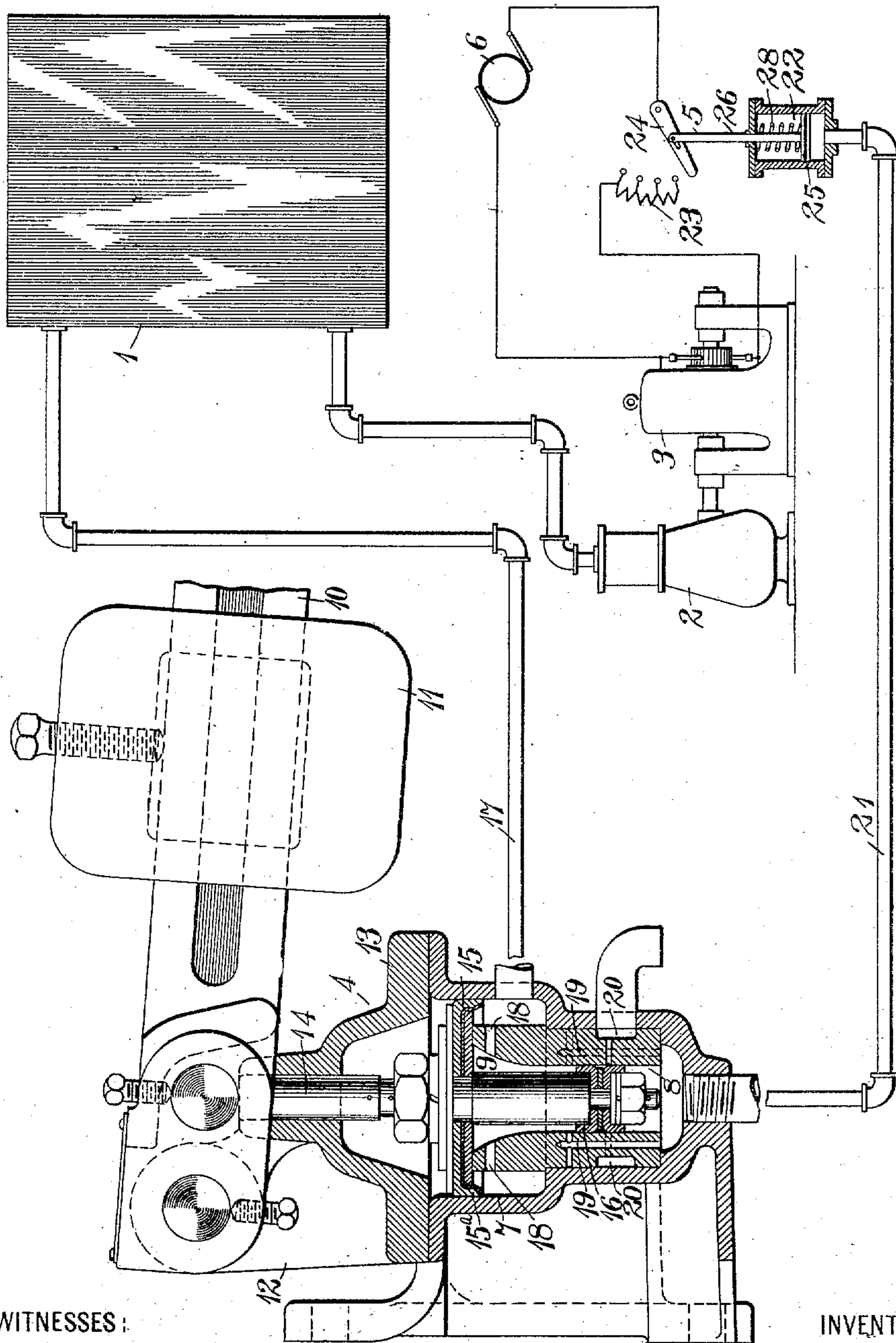


T. S. PUKERUD.  
 FLUID PRESSURE REGULATOR.  
 APPLICATION FILED OCT. 3, 1906.

967,234.

Patented Aug. 16, 1910.



WITNESSES:

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## FLUID-PRESSURE REGULATOR.

967,234.

Specification of Letters Patent. Patented Aug. 16, 1910.

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*To all whom it may concern:*

Be it known that I, THOMAS S. PUKERUD, a citizen of the United States, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Fluid-Pressure Regulators, of which the following is a specification.

My invention relates to fluid-pressure regulators, and has for its object to provide means for automatically regulating the action of a fluid-pumping device that shall be dependent upon the pressure existing in a storage tank or chamber which is supplied thereby.

It is often desirable to automatically maintain a substantially constant pressure in a fluid-pressure storage tank and, according to my present invention, I provide an automatic regulator which is simple and durable in construction, reliable in operation and relatively sensitive to pressure variations in the tank or chamber in which a constant pressure is desired.

The single figure of the accompanying drawing is a partially diagrammatic view of a system embodying my invention, the automatic regulator being shown in sectional elevation.

While the fluid-pumping device is illustrated in the drawing as propelled by means of an electric driving motor which is controlled indirectly by the automatic regulator of my invention, other suitable means may be employed for accomplishing the same result, and I desire that variations in the arrangement of the system and in the size and structural details of the regulator which do not depart from the spirit of my invention shall be included within its scope.

Referring to the drawing, the fluid-pressure in a storage tank 1 is supplied by a fluid-pumping device 2 which is propelled by an electric motor 3 and is maintained at a substantially constant value by means of a pressure regulator 4 which governs a motor-controlling device 5. Electrical energy may be supplied to the motor 3 from any suitable source, such as a generator 6. The automatic regulator 4 comprises a main cylinder 7, an auxiliary cylinder 8 of materially smaller size, a two-part or differential piston mechanism 9 which is adapted to operate in the cylinders and a steelyard or lever 10 which is provided with an adjust-

able weight 11. The lever 10 is pivotally connected, near one extremity, to a stationary projection 12 of a cylinder cap 13 and is adapted to exert, by reason of the action of gravity on the weight 11, a considerable downward pressure upon a piston rod 14 which projects through an opening in the cylinder cap 13 and engages the lever 10, at a short distance from its point of connection with the projection 12. The differential piston mechanism 9 comprises a main piston 15, which operates in the cylinder 7, and an auxiliary piston 16 which is connected thereto and operates in the auxiliary cylinder 8.

In the main cylinder 7, below the main piston 15, a pressure equal to that of the storage tank 1 is maintained, since the cylinder is connected to the tank by means of a pipe 17. The portion of the cylinder 8 above the piston 16 communicates with the cylinder 7 by means of ports 18 and, when the piston mechanism 9 is in one position, the cylinder communicates with the portion of the cylinder 8 below the piston 16 by means of ports 18 and 19. When the piston mechanism 9 occupies its upper position, the ports 19 are closed and the portion of the cylinder 8 below the piston 16 is disconnected from the cylinder 7, and exhaust ports 20, which were closed in the lower position, are now open, whereby the pressure in this portion of the cylinder 8 is reduced to zero. A permanent connection is established from the lower end of the cylinder 8 to an operating cylinder 22 of the electric motor controlling device 5 by means of a pipe 21.

The electric motor controlling device 5 comprises a suitable starting resistance 23 which may be connected in the motor circuit and gradually reduced to zero by means of a movable contact arm 24, an operating cylinder 22, a piston 25 that operates therein and a piston rod 26, whereby the piston is connected to the contact arm 24. The motor circuit is normally interrupted, since the arm 24 is held out of engagement with the contact terminals of the resistance 22 by means of a spring 28 located in the cylinder 22 and acting in opposition to the fluid pressure which is admitted to the cylinder from the automatic regulator 4.

The action of the regulating system is as follows: Assuming that the fluid-pressure in



the tank 1 is so low that it is unable to raise the weight 11 and that the piston mechanism 9 occupies its lower position, fluid-pressure is admitted from the tank 1 through the pipe 17 to the cylinder 7 below the piston 15. From this position of the cylinder, fluid-pressure is admitted through ports 18 and 19 to the cylinder 8 below the piston 16 and also through pipe 21 to the cylinder 22. The fluid pressure in this cylinder acts in opposition to the spring 28 and so moves the contact arm 24 that energy is supplied to the motor 3 from the generator 6 through the resistance 23. In this way, the motor 3 is accelerated and drives the fluid-pumping device 2 which serves to raise the pressure in the tank 1. As soon as the pressure in the tank 1 exceeds a predetermined amount, the weight 11 will be raised by the action of the fluid pressure on the pistons 15 and 16. As soon as the piston mechanism 9 has moved from its lower to its upper position, the pressure in the cylinder 8 and the cylinder 22 is exhausted through the ports 18, and the ports 19 which connect the cylinder 7 with the cylinder 8 are closed. As soon as the pressure is thus relieved in the cylinder 22 the spring 28 interrupts the supply of energy to the motor 3 and the fluid-pumping mechanism 2 comes to rest.

The application of the pressure-regulator is not confined to systems embodying storage tanks, and the regulator may readily be connected directly to the discharge pipe of the fluid-pumping device so that the motor will operate only when fluid is being drawn from this pipe. An arrangement of this kind is well adapted for use with liquid circulating pumps.

When sufficient pressure is applied to the lower side of the piston to raise the weight, the friction between the cylinder and the piston is materially greater than when a lower pressure exists, as is the case when the weight is falling on account of an annular flange 15<sup>a</sup> on the piston against which an outward pressure is exerted. The useful pressure exerted directly upon the piston 15 is always proportional to the difference in the total areas of the two pistons 15 and 16, irrespective of the size of the stem which connects the two, since the exposed area on the upper side of the piston 16 is neutralized by a corresponding exposed area on the under side of the piston 15. Consequently, the downward pressure exerted upon the piston 16 may be disregarded. It will be observed that useful fluid-pressure is exerted against both piston 15 and piston 16 in raising the weight 11, when the friction is greater, and that useful pressure is only exerted against the piston 15 in opposing the fall of the weight from its upper position when the friction is less, consequently, a compensation for the difference in the friction is effected

and a relatively slight diminution of the pressure in the regulator chamber will permit the weight 11 to fall.

By properly proportioning the areas of the pistons 15 and 16, the regulator 4 may be made sensitive to relatively slight variations in the pressure of the tank or discharge pipe to a degree which would be impossible if the same piston area was active in both raising and lowering the weight 11.

I claim as my invention:

1. The combination with a fluid-pressure tank or chamber, a fluid-pumping mechanism connected thereto, a driving motor for said pumping mechanism, a starting controller for the motor, and an operating cylinder and piston, of a regulator for automatically admitting fluid-pressure to and exhausting it from the operating cylinder to respectively start and stop the motor as the pressure in the storage tank or chamber rises above and falls below a predetermined value, and means for compensating for the variations in the friction of the regulator.

2. The combination with a fluid-pressure tank or chamber, a fluid-pumping mechanism connected thereto, a driving motor for said pumping mechanism, a starting controller for the motor, and an operating cylinder and piston, of means for automatically admitting fluid-pressure to and exhausting it from the operating cylinder to respectively start and stop the motor as the pressure in the storage tank or chamber rises above and falls below a predetermined value, said means comprising a regulator having a differential piston which acts in opposition to a substantially constant external force.

3. The combination with a fluid-pressure storage tank or chamber, a fluid-pumping mechanism connected thereto, a driving motor for said pumping mechanism, a starting controller for the motor, and an operating cylinder and piston, of means for regulating the fluid-pressure in the operating cylinder to start and stop the motor, said means comprising a main cylinder having communication with the storage tank, a piston in said cylinder, a relatively small auxiliary cylinder, a piston in said auxiliary cylinder which is connected to the piston in the main cylinder, and a weight connected to said pistons to act in opposition to the fluid-pressure which is supplied to the main cylinder from the storage tank.

4. A pressure regulator comprising a main cylinder, a piston operating therein, a relatively small auxiliary cylinder, a piston operating in said auxiliary cylinder and connected to the piston in the main cylinder, and means for producing a stroke in one direction, in opposition to an external force, by a useful pressure exerted upon both pistons and for opposing a stroke in the oppo-



site direction by a useful pressure exerted only upon the main piston.

5 5. A pressure regulator comprising a main cylinder, and a piston operating therein, a relatively small auxiliary cylinder, a piston operated therein and connected to the piston in the main cylinder, and means for exerting cooperating pressures on the pistons in one direction of motion and for exerting a useful pressure only on one of the pistons in the opposite direction.

10 6. In a pressure regulator, the combination with a main cylinder, a small auxiliary cylinder connected in tandem therewith, a two-part piston operating in the cylinders, and a balance weight, of means for imparting a useful pressure on both pistons for raising the balance weight, and for exerting a useful pressure only on the main piston for opposing the fall of the balance weight.

20 7. A pressure regulator comprising a main cylinder, a relatively small auxiliary cylinder in alinement therewith, a two-part piston which operates in the cylinders, means for limiting the piston stroke, means for applying a substantially constant inward force upon the main piston, a fluid-pressure admission port between the two parts of the piston, an exhaust port at the extremity of an auxiliary cylinder, and an intermediate connection between the main and the auxiliary cylinders which shunts the auxiliary piston and is effective only when the exhaust port is closed.

30 8. A pressure regulator comprising a main cylinder, a relatively small auxiliary cylinder in alinement therewith, a two-part piston that is adapted to operate in the cylinders, a fluid-pressure admission port between the two parts of the piston, an exhaust port communicating with the outer end of the small cylinder, an intermediate port connecting the outer end of the small cylinder with the main cylinder, and means for limiting the motion of the piston so that the exhaust port is open and the intermediate port closed when the piston occupies one extreme position and so that the exhaust port is closed and the intermediate port open when the piston occupies its other extreme position.

50 9. In a system of fluid pressure regulation, the combination with a storage tank or chamber, a supply pump therefor, a pump-driving motor and a motor controller, of an automatic regulator comprising a main cylinder, a relatively small auxiliary cylinder in alinement therewith, a two-part piston which operates in the cylinders, means for limiting the piston stroke, means for applying a substantially constant inward force upon the main piston, a fluid pressure admission port between the two parts of the piston, an exhaust port at the extremity of an auxiliary cylinder, and an intermediate connection which shunts the auxiliary piston

and is effective only when the exhaust port is closed.

10. In a system of fluid pressure regulation, the combination with a storage tank, a supply pump therefor, a pump-driving motor, and a motor controller that is actuated by a fluid-pressure operating cylinder, of an automatic regulator that comprises a main cylinder, a relatively small auxiliary cylinder in alinement therewith, a two-part piston which operates in the cylinders, means for limiting the piston stroke, means for applying a substantially constant inward force upon the main piston, a fluid-pressure admission port between the two parts of the piston, an exhaust port at the outer extremity of the auxiliary cylinder, an intermediate connection between the main and the auxiliary cylinders which shunts the small piston and is effective only when the exhaust port is closed, a supply pipe connection for said operating cylinder that is connected to the outer extremity of said auxiliary cylinder.

11. In a system of fluid-pressure regulation, the combination with a storage tank, a supply pump therefor, an electric driving motor for the pump, a motor-starting controller and a fluid-pressure operating cylinder therefor, of a pressure regulator comprising a main cylinder, a relatively small auxiliary cylinder in alinement therewith, a two-part piston that is adapted to operate in the cylinders, means for limiting the stroke of the piston, a pipe that connects the storage tank to said main cylinder at a point between the two parts of the piston, a second pipe that connects the outer end of the auxiliary cylinder to the operating cylinder, an exhaust port for the auxiliary and operating cylinders, an intermediate connection which shunts the small piston, and a substantially constant external force which acts in opposition to the fluid-pressure in the main cylinder, the arrangement of parts being such that the exhaust port is open and the intermediate port closed when the two-part piston occupies one extreme position, and the exhaust port is closed and the intermediate port is open when the piston occupies its other extreme position.

12. A fluid-pressure regulator comprising a piston mechanism, a weight acting thereon, and means for so applying a fluid-pressure in opposition to said weight that its lifting force is greater than its sustaining force.

13. A fluid-pressure regulator comprising a double piston mechanism, a weight that exerts a substantially constant downward pressure thereon, and means for automatically rendering the larger piston area effective for raising the weight and for rendering only a part of the piston area effective for opposing the fall of the weight.

14. The combination with a storage tank or chamber and a supply pump therefor, of a fluid-pressure regulator comprising a double piston mechanism, an actuating weight 5 that exerts a substantially constant pressure thereon, and means for automatically rendering the larger piston area effective for raising the weight and stopping the pump and for rendering only a part of the piston 10 area effective for opposing the fall of the weight and starting the pump.

15. A fluid-pressure regulator comprising a cylinder, a piston mechanism having a substantially constant external force applied thereto, and means for automatically compensating for the variations in friction between the cylinder and the piston mechanism. 15

16. A fluid pressure regulator comprising 20 a cylinder, a piston mechanism, a weight which acts against the piston, and means for automatically compensating for the variations in friction between the cylinder and the piston mechanism when the weight is 25 being raised and when it is permitted to fall.

17. In a pressure regulator, the combination with two cylinders of unequal diameters, and pistons operating therein and mechanically connected together, of means 30 for exerting cooperating useful pressures in producing piston movement in one direction and for exerting a useful pressure only on one of the pistons for opposing piston movement in the opposite direction. 35

18. In a pressure regulator, the combination with two cylinders of unequal diameters, and pistons operating therein and connected together in tandem, of means for 40 exerting cooperating useful pressures in producing piston movement in one direction and for exerting a useful pressure only on the larger piston for opposing piston movement in the opposite direction.

In testimony whereof, I have hereunto 45 subscribed my name this 26th day of September, 1906.

THOS. S. PUKERUD.

Witnesses:

FREDERIC SCHAEFER,  
BIRNEY HINES.