No. 723,060. PATENTED MAR. 17, 1903.

J. E. SPENCER.

PRESSURE REGULATOR.

APPLICATION FILED SEPT. 12, 1901.

NO MODEL. 3 SHEETS—SHEET 1.

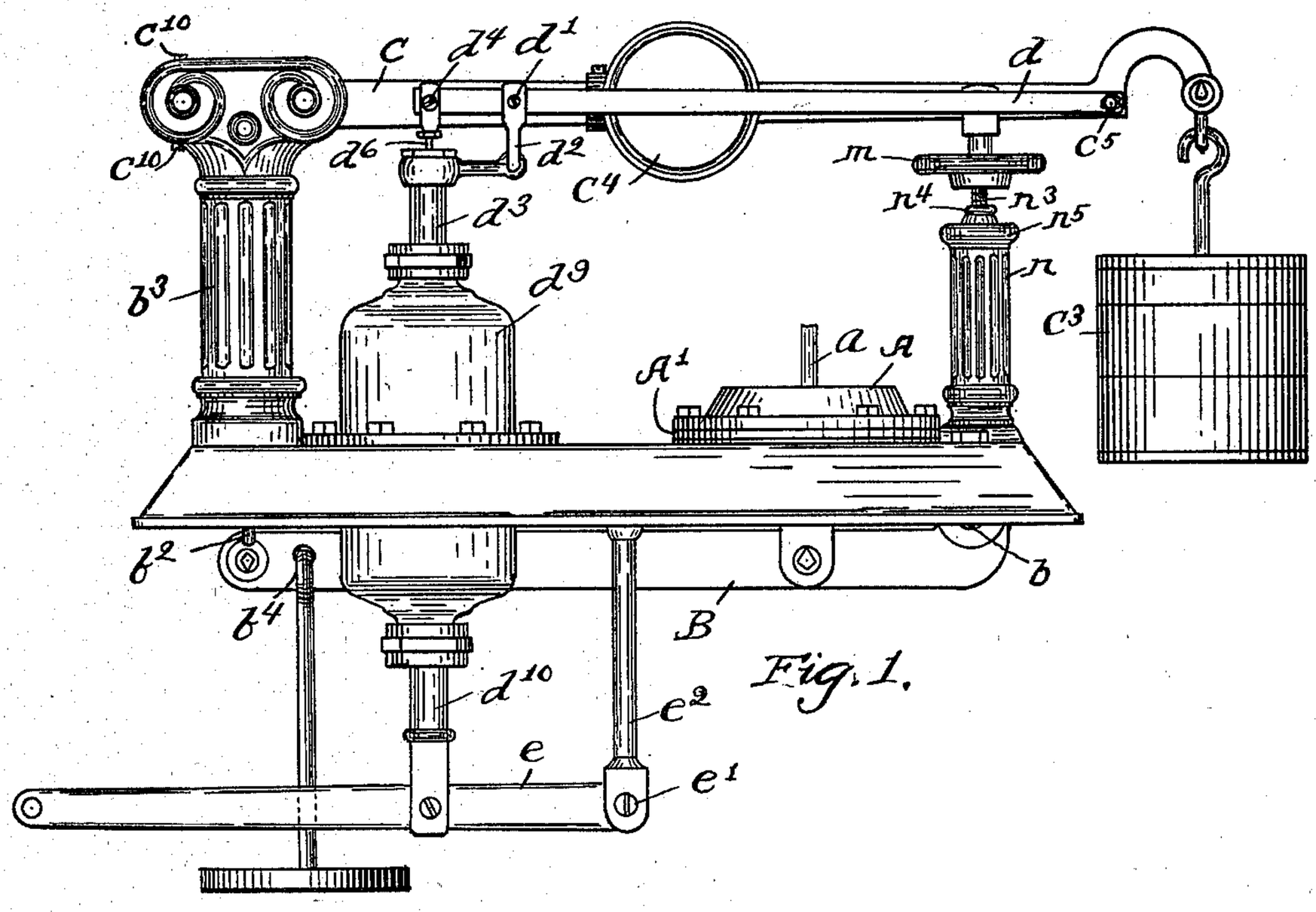

Fig. 1.

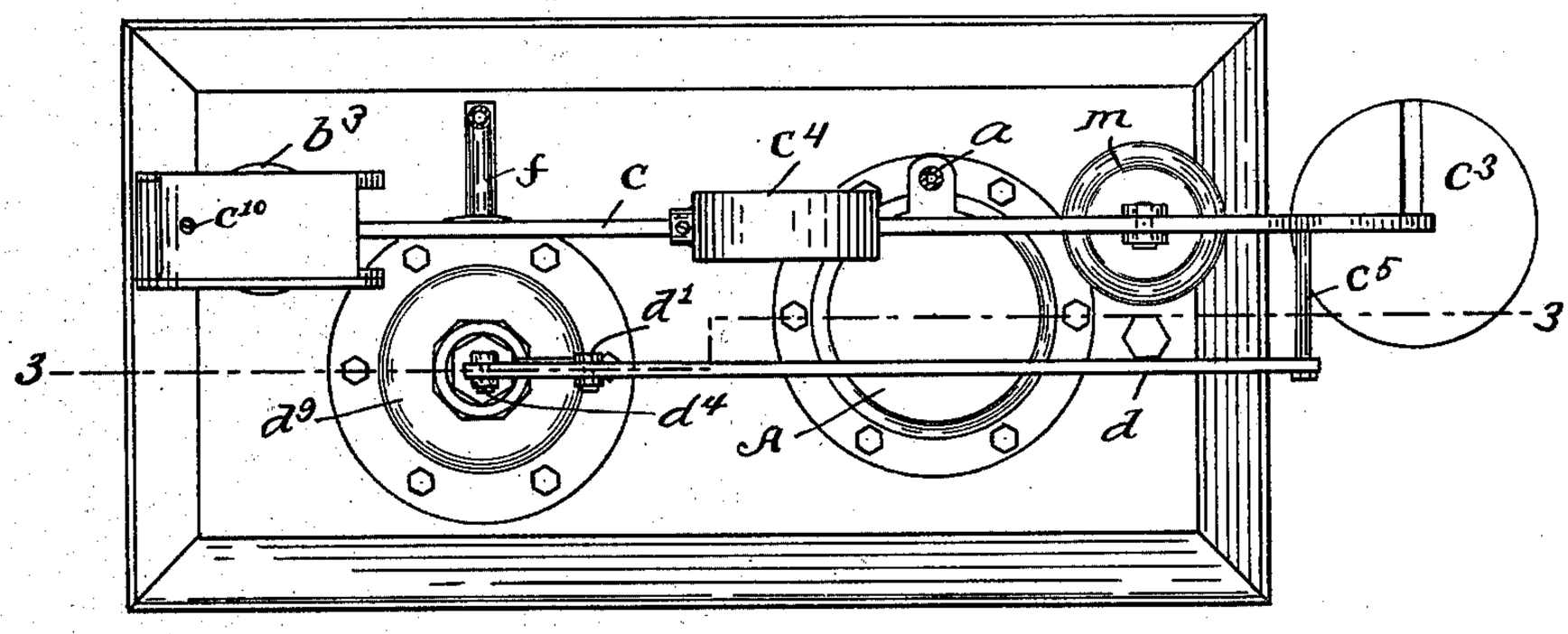

Fig. 2.

Witnesses:
H. B. Davis
John W. Orerow.

Inventor:
John E. Spencer.
by B. J. Noyes
Atty.

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NO MODEL. 3 SHEETS—SHEET 2.

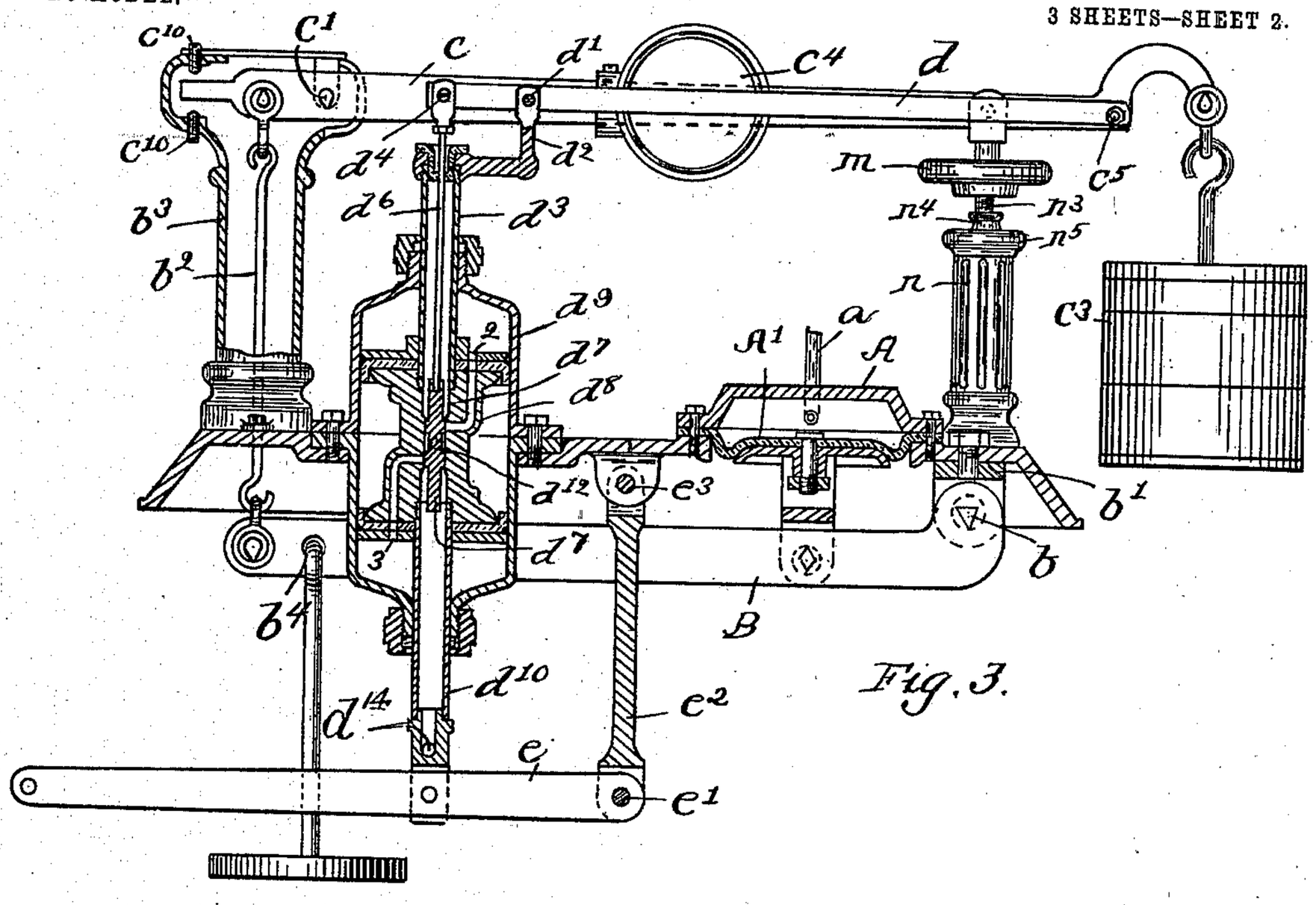

Fig. 3.

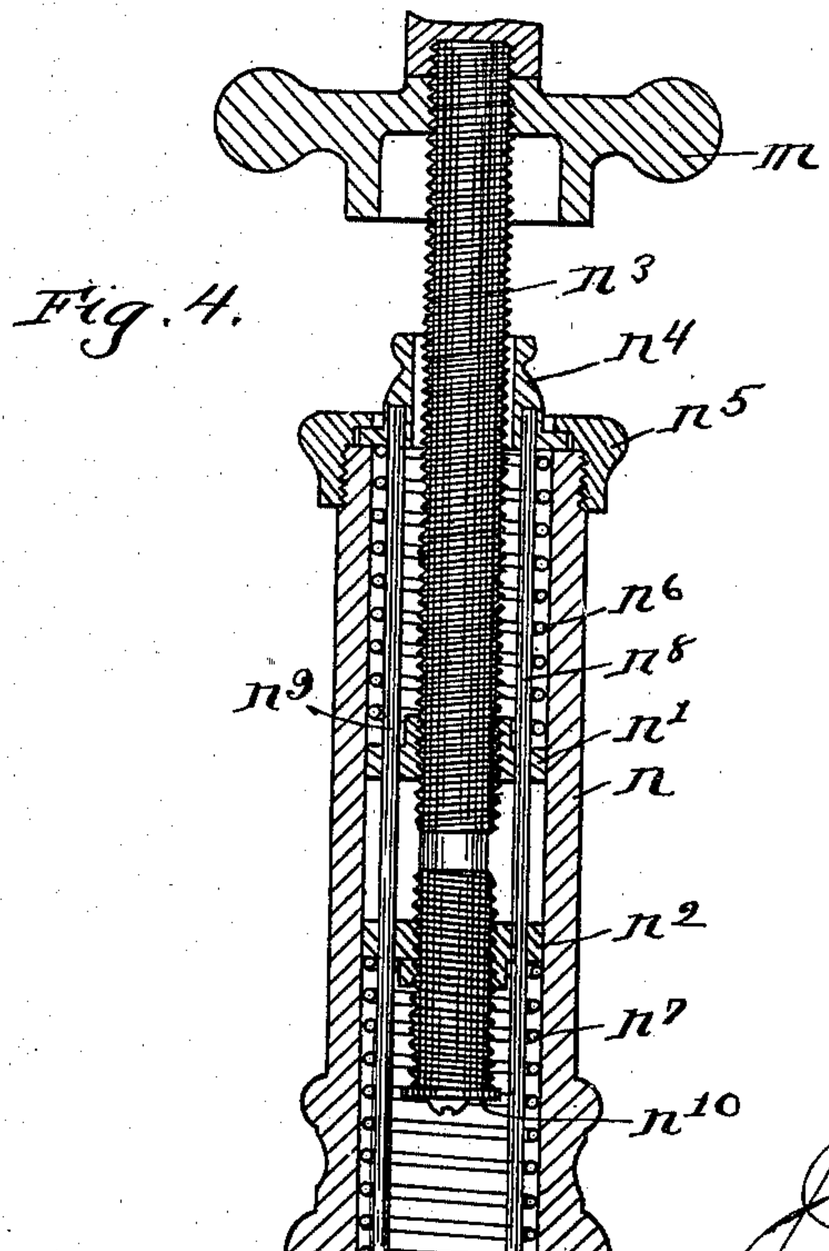

Fig. 4.

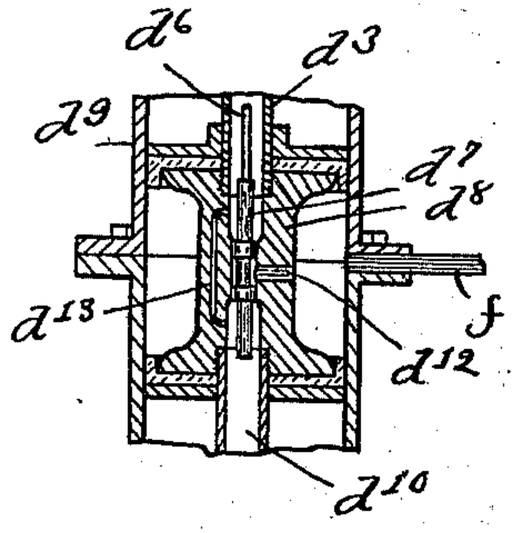

Fig. 5.

Witnesses:
H. B. Davis.
John W. Dickerson.

Inventor:
John E. Spencer
by H. B. Davis
Atty.

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NO MODEL. 3 SHEETS—SHEET 3.

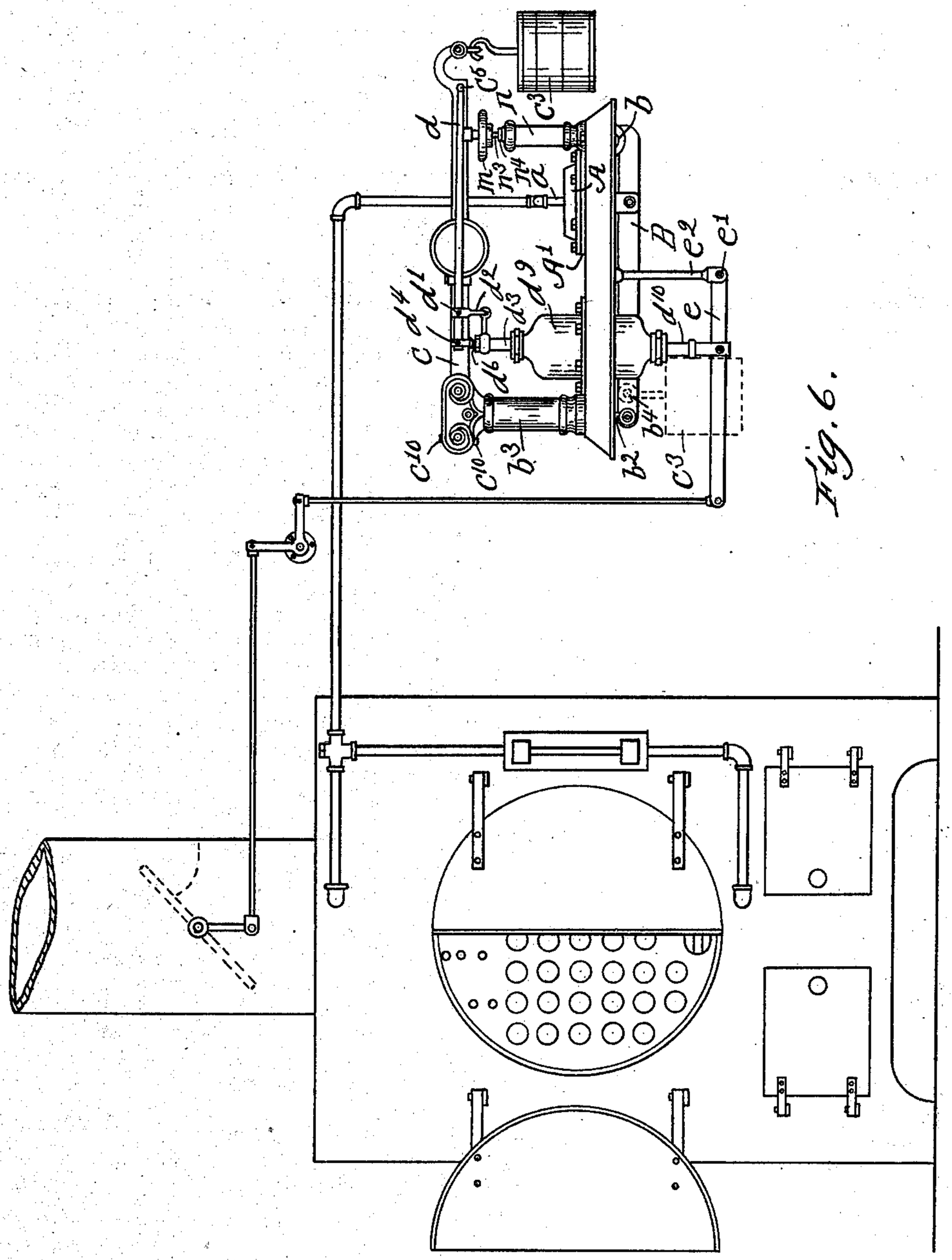

Fig. 6.

Witnesses:
H. B. Sans.
Maud M. Piper

Inventor:
John E. Spencer
by B. J. Noyes
Atty.

UNITED STATES PATENT OFFICE.

JOHN E. SPENCER, OF SALEM, MASSACHUSETTS.

PRESSURE-REGULATOR.

SPECIFICATION forming part of Letters Patent No. 723,060, dated March 17, 1903.

Application filed September 12, 1901. Serial No. 75,183. (No model.)

To all whom it may concern:

Be it known that I, JOHN E. SPENCER, of Salem, in the county of Essex and State of Massachusetts, have invented an Improvement in Pressure-Regulators, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

This invention relates to pressure-regulators, and is intended as an improvement upon the pressure-regulator shown and described in United States patents granted to me, No. 327,337, dated September 29, 1885, and No. 338,686, dated March 23, 1886, and has for its object to improve the construction of the same to the end that the pressure-regulator may be adapted for use in connection with high or low pressures or even with a vacuum and in either instance will work positively, yet gradually; also, that compactness of parts is insured, whereby the apparatus will occupy less space than the pressure-regulator shown in my aforesaid patents; also, that a further gradual movement of the regulating-lever may be obtained by the provision of a retarding device for one of the levers interposed between the pressure device and the valve, preferably the secondary lever, which is constructed and arranged to retard or oppose the action of the pressure device and also the action of the motor for the regulating-lever; also, that the movement of the valve-actuating lever may be limited in both directions.

Figure 1 shows in side elevation a pressure-regulator embodying this invention. Fig. 2 is a plan view of the pressure-regulator shown in Fig. 1. Fig. 3 is a longitudinal vertical section of the pressure-regulator, taken on the dotted line 3 3, Fig. 2. Fig. 4 is an enlarged vertical section of the retarding device, and Fig. 5 is a sectional detail of the piston of the motor. Fig. 6 shows in side elevation a pressure-regulator embodying this invention in operative relation to a boiler and damper.

A represents a pressure device which may be of any usual or suitable construction, having a diaphragm A′ or other movable or yielding member, and *a* is a pipe leading to said pressure device.

B is a main actuating-lever pivoted at one end, as at *b*, to a block *b′*, swiveled to the base of the machine and loosely connected at its opposite end by a link b^2 to one end of a secondary or intermediate lever *c*, and at a point between its ends said main actuating-lever is loosely connected to the diaphragm or other movable or yielding member A′ of the pressure device in such manner that as the diaphragm moves in either direction said lever will be correspondingly moved.

The main actuating-lever B has a pin b^4, on which a weight may be hung, if desired, to assist the pressure device when operating under the influence of a very low pressure or a vacuum, as will be hereinafter more fully explained. The link b^2 passes up through a column b^3, erected on the base, and the secondary or intermediate lever *c*, to which the upper end of said link is connected, is pivoted at *c′* to an ear or bracket at the upper part of said column.

The secondary or intermediate lever *c* has at its outer or free end means for supporting one or more weights c^3, which may be applied thereto or removed therefrom at will, said weights operating to oppose the action of the pressure device when working on high pressures or such pressures as may require their employment, as will be hereinafter more fully explained. A weight c^4 is mounted on the secondary or intermediate lever *c*, adapted to be moved along in either direction thereon and to be secured in whatever position it may be placed for the purpose of balancing the machine at any predetermined pressure. The movement of the secondary or intermediate lever is limited by adjusting-screws c^{10}. The outer or free end of the secondary or intermediate lever *c* is loosely connected by a bar c^5 or otherwise with one end of a valve-actuating lever *d*, so as to in turn move said valve-actuating lever when it is moved by the main actuating-lever.

The valve-actuating lever *d* is pivoted at *d′* to an upright arm or bracket d^2, which is connected to a tubular rod d^3 of the motor for the regulating-lever *e*, and the end of said valve-actuating lever *d* opposite its loose connection with the secondary or intermediate lever *c* is loosely connected at d^4 to the up-

per end of a valve-rod d^6, which operates the valve which controls the operation of said motor. The valve-rod d^6 passes down through the tubular member d^3, and its lower end is connected to the upper end of the controlling-valve d^7. The controlling-valve d^7 is made as a balanced valve having two enlargements and is arranged to work within a piston d^8, which in turn works within a cylinder d^9 provided for it. The tubular member d^3 is rigidly secured to the upper end of the piston d^8 and works in a suitable stuffing-box provided at the upper end of the cylinder d^9, and a similar tubular member d^{10} is rigidly secured to the lower end of said piston d^8, which works in a suitable stuffing-box provided at the lower end of the cylinder d^9, and the lower end of said tubular member d^{10} is loosely connected to the regulating-lever e.

One end of the regulating-lever e is pivoted at e' to the lower end of a depending arm e^2, pivoted at e^3 to the under side of the base of the machine, and the opposite end is designed to be connected to a damper or other device to be moved when operated by the motor. The piston d^8 working in the cylinder d^9 serves as and constitutes a motor or operating device for the regulating-lever, and the operation or movement of said piston d^8 is controlled by the valve d^7. A pipe f is connected to the cylinder d^9 at a point midway its height, which admits air, steam, water, or other fluid to said cylinder between the opposite ends or heads of the piston d^8, so that normally said piston will be balanced, and thereby held at rest, and said piston d^8 at a point midway its length or height has a transverse hole d^{12}, (see dotted lines, Fig. 3,) which communicates with the chamber between the enlargements of the valve d^7, so that normally said valve will be balanced, and thereby held at rest. The enlargements on the valve d^7 normally close suitable ports 2 3, which are provided through the piston d^8 and extended in opposite ways, one leading to a chamber within the cylinder d^9 above said piston and the other leading to a chamber within the cylinder d^9 below said piston. The piston d^8 has a longitudinal hole d^{13} through it communicating with the chambers in the tubular members d^3 d^{10}.

The motor and controlling-valve therefor are substantially the same as shown in the patents above referred to except that herein the parts are inverted and the hole d^{13} is through the piston d^8 instead of through the valve.

The operation of the device so far described is as follows: As the pressure in the pressure device increases the diaphragm or other movable member A′ will be moved downward and the main actuating-lever correspondingly moved downward, thereby pulling down the left-hand end of the secondary or intermediate lever c and raising its opposite or weighted end, which in turn correspondingly raises the right-hand end of the valve-actuating lever d, which depresses the valve-rod d^6 and correspondingly moves downward the valve d^7, slightly opening both ports 2 and 3, and the air, steam, water, or other fluid contained in the cylinder d^9 between the heads or ends of the piston and which may be admitted by the pipe f then passes through the port 3 into the chamber beneath the lower end of the piston d^8, causing said piston to rise, and at such time the port 2 is opened to the atmosphere through the tubular member d^3, hole d^{13}, tubular member d^{10}, and exit d^{14}, provided at or near the lower end of the tubular member d^{10}. The piston d^8 continues to rise until the ports 2 3 are again closed, as will be more fully explained. In consequence of which the apparatus comes to rest. When the pressure on the pressure device decreases, the diaphragm or other movable member A′ moves upward and the aforesaid parts all move in a direction opposite to that above described.

I find in practice that by providing three levers, as herein shown—viz., a main actuating-lever, a secondary or intermediate lever, and a valve-actuating lever—the movement of the valve is very gradual, and all the levers may be made quite short, so that the entire apparatus will occupy but little space, which in many cases is important.

When the pressure to be regulated is high, the weight c^4 will be moved well along toward the right-hand end of the secondary or intermediate lever c and sufficient weights c^3 will be connected to the extremity of said lever, and in such event all the weights, as well as the weight of the levers d and c, will be employed in opposing the action of the pressure device in addition to the friction of the moving parts of the valve.

For low pressures some of the weights c^3 may be removed and the weight c^4 adjusted along on the secondary or intermediate lever c in a direction toward the left, or if the pressure to be regulated is quite low all the weights c^3 may be removed from the secondary or intermediate lever.

In case the pressure to be regulated is not high enough to lift the secondary lever c and valve-actuating lever d and also operate the valve d^7 a weight may be added to the main actuating-lever d, so as to assist the pressure device in performing its work, said weight being hung on the pin b^4, as represented by dotted lines.

I find in practice that by removing the weights from the secondary or intermediate lever c and applying them to the main actuating-lever the device will also operate under the influence of a vacuum.

Providing three levers, as herein shown, also especially provides for removing the weight from one lever and applying it to another to thereby oppose or assist the action of the pressure device, as may be required.

The bracket d^2, to which the valve-actuating lever is pivoted, being attached to the tubular member d^3 of the motor will move

up and down with the piston d^8, and therefore serves as a movable fulcrum for the valve-actuating lever.

When the valve-actuating lever is operated by the pressure device, it will turn on the movable fulcrum as a pivot, being therefore a lever of the first order; but when said valve-actuating lever has been moved and the valve d^7 operated to slightly open the ports 2 3 it will be seen that as the piston d^8 moves the said valve-actuating lever becomes a lever of the third order, turning on the bar c^5 as a pivot. In the present instance the valve first moves in either direction to slightly open the ports, and then the piston moves in the opposite direction, and the valve is also moved by the piston in the opposite direction to that imparted to it by the pressure device; but said valve traveling faster than the piston will soon overtake said piston and close the ports. This result is due to changing the valve-actuating lever from a lever of the first order when operated by the pressure device to a lever of the third order when operated by the motor.

Suppose, for instance, that the valve d^7 has been lowered a short distance by the pressure device to slightly open the ports. Then the piston d^8 rises, and as said piston rises the bracket d^2 correspondingly rises and moves the valve-actuating lever on the pivot c^5, and acting as a lever of the third order the valve d^7 will be moved upward faster than the piston, and consequently the ports 2 3 will soon be closed. I find in practice that by arranging the parts in this manner a much more gradual and effective operation of the regulator is insured.

The retarding device which I have devised for use in conjunction with the pressure device is connected to the secondary lever and is made double-acting to retard or oppose the action of the pressure device and consists of a cylinder n, containing two pistons or disks n' n^2, which need not snugly fit the cylinder, mounted on a right and left threaded screw n^3, which projects down into said cylinder through an end piece n^4, located at the upper end of the cylinder and inside of a cap n^5. The screw-threaded bar n^3 is loosely connected at its upper end to the secondary lever c. Above the piston n' a spring n^6 is contained in the cylinder, and below the piston n^2 a similar spring n^7 is contained in the cylinder, said springs acting in opposite ways each upon the piston which it engages. The cylinder is adapted to be filled with oil or any equivalent fluid, which prevents the fluctuations caused by the steam vibrations. Both the up and down movements of the secondary lever of the pressure device are therefore retarded by this device.

The action of the retarding device in opposing the action of the pressure device is important on account of the pressure device being susceptible to the steam vibrations.

To adjust the retarding device, the end piece n^4 at the upper end of the cylinder is adapted to be rotated and has depending from it two rods n^8 n^9, which extend down toward the bottom of the cylinder, and said rods pass through holes provided in both pistons n' n^2, and as said end piece is turned in either direction the two pistons will be correspondingly turned and will be moved up and down on the right and left threaded screw, thus compressing the springs and adding more resistance to the secondary lever of the pressure device. A hand-operated nut m is placed on the screw above the cylinder, which may be turned down so as to bear on the cap n^5, and when thus moved the secondary lever will be held in fixed position. At the lower end of the screw-threaded bar n^3 a disk n^{10} is secured, which limits the downward movement of the piston n^2 on the bar and by so doing limits the upward movement of the piston n'.

It is obvious that many other forms of retarding devices may be provided for carrying out this part of my invention and also that a retarding device having less capabilities than the one herein shown may be employed with correspondingly-effective results. Consequently I do not desire to limit my invention to the employment of any particular form of retarding device, and, furthermore, the retarding device may be employed for carrying ing out the purposes of this invention even though the regulator is not constructed in all respects as herein shown.

I claim—

1. In a pressure-regulator, the combination of a pressure device, a main actuating-lever connected with and positively operated by a movable member of said pressure device, a pivotally-supported secondary or intermediate lever, a link connecting said secondary or intermediate lever with said main actuating-lever, a regulating-lever, a motor for operating said regulating-lever, and a controlling device for starting and stopping said motor, said controlling device being operatively connected with said secondary or intermediate lever, substantially as described.

2. In a pressure-regulator, the combination of a pressure device, a main actuating-lever connected with and positively operated by a movable member of said pressure device, a pivotally-supported secondary or intermediate lever, a link connecting said secondary or intermediate lever with said main actuating-lever, a pivoted valve-actuating lever pivotally connected to said secondary or intermediate lever, a valve connected by a rod to said valve-actuating lever, a regulating-lever, and a motor for operating said regulating-lever controlled by said valve, substantially as described.

3. In a pressure-regulator, the combination of a pressure device, a main actuating-lever connected with and positively operated by a movable member of said pressure device, a pivotally-supported secondary or intermediate le-

ver, a link connecting said secondary or intermediate lever with said main actuating-lever, a pivoted valve-actuating lever loosely connected to said secondary or intermediate lever, a valve connected by a rod to said valve-actuating lever, a piston in which said valve works, a regulating-lever connected with said piston, and a cylinder containing said piston, substantially as described.

4. In a pressure-regulator, the combination of a pressure device, a main actuating-lever connected with and positively operated by a movable member of said pressure device, a secondary or intermediate lever, means for operatively connecting said main actuating-lever with said secondary or intermediate lever, a regulating-lever, a motor for operating it, a valve for controlling the operation of said motor operatively connecting with said secondary or intermediate lever, and weights carried by said main actuating-lever and said secondary or intermediate lever to oppose or assist the action of said pressure device, substantially as described.

5. In a pressure-regulator, the combination of a pressure device, a main actuating-lever connected with and positively operated by a movable member of said pressure device, and adapted to receive a weight, a pivotally-supported secondary or intermediate lever, also adapted to receive a weight, a link connecting said secondary or intermediate lever with said main actuating-lever, a pivoted valve-actuating lever loosely connected to said secondary or intermediate lever, a valve connected by a rod to said valve-actuating lever, a regulating-lever and a motor for operating said regulating-lever controlled by said valve, substantially as described.

6. In a pressure-regulator, the combination of a pressure device, a main actuating-lever connected with the movable member of said pressure device to be positively moved in opposite ways thereby, a weight-support on said main actuating-lever, another lever connected by a link to said main actuating-lever also having a weight-support, a regulating-lever, a motor for operating it, and means for controlling the operation of said motor actuated by the pressure device through the aforesaid levers, substantially as described.

7. In a pressure-regulator, the combination of a pressure device, a main actuating-lever connected with and positively operated by a movable member of said pressure device, a pivotally-supported secondary or intermediate lever, a link connecting said secondary or intermediate lever with said main actuating-lever, a valve-actuating lever operatively connected with said secondary or intermediate lever, a movable fulcrum for said valve-actuating lever, a valve connected to said valve-actuating lever, a regulating-lever, and a motor for operating said regulating-lever controlled by said valve, substantially as described.

8. In a pressure-regulator, the combination of a pressure device, a main actuating-lever connected with and positively operated by a movable member of said pressure device, a pivotally-supported secondary or intermediate lever, a link connecting said secondary or intermediate lever with said main actuating-lever, a valve-actuating lever loosely connected to said secondary or intermediate lever, a movable fulcrum for said actuating-lever, a valve connected to said valve-actuating lever, a regulating-lever, and a motor for said regulating-lever controlled by said valve comprising a piston, a cylinder in which said piston moves, to which said valve-actuating lever is fulcrumed, substantially as described.

9. In a pressure-regulator, the combination of a pressure device, a main actuating-lever connected with and positively operated by a movable member of said pressure device, a pivotally-supported secondary or intermediate lever, a link connecting said secondary or intermediate lever with said main actuating-lever, a valve-actuating lever pivotally connected to said secondary or intermediate lever, a movable fulcrum for said valve-actuating lever, a valve connected to said valve-actuating lever, a regulating-lever, a motor for said regulating-lever controlled by said valve comprising a piston moving in a cylinder to which the valve-actuating lever is fulcrumed, said valve-actuating lever moving on said fulcrum when operated by the pressure device and moving on its pivotal connection with the secondary lever when operated by the motor, substantially as described.

10. In a pressure-regulator, the combination of a regulating-lever, a motor for operating it comprising a cylinder, a piston moving in said cylinder having two passages, 2, 3, leading from the opposite ends thereof to the corresponding ends of an internal chamber, a valve contained in said piston having two enlargements thereon, the uppermost enlargement controlling the upper passage 2, and the lowermost enlargement controlling the lower passage 3, an actuating-lever for said valve, a bracket connected with said piston, to which said actuating-lever is pivoted, and a pressure device for positively oscillating said valve-actuating lever, substantially as described.

11. In a pressure-regulator, a regulating-lever, a motor for operating it comprising a cylinder, a piston moving in said cylinder having two passages 2, 3, leading from the opposite ends thereof to the corresponding ends of an internal chamber, a valve contained in said piston having two enlargements thereon, the uppermost enlargement controlling the upper passage 2, and the lowermost enlargement controlling the lower passage 3, a pivoted actuating-lever to one of which said valve is connected, a bracket connected to said piston to which said valve-actuating lever is pivoted at a point remote from its end connection with the valve, a pressure device for positively oscillating said valve-actuating

lever on said pivot, said lever being subsequently moved in the opposite direction by said piston to move the valve at a greater speed than the piston, substantially as described.

12. In a pressure-regulator, the combination of a regulating-lever, a motor for operating it, a valve controlling the operation of said motor, a valve-actuating lever, a pressure device for operating said valve-actuating lever, and a retarding device operatively connected with said pressure device to oppose its action in both directions, substantially as described.

13. In a pressure-regulator, the combination of a regulating-lever, a motor for operating it, means for controlling the operation of said motor, a pressure device for operating said means, and a retarding device operatively connected with said pressure device to oppose its action in both directions, substantially as described.

14. In a pressure-regulator, the combination of a regulating-lever, a motor for operating it, means for controlling the operation of said motor, a pressure device for operating said means, and a retarding device for said pressure device comprising a cylinder, pistons, or disks working therein, a right and left threaded screw passing through said pistons or disks, means for turning the pistons or disks on said screw, and springs bearing upon the remote faces of said pistons or disks, substantially as described.

15. In a pressure-regulator, the combination of a regulating-lever, a motor for operating it, a valve controlling the operation of said motor, a valve-actuating lever, a pressure device connected by levers with said valve-actuating lever, and a retarding device for the pressure device connected with one of said levers, and adapted to oppose the action of said pressure device in both directions, substantially as described.

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

JOHN E. SPENCER.

Witnesses:
B. J. NOYES,
H. B. DAVIS.