G. C. DAVIS & W. A. DALEY.

PRESSURE REGULATOR.

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959,474. **Patented May 31, 1910.**

Fig. 1.

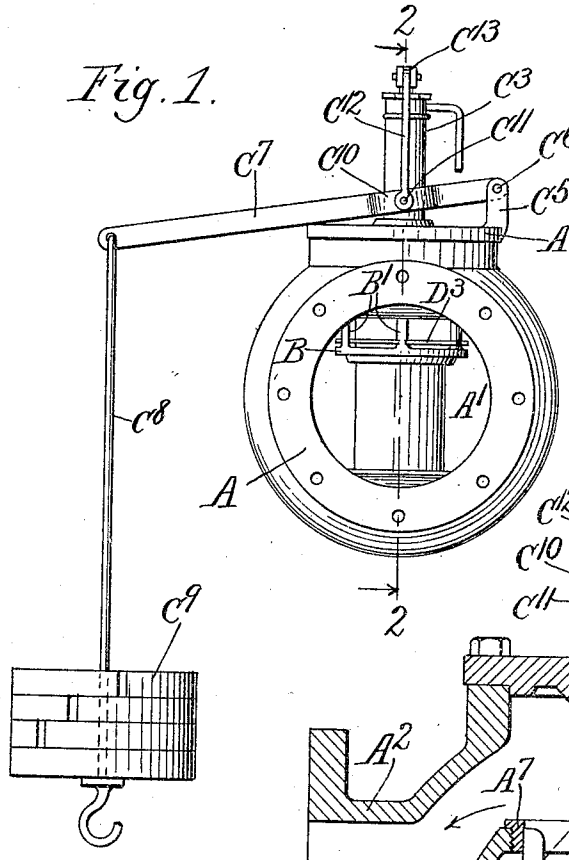
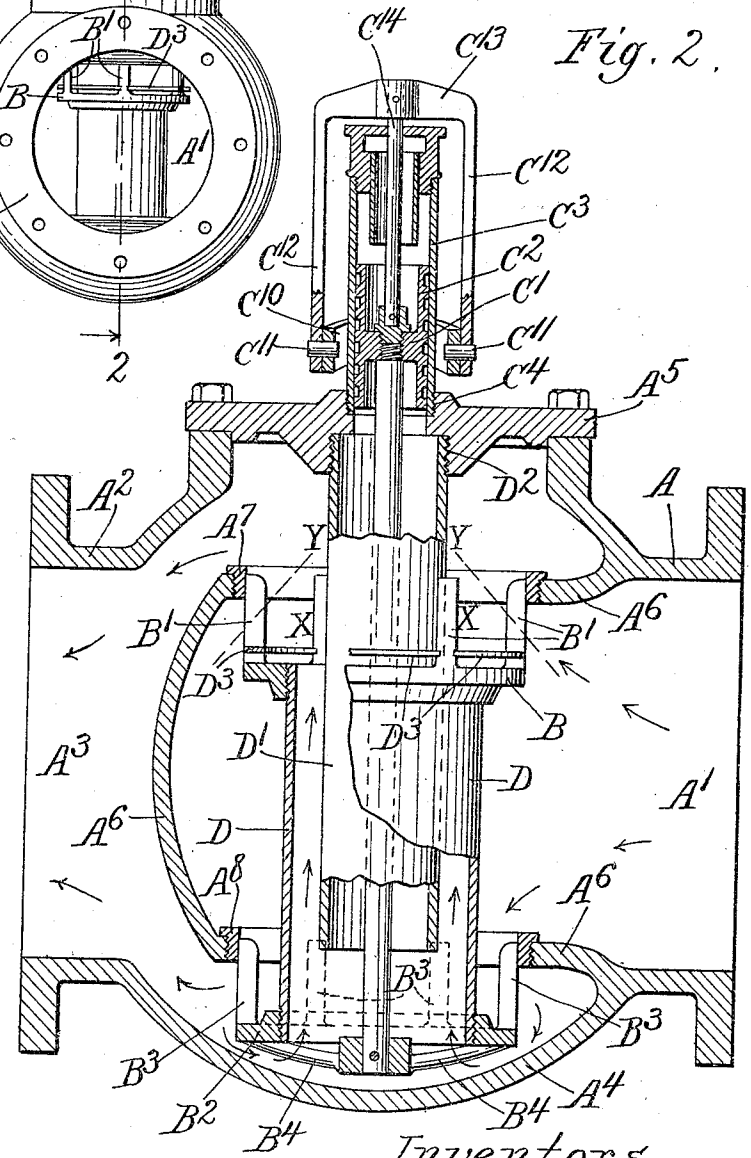


Fig. 2.



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PRESSURE-REGULATOR.

959,474. Specification of Letters Patent. **Patented May 31, 1910.**

Application filed November 7, 1908. Serial No. 461,476.

To all whom it may concern:

Be it known that we, GEORGE C. DAVIS and WALTER A. DALEY, citizens of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Pressure-Regulators, of which the following is a specification.

Our invention relates to pressure regulators or reducing valves designed to automatically reduce the pressure of any moving fluid from an initial pressure on one side of the regulator to a predetermined delivery pressure on the other side, and its particular object is to provide means for overcoming certain inequalities of action in such pressure regulators as are particularly incident to their use where relatively high pressures are found on the initial side with relatively low pressures on the delivery side of the pressure regulator.

The invention is illustrated in one form in the accompanying drawings, wherein—

Figure 1 is an end elevation of the valve, Fig. 2, a vertical section on line 2—2 of Fig. 1.

Like parts are indicated by the same letter in all the figures.

A is the pressure side of the valve case showing the supply opening A^1. A^2 is the delivery side of such case showing the discharge or delivery opening A^3.

A^4 is the bottom of the valve case and A^5 is the movable top.

A^6 A^6 are the several parts of the intermediate double diaphragm in which the two seats A^7 and A^8 of the balance valve are shown as screw-threaded at the proper points.

The valve proper is in the nature of a cage structure consisting of the upper annulus B with the guide wings B^1 B^1 thereon which are adapted to slide within the seat A^7, and the lower annulus B^2 having the wings B^3 B^3 adapted to slide within the lower seat A^8. These several wings are separated so as to leave wide openings between them for the passage of the fluid. The lower annulus is provided with the inwardly extending arms B^4 B^4 whereby that annulus is secured centrally to the stem C. This stem is screw threaded into the central diaphragm C^1 of the cylindrical piston C^2 which slides in the cylinder C^3 mounted, as for example, by being screw threaded at C^4 on the top of the valve A^5. On the top of the valve is also mounted a fulcrum C^5 to which is pivoted at C^6 the lever C^7, to the other end of which is pivoted the rod C^8 which carries the variable and adjustable weight C^9. The lever C^7 is bifurcated at C^{10}, its two portions lying respectively on opposite sides of the cylinder C^3 and each connected pivotally at C^{11} C^{11} with the depending arms C^{12} C^{12} of a yoke C^{13} to the upper end of which is secured one end of a rod C^{14}, the other end of which is secured to the upper end of the rod or stem C.

The two annular valves B and B^2 are connected by the cylinder D which performs three functions, of connecting the two valves to complete the cage structure, of separating the high pressure from the low pressure side of the valve, and of transmitting the low pressure of the delivery side upwardly through such cylinder to a point near the top thereof for the purpose hereinafter referred to. D^1 is a somewhat similar but smaller cylinder approximately axially arranged with relation to the cylinder D, screw threaded at D^2 into an enlargement on the lower side of the top of the valve and surrounding and inclosing the stem C. It performs several functions and among them those of deflecting the current of fluid as it escapes from the high pressure side to the delivery side into a direction approximately parallel with the direction of motion of the piston, the further function of separating an area immediately above the valve from the piston, and the third function of connecting the bottom of the piston with the delivery side of the valve by a passage-way which is protected at the upper part of the valve for a reason hereafter to be more fully set out. D^3 is an annular deflector just above the annulus B parallel therewith and extending toward the cylinder D^1. It will be understood that these parts can be greatly varied in size, shape, form, structure and relation and that some of them may be omitted and other devices substituted therefor without departing from the spirit of our invention. It will also be readily observed that some of the devices which we have shown and described as having more than one function may be varied in size, proportion or relation to other parts in a similar valve or structure or regulator so as to retain some though not all of said functions where all are not need-

ed. This explanation is necessary because we have shown our invention as applied to a balanced or double valve structure and not a single valve structure, and because we have shown it as associated directly with the valve and piston and not with some other form of balancing device which might have been associated with the valve.

The stem C may be secured in any desired manner to the piston. The top of the cylinder D^1 is spoken of as closed. We mean by that closed to the chamber immediately around it. The valves could be of different shape, and the function performed by the cylinder D could be performed by one or more tubular connecting parts.

The use and operation of our invention are as follows:—We shall spend a little time in describing the pressure balancing device which is mounted on the valve and which consists in this case, of a piston with a weight and a connection to the valve whereby the normal inequality of pressure between the high pressure side and the delivery side may be balanced by such weight or equivalent device substituted therefor. Thus if the pressure on the high pressure side is one hundred and fifty pounds and the desired pressure on the delivery side is fifty pounds and the valve is mounted so as to move in the direction indicated in Fig. 2, then the weight and piston should be adjusted so that their combined tendency will produce a pressure of fifty pounds, tending to keep the valve open or in its lower position, while the fifty pounds pressure on the low pressure side tends to close the valve by overcoming the combined influence of the piston and weight. The regulator is then properly adjusted. Now when the pressure on the delivery side falls, the valve tends to open. The first action is an in-rush of fluid which, if we employ the annular deflector D^3, is directed at right angles toward the cylinder D^1, and does not materially tend to cause any irregularity in the movement of the piston. If, however, the condition continues or if we had not used in our structure the annular deflector D^3, the in-rush of the fluid from the high pressure to the delivery side assumes more or less the form of a cone, the outlines of which are indicated in dotted lines in Fig. 2. This and some other of the actions and results which we are about to describe are more or less negligible in cases where we are dealing with low pressures, but where high pressures and great differences between the high pressure side and the delivery side are being dealt with the conditions now to be described become serious. The immediate effect of this direction of currents or streams of high pressure fluids as they emerge, is to produce, let us say, somewhere at X a low pressure area which tends to reduce the pressure on the top of the upper annular valve below the normal pressure on the delivery side and this is obviously a disturbing element or condition for it tends to cause the high pressure fluid to close the valve at the moment when it ought to leave it open. This movement of the stream of high pressure fluid develops also another area approximately at Y, Y, Fig. 2, of relatively high pressure, that is, pressure higher than the normal pressure on the delivery side. If, as in many forms of such valves, this high pressure area is directly open to the lower side of the piston, or if the lower side of the piston is exposed to the action of this stream of high pressure fluid or this high pressure area, the weight is improperly counterbalanced and again the tendency of the device is to close the valve when it ought to remain open.

Referring now to the low pressure area at X, its tendency is overcome in the device of our invention by the conduit D, which, opening from immediately below such low pressure area to the interior of the delivery side of the valve at a great distance from the in-rushing streams of high pressure fluid, supplies pressure to such low pressure area which overcomes its action or prevents the formation of such low pressure area. This action is suggested by the inwardly pointing arrows in the lower part of Fig. 2.

Having reference now to the high pressure area, the cylinder D^1 operates as a deflector for the currents moving toward it and directs them along the outer surface of such cylinder or in a direction substantially parallel to the direction of movement of the piston. Any deflector which will accomplish this result will prevent the action of these high pressure currents or streams on the lower side of the piston to a great extent even though such deflector does not operate as in this instance, as a perfect guard between such streams and the piston. This particular deflector, however, performs such second function for it is a guard interposed between such streams or currents and the lower side of the piston, and as such guard prevents the influence of such high pressure area and such streams, even though no action of deflection took place. In point of fact, however, these streams are deflected by the cylinder D^1 and their influence dispersed in the upper part of the valve far from any point where they might tend to disturb or make irregular the action of the regulator or reducing valve. The cylinder D^1 to more effectively assist in maintaining normal conditions, serves also as a conduit to connect the lower side of the piston with the delivery chamber far from the areas of disturbance. In this manner, and by these structures, no matter how sudden, how trifling or how considerable the motion of

the valve may be or how high the pressure on one side and how low it may be on the other, the regulator or reducing valve is always in condition for relatively normal action. We have assumed a case where the pressure on the outlet or delivery side has become too low, but of course it makes no difference what the cause of the variation, the action is the same so far as our new invention is concerned. Generally speaking, the object of our invention is to create conditions which shall maintain equality of action during such variations in the position of the valve as may be necessary to maintain on the delivery side the predetermined pressure and to avoid the disturbance of those conditions by the creation of high and low pressure areas, either or both, by the action of the escaping stream of high pressure fluid.

As previously suggested, of course, the practice may be varied so as to accomplish only a part of what we seek to obtain or to accomplish all of it. Moreover, we have shown the invention as applied to a reducing valve adapted to open on the downward motion. Under these conditions the structure of the valve is such that the tendency of the escaping high pressure fluid at the lower end of the valve to disturb its action is negligible under ordinary conditions. Hence we have no device for equalization at that point. If, however, the valve is reversed so that it opens on the upward movement then the arrangement of parts would have to be varied but this any mechanic can do and instructions here given are sufficient to enable him to apply the invention to a valve of such different designs.

The parts D and D^1 take the shape of cylinders in our illustration. They perform various functions, as for instance, that of deflectors, that of guards, and that of conduits. The deflector, of course, theoretically need not be so constructed as to act as a conduit, and the guard need not be cylindrical but there is in the form of device shown, these two parts which act as conduits and one of them as a deflector and a guard.

We have spoken of a cylinder having two valves. Of course the term "valve" is here to be used in the broad sense as meaning any valve-like structure which is used to close and open an aperture. In some cases we have spoken of the valves as being at the two ends of the cylinder. It is obvious, of course, that they need not be at the ends. The essential point is that the cylinder or like part carries a plurality of valves, for example, one or more valves or surfaces which act as valves, whereby the two apertures are closed when the cylinder has been moved into the valve closing position.

We claim:

1. In a reducing pressure regulator, the combination of a valve proper with a balancing device and a part which acts as a deflector parallel with the line of movement of that portion of the balancing device which is exposed to the internal fluid pressures and a fluid connection from the end of such part which acts as a deflector to a part of the low pressure chamber where the pressure is substantially uniform.

2. In a reducing pressure regulator, the combination of a valve proper with a balancing device and a part which acts as a guard interposed between the inlet for the high pressure fluid and that part of the balancing device which is exposed to the internal pressures and a fluid connection from the end of such part which acts as a guard to a part of the low pressure chamber where the pressure is substantially uniform.

3. In a reducing pressure regulator, the combination of a valve proper with a balancing device and a part which acts as a deflector to deflect high pressure fluid streams in a line substantially parallel with that portion of the balancing device which is exposed to the internal fluid pressures, said part which acts as a deflector consisting of a cylinder intersecting the paths of such high pressure fluid streams and a fluid connection from the end of such part which acts as a deflector to a part of the low pressure chamber where the pressure is substantially uniform.

4. In a reducing pressure regulator, the combination of a valve proper with a balancing device and a part which acts as a guard interposed between the inlet for the high pressure fluid and that part of the balancing device which is exposed to the internal pressures, said part which acts as a guard consisting of a cylinder intersecting the paths of such high pressure fluid streams and a fluid connection from the end of such part which acts as a guard to a part of the low pressure chamber where the pressure is substantially uniform.

5. In a reducing pressure regulator, the combination of a valve proper with a balancing device and a part which acts as a conduit leading from that portion of the balancing device, which is exposed to the internal pressures, to the delivery chamber of the valve at a point remote from the point where the in-leading streams of high pressure fluids enter the delivery chamber on lines directed toward the exposed portion of the balancing device, said part which acts as a conduit consisting of a cylinder intersecting the paths of such high pressure fluid streams and inclosing the moving part of the balancing device.

6. In a reducing pressure regulator, the combination of a valve proper with a balancing device and a part which acts as a deflector to deflect high pressure fluid streams in a line substantially parallel with the line

of movement of that portion of the balancing device which is exposed to the internal fluid pressures, said part which acts as a deflector consisting of a cylinder intersecting the paths of such high pressure fluid streams, and inclosing the stem which connects the moving portion of such balancing device with the moving portion of the valve proper and a fluid connection from the end of such part which acts as a deflector to a part of the low pressure chamber where the pressure is substantially uniform.

7. In a reducing pressure regulator, the combination of a valve proper with a balancing device and a part which acts as a guard interposed between the inlet for the high pressure fluid and that part of the balancing device which is exposed to the internal pressures, said part which acts as a guard consisting of a cylinder intersecting the paths of such high pressure fluid streams, and inclosing the stem which connects the moving portion of such balancing device with the moving portion of the valve proper and a fluid connection from the end of such part which acts as a guard to a part of the low pressure chamber where the pressure is substantially uniform.

8. In a reducing pressure regulator, the combination of a valve proper with a balancing device and a part which acts as a conduit leading from that portion of the balancing device which is exposed to the internal pressures to the delivery chamber of the valve at a point remote from the point where the in-leading streams of high pressure fluids enter the delivery chamber on lines directed toward the exposed portion of the balancing device, said part which acts as a conduit consisting of a cylinder intersecting the paths of such high pressure fluid streams, and inclosing the stem which connects the moving portion of such balancing device with the moving portion of the valve proper.

9. In a reducing pressure regulator, the combination of two valves and a cylinder, to the open ends of which valves are respectively secured, and an inclosing casing, the cylinder opening at both ends into the delivery side.

10. In a reducing pressure regulator, the combination of two valves and a cylinder which connects them, and is open at top and bottom into the delivery side, and a balancing device, the movable portion of whose stem passes through such cylinder at one end and is connected to the valve at the other end.

11. In a reducing pressure regulator, the combination of two valves, a cylinder which connects them, and is open at top and bottom into the delivery side, a balancing device, the movable portion of whose stem passes through such cylinder at one end and is connected to the valve at the other end, and an inner cylinder surrounding said stem.

12. In a reducing pressure regulator, the combination of two valves, a cylinder which connects them and is open at top and bottom into the delivery side, a balancing device the movable portion of whose stem passes through such cylinder at one end and is connected to the valve at the other end, and an inner cylinder surrounding said stem and closed at one end where it leads to such movable portion of the balancing device and opening at the other end into the delivery chamber.

13. In a reducing pressure regulator, the combination of two valves, a cylinder which connects them and is open at top and bottom into the delivery side, a balancing device the movable portion of whose stem passes through such cylinder at one end and is connected to the valve at the other end, and an inner cylinder surrounding said stem and closed at one end where it leads to such movable portion of the balancing device and opening at the other end into the delivery chamber at a point remote from the point where the in-flowing high pressure streams of fluid move toward such stem.

14. In a reducing pressure regulator, the combination of a valve proper separating the high and low pressure chambers, with a balancing device containing a movable piston, one side of which is exposed to the low pressure chamber at a point where its pressure is uniform, and a fixed cylindrical deflector interposed between such piston and the opening through which streams of high pressure fluid tend to move toward such piston.

15. In a reducing pressure regulator, the combination of a valve proper separating the high and low pressure chambers, with a balancing device containing a movable piston, one side of which is exposed to the low pressure chamber at a point where its pressure is uniform, and a fixed guard interposed between such piston and the opening through which streams of high pressure fluid tend to move toward such piston.

16. In a reducing pressure regulator, the combination of a valve proper separating the high and low pressure chambers, with a balancing device containing a movable piston, one side of which is exposed to the low pressure chamber, and a conduit open to the delivery side of the chamber at a point remote from the point at which high pressure fluid streams enter the low pressure chamber flowing toward the piston and leading to the inner surface of the piston.

17. In a reducing pressure regulator, the combination of two annular valves connected by a cylinder separating the high and low pressure chambers, with a balancing device containing a movable piston, one side

of which is exposed to the low pressure chamber, and a cylindrical part which acts as a deflector interposed between such piston and the opening through which streams of high pressure fluid tend to move toward such piston.

18. In a reducing pressure regulator, the combination of two annular valves connected by a cylinder separating the high and low pressure chambers, with a balancing device containing a movable piston, one side of which is exposed to the low pressure chamber, and a cylindrical part which acts as a guard interposed between such piston and the opening through which streams of high pressure fluid tend to move toward such piston.

19. In a reducing pressure regulator, the combination of a valve proper separating the high and low pressure chambers, with a balancing device containing a movable piston, one side of which is exposed to the low pressure chamber, and a fixed guard interposed between such piston and the opening through which streams of high pressure fluid tend to move toward such piston, said guard consisting of a cylinder which protects the inner end of such piston and leads thence to the low pressure chamber.

20. In a reducing pressure regulator the combination of two valves, and a cylindrical like structure connecting them, and opening at the top and bottom into the delivery side and a deflector within the upper part of such cylinder.

21. In a reducing pressure regulator, the combination of two valves, and a cylindrical like structure connecting them, and opening at the top and bottom into the delivery side, and a balancing device, the movable portion of whose stem is connected with such valves and a deflector within the upper part of such cylinder.

22. In a reducing pressure regulator, the combination of a cylinder having a plurality of valve-like surfaces opening at the top and bottom into the delivery side, and a balancing device, the movable portion of whose stem passes through such cylinder at one end and is connected to the cylinder at the other end.

23. In a reducing pressure regulator, the combination of a cylinder having a plurality of valve-like surfaces opening at the top and bottom into the delivery side, a balancing device the movable portion of whose stem passes through such cylinder at one end and is connected to the cylinder at the other end and a second cylinder surrounding such stem.

24. In a reducing pressure regulator, the combination of a cylinder having a plurality of valve-like surfaces opening at the top and bottom into the delivery side, a balancing device, the movable portion of whose stem passes through such cylinder at one end and is connected to the cylinder at the other end, and a second cylinder surrounding such stem leading from such movable portion of the balancing device and opening at the other end into the delivery chamber.

25. In a reducing pressure regulator, the combination of a cylinder having a plurality of valve-like surfaces opening at the top and bottom into the delivery side, a balancing device, the movable portion of whose stem passes through such cylinder at one end and is connected to the cylinder at the other end, and a second cylinder surrounding such stem leading from such movable portion of the balancing device and opening at the other end into the delivery chamber at a point remote from the point where the inflowing high pressure streams of fluid move toward such stem.

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