^2 or C^3 and allowed to escape from passages C^2 or B^3, for the purpose and substantially as described.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

WILLIAM O. WORTH.

Witnesses:
B. P. DONNELLY,
W. R. DONALDSON.