Feb. 26, 1924. 1,485,000

E. R. WILLIAMS

PRESSURE REDUCING REGULATING VALVE

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Fig. 1.

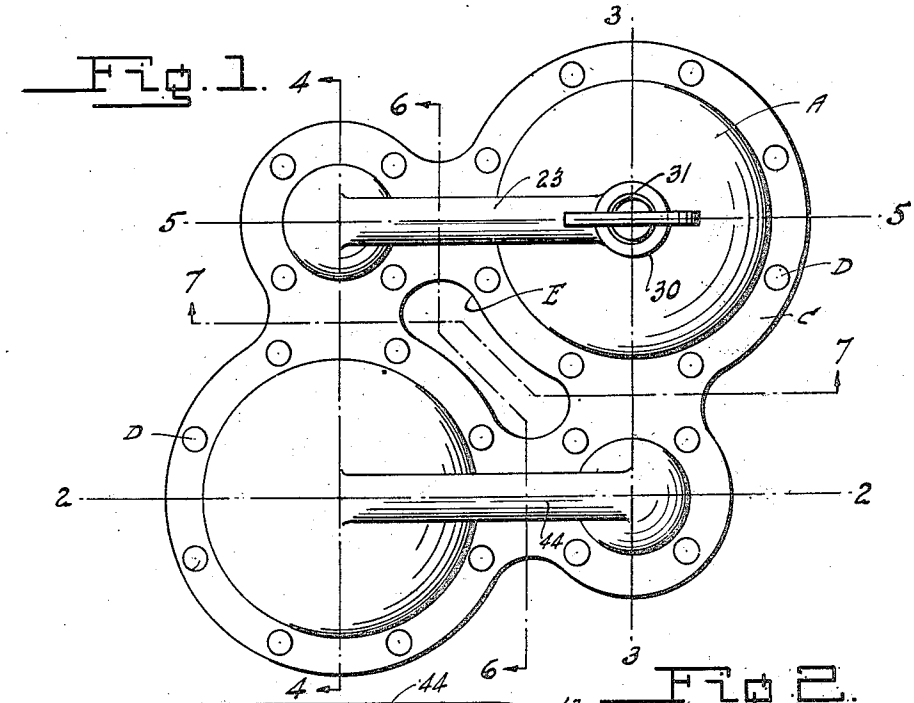


Fig 2.

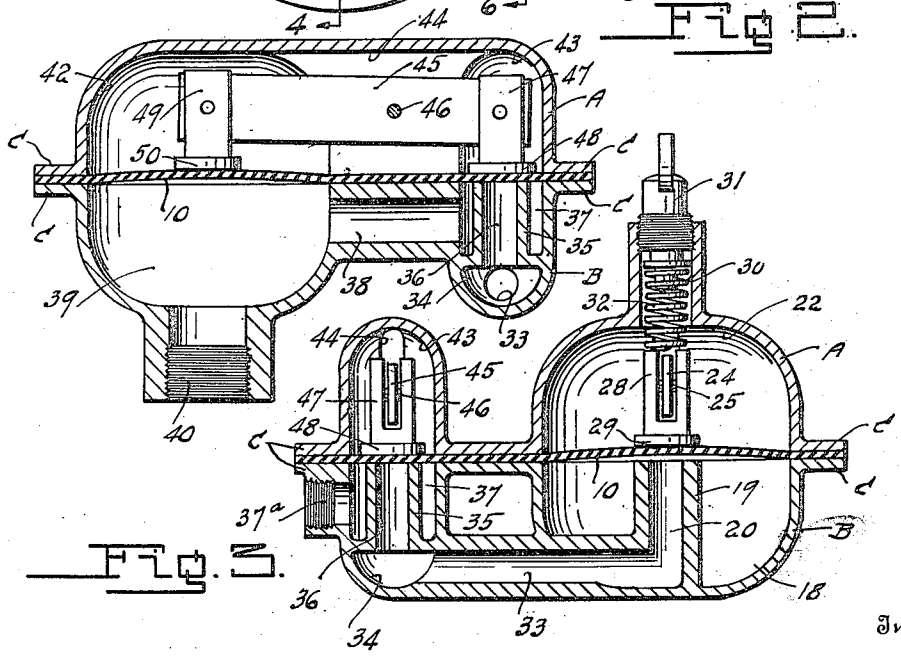


Fig. 3.

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Fig. 4.

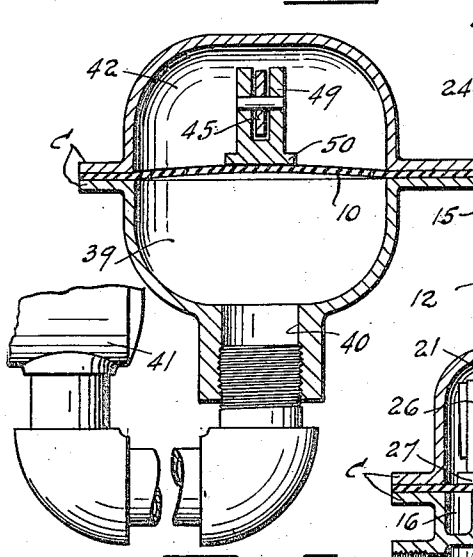


Fig. 5.

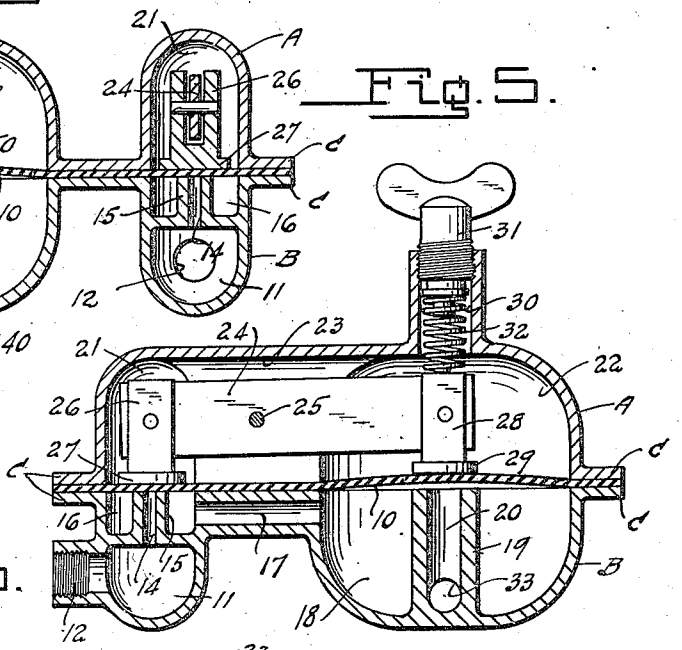


Fig. 6.

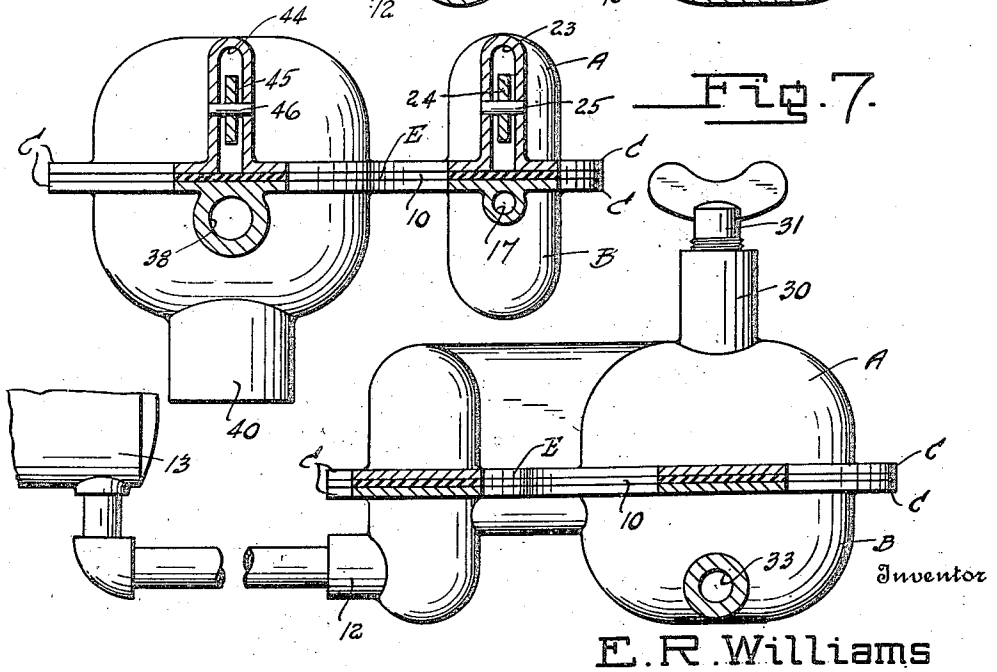


Fig. 7.

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Patented Feb. 26, 1924. 1,485,000

UNITED STATES PATENT OFFICE.

ELMER R. WILLIAMS, OF SPRINGFIELD, MISSOURI.

PRESSURE-REDUCING REGULATING VALVE.

Application filed November 26, 1921. Serial No. 517,876.

To all whom it may concern:

Be it known that I, ELMER R. WILLIAMS, a citizen of the United States, residing at Springfield, in the county of Greene and State of Missouri, have invented certain new and useful Improvements in Pressure-Reducing Regulating Valves, of which the following is a specification, reference being had to the accompanying drawings.

This invention relates to valves, and particularly to valves designed for the purpose of reducing pressure and maintaining a uniform pressure at the exit end of the valve without regard to the fluctuation of pressure at the inlet side of the valve.

The general object of this invention is to provide a very simple automatically acting, pressure reducing and regulating valve of the type described whereby pressure shall be stepped down by a series of steps from the inlet side of the valve to the exhaust side of the valve, and to provide a regulator of this character having a plurality of controlling valves, as they may be termed, actuated automatically by difference in pressure between the inlet and outlet sides of the valve, a rise in pressure beneath the valve causing it to open and permit an equalization of pressure between two chambers so as to thereby permit the step by step passage of the fluid from one chamber to the other, with a reduction of pressure in each chamber until its final exit from the regulator, the chambers being arranged in pairs and the valves being arranged in pairs, the pairs of valves being connected by a lever and so arranged that a relatively small pressure on one valve and one end of the lever will counterbalance the relatively high pressure at the other end of the valve or lever and cause the closing of the last named valve and the opening of the first named valve to discharge the gas, air or liquid into the next succeeding chamber of the series.

A further object is to provide a construction of this character in which the body of the regulator is formed in two sections and wherein the several diaphragms used for operating the valves and constituting, to a large extent, the valves themselves are formed of a single sheet of elastic material disposed between the two sections and also constituting a gasket.

A still further object is to provide means whereby the initial inlet of fluid may be controlled and the initial reduction in pressure may be adjustably regulated.

Other objects have to do with the details of construction and arrangement of parts as will more fully appear hereinafter.

My invention is illustrated in the accompanying drawings, wherein:—

Figure 1 is a top plan view of my pressure reducing regulator;

Figure 2 is a section on the line 2—2 of Figure 1;

Figure 3 is a section on the line 3—3 of Figure 1;

Figure 4 is a section on the line 4—4 of Figure 1;

Figure 5 is a section on the line 5—5 of Figure 1;

Figure 6 is a section on the line 6—6 of Figure 1;

Figure 7 is a section on the line 7—7 of Figure 1.

Referring to these drawings, it will be seen that my improved regulator is formed in two sections, an upper section A and a lower section B, these two sections having marginal flanges C through which connecting bolts D may be passed. Both of these sections are cut out at E, and disposed between the two sections and extending to the edges of the flanges C is a diaphragm 10 of rubber, leather, metal, or other suitable, more or less elastic material, this diaphragm 10 constituting a gasket between the two sections, making these sections leak-proof and separating the upper section from the lower section. This diaphragm may be cut out at the opening E or extend across this opening E if desired. The lower section B is formed to provide a relatively small chamber 11 (see Fig. 5) having an inlet duct or nipple 12 operatively connected to a tank 13, as diagrammatically illustrated in Figure 7, and this chamber 11 is formed with a relatively small outlet opening 14 defined by an upstanding wall 15, and exterior to this wall 15 there is formed a relatively small chamber 16 immediately below the diaphragm 10. This chamber 16 communicates by a longitudinally extending duct 17 with a relatively large chamber 18 whose upper end is closed by the diaphragm 10. Extending upward from the bottom of this chamber 18 is an annular wall 19 defining a passage 20.

That part of the section A which is im-

mediately above the chambers 11 and 18 is formed to provide two communicating chambers 21 and 22, the chamber 21 having a diameter the same as the chamber 11 but being relatively high, the chamber 22 having a diameter the same as the chamber 18 and being of about the same cubic capacity and the chambers being connected by a longitudinally extending passage 23 opening at its opposite ends into the chambers. This passage is relatively narrow, and disposed within this passage is a lever 24 pivoted at 25. To the extremity of the lever 24 there is pivoted the bifurcated shank 26 of a head or valve 27 which rests upon the diaphragm 10 and is immediately above and concentric to the duct or passage 14, this head being larger in diameter than the diameter of the wall 15 of the passage. The opposite end of the lever 24 is pivotally connected to a forked shank 28 having upon it the head or valve 29 which has a diameter equal to the exterior diameter of the wall 19 and is disposed immediately above the axis of the duct 20 and is adapted to be forced against the diaphragm 10.

The section A is formed immediately above the shank 28 with an upwardly extending chamber 30 interiorly screw-threaded at its upper end for a manually adjustable plug 31, and disposed between this plug and the upper end of the shank 28 is a compression spring 32, the plug having a downwardly extending, centrally disposed pin inserted into the upper end of the spring 32 to retain the spring in place. It will be obvious that by rotating the plug 31 in one direction or the other, the tension of the spring 32 may be increased or decreased. It is to be noted that the area of the diaphragm forming the upper wall of chamber 18 is relatively great in comparison with the area of the diaphragm across the upper end of the chamber 16, and it is also to be noted that the lever 24 has its pivot 25 disposed, not at the middle portion of the lever, but nearer to the point of pivotal connection with the fork 26 than its point of pivotal connection with the fork 28.

The lower end of the passage 20 communicates with a horizontally extending duct 33 (see Figure 3) which extends at right angles to the duct 17 and this duct opens into the relatively small chamber 34 formed in section B. Extending upward from this chamber 34 is an annular wall 35 defining a vertically extending duct or chamber 36. The wall 35 extends up to the gasket or diaphragm 10 and surrounding this wall 35 is an annular chamber 37 having a relatively small area. From this chamber 37 extends a duct 38 (Fig. 2) which is at right angles to the duct 34 and parallel to the duct 17, this duct being relatively large in diameter and opening into the relatively large chamber 39 formed in the section B, the upper wall of this chamber being formed by the diaphragm 10. From this chamber extends an interiorly screw-threaded nipple or branch 40 constituting an outlet and which is adapted to be connected to a storage tank 41, as shown in Figure 4.

Above the chamber 39 and above the diaphragm 10 which forms the upper portion of this chamber there is formed a relatively large chamber 42, and above the chamber 37 there is formed a relatively small chamber 43 and these chambers are connected by a longitudinally extending passage 44. Disposed in this passage is a lever 45. This lever is pivoted at 46. The lever is unequally pivoted and the short end of the lever is attached to the forked shank 47 of a head or valve 48 which rests upon the diaphragm 10 immediately above the wall 35 and has a diameter approximately equal to the exterior diameter of this wall. The opposite end of the lever is connected to the forked shank 49 of a head or valve 50 which rests upon the center of that portion of the diaphragm 10 which forms the top of the chamber 39. It will be noted here that there is a very small diaphragm area above the chamber 37 and above the duct 36 and that the area of the diaphragm forming the top of the chamber 39 is relatively large.

It will be seen that notwithstanding the fact that I use a continuous sheet of rubber, leather or other material to form the gasket and diaphragm, that in effect this sheet 10 constitutes four diaphragms, namely a diaphragm for the chamber 16, a diaphragm for the chamber 18, a diaphragm for the chamber 37, and a diaphragm for the chamber 39, and it will be obvious that instead of using one continuous sheet of material to form these four diaphragms and the gasket between the two sections that it is possible to use four separate diaphragms and accomplish the same result. It will be seen that the sheet of material 10 which constitutes the several diaphragms and the gasket is firmly held around its margin by the flanges C and that it is firmly clamped by the adjacent portion of the upper and lower sections where they come close to each other on each side of the passages 23 and 45 and the ducts 17, 33 and 38 so that this sheet of rubber is firmly clamped at all points except where the sheet of rubber extends across the space forming a chamber.

It will be noted that the upper section A of the casting constitutes a housing for the two levers 24 and 45 and for the valves 27, 29, 48 and 50, and that all the moving parts are disposed within the upper section out of contact with the gas or liquid which may be passing through the lower section of the regulator. This regulator is adapted to be used either with air, steam, gas water or oil,

and where water, air or gas is regulated by this device a rubber diaphragm will ordinarily be used. Where gasoline, oil or steam are to be regulated, a metal diaphragm will be preferably used with metal valve seats and valves. It will, therefore, be understood that this device may be used with any fluid, though in the description of the operation of the device I confine myself to the description of its use with gas.

I have illustrated a regulator of this kind having four chambers within which the pressure is gradually stepped down by four stages, but it will be obvious that the regulator might be made with more than two pairs of connected chambers and more than two pairs of valves and levers to secure a more gradual stepping down of the pressure and, therefore, I do not wish to be limited to the exact construction illustrated. It will also be obvious that many changes might be made in the details of this construction without departing from the spirit of the invention.

The operation of this mechanism is as follows: Assuming that the pressure in the tank 13 is 200 pounds and that the pressure in the storage or receiving tank 41 is 5 pounds, when the pressure in the receiving tank is reduced below 5 pounds the head or valve 50 will be lowered by the collapse of the diaphragm in chamber 39 and the valve 48 will be raised, thus permitting the pressure in the duct 36 and chamber 34 to force up the diaphragm forming the top of this chamber 34 and gas will pass from the duct 36 into the chamber 37, thence by duct 38 into the chamber 39. The diaphragm of the chamber 39 has a relatively large area so that a relatively slight increase in pressure (an increase which will bring the pressure up to 5 pounds) will be sufficient to counter-balance the pressure in the duct 36 and the valve 48 will close. When the pressure in chamber 34 is relieved, the pressure in the ducts 33 and 20 will also be relieved. At this time the valve 29 is opened by reason of the fact that the area of the chamber 18 is relatively large and thus the gas in chamber 18 flows into the duct 20 until the pressure in chamber 18 is so reduced as to permit the descent of the valve or head 29. As soon as this occurs, the valve 27 lifts, permitting gas to pass from chamber 11 into the chamber 16 and duct 17 into chamber 18 until the pressure in chamber 18 is great enough to cause the closing of the valve 27 in the diaphragm against the end of the wall 15. The valve 27 remains in this position until the pressure in the chamber 18 is again reduced. Obviously also if the pressure in the chamber 11 rises beyond a predetermined amount it will act to lift the diaphragm from the top of chamber 16 and depress the diaphragm against the wall 19 and gas will pass from chamber 11 into chamber 18 until the pressure in chamber 18 is sufficient to overbalance the pressure in chamber 11, whereupon the diaphragm in chamber 18 will rise, causing the closing of the valve 27 and cutting off the inlet of gas, permitting the passage of gas from chamber 18 into duct 20, and so to the chamber 24. Upon a rise in pressure in chamber 34, however, sufficient to depress the relatively large diaphragm in chamber 39 and overbalance the pressure in chamber 39 due to a reduction of pressure in chamber 39, gas will pass from chamber 34 through duct 38 into the chamber 39. It will thus be seen that this regulator will act to keep a practically uniform pressure at both ends of the regulator, while at the same time reducing the pressure at the exit end of the regulator.

It will be seen that reducing the pressure in the chamber 39 causes the regulator to function and permits the passage of gas through all the chambers and ducts. The valves and levers are so arranged and balanced that when there is a reduction in chamber 39 all the valves stand open just enough to keep the same volume coming through the ports that is desired to be used. Any pressure desired can be secured by adjusting the plug 31 until the required amount of pressure desired in the low pressure tank is secured which will show on any suitable gauge. This gauge may be connected to the port 37ª, shown in Figure 3, or to any other suitable part of the apparatus. By adjusting the regulator to handle the highest pressure, it will work just the same when the pressure gets lower in the high pressure tank.

The duct 14 under valve 27 has a very small bore, the duct 17 has a larger bore, the passage 20 is still larger, and the passage 38 is still larger, thus furnishing a larger volume of fluid to chamber 39 and lowering the pressure. The pressure in chamber 34 and duct 36 is equal to the pressure in chamber 18 and ducts 33 and 20. Inasmuch as the levers 24 and 45 are approximately twice as long from 25 to 28 as they are from 25 to 26 and from 46 to 49 as from 46 to 47, another reduction is secured. It will be noted that the valve 27 in Figure 5 is larger than the circumference of the wall 15. This is necessary in order to cover most of the diaphragm above the chamber 16, as it is in this chamber that the highest pressure occurs and the greatest strain is on the diaphragm. The high pressure in chamber 11 starts the regulator to work, while the back pressure in chamber 39 causes it to stop.

Obviously the details of construction of this device might be varied in many ways without departing in any way from the spirit of the device.

I claim:—

1. A regulator comprising a receiving high pressure chamber and a discharging low pressure chamber, a valve controlling communication between the two chambers, a diaphragm extending across the discharging low pressure chamber, the low pressure chamber having an outlet opening, a valve operated by said diaphragm and seating against the outlet opening, and a lever operatively connected at one end to the diaphragm and the second-named valve and at its other end to the first named valve whereby the first named valve will be held closed by a predetermined pressure within the low pressure chamber acting on said diaphragm but will be opened upon a decrease in pressure in the low pressure chamber, the second named valve closing the outlet opening upon a predetermined reduction in pressure in the low pressure chamber.

2. A regulator comprising a receiving high pressure chamber having a relatively small discharge duct, a chamber into which said duct discharges, a relatively large discharging low pressure chamber having communication with the first named chamber and having a discharge duct, a diaphragm extending across the low pressure chamber and normally resting upon the wall of and closing said duct, a valve in the high pressure chamber adapted to close the duct leading therefrom, a lever connected to the valve at one end and at its other end so connected to said diaphragm that the valve will be held closed by a predetermined pressure in the low pressure chamber but will be opened upon a reduction in pressure in the low pressure chamber, said reduction in pressure causing the diaphragm to close against the outlet duct of the low pressure chamber.

3. A regulator comprising a receiving high pressure chamber having a relatively small outlet duct, a relatively large discharging low pressure chamber having a discharge duct, a valve associated with the high pressure chamber and controlling communication between the discharge duct thereof and the low pressure chamber, a valve associated with the low pressure chamber and controlling communication between said low pressure chamber and the discharge duct thereof, and pressure actuated means in the low pressure chamber holding said last named valve opened and the first named valve closed when the pressure in the low pressure chamber is at a predetermined point but acting to close the valve in the low pressure chamber and open the valve in the high pressure chamber when the pressure within the low pressure chamber falls below a predetermined point.

4. A regulator comprising two pairs of chambers, one of said pairs including a relatively small high pressure chamber adapted to be connected to a source of fluid under high pressure and having a relatively small discharge duct, a chamber surrounding the discharge duct, a relatively large low pressure chamber with which the second chamber communicates, a discharge duct leading therefrom, a diaphragm disposed across the first named chamber and extending over the opening of said first named duct, a diaphragm extending across the low pressure chamber and seating upon the inlet opening of the second named duct, valves disposed above the ducts, a lever pivotally connected at its ends to said valves, a spring normally urging the second named valve against the diaphragm and the diaphragm against the opening of the outlet duct from the low pressure chamber, a third chamber into which the outlet duct from the second named chamber opens, a relatively large fourth chamber communicating with the third named chamber and having a discharge outlet, a diaphragm extending across the last named chamber, a diaphragm extending across the third named chamber and adapted to close the duct leading thereinto, a valve associated with the third named chamber and resting upon said diaphragm, a valve resting upon the diaphragm in the fourth named chamber, and a lever pivotally connected to said valves.

5. The combination with a source of fluid under relatively high pressure and a container holding fluid under relatively low pressure, of a plurality of pairs of chambers, each pair of chambers comprising a receiving chamber and a discharging chamber, the receiving chamber of the first pair being connected to the source of fluid under pressure, the discharging chamber of the last pair being connected to the container, the receiving chamber of the second pair being connected to the discharging chamber of the first pair, and pressure operated means in the discharging chamber of the first pair adapted to close communication between its associated receiving chamber and the discharge chamber and open communication between the discharge chamber and the next succeeding receiving chamber when the pressure in the discharge chamber has reached a predetermined degree and close communication between the discharge chamber of the first pair and the receiving chamber of the second pair and open communication between the receiving chamber of the first pair and the discharging chamber of the first pair upon a predetermined reduction in pressure in said discharging chamber, and means opening communication between the receiving chamber of the second pair and the discharging chamber of that pair upon a predetermined reduction in pressure in the discharge chamber of the second named pair or close

communication between the receiving chamber of the second named pair and the discharging chamber thereof upon a predetermined rise in pressure in said last named discharging chamber.

6. A pressure reducing regulator formed of two confronting sections, one of the sections being formed to provide a high pressure diaphragm chamber and the other a low pressure diaphragm chamber, said chambers being connected by a duct, the other section being formed to provide chambers confronting the chambers in the first section and connected by a passage, a diaphragm disposed between said sections and extending across the two chambers, one of said chambers in the first section having an outlet duct formed with walls extending to the diaphragm, a lever mounted in the passage connecting the chambers of the second named section, and heads carried by the lever and disposed in the respective chambers and bearing against the diaphragm, one of said heads being disposed immediately above the upstanding wall of the said outlet duct.

7. A pressure regulator comprising a receiving high pressure chamber and a discharging low pressure chamber, the high pressure chamber having an inlet duct, the low pressure chamber having an outlet duct, a diaphragm in the high pressure chamber, a lever disposed above the diaphragm and operatively engaged at its opposite ends with the diaphragm, an oscillation of the lever in one direction permitting the diaphragm to lift from its engagement with the outlet duct of one chamber and be depressed against the inlet duct of the other chamber and upon an oscillation in the opposite direction opening the inlet duct of the last named chamber and closing the outlet duct of the first named chamber, said diaphragm under a predetermined pressure holding the diaphragm seated against the outlet duct and upon a reduction of pressure in the low pressure chamber closing the diaphragm against the outlet duct but opening the passage through the inlet to the high pressure chamber.

In testimony whereof I hereunto affix my signature.

ELMER R. WILLIAMS.