(No Model.)

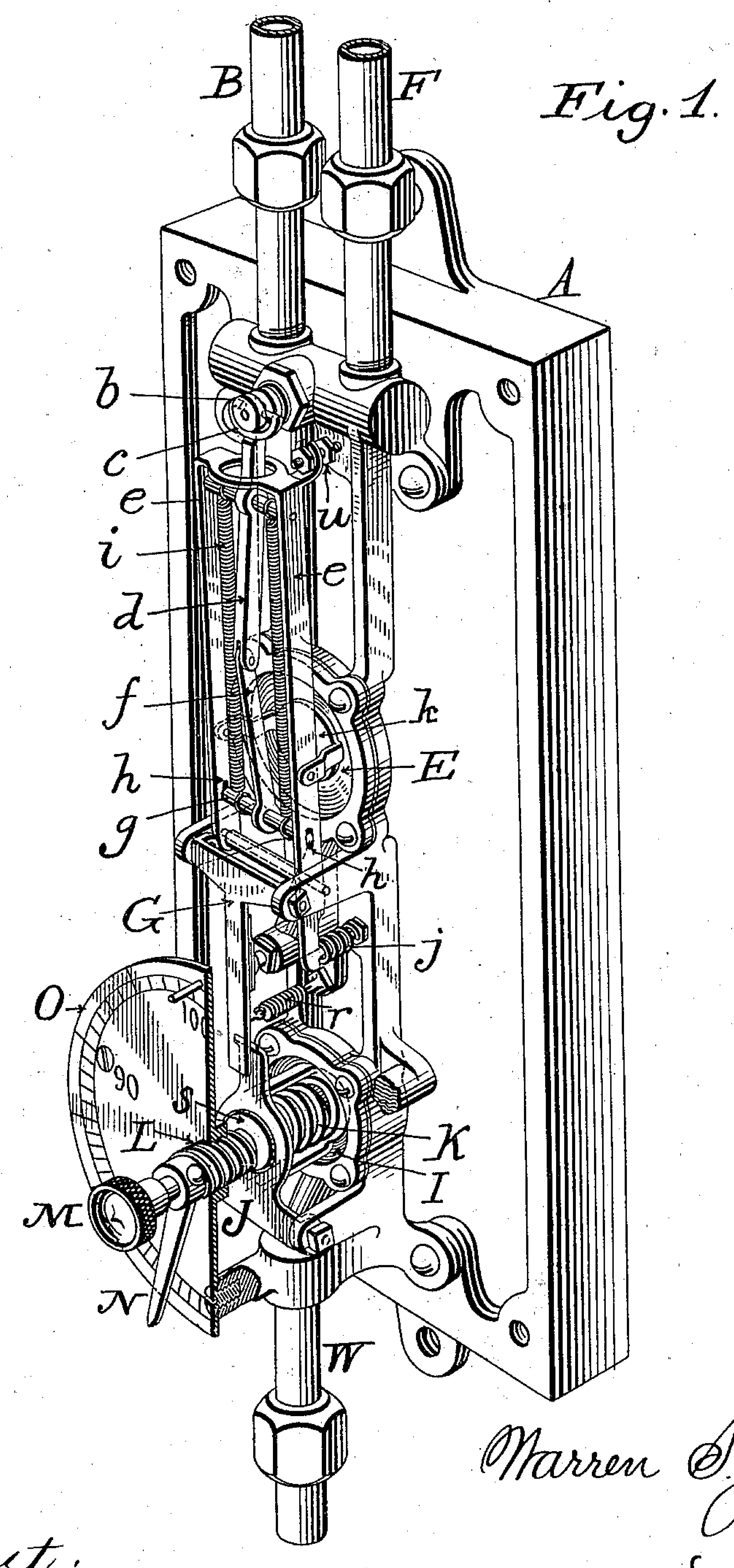
3 Sheets—Sheet 1.

W. S. JOHNSON.

PRESSURE REGULATOR.

No. 558,730.

Patented Apr. 21, 1896.



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(No Model.)

3 Sheets—Sheet 2.

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Fig. 2.

Fig. 3.

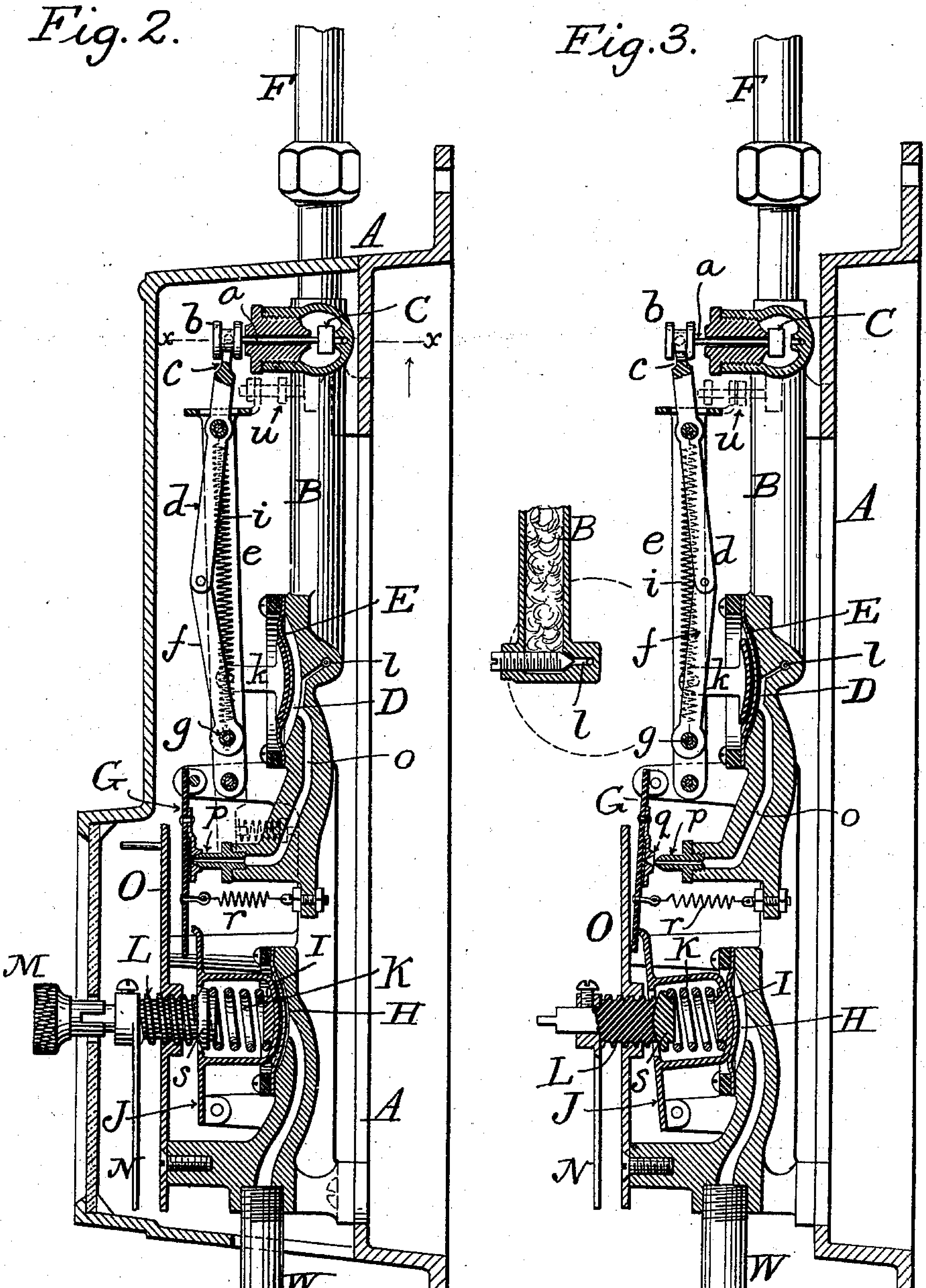

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Fig 4.

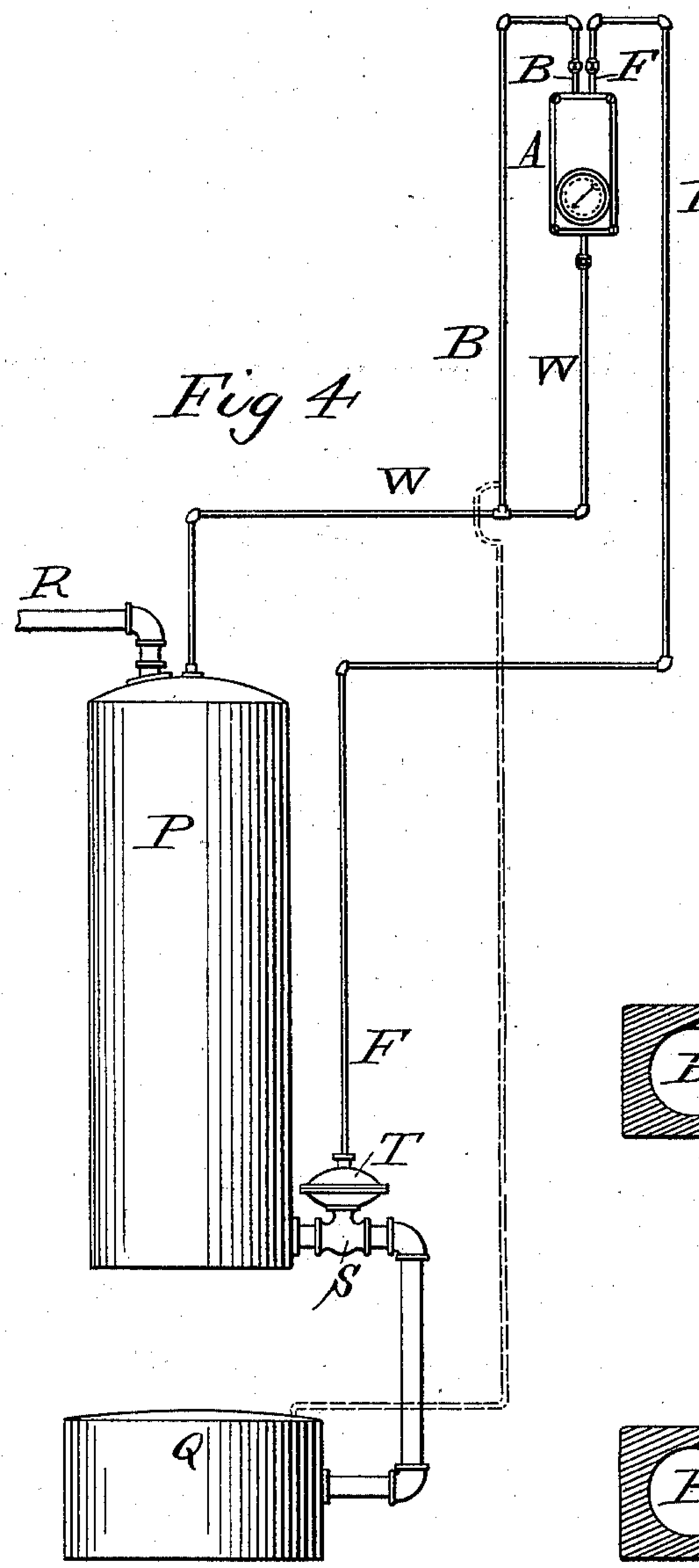


Fig. 5.

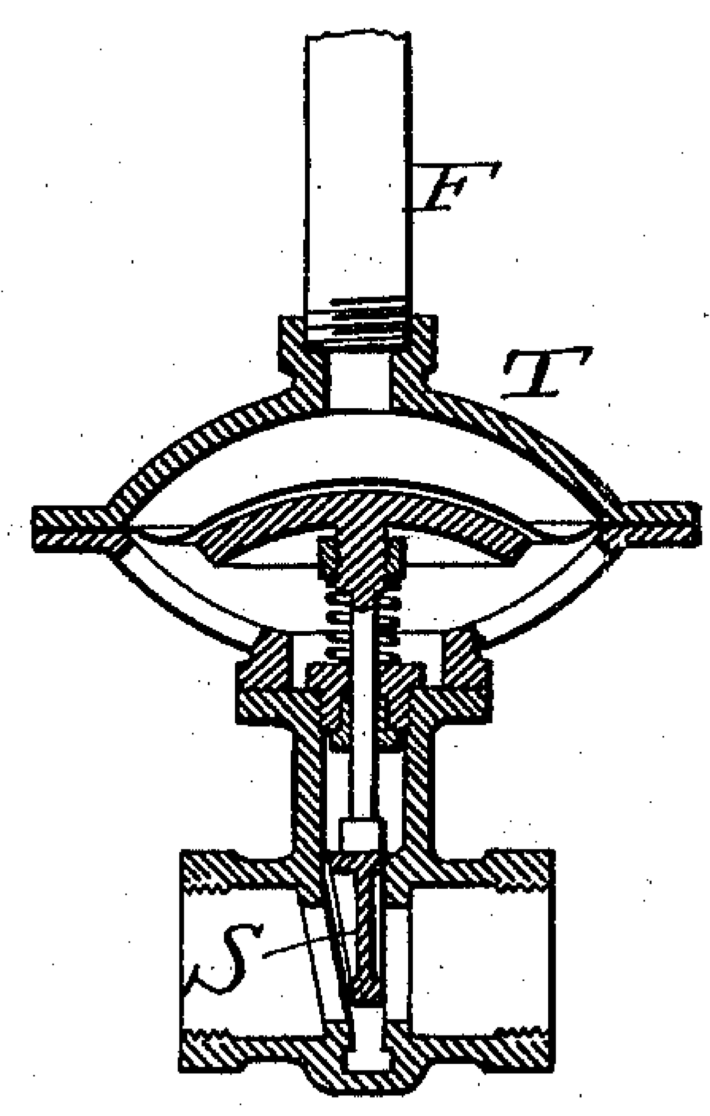


Fig. 6.

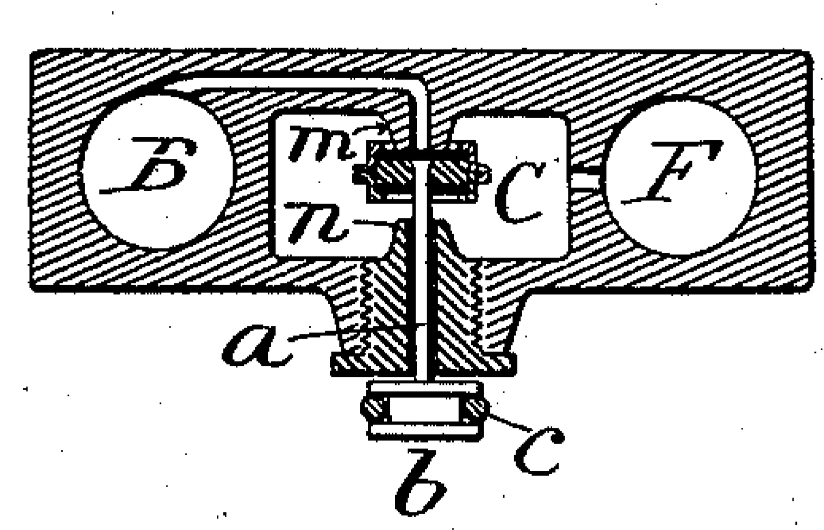
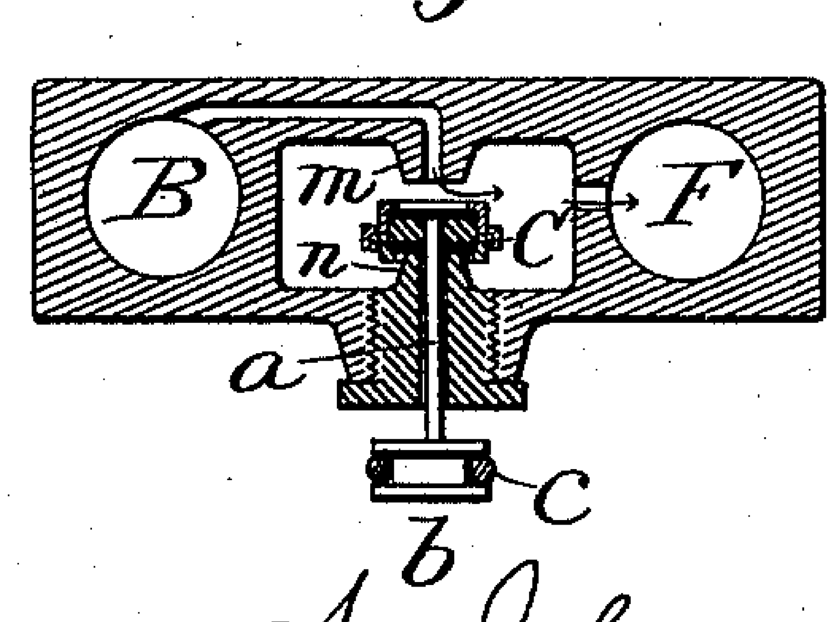


Fig. 7.



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UNITED STATES PATENT OFFICE.

WARREN S. JOHNSON, OF MILWAUKEE, WISCONSIN.

PRESSURE-REGULATOR.

SPECIFICATION forming part of Letters Patent No. 558,730, dated April 21, 1896.

Application filed October 22, 1895. Serial No. 566,570. (No model.)

To all whom it may concern:

Be it known that I, WARREN S. JOHNSON, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Pressure-Regulators, of which the following is a specification.

My invention relates to pressure-regulators; and it consists in various features, details, and combinations hereinafter set forth, whereby simplicity, efficiency, and promptness of action are united in a compact structure.

In the accompanying drawings, Figure 1 is a perspective view of the primary pressure-actuated device and the valve-controlling mechanism of a secondary pressure apparatus, by which latter a valve, vent, or pressure-controlling device is actuated; Figs. 2 and 3, vertical sectional views of the same, showing the parts in two different adjustments; Fig. 4, a diagrammatic elevation showing the complete apparatus as applied to a regulation of pressure in a tank or chamber; Fig. 5, a sectional view of the valve shown between the two tanks or chambers of Fig. 4; and Figs. 6 and 7, enlarged sectional views of the valve-chamber and valve of the secondary pressure apparatus on the line *x x*, Fig. 2.

The purpose of the invention is to provide a simple, compact, and efficient apparatus for regulating pressure and maintaining uniformity therein, and is applicable in a great variety of relations—among others, in pneumatic time systems.

Referring first to Figs. 1, 2, and 3, A indicates a suitable frame, upon which are mounted the operative parts of the pressure-gage and valve mechanism hereinafter described. B indicates a fluid-pressure pipe preferably supplied with compressed air, and F a delivery-pipe which may be thrown into or out of communication with pipe B by a valve C, the stem of which is shown in Fig. 1, while the entire valve is clearly shown in Figs. 2, 3, 6, and 7.

To the stem *a* of the valve C is applied a circumferentially-grooved head or button *b* to receive the inturned arms or studs of a fork *c*, formed on the upper end of a lever *d*, pivoted in a swinging frame *e*, which latter is supported in arms or brackets projecting from the frame A. The lower end of lever *d* is pin-jointed to a similar lever *f*, the lower end of which carries a cross-bar *g*, which is guided at its ends in slots *h* of swinging frame *e*. Two springs *i*, connected at one end with the pivot-bar of lever *d* and at the other end with the cross-bar *g*, tend constantly to elevate the cross-bar *g*, and thereby to bow or buckle the toggle formed by the members *d* and *f*.

As shown in Fig. 1, the swinging frame *e* has one side bar carried down below its pivot, and a spring *j*, interposed between the depending arm and the frame A, tends to throw said arm outward and thereby to swing inward the upper end of frame *e*. This action takes place whenever the spring *j* is unopposed by a greater force, and when the frame *e* is thus thrown inward the fork *c* of lever or member *d*, bearing in the grooved head *b*, causes the pivot pin or joint connecting the members *d f* to swing past the center, whereupon the springs *i*, drawing upward on the cross-bar *g*, bow the toggle to the right or in the direction indicated in Fig. 3. Thus when the frame *e* is thrown inward the fork *c* is thrown outward and draws the valve C away from its seat in the manner indicated in Figs. 3 and 7; but when the frame *e* is thrown outward the action is reversed, the toggle goes outward, as in Fig 2, and the valve C is forced against its seat, as shown in Figs. 2 and 6.

The frame *e* is forced and normally held outward by fluid-pressure entering through pipe B and passing down through a continuation thereof (shown in Figs. 1, 2, and 3) into an expansion-chamber D. The continuation of pipe B below the valve-chamber is packed with wool or other substance capable of filtering the air and completely excluding dust or other foreign matters which might otherwise be carried into the chamber D.

The communication with chamber D is controlled by a needle-pointed valve, as shown in the fragmentary view Fig. 2, and the adjustment is such that only a minute quantity of air can pass through said opening. Owing, however, to the comparatively high pressure of the air, it is found sufficient to force outward the flexible diaphragm E of said chamber D and to swing outward the frame *e* with which the diaphragm is connected through a yoke *k*, which latter has a rounded disk resting against said diaphragm.

Assuming now that the pressure-chamber D be closely sealed, with the exception of its inlet *l*, and that fluid-pressure be supplied to pipe B, the diaphragm E will be forced outward, as shown in Fig. 2, and the valve C will be forced to its seat, closing communication between the pipes B and F. So long as these conditions continue the valve C will remain closed and no fluid-pressure will pass beyond said valve.

When the valve C is thrown inward to close communication with pipe B, its inner face seats upon a nipple or valve-seat *m*, and when it is thrown outward or away from the nipple *m* it seats against a similar nipple *n*, thereby sealing the opening or discharge through which the stem *a* of the valve passes. When the valve is seated against the nipple *m*, a vent-opening is afforded around the stem *a*, through which fluid-pressure may escape from the pipe F.

As shown in Figs. 2 and 3, a passage *o* opens from the expansion-chamber D downward and terminates in a conically-pointed nipple *p*, the opening of which is materially larger than the opening *l*, through which air enters the expansion-chamber D.

Suspended from the arms in which the swinging frame *e* is mounted is a bar or plate G, carrying on its inner face a conically-socketed plate or washer *q*, between which and the bar G is placed a layer of leather, rubber, or other suitable material, preferably patent-leather, capable of effectively sealing the mouth of nipple *p*. The bar or plate G is normally drawn toward the nipple *p* by a spiral spring *r*, one end of which is attached to the frame A.

At the lower part of frame A is a second expansion-chamber H, having a flexible diaphragm I, against which latter bears the rounded face of a swinging lever or member J of the form shown in Figs. 1, 2, and 3. This lever, as shown in said figures, has a cup or yoke shaped portion projecting backward from the main bar of the lever, the rear or bottom portion of the cup forming a disk to bear against the diaphragm I and having a central boss to receive one end of a spiral spring K, by which the diaphragm is pressed back toward the rear or inner wall of the expansion-chamber.

The compression and consequent pressure of the spring K is adjusted, regulated, and controlled by an adjusting-screw L, provided with a milled nut or head M and with a pointer or indicator N, which moves over the face of a graduated dial O, as shown in Figs. 1, 2, and 3. The inner end of the screw L is made concave to receive the convex face of a block or button *s*, which is seated in the end of the spring K. By turning the head or button M the screw L may be forced inward to compress the spring or let back to allow its expansion, and the pointer N will indicate upon the dial the pressure required to overcome the resistance of the spring and to force outward the diaphragm I and lever J.

The upper end of lever J stands directly in rear of the plate or bar G and when forced outward carries before it said plate G, thereby unsealing the mouth of nipple *p* and permitting the escape of fluid from expansion-chamber D much faster than it can enter the same through the inlet-opening *l*. As a consequence of such venting of the expansion-chamber D, the spring K, Fig. 1, will throw the frame *e* inward, thereby unsealing valve C, as above explained, sealing the nipple *n* and permitting fluid under pressure to pass from the supply-pipe B to delivery-pipe F, whence it may be carried to any pressure relieving or reducing device desired.

Referring to Fig. 4, the action of the apparatus as applied to the regulation of pressure in an accumulator or fluid-pressure tank will be explained, this affording a convenient illustration.

P indicates a tank, reservoir, or chamber in which a uniform pressure is to be maintained, it being supplied by a pipe or connection from another tank or chamber Q, in which a materially higher pressure exists, or from any convenient source of supply. The tank Q is not a necessary part of the apparatus, but is merely shown for convenience of illustration and explanation. Hence P will be treated and referred to as the primary pressure-chamber. From the chamber or reservoir P a pipe or main R is carried to any apparatus to be actuated by fluid-pressure, as indicated.

W indicates a pipe, which connects chamber P with expansion-chamber H of the regulator, and from which supply-pipe B of the regulator branches, as shown.

S indicates a valve controlling the ingress of fluid under pressure to chamber P. It is provided with a fluid-pressure motor T, consisting of a chamber having a flexible diaphragm or other movable wall or member to be moved outward by pressure within the motor shell or chamber, and a spring for opening said valve whenever the pressure upon the diaphragm falls below that necessary to overcome the power which the spring is set or adapted to exert. This is a common type of device.

The fluid-pressure motor or chamber T is connected with the delivery or discharge pipe F of the regulator, as shown.

Assuming now that it be desired to maintain a constant pressure of, say, twenty pounds in the chamber P, and that the chamber Q or other supply will deliver fluid under a greater pressure, say, one hundred pounds, the action will be as follows: Whenever the inflow into chamber P exceeds the outflow through the the main R, the pressure in chamber P will rise above the normal twenty pounds for which the regulator is set or adjusted. The consequent pressure exerted in expansion-chamber H will overcome the resistance of spring K, rock the yoke or lever J, swing outward the plate or bar G, thereby venting expansion-chamber D, and permitting swinging frame *e* to move inward, thus causing fork *c* to move outward the valve C and to open communication between inlet-pipe B and outlet-pipe F. Fluid being thus permitted to flow into expansion chamber or motor T, will cause the diaphragm to move outward and to carry before it the stem of valve S, overcoming the power of the spring, which, in the absence of pressure in chamber T, holds the valve open. The valve will thus be closed and will so remain until the pressure in chamber P falls to or slightly below the predetermined limit, at which instant spring K will again overcome the fluid-pressure in expansion-chamber H, whereupon all the moving parts of the regulator will reverse positions, vent *p* will be sealed, pressure will be cut off from expansion chamber or motor T, and valve S will open to admit a supply of fluid under pressure.

In practice the regulation is found to be so close that there is scarcely a perceptible variation of the pressure in chamber P, an ordinary pressure-gage being incapable of indicating the minute changes to which the regulator responds.

It will be apparent that expansion chamber H must be in communication with the reservoir or chamber in which the pressure is to be regulated, but that it is immaterial whence the fluid-pressure for expansion chamber or motor D is derived. As a matter of convenience I have represented it as communicating with the reservoir P, but obviously it may be connected with reservoir Q or any other source of fluid-pressure as well. Such a connection is indicated by dotted lines in Fig. 4.

Suitable stops *u* are provided to limit the play of frame *e*, as shown in Fig. 1 and indicated by dotted lines in Figs. 2 and 3.

The pressure device, valve mechanism, dial, and pointer are advisably incased to protect them against injury, and a cover of glass or other transparent material is placed over the dial so that its face may be conveniently read. The milled head or button by which the screw is turned protrudes beyond the glass, as indicated.

For convenience of reference the chamber or reservoir P may be termed the "fluid-pressure" reservoir, chamber H the "primary" expansible chamber, chamber D the "secondary" expansible chamber, and chamber T the "tertiary" expansible chamber, and in speaking of chamber D as communicating with a fluid-pressure reservoir it is to be understood that it may be either the one just mentioned or any other, as above suggested.

It is obvious that instead of controlling a supply-valve the regulator may govern a waste valve or opening, the character of such devices being wholly immaterial to the present invention.

Having thus described my invention, what I claim is—

1. In combination with a fluid-pressure reservoir, a primary expansible chamber in communication therewith; a secondary expansible chamber in communication with a source of fluid-pressure and provided with a vent-opening; a valve adapted to normally seal said vent; a lever bearing against the movable wall or member of the primary expansible chamber and arranged to act upon the vent-valve; and a yielding device bearing against said lever and serving to hold it against a predetermined fluid-pressure in the primary expansible chamber, but adapted to yield when such pressure is exceeded; whereby excess of pressure is caused to move said lever and to unseal the vent.

2. The herein-described pressure-regulating apparatus, comprising the following elements in combination: a fluid-pressure reservoir; a primary expansible chamber in communication therewith; a source of fluid-pressure; a secondary expansible chamber in communication therewith and provided with a vent; a tertiary expansible chamber in communication with the secondary expansible chamber; a lever bearing upon the movable wall of the primary expansible chamber; a yielding device arranged to offer a predetermined resistance to the movement of said lever; a movable plate or bar provided with a seal for the vent of the secondary expansible chamber and arranged in the path of the lever of the primary expansible chamber; a valve interposed between the source of fluid-pressure and the secondary expansible chamber; connections between a movable member of the secondary expansible chamber and said valve; and a valve or equivalent device applied to the fluid-pressure reservoir and serving to control the pressure therein.

3. In combination with a fluid-pressure reservoir, as P, a primary expansible chamber H communicating therewith; lever J bearing upon the movable wall of chamber H; spring K bearing against said lever J; a source of fluid-pressure; secondary expansible chamber D provided with vent *p*; movable plate G provided with a seal to close vent *p*; supply-pipe B, connecting the source of fluid-pressure and chamber D; tertiary expansible chamber T; a valve connected with the movable wall or member of said chamber; pipe F communicating with chamber T; valve C interposed between pipes B and F; and connecting mechanism substantially such as shown and described, between valve C and the movable wall or member of expansible chamber D; whereby the admission and escape of fluid to and from expansible chamber T are permitted and controlled.

4. In combination with a fluid-pressure reservoir, as P; two expansible chambers D and

T; a valve-chamber provided with a vent opening to the atmosphere; a pipe connecting the reservoir with the chamber D and with the valve-chamber; a second pipe connecting the valve-chamber and the chamber T; and a double-acting valve located in the valve-chamber and serving to close the inlet-opening from the reservoir into the valve-chamber and to open the vent to the atmosphere; or to open the inlet from the reservoir and close the vent to the atmosphere, according to adjustment of the valves, substantially as and for the purpose set forth.

5. In combination with reservoir P, expansion-chambers D and T; pipes B and F connecting said reservoir and chambers; a valve-chamber interposed between said pipes and provided with nipples *m* and *n*; valve C adapted to simultaneously close one and open the other of said nipples; and valve-actuating mechanism substantially such as described and shown between the movable wall of chamber D and the valve C; whereby the valve is moved in accordance with the movements of said wall.

In witness whereof I hereunto set my hand in the presence of two witnesses.

WARREN S. JOHNSON.

Witnesses:
HORACE A. DODGE,
WILLIAM W. DODGE.