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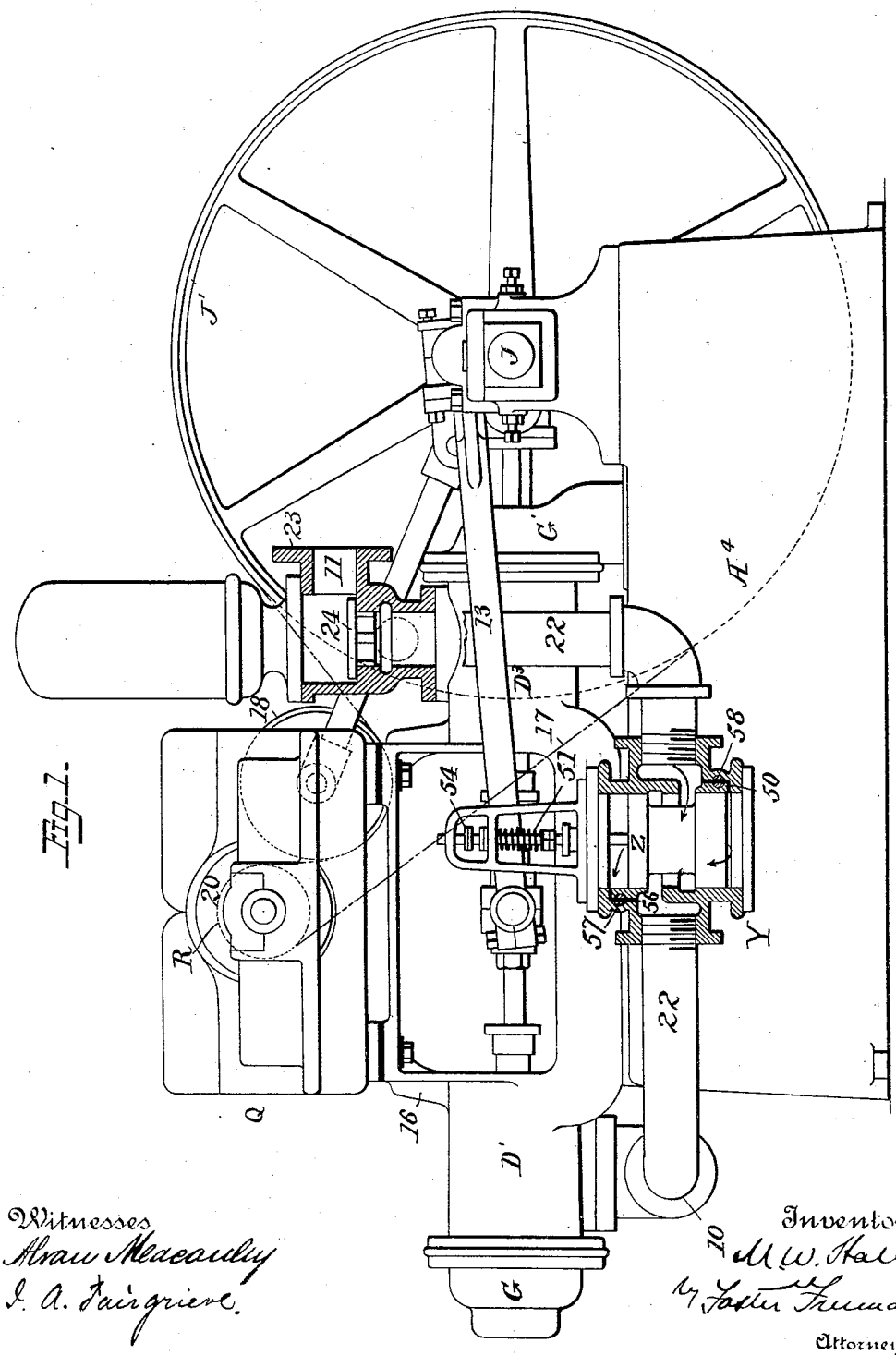

Fig. 1.

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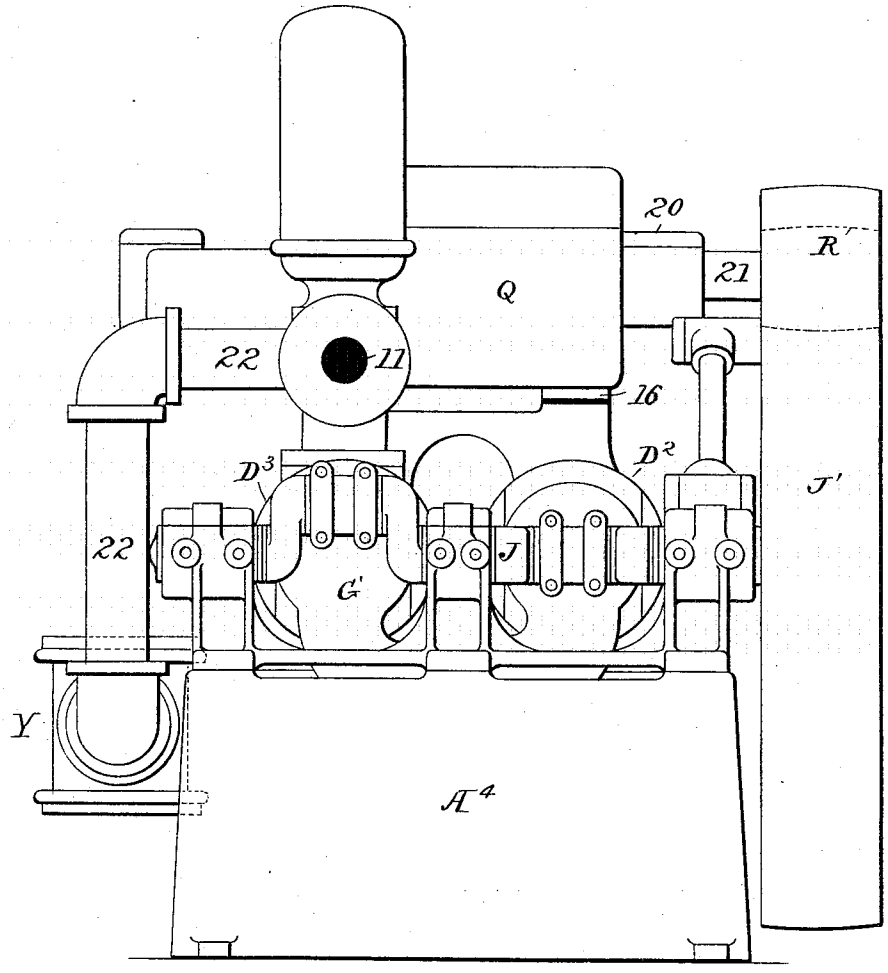
Fig. 2.



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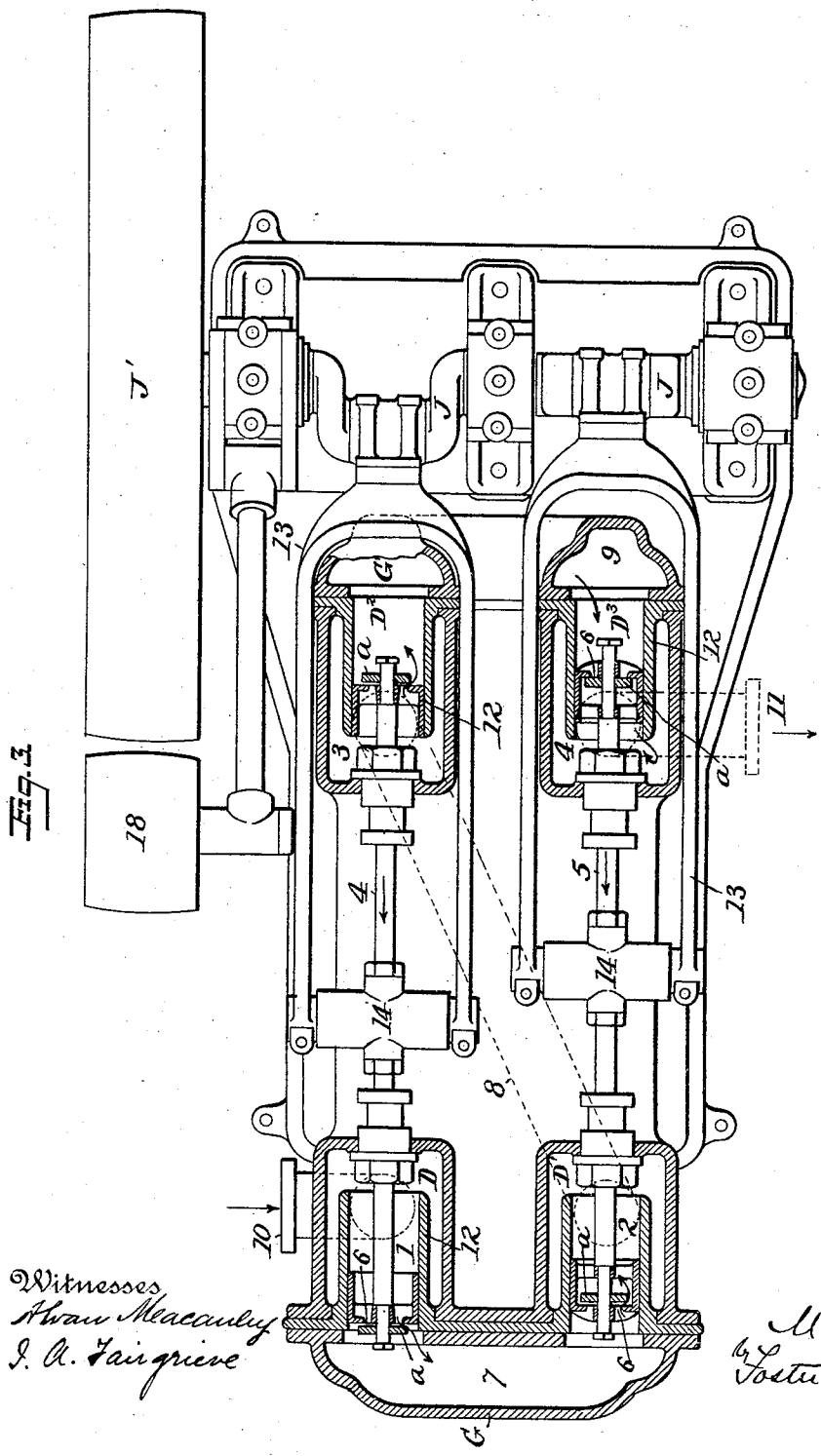

Fig. 3.

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Fig. 7.

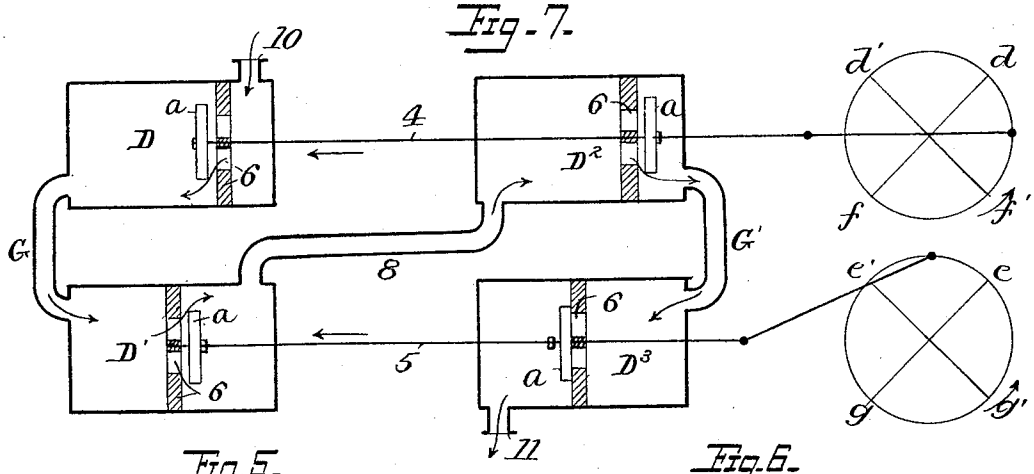

Fig. 5.

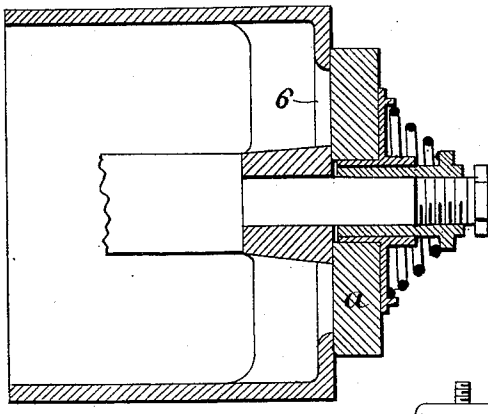

Fig. 6.

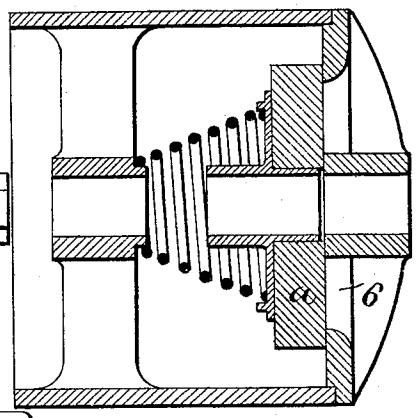

Fig. 4.

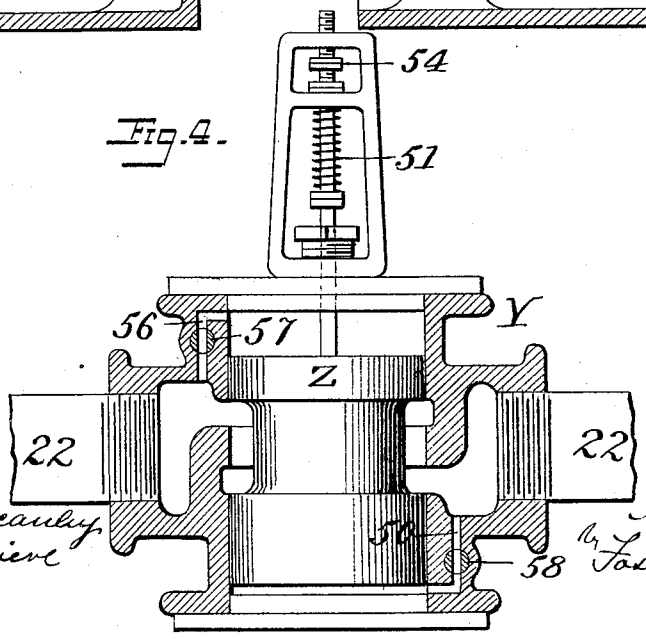

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Fig. 8.

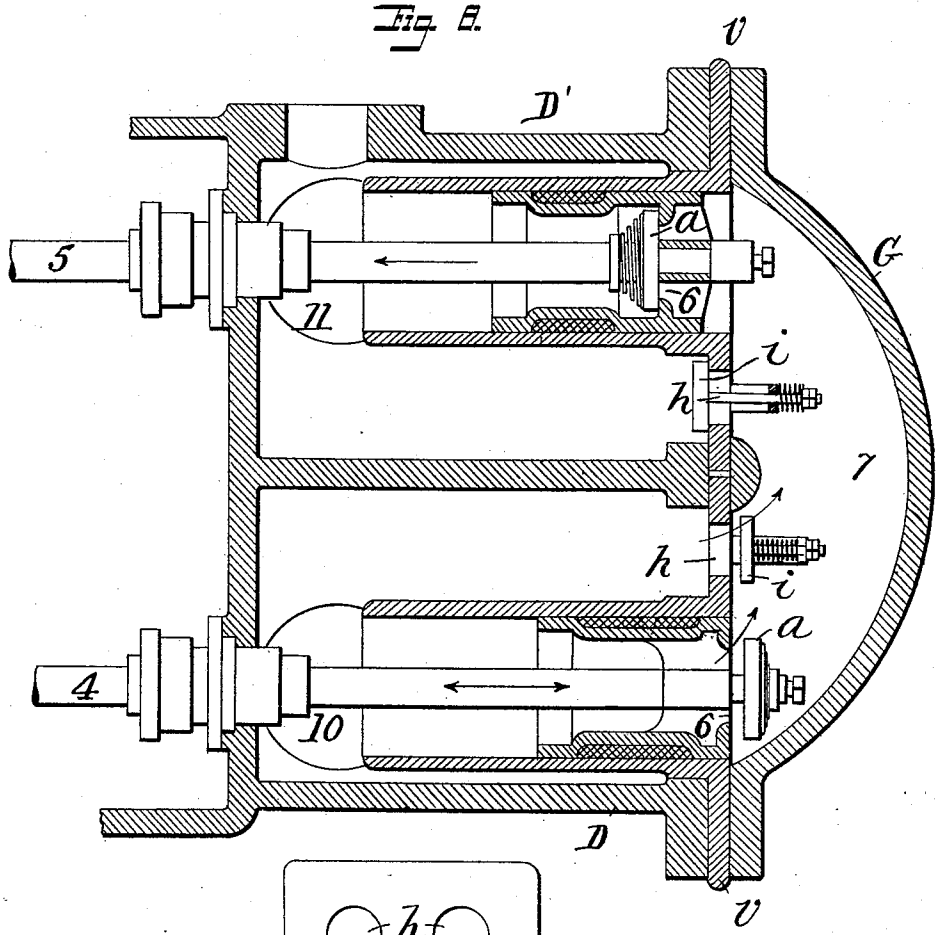
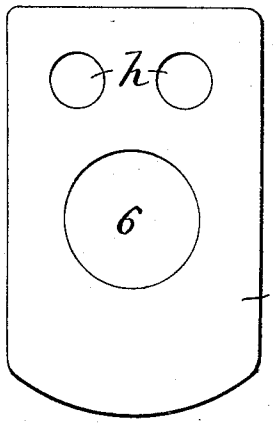


Fig. 9.



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UNITED STATES PATENT OFFICE.

MILAN WOODBURN HALL, OF PLAINFIELD, NEW JERSEY, ASSIGNOR TO OTIS BROTHERS & COMPANY, OF NEW YORK, N. Y.

PUMP.

SPECIFICATION forming part of Letters Patent No. 482,921, dated September 20, 1892.

Application filed January 7, 1892. Serial No. 417,338. (No model.)

To all whom it may concern:

Be it known that I, MILAN WOODBURN HALL, a citizen of the United States, residing at Plainfield, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Pumping Apparatus, of which the following is a specification.

My invention relates to pumping apparatus, and has for its object to provide means whereby a continuous, practically uniform, and regular stream of water may be forcibly propelled from any suitable source of supply to its destination; and to this end I construct a pump, as fully set forth hereinafter, thereby securing an apparatus which is especially serviceable in use with electromotors for operating the same.

Attempts to make use of electromotors in pumping water and other inelastic fluids have hitherto not been attended with success, except with engines of very limited capacity, owing to the fact that in the attempt to connect electromotors, which of necessity run at high rates of speed, and pumps of ordinary construction, which of necessity must be operated at comparatively slow speeds and in which the movements of the liquids are intermittent and pulsating, and in many instances are frequently reversed, the intermittent and irregular action of the pump interferes with the uniform movement of the electromotor and results in variations of the motive current, which are extremely detrimental to the efficiency of the engine and wasteful of power. Further, it is almost impossible to start the electromotor against the full pressure of the load of water. While these difficulties would be partially overcome by the use of intermediate gears between the high-speed motor and the low-speed pump, this is attended with friction and loss of power, noise, and in many instances unduly increases the cost and size of the apparatus, especially objectionable in such pumping-engines as must be operated in very contracted sources, as is frequently the case. Theoretically a rotary pump directly geared with the revolving armature would overcome any objections incident to electricity as a motive power; but rotary pumps as heretofore constructed and available for use in such connection do not attain the percentage of efficiency desirable and necessary in competition with pumps of other constructions, while it is not practicable to drive the pump-piston at the same speed as the armature of the motor. In seeking to overcome these difficulties I have endeavored to relieve the motor of the water-pressure in starting and to secure a uniform resistance to the action of the motor in operation; and to this end I have so constructed the parts of a reciprocating piston-pump as to preserve a continuous flow of fluid under the action of the pistons and a comparatively uniform rate of flow of the current in one course, so as to avoid variations resulting from a change of direction, and have connected the revolving armature of the motor directly with the driving-shaft of the pump by means of a belt and pulleys so proportioned as to secure the desired differences in the rates of motion without noise or friction, but with the motor in close proximity to the pump, and I have provided a by-pass to permit the water to circulate without pressure until the motor is nearly in full operation. While these results may be secured to the use of pumping devices of different constructions having the characteristics which I have named, I will refer, first, to constructions which have proved effective and which are illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation in part section of the preferred construction; Fig. 2, an end elevation of Fig. 1; Fig. 3, a sectional plan through the cylinders. Figs. 4, 5, and 6 are detail views; Fig. 7, a diagram. Figs. 8 and 9 are views illustrating additional features embodying the invention.

The base or foundation A^4 is suitably constructed to support the other parts, including the cylinders, crank-shaft, and an electromotor. In the constructions, Figs. 1 to 9, there are four cylinders D D′ D^2 D^3, the pistons 1 3 of the cylinders D D^2 being upon a common rod 4 and the pistons 2 4 of the cylinders D′ D^3 being upon a common rod 5, and each piston has a passage 6 through it, to which is adapted a spring-seated valve *a*. A head G, common to both cylinders D D′, has a channel 7 communicating with the ends of both of said cylinders, and from the opposite end

of the cylinder D′ to the cylinder D^2 extends a pipe 8, and a channel 9 in a head G′, common to both cylinders D^2 D^3, serves as a communication between the ends of said cylinder. The inlet-pipe 10 communicates with the cylinder D, and the outlet-pipe 11 extends from the cylinder D^3. The pistons, instead of sliding in the cylinders themselves, slide in tubular linings 12, each narrower than the cylinder, shorter in diameter, and with a flange that is clamped between the body of the cylinder and the head. Figs. 5 and 6 show the details of construction of the pistons and valves.

The shaft J has a fly-wheel J′ at one end and two cranks at right angles connected each by means of a yoke 13 with a cross-head 14 of the adjacent piston, and the valves are so arranged upon the pistons that as the rod 4 moves in the direction of the arrow, Fig. 3, the valves of the pistons 1 3 will open, and the movement of the piston-rod 5 in the same direction will cause the valve of the piston 2 to open and the valve of the piston 4 to close.

As a result of the described arrangement of cylinders, valve-pistons, and cranks, channels, and ports, the water will flow continuously in one direction, whatever may be the direction of the movement of the pistons, while the change of load from one piston to the other is always effected during one-fourth of a revolution, and begins as the loaded piston approaches the end of the cylinder toward the termination of its stroke, so that the transfer is effected without shocks. Thus, as indicated in the diagram Fig. 7, when the loaded piston is traveling with the crank moving at the maximum speed between the points $d\ d'$, or $f\ f'$, or $e\ e'$, or $g\ g'$ the unloaded piston is moving and reversing its movement under the travel of the crank between the points $d'\ f$, or $f'\ d$, or $e'\ g$, or $g'\ e$, so that the load is transferred to the unloaded piston as the latter changes its direction of movement and when it is moving at its slowest speed through one-fourth of its revolution, while the current of water is always being acted upon in one of the cylinders by a piston traveling at its maximum speed, so that the said current is constantly maintained traveling in one direction without change of course and without material variation in speed, thereby avoiding shocks, pulsations, and other irregularities of motion or action. There is thus secured such a uniform resistance to the action of the motor that an electromotor may be connected directly with the driving-shaft or intermediately through suitable appliances, and the pump may be driven electrically, so as to secure effective results, which could not be done if the pump were constructed and operated in the ordinary manner. One connection and arrangement is illustrated in Figs. 1, 2, and 3, in which the electromotor Q, of any suitable construction, is shown as bolted to a bridge 16, supported by the cylinders D′ D, and upon the transverse armature-shaft 21 of the motor is a pulley R, around which a belt 17 passes to the fly-wheel J′, a belt-tightening pulley 18 serving to take up slack. The pulley R is properly proportioned to the wheel J′ to permit the armature to revolve at its most efficient speed without imparting a too-rapid movement to the crank-shaft of the pump. It will be evident, however, that friction-gears or other connections may be substituted for the belts and pulleys.

Inasmuch as the motor in most cases can be best started at or nearly at its maximum speed, there would be a great and detrimental resistance to its initial action if the entire load of the fluid to be pumped were upon the pump at the moment it started. To avoid this, means are provided whereby at the moment of starting the inlet 10 and outlet 11 are connected by a by-pass or any suitable channel, so that the fluid pumped merely circulates through the cylinders and through said channel until such pump acquires a predetermined speed, when the by-pass is slowly and automatically closed and the water is sent into the discharge-pipe without returning to the inlet. Various different automatic appliances may be employed for effecting this result, the preferred arrangement being that shown in Figs. 1 and 4. As shown, a pipe 22 extends from the inlet-pipe 10 to a casing 23, in which is the outlet-port 11, the said pipe 22 leading to a point of the casing 23 below a check-valve 24. At any point in the pipe 22 is a valve-casing Y, containing an automatic cut-off valve Z, shown in the form of a double piston-valve.

The position of the parts in starting is shown in Fig. 1, the weight of the water in the discharge-pipe holding the valve 24 to its seat, so that the water first discharged from the outlet-port of the piston D^3 passes to the pipe 22 and through the valve-casing Y back to the inlet 10. As the pressure increases, the pressure from the pipe 22 is transferred to the bottom of the valve Z through the medium of the channel 50, and the valve Z rises, compressing a spring 51 until the pressure is sufficient to close the valve. As the passage through the pipe 22 becomes throttled, there is an accumulating pressure below the valve 24 until the pipe 22 is finally closed and the valve 24 finally opened, so that the entire discharge is through the port 11. Nuts 54 may be adjusted to prevent the valve Z from closing entirely, so that when the pump stops and the valve 24 closes there will be a slight back flow through the valve-casing Y, and the spring 51 will then force the valve Z to an open position, a channel 56 permitting the water to flow from or to the top of the valve Z. The channels 50 56 are provided with cocks 58 57 to regulate the flow and the rapidity of movement of the valve Z. By this automatic by-pass valve the pump is relieved of pressure in starting, so that the electromotor may acquire its full speed with but little initial resistance, and after said speed is acquired and

the pressure accumulates the valve closes automatically.

It will be seen that the displacing action of any piston pushing the water before it is equal to the superficial area of that piston, while the channels through which the water must pass through the other pistons are necessarily less in area than the working area of the actuating-piston. This at high rates of speed would act to throttle the throw of the water, to remedy which I provide an auxiliary passage *h* between the ends of each cylinder; or, if desired, a number of such passages, as illustrated in Figs. 8 and 9, and provide such passages with self-actuating valves *i*. As shown, the cylinders are elongated in diameter in one direction, and the flange *v* of the cylinder-lining contains the passage or passages *h*, to which are adapted the spring-seated valves *i*, which yield under the movement of the water toward the outlet and serve to permit the passage of any water in excess of that which can pass through the openings in the pistons. The full effective area of the working piston at any practicable speed is thus secured.

Without limiting myself to the precise construction and arrangements of parts shown and described, I claim—

1. The combination, in a pump, of four cylinders arranged and connected for the fluid to flow through the same successively, valved pistons and piston-rods, each connecting two pistons of adjoining cylinders, and a crank-shaft having cranks at right angles, each connected with one of the piston-rods, substantially as set forth.

2. A pump with two pairs of connected cylinders having inlet and outlet ports and intermediate connecting-channels, a reciprocating valved piston in each of said cylinders, whereby to force the water in one direction through the same, and means, substantially as described, to move each piston to reverse the direction of one before the movement of the other is completed, substantially as set forth.

3. The combination of four cylinders communicating in succession, each having a piston with a port, and connections between the pistons in line with each other, and means for driving all the pistons, the valves of the pistons in line with each other opening in opposite directions, substantially as described.

4. The combination, in a pump, of two pairs of cylinders arranged and connected to permit the fluid to flow successively to the same, and valved pistons, those in line connected together, the valves in two pistons opening in one direction and those in the others opening in the opposite direction, substantially as described.

5. The combination, with the cylinders and pistons of a duplex or multiple pump and with the openings and valves with the pistons thereof, of auxiliary openings or passages between the ends of the cylinders and self-acting valves adapted to said openings, substantially as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

MILAN WOODBURN HALL.

Witnesses:
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H. L. HART.