(No Model.) 9 Sheets—Sheet 1.

S. FORTER.

HYDRAULIC MOTOR.

No. 482,732. Patented Sept. 20, 1892.

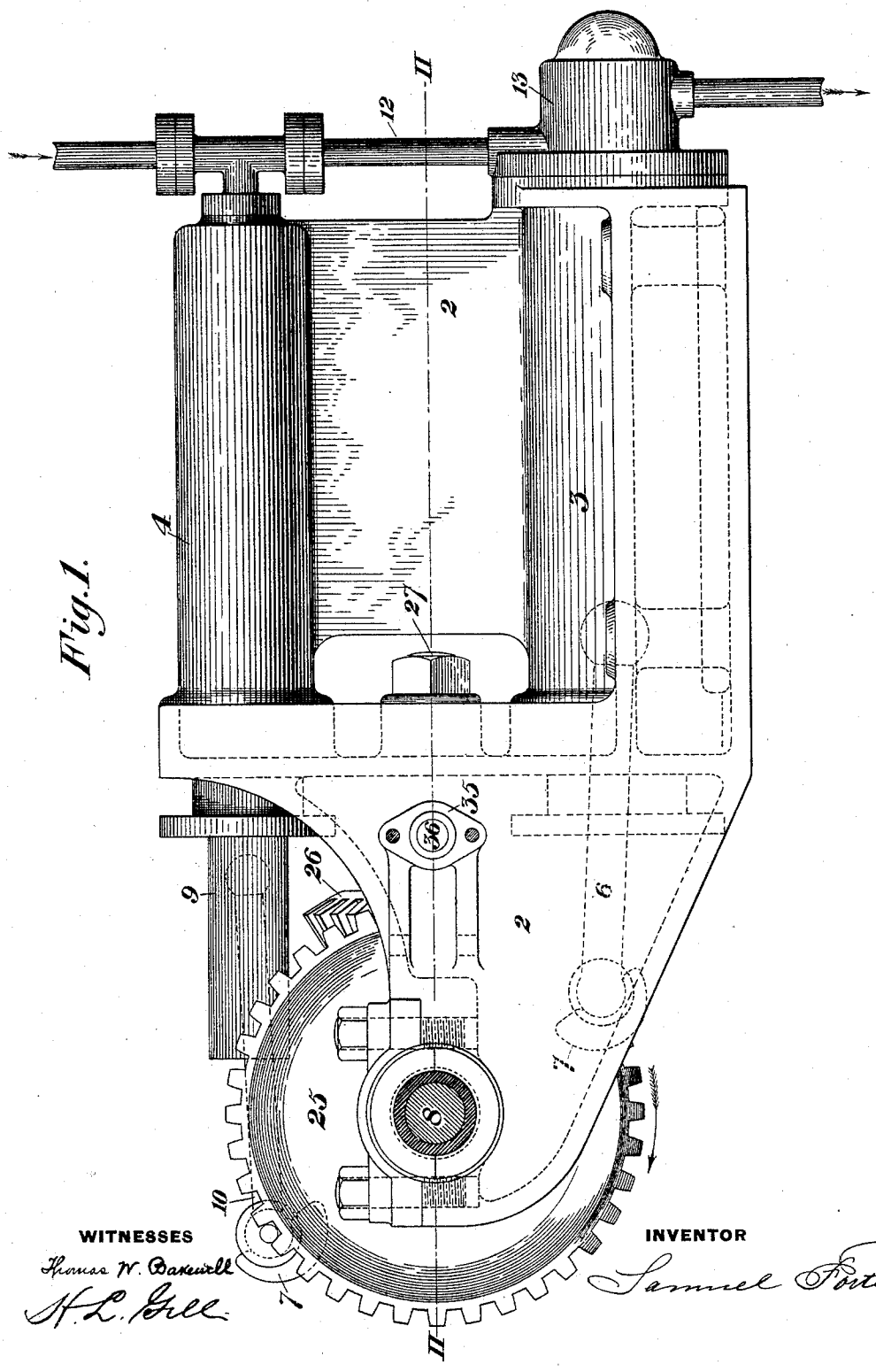

Fig. 1.

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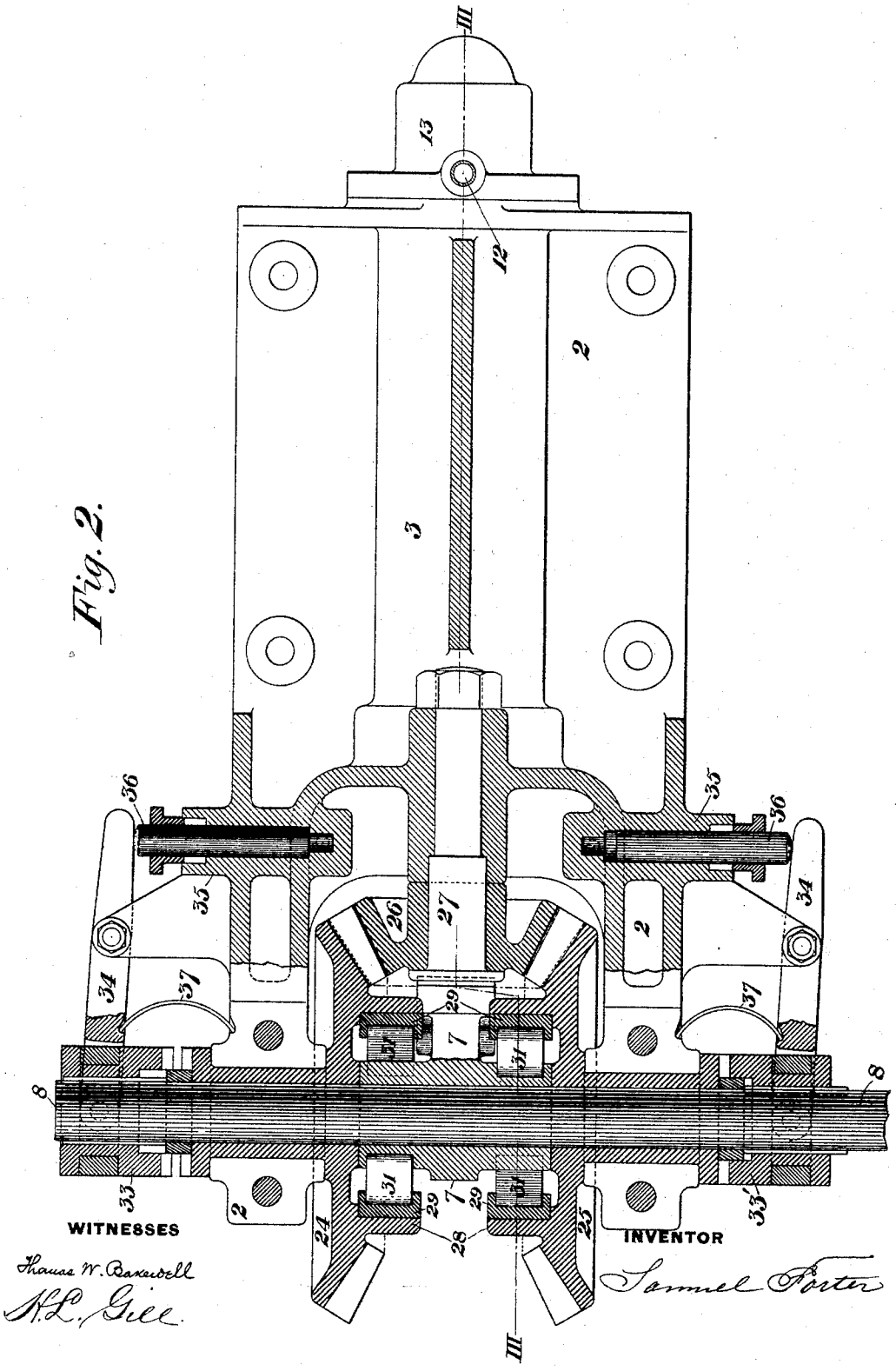
Fig. 2.



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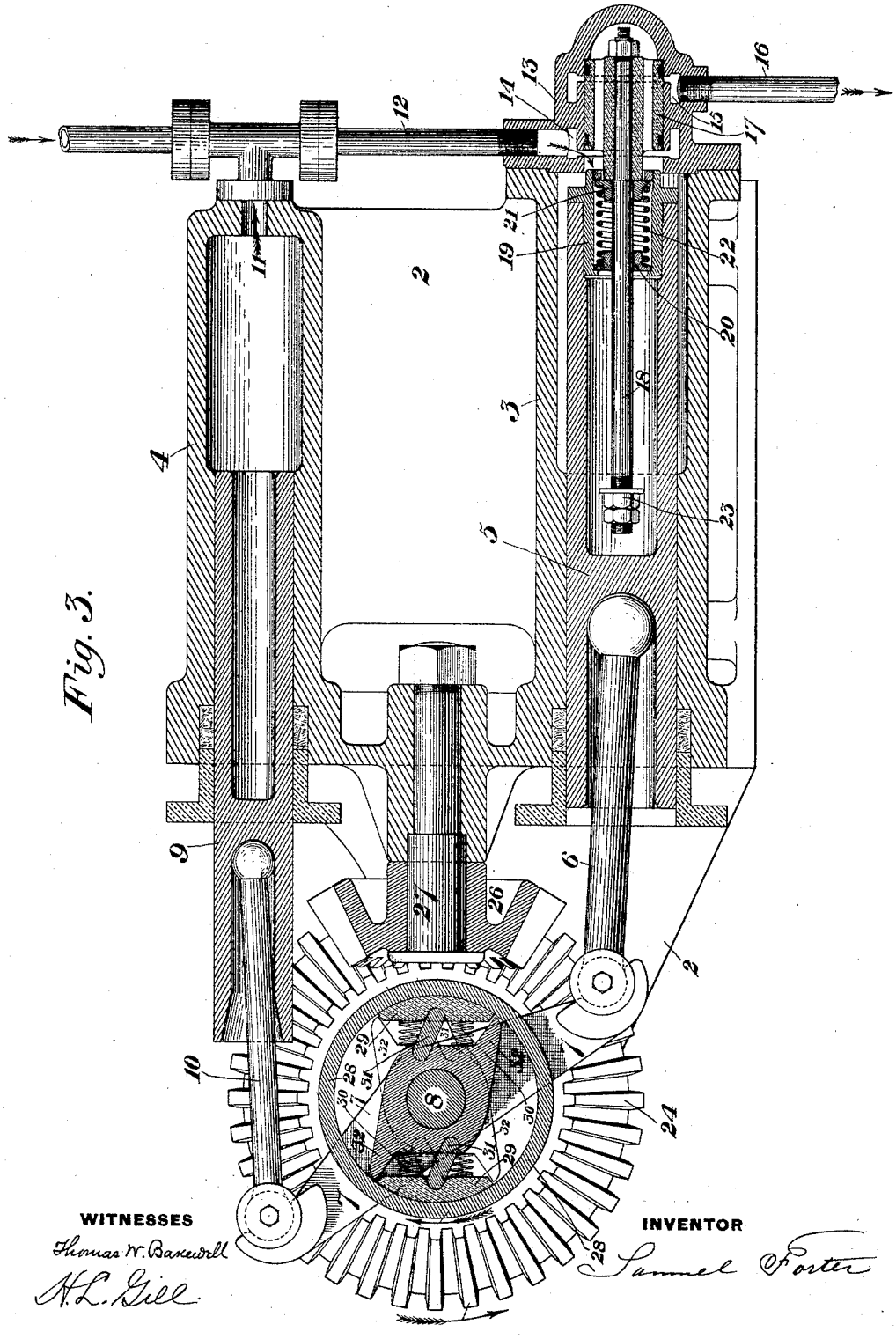

Fig. 3.

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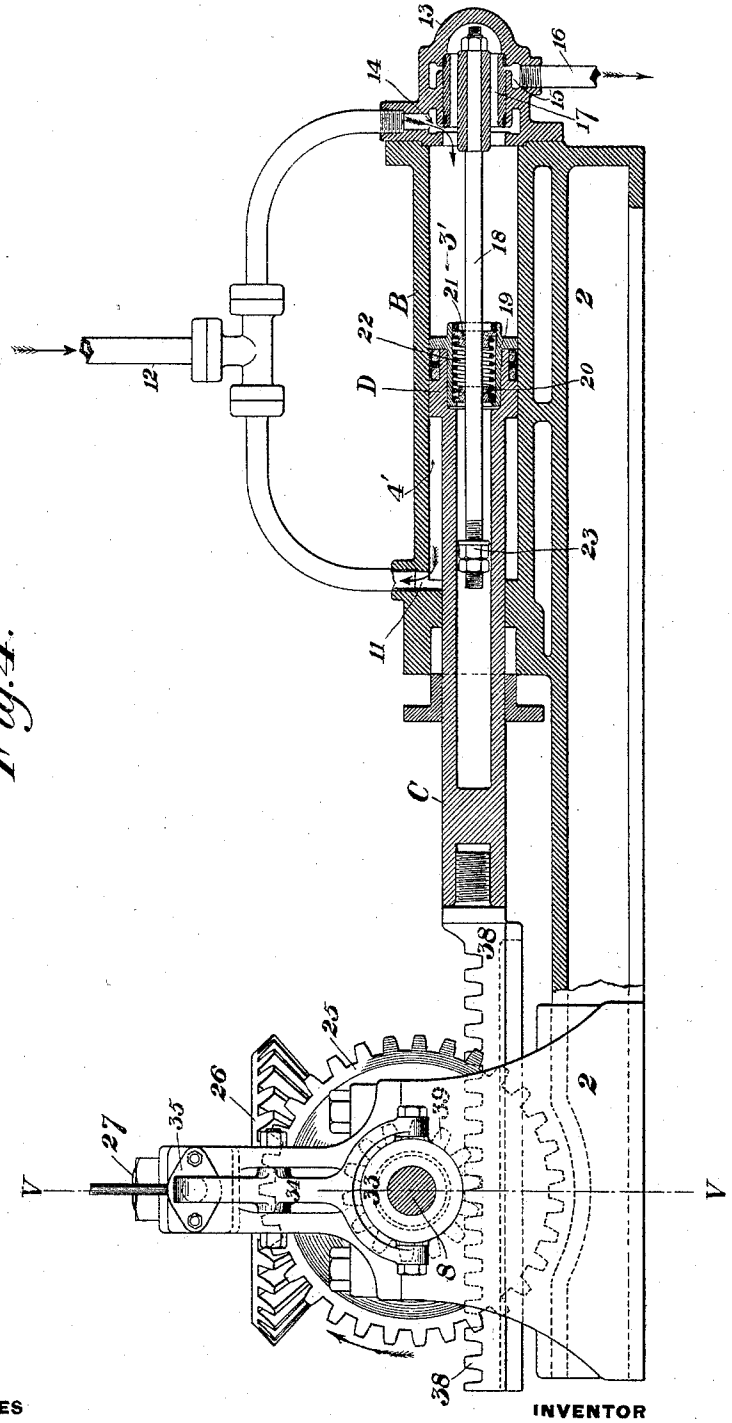

Fig. 4.

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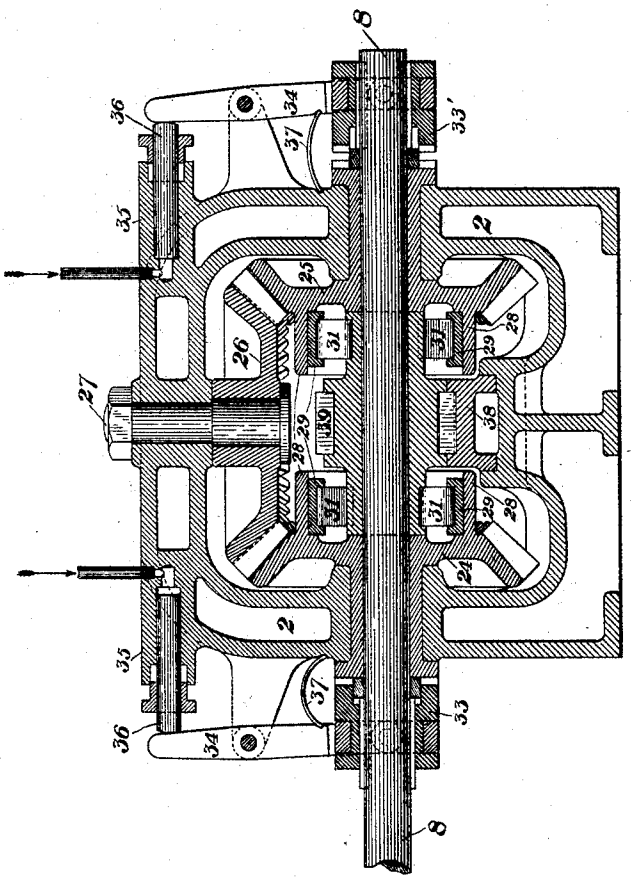
Fig. 5.



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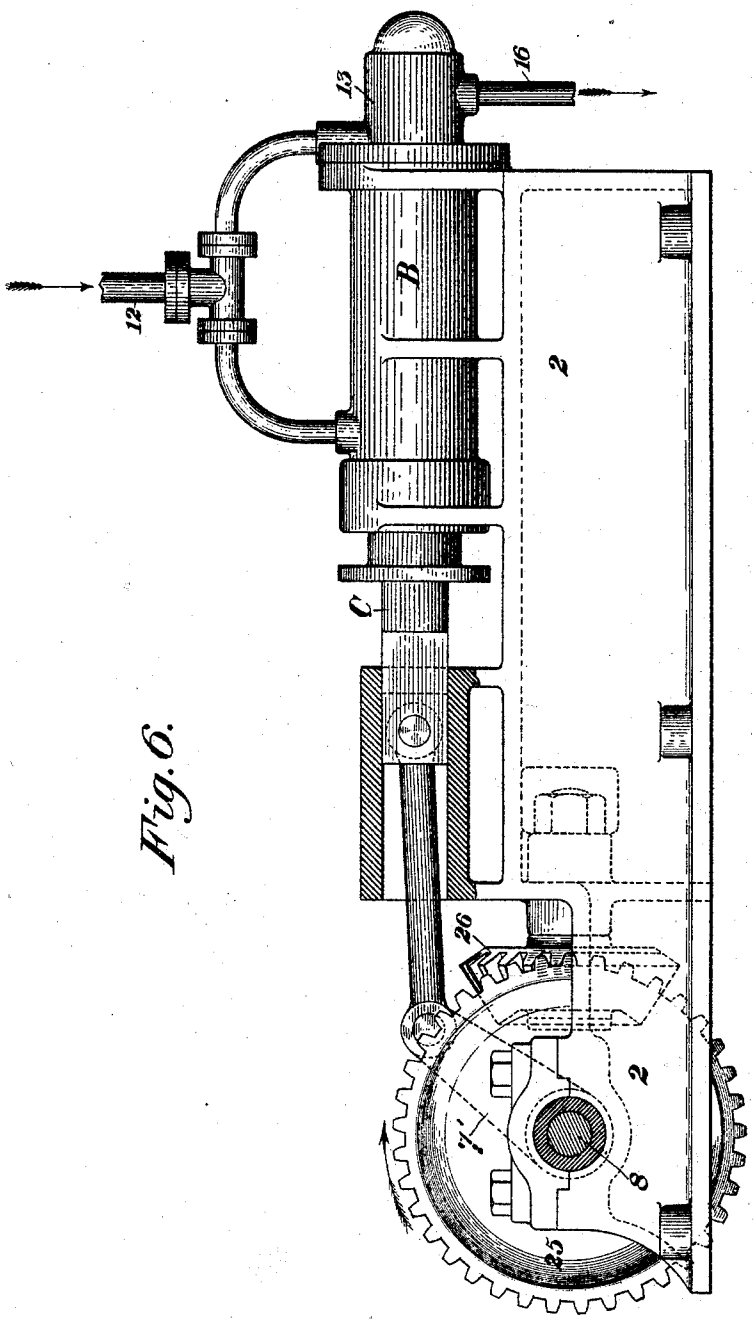

Fig. 6.

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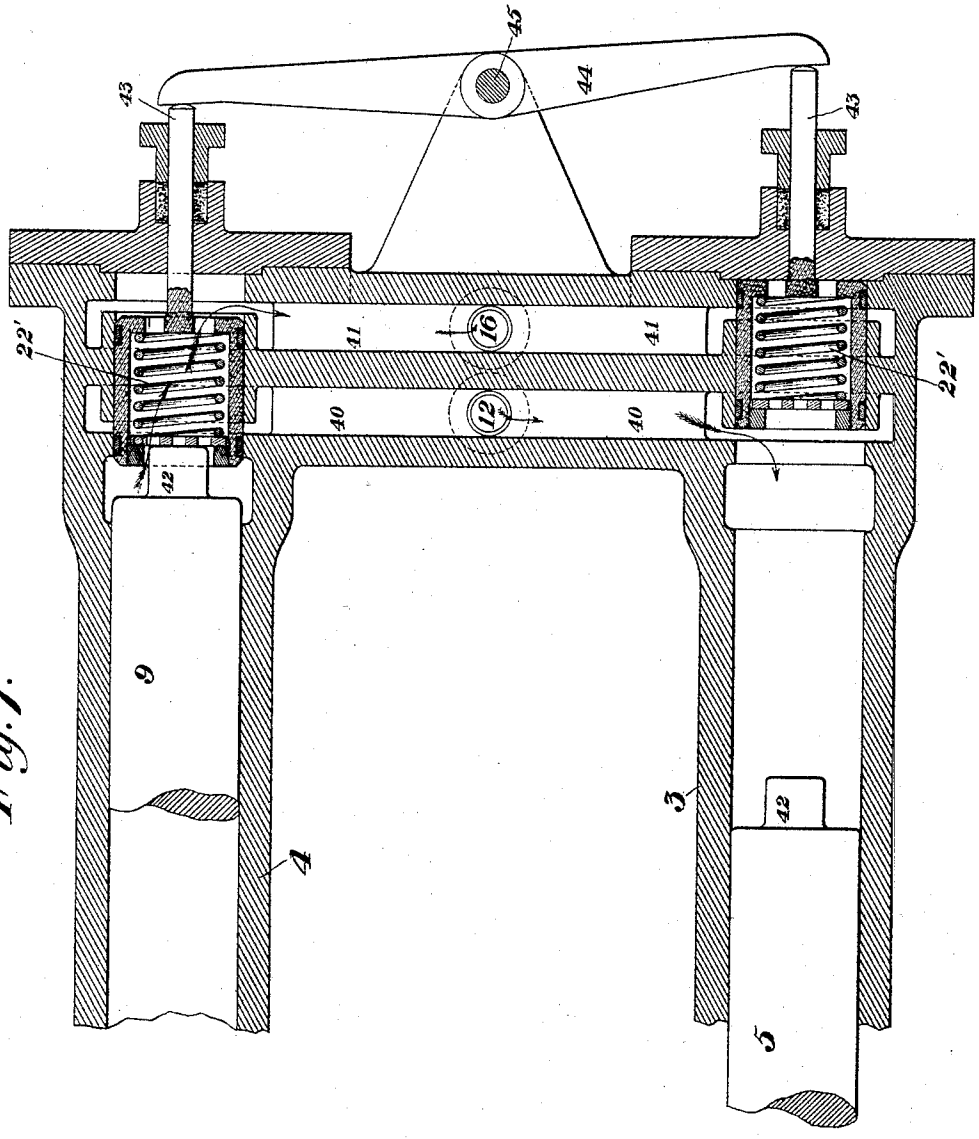

Fig. 7.

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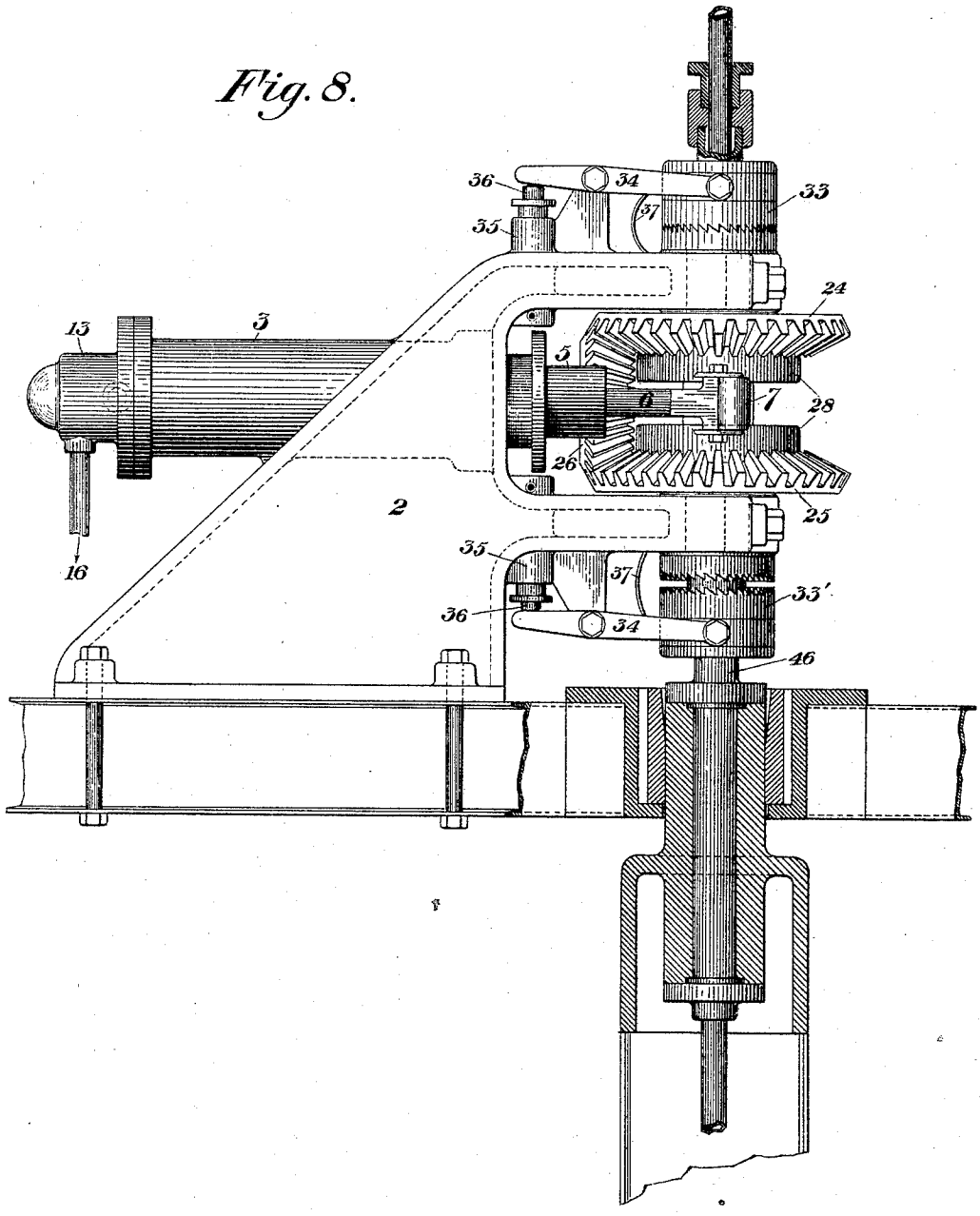
Fig. 8.



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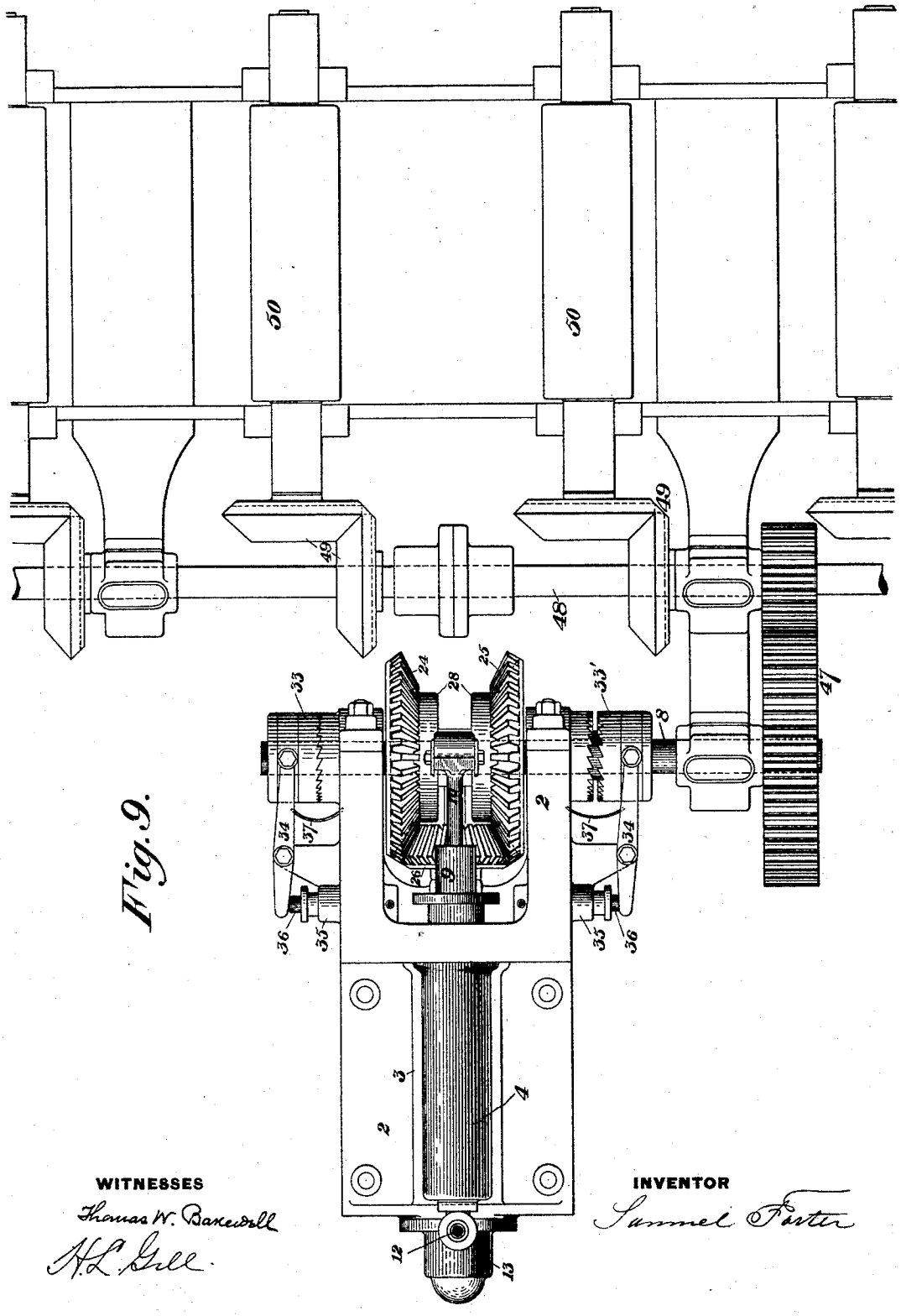

Fig. 9.

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UNITED STATES PATENT OFFICE.

SAMUEL FORTER, OF ALLEGHENY, PENNSYLVANIA.

HYDRAULIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 482,732, dated September 20, 1892.

Application filed September 19, 1891. Serial No. 406,169. (No model.)

To all whom it may concern:

Be it known that I, SAMUEL FORTER, of Allegheny, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Hydraulic Motors, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a side elevation partly in section, showing one form of my improved motor, having two single-acting cylinders and a double-armed lever. Fig. 2 is a horizontal section on the line II II of Fig. 1. Fig. 3 is a vertical section on the line III III of Fig. 2. Fig. 4 is a side elevation principally in vertical longitudinal section, showing a modified construction of the motor, having in this case one double-acting cylinder and a rack-and-pinion transmission-gear instead of the lever shown in Fig. 1. Fig. 5 is a vertical cross-section on the line V V of Fig. 4. Fig. 6 is a side elevation partly in section, showing a third construction of the motor, having one double-acting cylinder with lever-transmission mechanism. Fig. 7 is a vertical section of the valves and parts of the power-cylinders, showing a modified construction of the valves. Fig. 8 is a side elevation partly in section, showing the motor applied to the mast of a crane for turning the latter on its vertical axis. Fig. 9 is a plan view showing the application of the motor to driving the feed-rollers of a mill-table.

Like symbols of reference indicate like parts in each.

The object of my invention is to provide a hydraulic motor of improved construction which shall be more efficient, steadier in its action, and easier to keep in repair than other motors heretofore known.

Referring to Figs. 1, 2, and 3, 2 represents the frame of the motor, containing two single-acting hydraulic cylinders 3 and 4, extending parallel with each other, the area of the plunger of the cylinder 3 being twice the area of the other plunger. The cylinder 3 is provided with a plunger 5, connected by a pitman 6 with one end of a lever 7, which extends radially in opposite directions from the main shaft 8 of the motor. The plunger 9 of the other cylinder is connected in like manner by a pitman 10 with the other end of the lever 7, and as the said plungers reciprocate in opposite directions they rock the lever, which is so connected with gearing on the main shaft by clutch mechanism, hereinafter described, that in moving in both directions it will transmit rotation to said gearing.

The advantage of employing two single-acting cylinders instead of one double-acting cylinder having a piston-head is that while in the latter case there is considerable difficulty and expense in constructing and fitting the piston-head and keeping its packings in repair, so that it shall not leak, the plungers of the single-acting cylinder are easy to pack, and any leak being on the outside from within can be detected easily. I am enabled to use the two single-acting cylinders by reason of the fact that I employ a clutch-transmission device, hereinafter described, which transmits rotary motion to the main shaft on each stroke of the plunger. The cylinder 4 has at its rear end a port 11, constantly in communication with the water-supply pipe 12, which also extends to the valve-chamber 13 of the other cylinder 3. Said valve-chamber is provided with an annular inlet-port 14, into which the pipe 12 opens, and an annular exhaust-port 15, from which leads a discharge-pipe 16.

17 is a piston-valve adapted to reciprocate in the valve-chamber, and when at one end of its stroke (shown in Fig. 3) to open communication between the port 14 and the cylinder, and when at the other end of its stroke to establish communication between the port 15 and the rear end of the valve-chamber. The valve is made hollow, as shown, and therefore it permits passage of water from the cylinder to the port 15, and its action is balanced, so that but little force need be exerted to move it.

In order to operate the valve, I may use the following mechanism: A rod 18 extends from the valve into the longitudinal cavity of the hollow plunger 5, and an annular shell 19 is set inside the plunger and is provided with washers 20 21, which fit around said rod and have an interposed spring 22. When the plunger reaches the end of its instroke, as shown in Fig. 3, the washer 21 will engage the valve and will push it back, so as to open the inlet-port and to close the exhaust-port. At the end of the outstroke of the plunger the

washer 20 will engage a head or nut 23 on the rod 18 and will move the valve in the reverse direction, so as to close the inlet-port and to open the outlet-port. The action of the spring 22 in both cases is such that the valve is not immediately moved on the engagement of the parts above referred to, but the spring is first compressed until it acquires tension sufficient to overcome the frictional resistance of the valve, and it is then carried by the spring in the direction of motion of the plunger. The advantage of this use of the spring is that it cushions the valve's action and serves as a safety device to insure the motion of the valve to the full end of its stroke, preventing it from sticking at intermediate points.

When the parts are in the position shown in Fig. 3, the water enters the port 14 of the cylinder 3 and projects the plunger, the force of which, acting through the lever 7, pushes back the plunger 9 against the force of the water in the cylinder 4, which is continually exerted in the latter cylinder. When the plunger 5 reaches the end of its outstroke, the valve 17 is shifted, so as to close the inlet-port and to open the exhaust-port. Thereupon the water acting on the plunger 9 projects it and through the lever 7 pushes back the plunger 5 and displaces the water from the cylinder 3. The cylinder 4 thus acts as a retracting-cylinder for the cylinder 3, and as it exhausts directly into the supply-pipe 12 the water employed therein is not wasted.

I shall now describe the clutch mechanism by which the motion of the plungers is made effective in rotating the shaft 8. 24 25 are beveled pinions set loosely on the shaft 8 at the ends of the hub of the lever 7 and connected by an intermediate gear-wheel 26, so that when driven these pinions 24 25 must rotate in opposite directions. The gear-wheel 26 is suitably journaled on a pin or shaft 27, fixed to the frame of the motor. On its inner face each pinion 24 25 has an annular flange 28, within which are fitted diametrically-opposite segmental shoes 29, held against the flange by springs 30, and inclined toggles or links 31 are interposed between said shoes and the hub of the lever 7, fitting in sockets in these parts. It results from this construction that when the lever 7 is moved in one direction it will cause the links 31 to move toward a radial position, and thus to force the shoes 29 out against the flange of one of the pinions, and will thus rotate said pinion by friction. When the lever moves in the other direction, it will tend to move the links 31 of said pinion back into a more inclined position, thereby loosening the pressure on the shoes 29 and permitting the latter to be turned idly within the flange 28 by means of horns 32 on the lever-hub. The links 31 of the other pinion are oppositely inclined, so that while in moving in one direction the lever applies rotation to one pinion in one direction and in moving oppositely it applies rotation to the other pinion in the opposite direction. The pinions being connected by the intermediate gear-wheel 26 mutually drive each other continuously. The rotation of the pinions is transmitted to the main shaft 8 by means of clutches 33 33′, connected by feather-and-spline connections to the shaft at the outer ends of the hubs of the pinions 24 25 and provided with levers 34, by which they may be moved into engagement with corresponding clutches on said hubs. As the pinions rotate in opposite directions, the shaft is driven in one direction when the clutch 33 is brought into engagement with the pinion 24 and is driven in the other direction when the clutch 33′ is engaged with the pinion 25. By bringing both clutches into gear with their respective pinions the motor can be locked and stopped without cutting off the water-supply, and by disengaging both clutches the motor will act without driving the main shaft.

In order to operate the levers 34, I prefer to employ small hydraulic cylinders 35, whose plungers 36 bear against the levers and serve to move them in one direction, the motion in the other direction being effected by retracting-springs 37.

The specific construction of the above-described mechanism for transmitting to the pinions on the main shaft the power of the motor-cylinders is desirable and efficient; but although I intend to claim it specifically it does not constitute a necessary feature of limitation of my invention when considered broadly, since other devices—such as pawls and ratchets—may be substituted therefor, as hereinafter explained. The peculiar efficiency of the form of clutch mechanism shown in the drawings is that it is continuous in its action, the transmitted motion not being interrupted by jerks, as when ratchet transmission is employed.

In Figs. 4 and 5 I show a modified construction of the motor, in which instead of employing two single-acting cylinders one double-acting cylinder B is used. The plunger C projects from the end of the cylinder and has a piston-head D, the effective area of the piston-head at the side next the end 4′ of the cylinder being one-half that of the head on the other side 3′. The arrangement of the valve at the end 3′ is the same as shown in Fig. 3, and the end 4′ is in constant communication with the water-supply pipe 12. The motor acts on the same principle as the motor of Fig. 3. I also show in Figs. 4 and 5 a modified construction of the power-transmitting mechanism, in that, instead of using a crank-lever 7, I connect the plunger to a rack 38, which is in gear with a loose pinion 39 on the main shaft. This pinion serves the function of the lever 7, and its hub in like manner is provided with toggle-links 31, connecting it with the pinions 24 and 25.

In Fig. 6 I show another modified construction of the motor, in which there is one double-acting motor-cylinder constructed like that of Fig. 4; but instead of using the rack-and-

pinion transmission device the plunger is connected to an oscillatory lever 7′, which is connected with the main shaft by the same mechanism as illustrated in Fig. 1.

In Fig. 7 I show the motor constructed with two single-acting cylinders differing from the construction shown in Fig. 1 in that each of the cylinders has a valve controlling the inlet and exhaust of water, thus enabling me to obtain the full working power of both. Both cylinders and plungers may be of the same cross-sectional area. The supply and exhaust pipes 12 16 communicate with the valve-chambers of the motors through passages 40 41. The valves are sliding piston-valves, constructed similarly to the valve of Fig. 1, but preferably having the spring 22′ within the valve cavity, and they are operated by engagement with tongues 42 at the ends of the plungers. In order that both valves may work in unison in opposite directions to secure the proper alternate strokes of the plungers, I provide them with outwardly-projecting stems 43, which engage the opposite arms of a double lever 44, pivoted at 45 to a bracket on the motor-frame, so that as one valve is pushed back by its plunger the other valve shall be advanced by action of the lever. This construction of my device is claimed by me specifically.

In Fig. 8 I show the application of my motor to turning a crane. Here the place of the main shaft 8 of the other figures is occupied by an extension 46 of the top journal of the crane-mast, or it may be the bottom of the mast, since the motor may be located at either end. The clutches are placed on the crane-journal in the same position relatively to the other parts as are the clutches on the shaft 8 of Fig. 2. With this construction the crane-mast can be rotated in either direction to as great an extent as may be desired, and in this respect the operation is much more convenient than when a simple rack and pinion, permitting only a limited rotation in either direction, is employed. Similar advantages are obtained when the motor is used for such purposes as driving the rollers of a rolling-mill feed-table. This is illustrated in Fig. 9, in which the main shaft 8 of the motor is connected by gearing 47 to the shaft 48, which by gearing 49 is connected with the feed-rollers 50. The steadiness of motion of the motor and the ease and rapidity with which the motion transmitted therefrom can be reversed adapt it especially to this use.

In cases where it is not desired that the motion should be capable of reversal I may dispense with one set of the clutches on the main shaft, or where it is not desired to stop the shaft without stopping the motor no clutch need be used, one of the pinions being keyed to the shaft.

I claim—

1. In a hydraulic motor having two coacting cylinders and plungers, the combination of two piston-valves, one situated in each cylinder and controlling its inlet and exhaust ports, plungers in said cylinders adapted to engage and move said valves in one direction, and connecting mechanism by which the motion of one valve by the plunger will move the other valve in reverse direction, substantially as and for the purposes described.

2. In a hydraulic motor, the combination, with a motor-cylinder, reciprocatory plunger, and main shaft, of gear-wheels connected by clutch mechanism with the motor and adapted to be rotated thereby in opposite directions, and a third gear-wheel connecting said first-named gear-wheels, substantially as and for the purposes described.

3. In a hydraulic motor, the combination, with a motor-cylinder, reciprocatory plunger, and main shaft, of gear-wheels connected by clutch mechanism with the motor and adapted to be rotated thereby in opposite directions, a third gear-wheel connecting said first-named gear-wheels, and clutches adapted to connect either of the latter gear-wheels with the main shaft, substantially as and for the purposes described.

4. In a hydraulic motor, the combination, with a motor-cylinder, reciprocatory plunger, and main shaft, of gear-wheels connected by clutch mechanism with the motor and adapted to be rotated thereby in opposite directions, a third gear-wheel connecting said first-named gear-wheels, clutches adapted to connect either of the latter gear-wheels with the main shaft, and auxiliary motor-cylinders adapted to operate the clutches, substantially as and for the purposes described.

5. The combination, with the reciprocatory plunger and main shaft, of a hub connected with the plunger and oscillatory thereby, flanged wheels 24 25, set in proximity to the hub, shoes bearing against the flanges of the wheels, and toggle-links interposed between the hub and shoes, substantially as and for the purposes described.

6. The combination, with the reciprocatory plunger and main shaft, of a hub connected with the plunger and oscillatory thereby, flanged wheels 24 25, set in proximity to the hub, shoes bearing against the flanges of the wheels, toggle-links interposed between the hub and shoes, and a gear-wheel 26, connecting the wheels 24 and 25, substantially as and for the purposes described.

In testimony whereof I have hereunto set my hand this 15th day of September, A. D. 1891.

SAMUEL FORTER.

Witnesses:
THOMAS W. BAKEWELL,
W. B. CORWIN.