No. 711,662. Patented Oct. 21, 1902.

F. E. HERDMAN.

HYDRAULIC OR LIQUID MOTOR OR PUMPING APPARATUS.

(Application filed Apr. 14, 1902.)

(No Model.) 5 Sheets—Sheet 1.

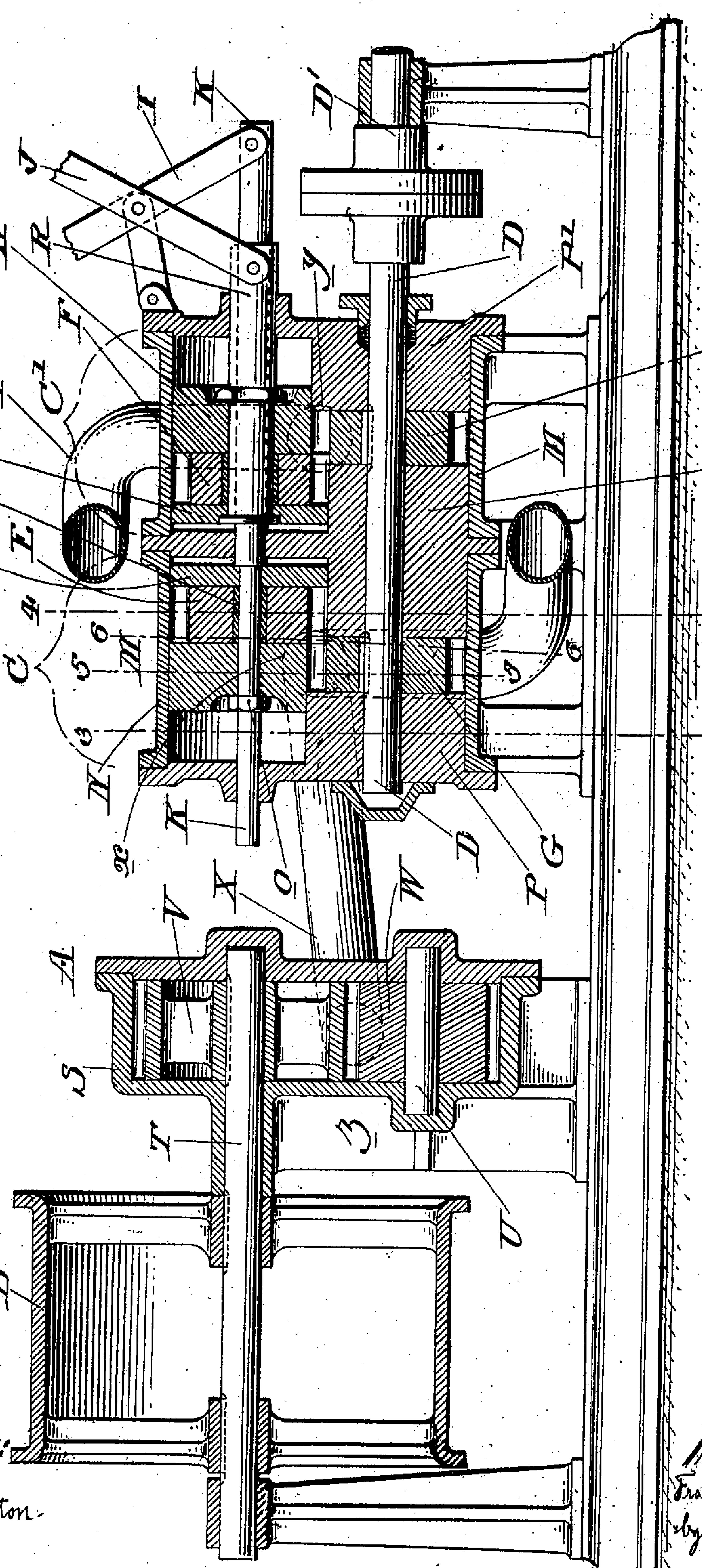

FIG. I.

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FIG. 2.

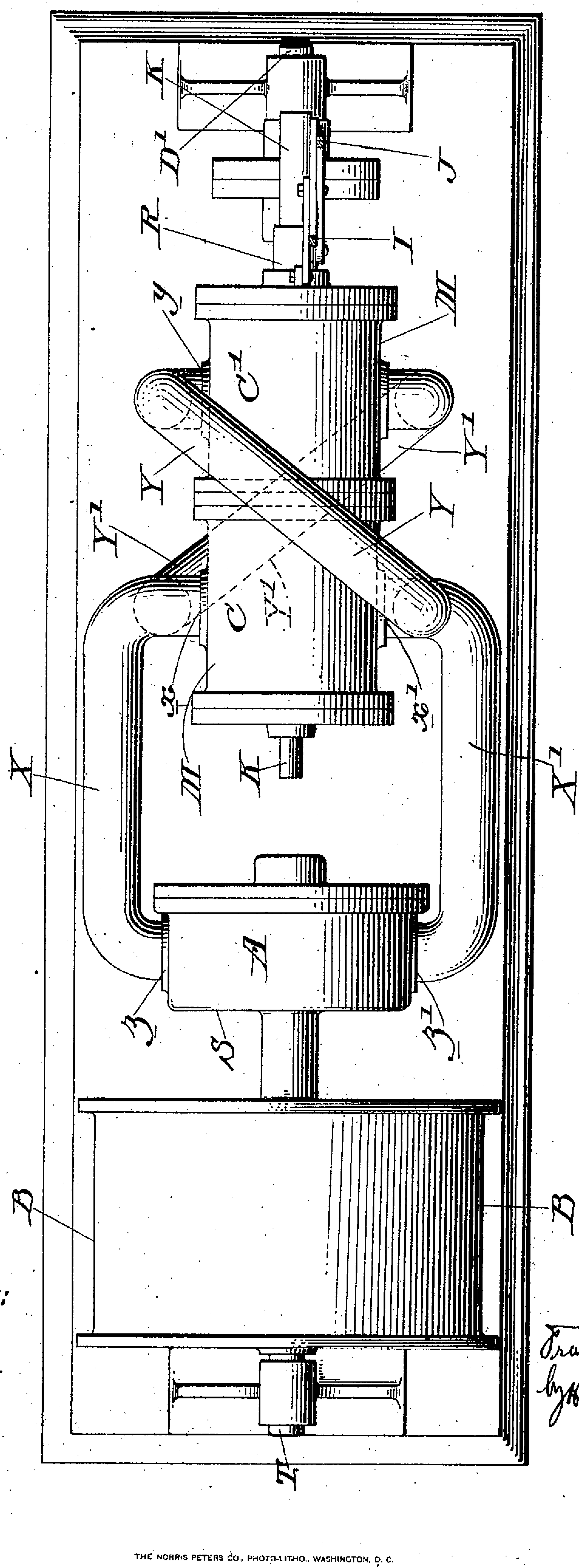

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FIG. 3.

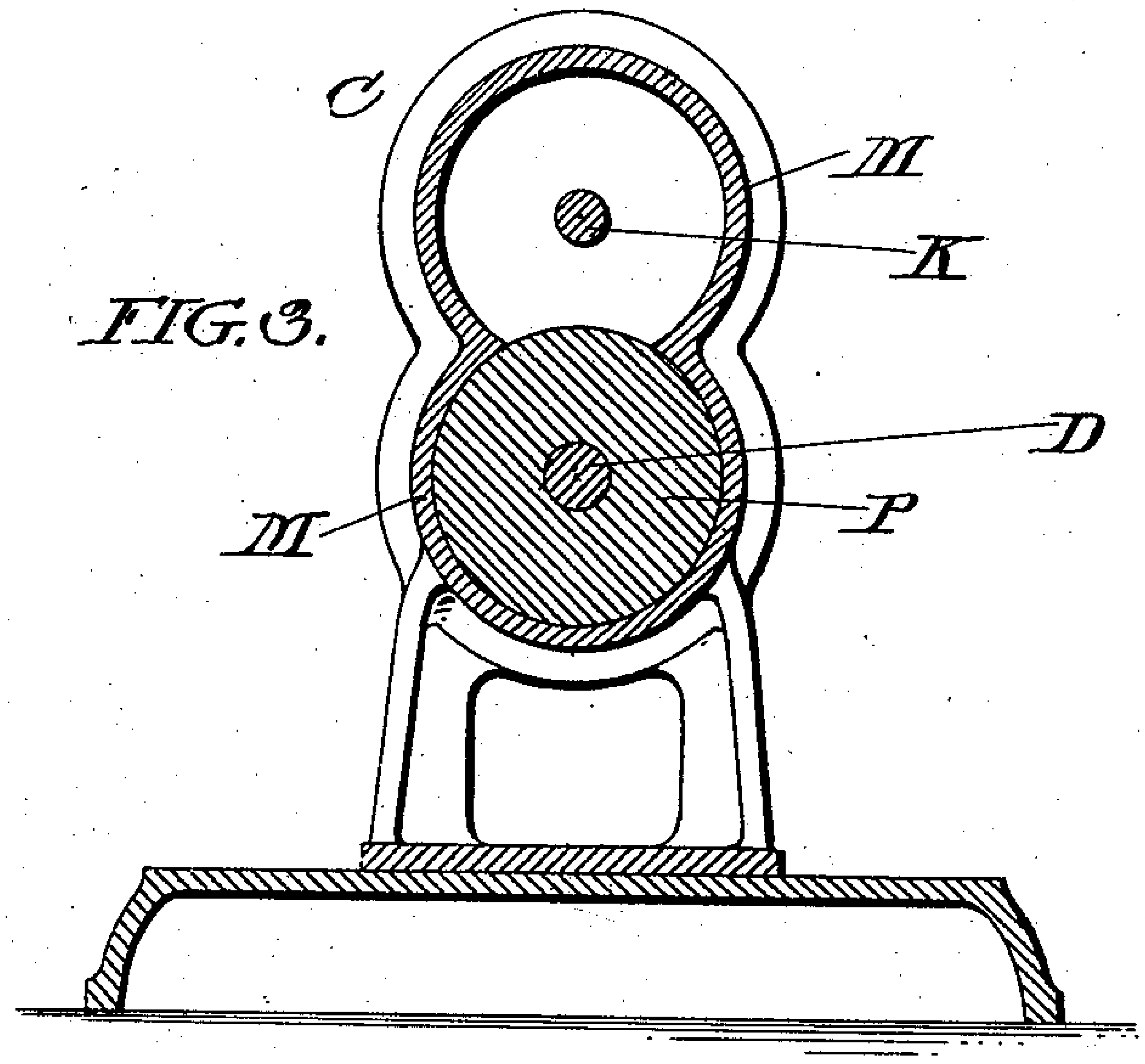


FIG. 5.

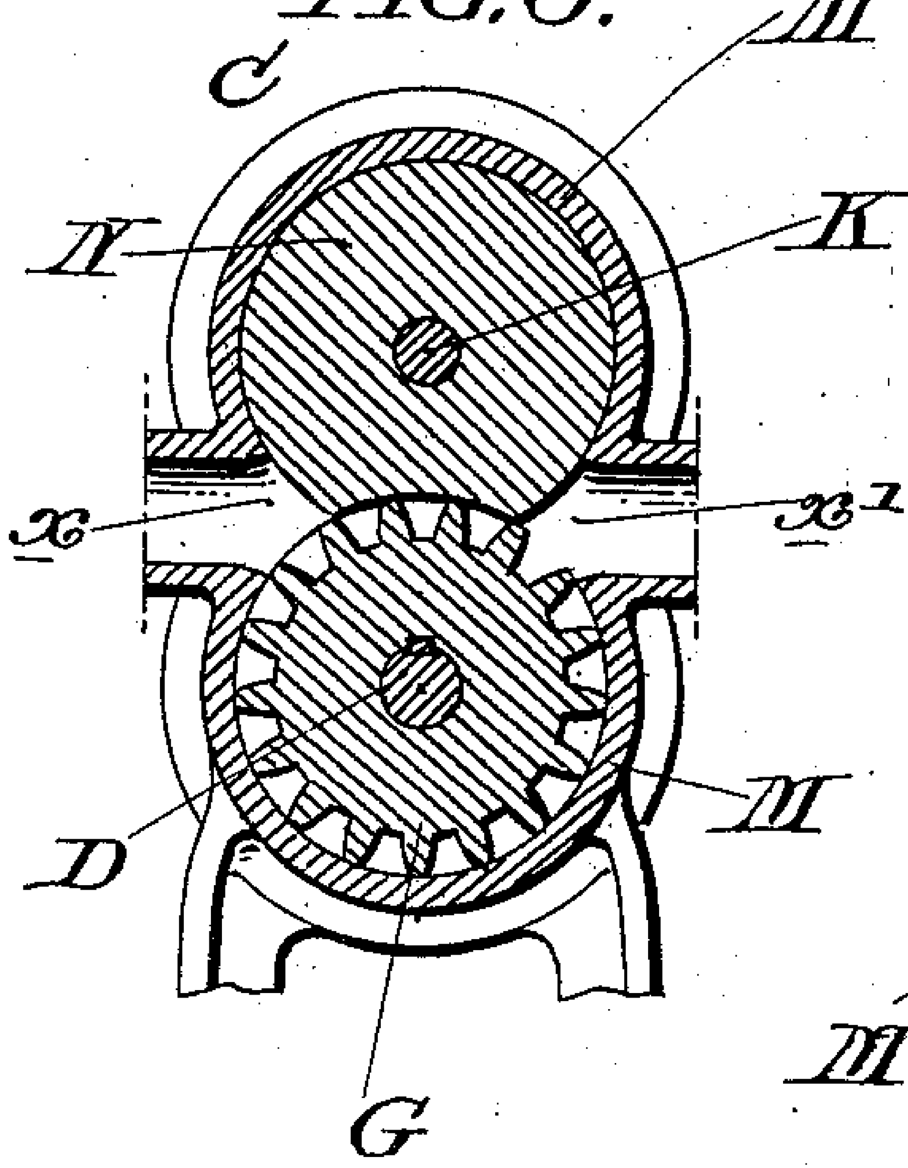


FIG. 4.

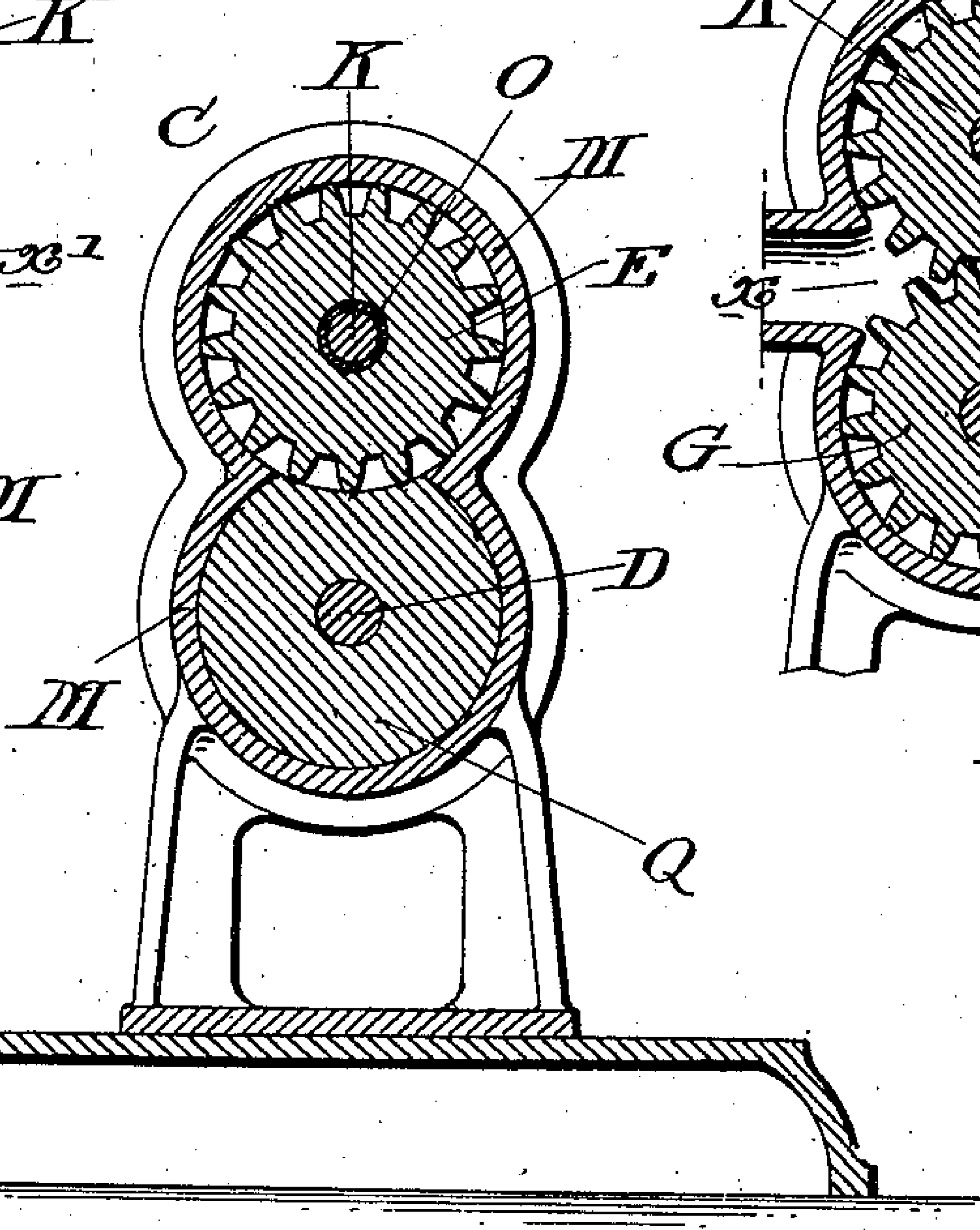
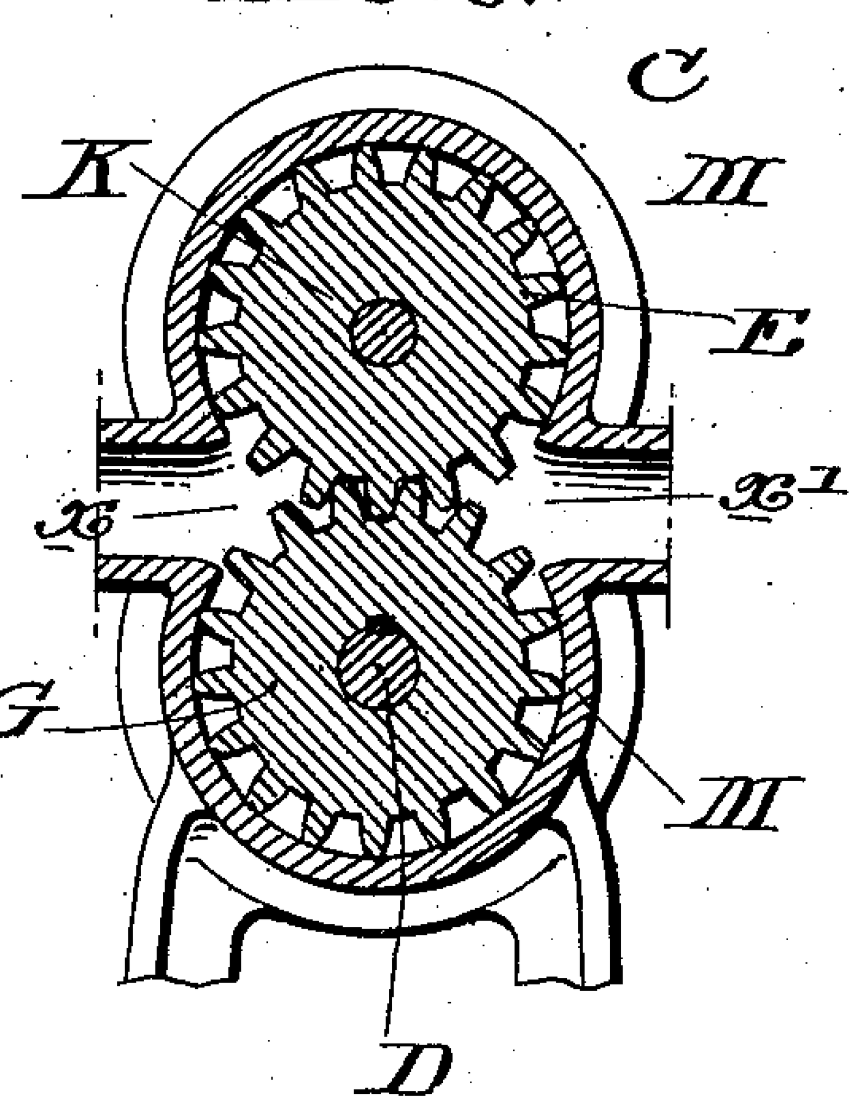


FIG. 6.



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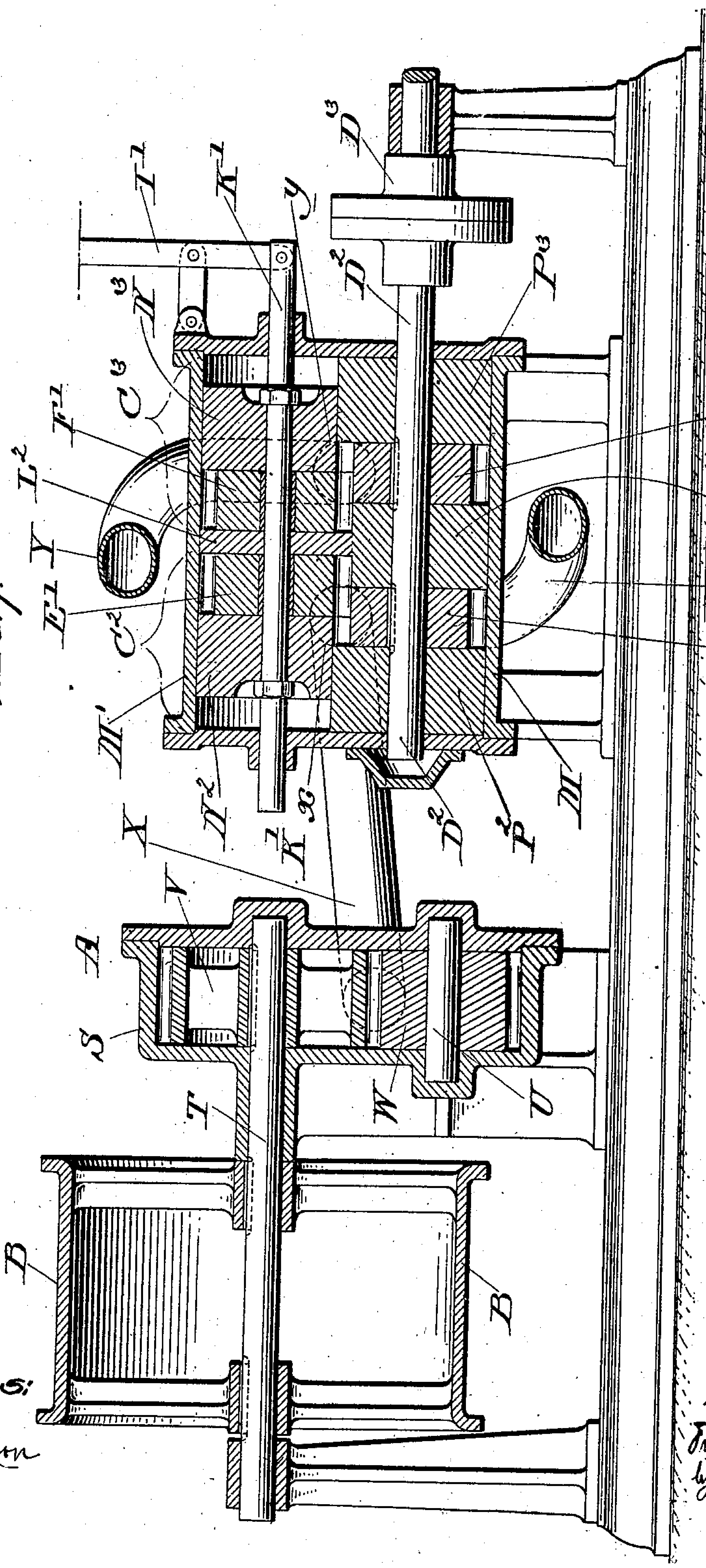

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FIG. 9.

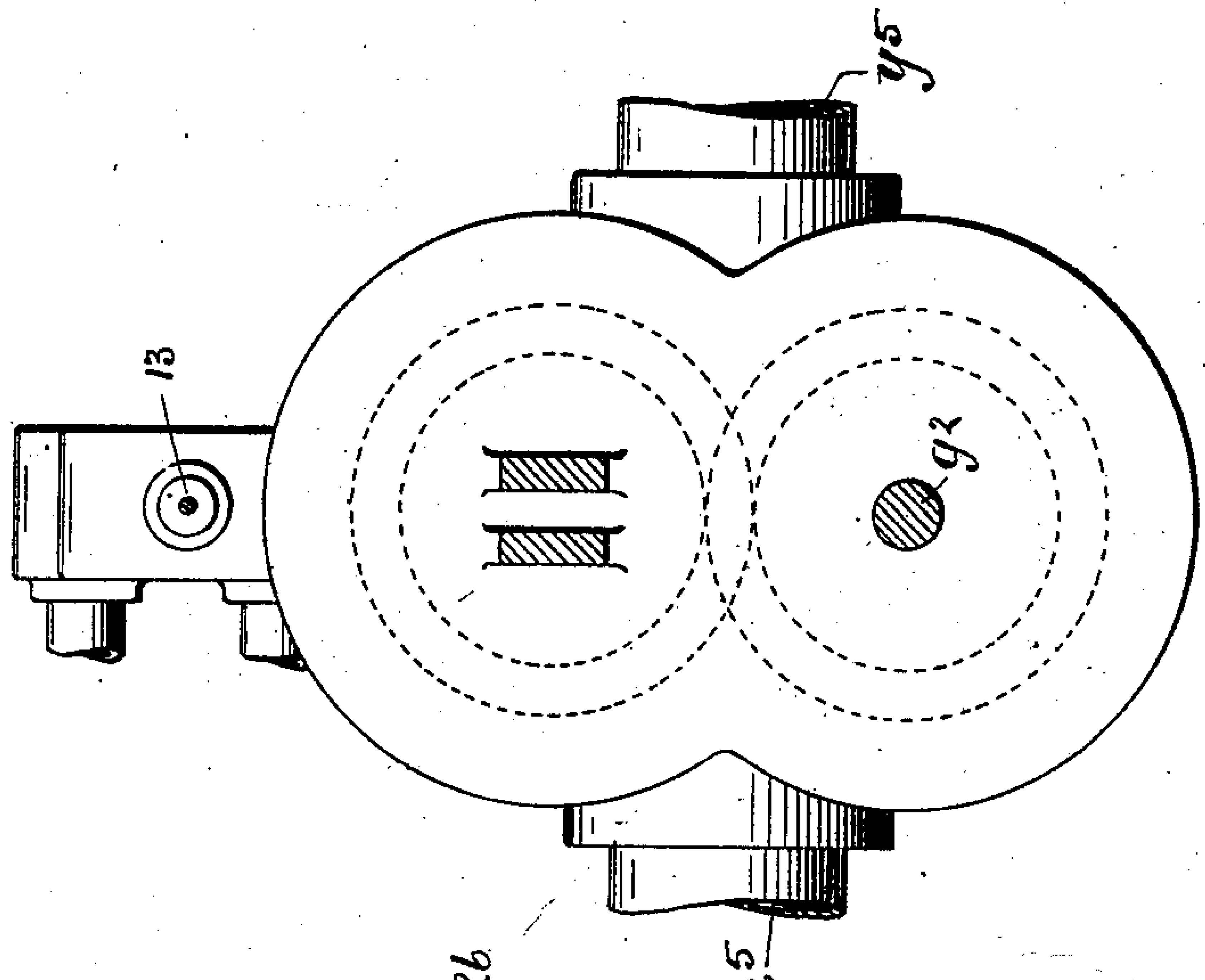
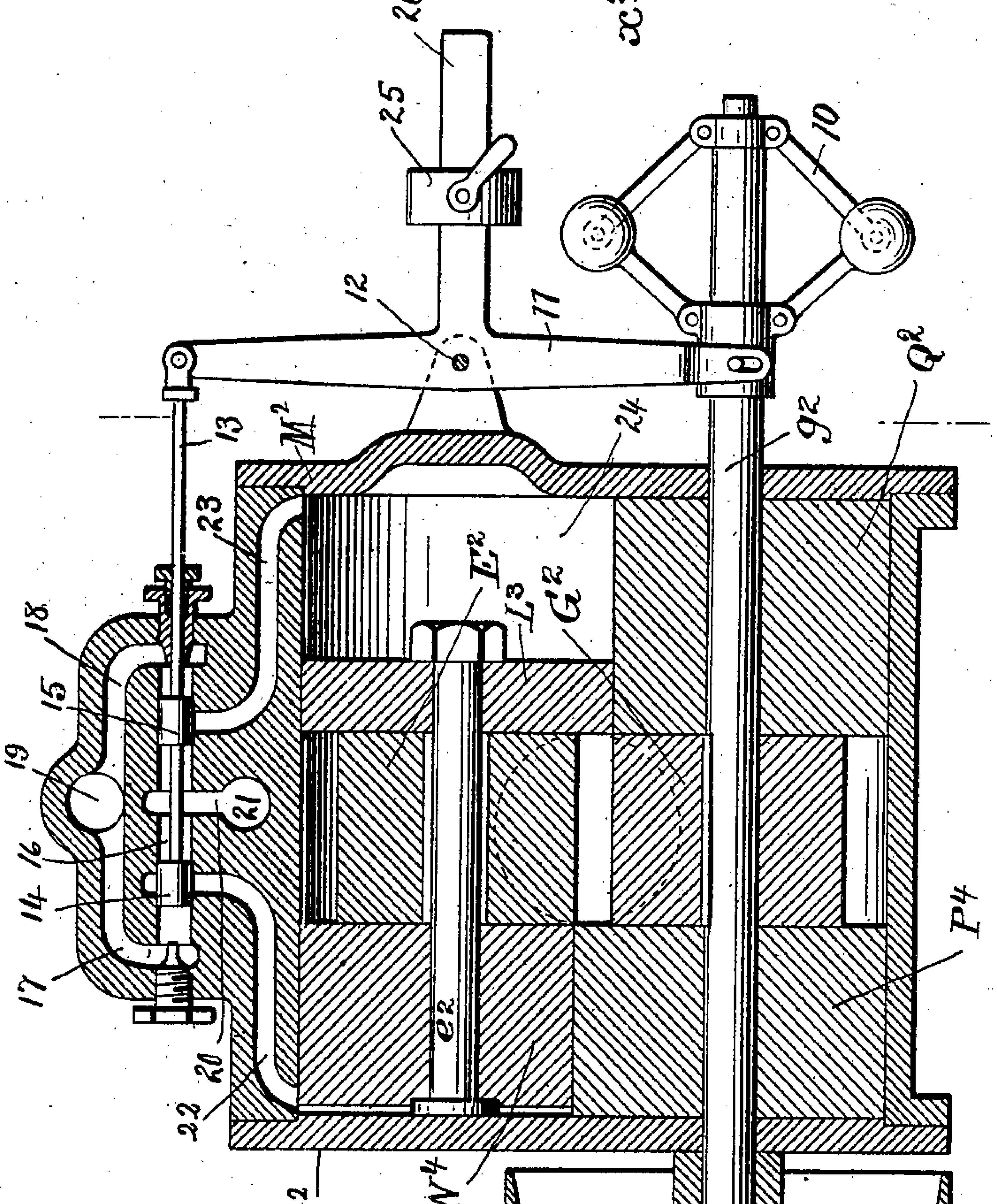


FIG. 8.



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UNITED STATES PATENT OFFICE.

FRANK E. HERDMAN, OF WINNETKA, ILLINOIS.

HYDRAULIC OR LIQUID MOTOR OR PUMPING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 711,662, dated October 21, 1902.

Application filed April 14, 1902. Serial No. 102,708. (No model.)

To all whom it may concern:

Be it known that I, FRANK E. HERDMAN, a citizen of the United States, residing at Winnetka, county of Cook, and State of Illinois, have invented a new and useful Improvement in Hydraulic or Liquid Motor or Pumping Apparatus, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, which form a part of this specification.

My invention relates to mechanical movements, and has for its object to give change of speed, change of direction, and rest to a driven device from a continuously-running motor.

It also has for its object to give change of speed, change of direction, and rest to a driven device without changing the speed or direction of the motor. I attain this broad object by means of a hydraulic pumping apparatus, which constitutes or controls the differential by means of which the power of the motor is transmitted to the device to be driven in such manner as to regulate the stoppage, speed, and direction thereof. The hydraulic pumping apparatus that I have devised is also novel, separately considered, and is adapted for use as a hydraulic motor, and is so constructed that it regulates the quantity of liquid consumed in the process of driving the driven device proportionately to the work to be performed without choking the pressure.

In the drawings, Figure 1 is a longitudinal section. Fig. 2 is a plan. Fig. 3 is a transverse section on the line 3 3 of Fig. 1. Fig. 4 is a transverse section on the line 4 4 of Fig. 1. Fig. 5 is a transverse section on the line 5 5 of Fig. 1. Fig. 6 is a transverse section on the line 6 6 of Fig. 1. Fig. 7 is a view similar to Fig. 1 of a modification. Fig. 8 is a view similar to Fig. 1, showing my improved hydraulic apparatus adapted for use as a hydraulic motor. Fig. 9 is an end view of Fig. 8.

D is a shaft secured to and driven by the driving-shaft D′ of a motor.

C C′ represent a double rotary pump. M is a casing inclosing the same.

E G are gears meshing with each other and constituting the revolving elements of pump C. (See Fig. 6.)

F H are intermeshing gears constituting the revolving elements of pump C′.

The gears G and H are keyed to the driving-shaft. The gear E is loose on the non-rotating shaft K. The gear F is loose on the non-rotating sleeve R, surrounding the shaft K.

The shaft K and sleeve R are connected, respectively, with the levers I and J, which may be operated directly, or, if desired, may be connected with any suitable operating mechanism whereby the shaft K and sleeve R may be shifted longitudinally to cause the teeth of gears E and G or F and H to mesh wholly or partly, as may be desired, for the purposes hereinafter described.

On one side of the gear E and fast to shaft K is a disk L of the same diameter as the extreme diameter of gear E and having a sliding fit in the case M. On the other side of gear E and fast to shaft K is the piston N, also of the same diameter as the extreme diameter of gear E, but cut out on its lower side on a line coincident with the circumference described by the rotation of the tips of the teeth of gear G. (See Fig. 5.) The disk L and piston N are kept from binding on gear E by means of the spacer O, against which they are drawn by a nut *o*.

On one side of gear G and loosely surrounding shaft D, circular in form and of the same diameter as the extreme diameter of gear G, and fitting closely against the sides of the case M is the head P. (See Fig. 3.) The part Q also loosely surrounds shaft D and extends between gears G and H and fits closely against the sides of the case M. The part Q is of the same diameter as gear G, but is cut out on the upper side on a line coincident with the circumference described by the rotation of the tips of the teeth of gear E. (See Fig. 4.) It will be seen that the gear E always revolves in a closed chamber, the only open space being occupied by the teeth of gear G. Similarly the gear G always revolves in a closed chamber, the only open space being occupied by the teeth of gear E. In the opposite walls of the casing M and midway between the axes of the two gears are the delivery-port x and the suction-port x'.

As will be understood by reference to Figs.

4 and 5, that portion of the teeth of gears E and G which are not in mesh exert no pumping action on the liquid, which merely passes around with the teeth. In other words, the teeth not in mesh carry the liquid in both directions through the pump. The active and effective portion of the pump is that portion of the teeth of gears E and G that are in mesh, this portion blocking the return of the liquid carried around by the teeth, so that, in effect, as much liquid is pumped from the suction to the delivery side of the gear-chamber as is carried around by the portion of the gears that are in mesh. Hence as the driving-shaft rotates at a constant speed the amount of delivery of pump C is in direct ratio to the width of the teeth in mesh. By sliding shaft K endwise the width of teeth in mesh can be controlled, and consequently the output of the pump can be varied from nothing (when the teeth are wholly out of mesh) to maximum, (when the gears are brought directly opposite each other and the full width of the teeth are in mesh.)

In the pump C' the various parts of pump C are duplicated, gear F corresponding to gear E, gear H to gear G, L' to L, N' to N, P' to P, delivery-port y to delivery-port x, and suction-port y' to suction-port x'. By sliding the sleeve R endwise the output of pump C' can be controlled in the same way as the output of pump C.

A is a driven pump, which consists of the casing S, shafts T and U, having their bearings therein, and intermeshing gears V and W on the shafts T and U, respectively.

z and z' are ports located in opposite sides of casing S and opposite the point where the gears V and W intermesh. The shaft T extends beyond the casing and is connected with the device to be ultimately driven. I have shown secured to the shaft T a drum B, adapted to carry the lifting-cable of an elevator.

Dependent upon the amount of liquid that is pumped through A and the direction in which it is pumped will depend the direction of travel and rate of speed of the shaft T and drum B. This is controlled by means of the double rotary pump C C', hereinbefore fully described, and the connections therefrom to the pump A, which I shall now describe.

The port x is connected directly, through pipe X, with port z. The port x' is connected directly, through pipe X', with port z'. The port y is cross-connected, by means of pipe Y running over case M and pipe X', with port z'. The port y' is cross-connected, by means of pipe Y' running under case M and pipe X, with port z.

It will be understood that if gears E and G are in mesh and F and H out of mesh the course of the liquid will be from port x, through pipe X, into port z and out of port z', through pipe X', to port x'. If gears F and H are in mesh and E and G out of mesh, the course of the liquid will be from port y, through pipes Y and X', into port z' and out of port z, through pipes X and Y', to port y'. It will thus be seen that pumps C and C' tend to drive A in opposite directions. Dependent, therefore, upon which of the two pairs of gears are in mesh A will be driven in one direction or the other, and the speed with which A is driven by either pair of gears will vary with the extent to which the said gears are in mesh. It is also obvious that if neither pair of gears are in mesh no circulation of the liquid can take place, and therefore no motion is imparted to A. The apparatus therefore enables the speed, direction of travel, starting and stopping of the driven element to be controlled to a nicety, while the driving-motor continuously runs at a constant direction at the same speed.

In practice neither pair of gears will ever be moved wholly out of mesh. This is because if they were brought free of each other it would be difficult to again mesh them. This, however, does not occasion any loss of power, nor does it make it impossible to entirely shut off the circulation of liquid through A. If we assume that gears E and G are fully in mesh and gears F and H slightly in mesh, a proportion of the amount of liquid discharged from port x equal to the ratio of the amount of mesh between gears F and H to the amount of mesh between gears E and G will pass from port x, through pipe Y', into port y' and help to revolve the driving-shaft D. In other words, the liquid will take the line of least resistance, and just the amount of liquid discharged from port x will be deflected to port y' as the gears F and H are capable of pumping. The rest of the liquid discharged from port x will pass through pipe X and perform useful work in revolving A. From this it will be seen that the power applied to do useful work is proportional to the difference in the amount of mesh between gears E and G and gears F and H. Consequently it is perfectly practicable to keep a greater or less portion of both pairs of gears always in mesh and still be able to stop and start A as well as vary its speed and direction of travel. Conditions may arise which will make this desirable, as it permits of the arrangement of gears E and F on the same shaft and their operation in unison.

In Fig. 7 I have shown such an arrangement, in which pumps C^2 and C^3 corresponds to pumps C and C' of Fig. 1, gears E' and F' to gears E and F, the casing M' corresponding to casing M, disks N^2 N^3 to disks N N', gears G' H' to gears G H, heads P^2 P^3 to heads P P', part Q' to part Q, driving-shafts D^2 D^3 to driving-shafts D D'. For the disks L and L' and the portion between them I substitute a single disk L^2. For the shaft K and sleeve R, I substitute the shaft K', and gears E' and F', pistons N^2 and N^3, and disks L^2 are all placed on the shaft and operated by means of lever I'. The piping and driven element are the same as in Fig. 1. The shaft K' is shown in its central position, wherein gears

E' and G' and gears F' and H' are in mesh to precisely the same extent. From the description of the device of Fig. 1 it will be understood that under these conditions no useful work will be performed, all the liquid passing from pump C^2 to pump C^3, back again to pump C^2, and so on in an endless circuit, there being theoretically no consumption of power, and practically no consumption of power, except that required to maintain a circulation of the liquid and the small loss due to friction. If, however, the shaft K' is moved in either direction from its central position, one pair of gears will mesh throughout a greater length than the other pair and an amount of liquid will be pumped to A proportional to the difference in the amount of mesh between the two pairs of gears. The direction of travel imparted to A will depend upon the direction in which shaft K' is moved from the center, and the speed imparted to A will depend upon the extent to which shaft K' is moved from the center.

The arrangement shown in Fig. 7 is more compact and has fewer parts than the arrangement shown in Fig. 1 and may be found in many situations preferable.

While I have referred to my improved hydraulic or liquid apparatus as a "pump," it is obvious that under some conditions, as in elevator service, A would be a motor and C a pump, while under other conditions C would be a motor and A a pump. Indeed, my improved hydraulic or liquid apparatus is very serviceable as a hydraulic or liquid motor, as in the construction shown in Figs. 8 and 9. In this construction, M^2 represents the casing, E^2 G^2 the intermeshing gears, the gear E^2 being loose on shaft e^2 and the gear G^2 being keyed to shaft g^2. The parts L^3, N^4, Q^2, and P^4 correspond, respectively, to the parts L N Q P of Fig. 1. x^5 is the supply-port, and y^5 the discharge-port. Water under pressure is supplied from a source of supply and the apparatus acts as a motor, M^5 representing a pulley on the shaft g^2, from which by belting power is transmitted to the mechanism to be driven. The shaft e^2 may be moved sidewise by hand in order to vary the gear-surface in mesh, and thereby vary the power consumed without choking the pressure. If a constant speed is desired, the side motion of the gears may be controlled by a governor, thereby accurately proportioning the consumption of power to the work performed. I have shown in Figs. 8 and 9 one such arrangement, in which 10 represents a governor on the shaft g^2, the governor being connected by means of a lever 11, pivoted at 12 to the valve-rod 13, having the valves 14 and 15. 16 is a valve-chamber in which the valves slide, the opposite ends of the valve-chamber being connected, by means of passages 17 and 18, with a discharge-port 19, while the middle of the valve-chamber is connected by a passage 20 with a supply-port 21, and passages 22 and 23 lead from the valve-chamber to opposite ends of the chamber 24, in which the parts E^2, L^3, and N^4 slide. 25 is a weight on an arm 26 integral with lever 11, by means of whose adjustment the speed at which the governor acts can be regulated.

The operation is as follows: As shown, the gear E^2 is in the position at which the maximum gear-surface is in mesh, and consequently at the position at which it will consume the maximum power. This condition exists when the motor is doing its maximum work. If the load on the motor decreases—that is, if less work is thrown upon it—the speed of shaft g^2 will be accelerated, causing the balls of the governor to fly out, the lower end of lever 11 to be pulled to the right, the upper end of lever 11 and the valve-rod 13 to be pushed to the left, and permitting the water to flow through passage 22 to the left-hand end of gear-chamber 24 and to discharge from the right-hand end of said chamber through passage 23, thus moving gear E^2 to the right, reducing the width of gear-surface in mesh. This continues until the speed of the shaft g^2 is reduced to its former rate, which causes the governor to return to its normal central position, which in turn moves the valves to their normal position, thus closing the passages 22 and 23 and holding the gear E^2 stationary in its new position until there is another variation in the load.

From the foregoing description it will be understood that my apparatus attains the very important result of regulating the quantity of liquid consumed in driving the driven device—that is, in doing useful work—proportionately to the work to be performed without, as heretofore, choking the pressure. This will be best understood by reference to the form shown in Figs. 8 and 9 in connection with the following explanation.

From any source of water-supply the pressure is practically constant, so as to suit the maximum load for all motors connected to it. With a motor of the displacement type operated from such source of supply the displacement or power consumed is always the same with a given speed whether no load or a full load is on the motor. It is true that light work could be done with less pressure; but the pressure-supply is constant, and to prevent the excess pressure being consumed in giving excess speed to the motor the valve is choked and the excess of pressure is consumed in forcing the water through the valve and is lost. My device is such that the pressure is not choked and lost; but the whole of it is utilized. I simply cut down the quantity of water consumed to the necessary amount, and the remainder instead of being wasted is held back in the source of supply.

In an application filed by me April 14, 1902, Serial No. 102,709, I have shown an apparatus in which the same broad principle is involved of giving change of speed, change of direction, and rest to the driven device from a continuously-running motor by means of a hydraulic pumping apparatus, and other applications of the principle can be devised that will equally embody my invention. In this application, Serial No. 102,709, I have also shown essentially the same construction of novel hydraulic pumping apparatus, in which the quantity of liquid consumed in driving the driven device varies proportionately to the work to be performed without choking the pressure.

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

1. In a hydraulic or liquid motor or pump, a chamber having an inlet and an outlet, a plurality of rotary coacting parts inclosed in said chamber and adapted by their coaction to regulate the quantity of liquid fed through said chamber, and means to move one of said rotary parts relatively to the other along its axis to vary the extent of the coaction of said rotary parts, thereby varying the quantity of liquid consumed.

2. In a hydraulic or liquid motor or pump, a chamber having an inlet and an outlet, a plurality of rotary parts having intermeshing teeth and inclosed in said chamber, and means to change the relative position of said rotary parts along their axis to vary the extent to which the teeth mesh, thereby varying the quantity of liquid consumed.

3. In a hydraulic motor or pump, a plurality of rotary coacting parts adapted to feed liquid in both directions therethrough and by their coaction to obstruct the back feed, and means to change the relative position of said rotary parts along the axes of said parts, thereby increasing or decreasing the extent of their coaction and consequently the extent to which said back feed is obstructed, thereby varying the net quantity of liquid consumed.

4. In a hydraulic motor or pump, a plurality of rotary parts having teeth adapted to feed liquid in both directions therethrough, said teeth being adapted to mesh and thereby obstruct the back feed, and means to change the relative positions of said rotary parts along their axes, thereby varying the extent to which the teeth mesh and consequently the extent to which the back feed is obstructed, thereby varying the net quantity of liquid consumed.

5. A hydraulic or liquid motor or pumping apparatus consisting of a casing, a chamber therein, ports opening into and out of said chamber, two revolving members in said chamber adapted in their coaction to draw the liquid from one side to the other of the chamber and obstruct its return, and means to shift said revolving members axially relatively to each other, thereby varying the effective driving surfaces of said revolving members, and thus varying the amount of liquid pumped through the chamber.

6. A hydraulic or liquid motor or pumping apparatus consisting of a casing, a chamber therein, ports opening into and out of said chamber, two rotary coacting pump members in said chamber adapted to propel the liquid in both directions, and means to change the relative positions of said members along their axes, whereby said pump members may be caused to coact with each other to a greater or less extent, said members being adapted by their coaction to obstruct the passage of the liquid in one direction through the pump.

7. The combination, with a device to be driven, of a driving hydraulic pumping apparatus consisting of two pumps, each pump having a plurality of rotary coacting parts, means acting upon the driven device and being acted upon by the two pumps in such manner as to tend to drive the driven device in opposite directions, and means to shift the rotary parts of each pump axially relatively to each other thereby varying the extent to which said parts coact, and thereby varying both the absolute and proportionate feeds of the two pumps.

8. The combination, with a driving hydraulic pumping apparatus consisting of two pumps, each pump having a plurality of rotary coacting parts, of a driven pump, connections from each driving-pump to the driven pump, the connections being such that the two driving-pumps tend to drive the driven pump in opposite directions, means to shift the rotary parts of each driving-pump axially relatively to each other, thereby varying the extent to which said parts coact and thereby varying both the absolute and proportionate speeds of the two driving-pumps, thus controlling the amount and direction of liquid pumped to the driven pump, and a device to be driven connected with the driven pump.

9. A hydraulic or liquid motor or pumping apparatus consisting of a casing, a chamber therein, ports opening into and out of said chamber, two revolving members in said chamber having driving projections adapted by their coaction to draw the liquid from one side to the other of the chamber and obstruct its return, means to vary the extent to which the driving projections coact, and parts arranged to permit the driving projections to propel liquid from the inlet to outlet side of the chamber and to permit the non-coacting parts of the driving projections to return liquid from the outlet to inlet side of the chamber, whereby the quantity of liquid pumped may be varied proportionately to the work performed without choking the pressure.

10. A hydraulic or liquid motor or pumping apparatus, consisting of a casing, a chamber therein, ports opening into and out of said chamber, two intermeshing gears in said chamber the teeth of which are adapted to propel the liquid in both directions through the pump, and means whereby said gears may be caused to slide laterally with respect to each other, thereby varying the extent to which

the two gears mesh, the intermeshing teeth being adapted to obstruct the passage of the liquid in one direction through the pump.

11. A hydraulic or liquid motor or pumping apparatus consisting of a casing, a chamber therein, ports opening into and out of said chamber, two intermeshing gears in said chamber the teeth of which are adapted to propel the liquid in both directions through the pump, disks on opposite sides of one of said gears of a diameter equal to the extreme diameter of such gear, heads on the opposite sides of the other of said gears of a diameter equal to the extreme diameter of such gear, one of said heads being cut away to fit the circumference of the opposing disk and gear, and one of said disks being cut away to fit the circumference of the opposing head and gear, and means to slide said disks and the corresponding gear laterally with respect to the opposing gear and heads.

12. The combination, with a driving hydraulic pumping apparatus consisting of two pumps, of a driven pump, connection from each driving-pump to the driven pump, the connections being such that the two driving-pumps tend to drive the driven pump in opposite directions, said driving-pumps being arranged to have an equal feed when in a central position, and an operating device connected with both pumps and adapted to be operated to simultaneously increase the feed of one pump and decrease the feed of the other pump, thereby controlling the amount and direction of liquid pumped to the driven pump, and a device to be driven connected with the driven pump, whereby the stoppage, direction of travel and speed of the driven device may be varied.

13. A hydraulic motor or pump the actuating parts of which consist of a plurality of rotary coacting parts, and means to move one of said rotary parts relatively to the other along its axis to vary the extent to which said parts coact.

In testimony of which invention I have hereunto set my hand, at Winnetka, on this 21st day of March, 1902.

FRANK E. HERDMAN.

Witnesses:
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HENRY C. JOHNSON.