E. P. NOYES.

FLUID OPERATED VALVE.

APPLICATION FILED MAY 8, 1908.

988,495. Patented Apr. 4, 1911

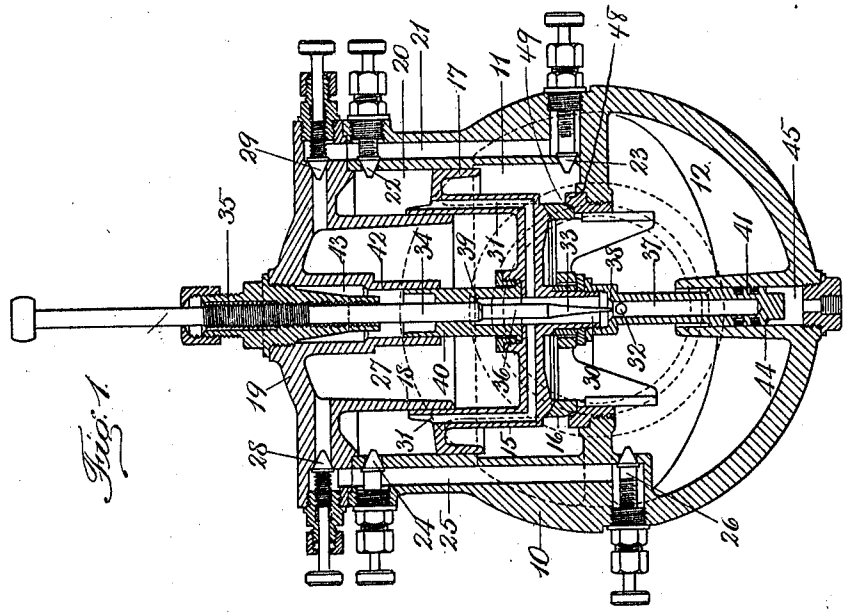

Fig. 1.

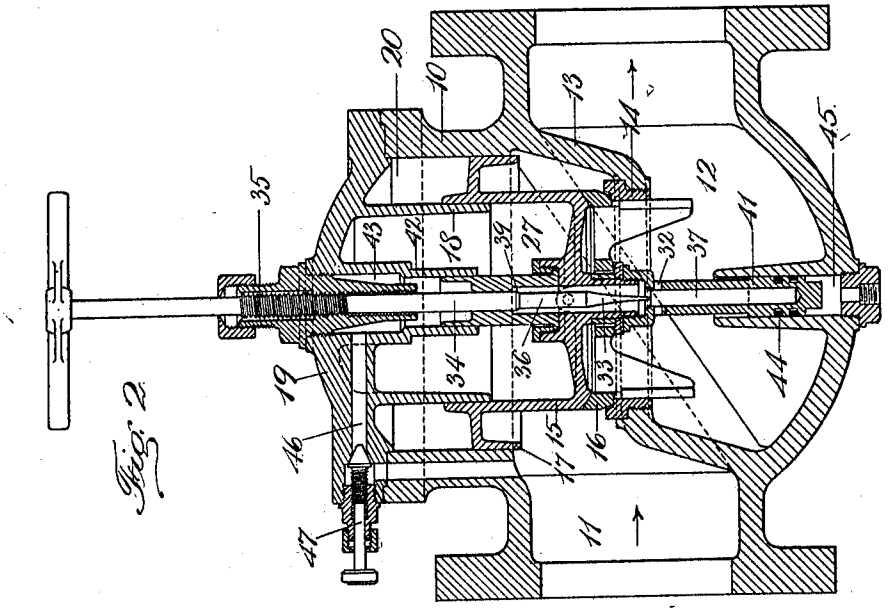

Fig. 2.

Witnesses:
August Minor
J. Blake

Inventor:
E. P. Noyes
by Robert McKerrow Atty.

UNITED STATES PATENT OFFICE.

EDWARD P. NOYES, OF WINCHESTER, MASSACHUSETTS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO C. P. POWER COMPANY, OF NEWARK, NEW JERSEY, A CORPORATION OF NEW JERSEY.

FLUID-OPERATED VALVE.

988,495. Specification of Letters Patent. Patented Apr. 4, 1911.

Application filed May 8, 1908. Serial No. 431,723.

To all whom it may concern:

Be it known that I, EDWARD P. NOYES, a citizen of the United States, residing at Winchester, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Fluid-Operated Valves, of which the following is a specification.

This invention relates to fluid-operated valves which are controlled by adjusting the pressure in a chamber in shunt or loop connection between the anterior and posterior branches of the valve casing, and it relates especially, though not exclusively, to single-seating valves of this type, which are more easily kept fluid-tight when closed than is a double-disk or ordinary "balanced" valve.

While attempts have been made to balance single-seating valves and operate them by control of a fluid-pressure derived from the main line, it has always been more or less difficult to reconcile the balancing and operating functions without introducing undue complication or other faults. Usually the valves are unbalanced, which makes them deficient in delicacy of control, especiallv in the larger sizes, the tendency of the valve-and-piston member being to move all the way when once started. There is commonly also a tendency to chatter.

My general object is to overcome or mitigate these faults, and my special objects are, principally, to secure greater delicacy and reliability of control; to provide for, or extend the range of, automatic stable equilibrium of the main valve in its intermediate openings; to control the leakage past sliding surfaces; to provide improved means for mechanical control of the main valve; to segregate the valve-balancing and valve-operating functions and improve the means for performing each of them; and to furnish a convertible valve-structure adapted for different modes of operation.

Of the accompanying drawings, Figure 1 represents a vertical transverse section of a valve apparatus constructed according to my invention. Fig. 2 represents a vertical longitudinal section thereof.

10 is the valve-casing formed with anterior and posterior chambers 11, 12 separated by a partition 13 which contains a central port surrounded by a valve-seat 14.

15 is the moving valve-and-piston member carrying the main valve 16 at its lower end and also formed with a motor piston 17 whose lower side is exposed to the anterior pressure in chamber 11 tending to raise the main valve.

I have segregated the balancing and valve-operating functions (in this instance substantially completely) by providing the guide 18 formed on the casing cover 19 and telescoping with the moving piece 15, thus making an annular chamber 20 which surrounds the telescopic connection, and a middle chamber 27 within the projected cylinder of said connection. In one of these chambers I establish the controlling pressure and in the other the balancing or posterior pressure, there being for the chamber 20 an inlet duct 21 leading from the anterior chamber 11 and controlled by pilot valves 22, 23 and an outlet duct 25 leading to the posterior chamber 12 and controlled by pilot valves 24 and 26. (It is permissible to employ, in place of either of the pilot-controlled ducts for the controlling chamber, and especially for the inlet-duct, a fixed leakage such as might be provided by making the piston 17 a loose fit in its cylinder, as will be evident to those skilled in the art.)

For the balancing chamber 27 there is an extension of outlet duct 25 controlled by pilot valve 28, on opening which the pressure posterior to the main valve will be established in chamber 27, and since in this illustration the diameter of said chamber is approximately the same as that of the main valve 16, the latter will have a substantially complete or exact balance as to posterior pressure. There is also shown an extension of the inlet duct 21 leading to chamber 27 and controlled by pilot-valve 29, the function of which will be hereinafter explained.

30 is a central outlet duct formed in the moving member 15, with entrances 31 from the controlling chamber 20 and exits 32 to the posterior chamber 12, this outlet from chamber 20 being usable either in conjunction with or in place of the outlet through duct 25, and controlled by a tapered valve 33 on a stem 34 having a threaded connection at 35 with the casing cover. Above the tapered valve 33, the stem has a cylindrical or piston portion 36 adapted to snugly fit the bore 37 so as to shut off the exits 32 while still permitting movement of the member 15; and stem 34 is further capable of me-

chanically controlling said member 15 by reason of a shoulder 39 formed on the stem and adapted to seat against a shoulder 38 above the exits 32, whereby also the outlet duct 30 may be sealed when the main valve is closed, and any leakage from the sliding surfaces of the member 15 to the posterior side of the main valve shut off.

40 is a small piston affixed to the member 15 and having a snug sliding fit on stem 34 and in a fixed cylinder 42 which projects from the casing cover 19, this piston being opposed by a piston 41 of substantially equal area working in a cylinder 44 which projects from the floor of chamber 12, the cylinder space 45 below piston 44 being adapted to contain atmospheric or other pressure, preferably a fixed pressure. From the cylinder space 43 above piston 40 the duct 46 leads to the anterior chamber 11 and is controlled by a pilot valve 47.

48 represents an annular lip surrounding the seat for the main valve and forming with the body of the main valve 16 an annular cleft 49 anterior to the seating face of the main valve, whereby as the main valve nears its seat the throttling function is performed by the sides of this cleft, which tends to relieve the faces of the valve and its seat of any cutting action and also to blow out from between the valve and its seat any particles which might prevent a tight closure. This lip slightly overbalances the main valve and tends to produce a sharp closing action as the latter approaches its seat, owing to the smaller area of piece 15 subjected to the upward pressure in chamber 11 as compared with the area of piston 17 subjected to the downward pressure in chamber 20, but as the valve approaches closer to its seat, the throttling action becomes transferred to the cleft between the valve and its seat and a cushioning effect ensues just prior to actual closure. While this construction is preferred, it may be modified or omitted without departing from the present invention.

The simplest mode of operation of my improved valve apparatus is that wherein posterior pressure is established in the chamber 27 and the position of the main valve is regulated by adjusting the relation between the inflow to and the outflow from the controlling chamber 20. Thus, assuming that stem 34 is retracted, but not enough to open the ports 32, valves 23, 26 and 28 being wide open, valve 22 slightly open, and valves 29 and 47 closed, the anterior pressure which has accumulated in chamber 20 above the piston 17 may then be drawn down by slightly opening the valve 24. As soon as the pressure in 20 has been reduced far enough to enable the pressure in chamber 11 to overcome the friction and weight of the member 15, the main valve will rise from its seat, and when posterior pressure has risen sufficiently in chamber 12, said pressure will tend to react upon and check the outflow from chamber 20. In the case of a liquid this reacting tendency of the posterior pressure is effective throughout the range of the main valve, but in the case of an elastic fluid, owing to a known law of the flow of such fluids, the reaction does not begin until the posterior pressure has risen to about 58% of the pressure in chamber 20. In the higher regions of throttling however, namely from full opening to about 40% throttle (or in some cases more, as hereinafter noted), I am enabled to automatically maintain the main valve in stable equilibrium by merely adjusting a pilot valve such as valve 24, to regulate the relation between the inflow to and the outflow from a controlling chamber such as 20. With a liquid, as already indicated, the range of automatic stable equilibrium substantially coincides with the range of the main valve. Thus great delicacy of control is attained by substantially balancing the main valve as to posterior pressure, but the degree of exactness of this balancing is of course subject to some variation without departing from my invention.

In order to lower the limit of stable-equilibrium control, various expedients may be employed. For example, an increase in the weight of the moving piece 15, by lowering that pressure in chamber 20 which will hold member 15 in equilibrium, will consequently lower the point at which the posterior pressure begins to react on the outflow from 20. Any other constant or substantially-constant valve-closing force may be substituted for an increase in weight. Thus in many situations the anterior pressure will be substantially constant, and this may be admitted to the space above piston 40 by opening valve 47. Then piston 41, whose lower side may be subject to a constant upwardly-acting force as stated, removes from the main piece the counter influence of the varying posterior pressure in chamber 12. It will be understood that these auxiliary pistons 40 and 41, while giving useful effects, are not essential to my invention in a broad sense. When present however they may be used in different capacities. Chamber 45 for example may contain any suitable operating or controlling pressure. Chamber 43 with valve 47 closed, acts as a dash-pot; or when valve 47 is open for an in-leakage less than the out-leakage past the sliding surfaces of piston 40, a pressure may be established in chamber 43 intermediate between the anterior and posterior pressures.

With the valve 33 in use, and adjusted approximately as shown in the drawings, the orifice for outflow from chamber 20 is varied

by the movement of the member 15, being in this instance increased as the main valve descends toward closure and vice versa, the position of the main piece 15 being controllable by adjusting stem 34 up or down.

Among the advantages of providing a web or separation between the chambers 27 and 12 are, first that it enables the leakage past the telescopic joint 15, 18 to be controlled, and secondly that it affords an additional area for the accumulation of anterior pressure to hold the main valve to its seat when closed. Also, by manipulating the pilot valves in the convertible structure here shown, pressures other than anterior and posterior may be established in chamber 27, as for example a pressure intermediate between the two, attained by a proper relative adjustment of valves 29 and 28. By opening wide the valves 22, 24, 29, 28, the chambers 20 and 27 may be placed in free communication and the pressure in both controlled by using the valves 23, 26. Or again, the posterior pressure may be established in both chambers 20 and 27 by opening 24, 26, and 28 and closing 22, 23, and 29, whereupon the valve will automatically maintain a substantially constant difference between the anterior and posterior pressures. Or still again the chambers 20 and 27 may be placed in series so as to contain staged intermediate pressures, by opening 22 slightly (23 being open) closing 24 and 29 (26 being open) and controlling the outflow from chamber 27 by means of valve 28, its inflow taking place from chamber 20 past the telescopic joint 15, 18. All of these last-described modes of operation assume that the ports 32 are closed by piston 36.

It will be evident that various other modes of operation may be attained by reason of the convertible character of the valve as shown, but it is to be understood that I do not limit myself to a valve having the means for attaining all these modes of operation, as my invention may be more simply embodied and it is also subject to considerable variation in mode of embodiment without departing from the principles herein set forth.

I claim,—

1. In valve apparatus, the combination of a casing having anterior and posterior chambers connected by a port, a moving member having a main valve controlling said port and opening counter to the direction of flow and a motor piston exposed on one side to the anterior pressure acting to open the valve, said member forming with the casing two chambers in shunt between the anterior and posterior chambers and adapted to contain pressures tending to close the valve, a pilot valve controlling the connection between one of said two chambers and the posterior chamber, and a second pilot valve controlling the relation between the inflow to and the outflow from the other of said two chambers.

2. In valve apparatus, the combination of a casing having anterior and posterior chambers, a movable member having a single valve controlling communication between said chambers and opening counter to the direction of flow and a motor piston subject on one side to the anterior pressure, a telescopic connection between the casing and said member, an intermediate-pressure chamber surrounding said connection and in shunt between the anterior and posterior chambers, and means for controlling the relation between the inflow to and the outflow from said intermediate-pressure chamber.

3. Fluid-pressure operated valve apparatus comprising a valve-casing having anterior and posterior chambers, a single-seating valve controlling the passage between said chambers and having a piston subject on one side to the anterior pressure, means for establishing a varying derivative of said pressure on the opposite side of the piston, a chamber for balancing the posterior area of the valve, and means for establishing posterior pressure in said balancing chamber.

4. In valve apparatus, the combination of anterior and posterior chambers connected by a port, a movable member having a single-seating valve controlling said port and opening counter to the direction of flow, a piston on said member having a valve-opening area exposed to the anterior pressure, a telescopic connection between said member and the casing, an intermediate chamber surrounding, and a balancing chamber within, said connection and both in shunt between the anterior and posterior chambers, and pilot valves for opening and closing the communications of said balancing chamber and for controlling the pressure in the intermediate chamber.

5. A convertible fluid-pressure-operated valve apparatus comprising a valve in a fluid pressure line, a piston attached to said valve and subject on one side to the pressure anterior to the valve, an intermediate chamber on the opposite side of said piston, means to establish in said intermediate chamber a mean between the pressures anterior and posterior to the valve, a second chamber for balancing the posterior area of the valve, and means to establish in said balancing chamber either the said mean pressure or the pressure posterior to the valve.

6. A convertible fluid-pressure-operated valve apparatus comprising a valve casing having anterior and posterior chambers connected by a port, a main valve controlling said port and having a piston subject on one side to the anterior pressure, an intermediate chamber on the opposite side of said piston having throttling passages connecting it with the anterior and posterior chambers, a

valve controlling the posterior connecting passage, a chamber for balancing the posterior area of the main valve and having passages connecting it with the anterior and posterior chambers, and separately adjustable valves controlling the respective last-said passages.

7. A convertible fluid-pressure-operated valve apparatus comprising a valve casing having anterior and posterior chambers connected by a port, a main valve controlling said port and having a piston subject on one side to the anterior pressure, an intermediate chamber on the opposite side of said piston, a chamber for balancing the posterior area of the main valve, a duct leading from the anterior chamber to the intermediate and balancing chambers and having three valves controlling respectively its inlet from the anterior chamber and its outlet to the intermediate and balancing chambers, and a second duct leading from the intermediate and balancing chambers to the posterior chamber and having three valves controlling respectively its inlets from the intermediate and balancing chambers and its outlet to the posterior chamber.

8. In valve apparatus, the combination of anterior and posterior chambers and an intermediate chamber in shunt between the two, a movable member having a valve controlling communication between the anterior and posterior chambers and adapted to be substantially balanced as to the posterior pressure, said member having opposed areas subject respectively to the anterior and intermediate pressures, and pilot-valve mechanism controlled by the movement of said member for varying the intermediate pressure.

9. Fluid-pressure-operated valve apparatus comprising a valve adapted to open and close a fluid-pressure line and having an attached piston subject on one side to the anterior pressure tending to open the valve, an intermediate-pressure chamber on the opposite side of said piston having throttling passages which connect with the anterior and posterior sides of the valve respectively, the opposed valve-operating areas being such that the valve automatically assumes equilibrium at intermediate openings without changing the size of said passages, and adjustable means for causing the movement of the valve to vary the escape of intermediate pressure to the outlet side of the valve inversely to the opening of said valve to maintain such equilibrium in the regions approaching minimum posterior pressure.

10. Fluid-pressure-operated valve apparatus comprising a casing having anterior-pressure, posterior-pressure and intermediate-pressure chambers, a main valve controlling the passage between the anterior-pressure and posterior-pressure chambers and having an attached piston with substantially equal opposite areas presented respectively to the anterior-pressure and intermediate-pressure chambers, and an adjustable valve controlling a passage between the intermediate-pressure and posterior-pressure chambers and adapted to automatically open said passage wider as the main valve closes and vice versa.

11. Fluid-pressure-operated valve apparatus comprising a main valve controlling the fluid flow and having a piston subject on one side to the pressure anterior to the valve, an intermediate-pressure chamber on the opposite side of said piston having an inlet from the anterior side and an outlet duct leading to the posterior side of the main valve, and an adjustable valve stem controlling said duct and having a taper valve portion and a plunger portion for closing said outlet duct while permitting movement of the main valve.

12. In valve apparatus, the combination of anterior and posterior chambers connected by a port, an intermediate chamber in shunt between the two, a movable member having a valve controlling said port and opposed motor areas subject respectively to the anterior and intermediate pressures, and a pilot member having two serially-acting valves, one controlling the fluid flow from the intermediate to the posterior chamber, and the other being a sealing valve seating on said movable member.

13. In valve apparatus, the combination of anterior and posterior chambers connected by a port, an intermediate chamber in shunt between the two, a movable member having a valve controlling said port and opposed motor areas subject respectively to the anterior and intermediate pressures, and a member having a pilot valve controlling the flow out of said intermediate chamber, a sealing valve adapted to seat on the movable member, and a plunger portion permitting the pilot valve to close before the sealing valve closes.

14. In valve apparatus, the combination of anterior and posterior chambers connected by a port, an intermediate chamber communicating with the two, means for controlling the pressure in said intermediate chamber, a chamber for balancing the posterior area of the valve, a movable member formed with an outlet from the intermediate chamber to the posterior chamber and having a main valve controlling said port and opposed motor areas subject respectively to the anterior and intermediate pressures, and a pilot valve controlling said outlet and closing in the same direction as the main valve.

15. Fluid-pressure-operated valve apparatus comprising a valve casing, a main valve controlling the fluid flow and having a piston subject on one side to the pressure an-

terior to the valve, an intermediate chamber on the opposite side of said valve having an inlet from the anterior side of the valve and an outlet duct leading through the main-valve piece to the posterior side of said valve, and a locking valve stem having a screw-threaded adjusting connection with the casing and formed with a tapered valve controlling said duct, a duct-closing plunger portion back of said tapered valve, and a duct-sealing and main-valve-locking shoulder back of said plunger portion.

16. Fluid-pressure-operated valve apparatus comprising a main valve controlling the fluid flow and having a piston subject on one side to the pressure anterior to the valve, an intermediate chamber on the opposite side of the piston having throttling passages connecting it with the anterior and posterior sides of the valve respectively, a second piston attached to the valve, a cylinder containing said second piston, means to establish the anterior pressure in said cylinder, a balancing piston and cylinder opposed to said second piston and its cylinder, and means to establish an inferior balancing pressure in said balancing cylinder.

17. Fluid-pressure-operated valve apparatus comprising a main valve controlling the fluid flow and having a piston subject on one side to the pressure anterior to the valve, an intermediate chamber on the opposite side of the piston having throttling passages connecting it with the anterior and posterior sides of the valve respectively, pilot valves controlling said passages, a chamber for balancing the posterior area of the main valve and having passages connecting with the anterior and posterior sides of the main valve respectively and provided with pilot valves, a cylinder having a passage connecting it with the anterior sides of the main valve and provided with a pilot valve, a second piston in said cylinder attached to the main valve, a third piston opposed to the last-said piston and attached to the main valve, and a cylinder for said third piston.

18. A convertible fluid-pressure-operated valve apparatus comprising a casing having anterior-pressure and posterior-pressure chambers, a valve controlling the passage between said chambers, a third chamber, means for establishing in said third chamber either the posterior pressure or a mean between anterior and posterior pressures, and a piston attached to the valve and having substantially equal areas presented respectively to the anterior-pressure chamber and the third chamber.

19. A convertible fluid-pressure-operated valve apparatus comprising a valve casing having anterior and posterior chambers connected by a port, a main valve controlling said port and having a piston subject on one side to the anterior pressure, and separate chambers adapted to contain pressures intermediate between the anterior and posterior pressures tending to close the valve, and provided with means for varying said intermediate pressures.

20. A convertible fluid-pressure-operated valve apparatus comprising a valve casing having anterior and posterior chambers connected by a port, a main valve controlling said port and having a piston subject on one side to the anterior pressure, separate chambers adapted to contain pressures intermediate between anterior and posterior pressures tending to close the valve, and provided with means for varying said intermediate pressures, and means for substantially freeing the pressure in one of said separate chambers from the direct opposition of the posterior pressure.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses, this 6th day of May 1908.

EDWARD P. NOYES.

Witnesses:

E. BATCHELDER,

P. W. PEZZETI.