(No Model.)

G. F. KNOX.

FLUID PRESSURE REGULATOR.

No. 596,601. Patented Jan. 4, 1898.

Fig. 1.

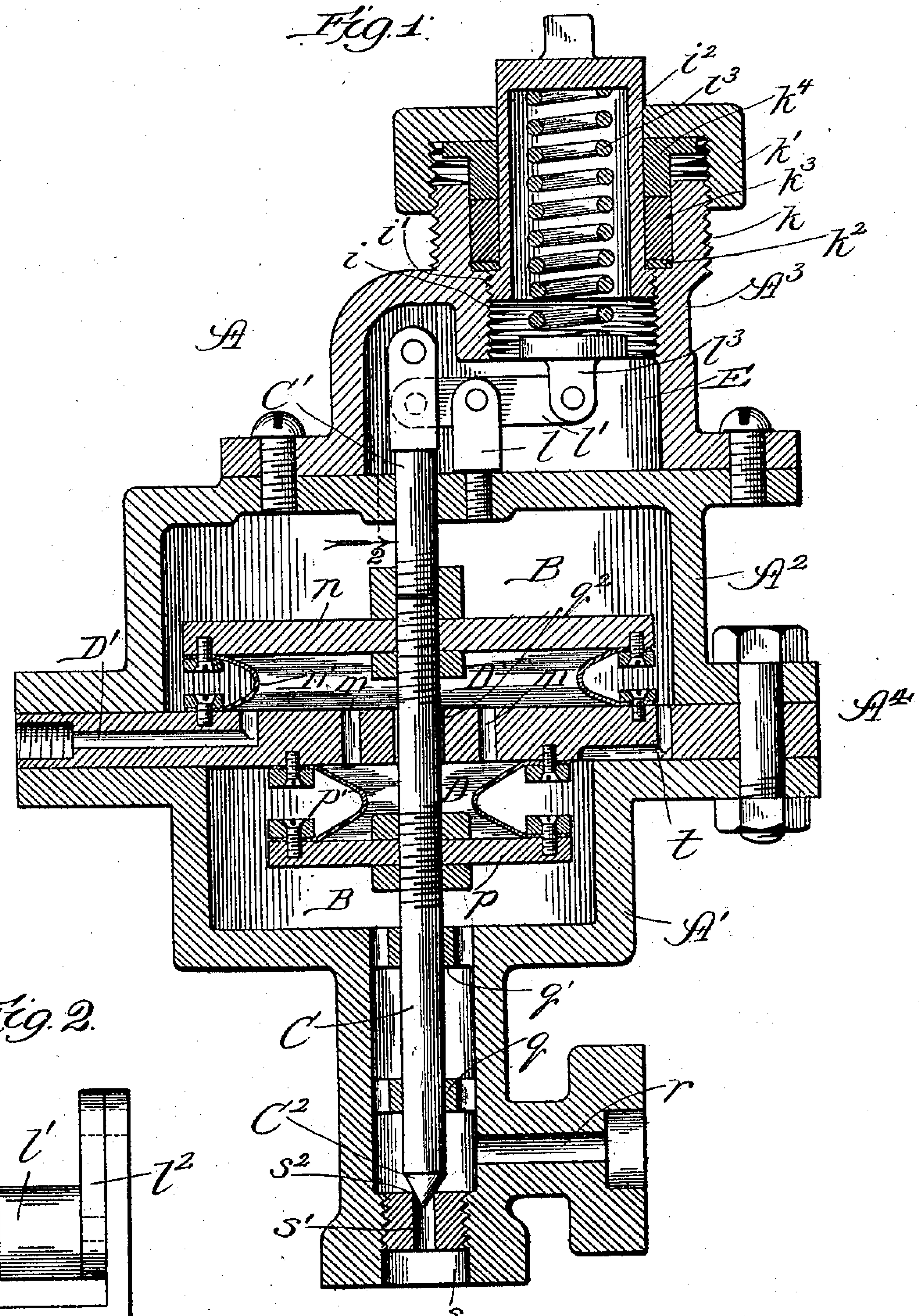
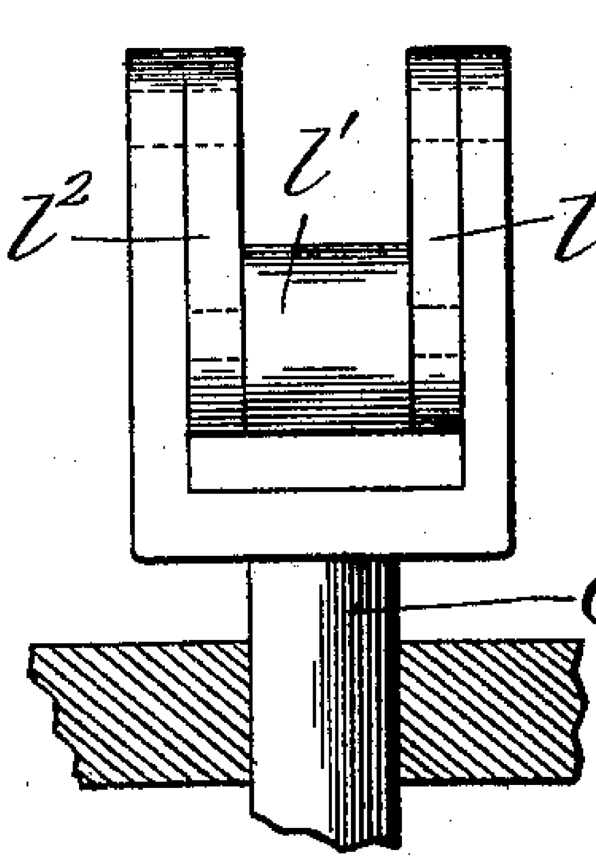


Fig. 2.



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UNITED STATES PATENT OFFICE.

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FLUID-PRESSURE REGULATOR.

SPECIFICATION forming part of Letters Patent No. 596,601, dated January 4, 1898.

Application filed February 26, 1897. Serial No. 625,086. (No model.)

To all whom it may concern:

Be it known that I, GEORGE F. KNOX, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in Expansion-Valves for Refrigerating Apparatus, of which the following is a specification.

My invention relates to improvements in valve devices for use in connection with refrigerating apparatus of the class employing anhydrous ammonia or a like refrigerating fluid and located between the liquid-refrigerant supplier and the expansion chamber or coil.

The apparatus of which my improved valve device is intended to form one of the details comprises, broadly stated, a mechanical compresser, a condenser, a liquid-refrigerant holder, and an expansion chamber or coil located in the room or compartment to be cooled. The compressor withdraws the return-gas from the expansion-coil, compresses it, and forces it through a condenser, where it is liquefied, into the liquid-holder, whence it is discharged through an expansion-valve device into the expansion-coil to produce the desired refrigerating effect and cool the compartment, the latter being a cold-storage or ice-making chamber, receptacle, or the like.

My object is to provide a particularly simple, durable, and sensitive expansion-valve which shall be readily adjustable to any desired pressure and which shall automatically regulate the flow of fluid from the liquid-holder to the expansion chamber or coil to maintain the pressure in the latter substantially uniform.

My object is, further, to provide the valve device with governing means actuated by the expansion and contraction of a fluid thermostatic column in the room or compartment being cooled to influence the action of the valve and thereby increase or diminish, according to the temperature desired, the standard of pressure in the expansion coil or chamber.

In the drawings, Figure 1 is a sectional view of my improved valve device, and Fig. 2 an enlarged broken section taken upon line 2 of Fig. 1.

A is the valve device, the shell of which, for convenience of manufacture, may be formed of three members A' A^2 A^3. In the shell is a chamber B, separated into upper and lower compartments by means of a stationary diaphragm A^4, which may, as shown, be a plate interposed between the shell members A' A^2. The upper and lower compartments are in open communication through one or more channels t. In the lower end of the shell member A' is an inlet-opening s, which in practice communicates with a pipe extending from the liquid-refrigerant supplier. Also in the said shell member is an outlet-port r, which in practice communicates with the expansion coil or chamber. At the opening s is a reduced inlet-port s', at its upper end affording a valve-seat s^2.

C is a stem movable through guides q q' in the shell member A' and through a guide-opening q^2 in the stationary diaphragm A^4. In the chamber B, below the diaphragm A^4 and rigidly fastened to the stem C, is a disk or plate p of comparatively small diameter, and rigidly secured to the said stem above the diaphragm A^4 is a disk or plate n of comparatively large diameter. Fastened to the disk p and adjacent under surface of the diaphragm A^4 is an annular spring p', formed, preferably, of spun steel and shaped in cross-section like a bellows-fold, as shown. An annular spring n', shaped in cross-section like the spring p', but of larger diameter, is interposed between and connected with the plate or disk n and adjacent upper surface of the diaphragm A^4. The springs p' n', plates p n, and diaphragm A^4 form two gas-tight compartments intercommunicating through openings m in the diaphragm, as shown, and forming together a chamber D, to which extends a port or passage D' through one edge of the diaphragm A^4. Firmly secured to the upper end of the stem C to form practically an integral part thereof is a stem member C', bifurcated at its upper end, as shown, and passing through a guide-opening at the top of the chamber B.

In the shell member A^3 is a chamber E. In the chamber E, in the position shown, is a lug l, upon which a lever l' is fulcrumed between its ends. At one of its ends the lever l' carries pivotal links l^2, which are pivotally connected with the bifurcated upper end of the stem member C', as shown in Fig. 2. Pivoted upon the opposite end of the lever l' is a head or bearing-plate l^3. The upper part of the shell member A^3 has an external thread k to receive a threaded cap k', and it is also internally threaded at i to receive the threaded end i' of an inverted tensioning-cup i^2. Confined in the cup i^2 and bearing against the bearing-piece l^3 on the lever is a spring i^3. The tension of the spring i^3 may be increased by screwing down the tensioning-cup i^2 and diminished by screwing the cup in the upward direction. Surrounding the cup in the upper part of the shell member A^3 is a washer k^2, and resting thereon is a packing-ring k^3. Fitting upon the packing-ring is a gland or tightening-ring k^4, which is pressed downward by the cap k'. The tendency of the spring i^3 and more or less of the springs n' and p' is to expand and resist contraction. Thus the downward pressure of the spring i^3 and the pressure of the spring n' tend to raise the stem C and plates or disks n p and maintain the valved end C^2 of the stem away from the seat s^2. The pressure of the liquid refrigerant entering at s, through the port s', also tends to lift the valve from its seat. The tendency of the spring p' may be in the direction of forcing the stem C and attendant parts downward, but the force of the springs i^3 n', supplemented by the fluid-pressure through the port s', tends to overbalance the resistance of the spring p' and hold the valve open for the entrance of refrigerating liquid through the port s'. As the liquid enters and expands in the refrigerating coil or chamber it also expands into the chamber B, and, owing to the channel or channels l, exerts pressure against both the plates or disks p and n. When the pressure in the coil or chamber B rises above a certain predetermined limit, the force against the large area of the plate n is sufficiently greater than the force against the small area of the plate p to overcome the resistance of the springs i^3 n' and the pressure against the valve to seat the latter. As no fluid will then enter through the port s' the pressure in the coil and chamber B falls and the valve will open again. As there is no stuffing-box at the stem C it moves without friction and is very sensitive. The resistance against closing of the valve may be regulated by turning the cup-piece i^2 to increase or diminish the tension of the spring i^3. Thus if it is desired that a greater pressure shall exist in the expansion-coil before the closing of the valve C the bearing-cup i^2 may be screwed downward to increase the tension of the spring. If it is desired that the valve shall be closed under a lower pressure in the expansion-coil, the tensioning-cup i^2 may be raised to diminish the tension of the spring. Thus the valve device may be regulated with great exactness to maintain a substantially uniform pressure in the expansion-coil.

To maintain an approximately even temperature in the cooling-chamber, in which the expansion-coil is located, it is common to provide thermostatic regulating means in connection with the expansion-valve, so that the quantity of refrigerating liquid which enters the expansion-coil may be limited or regulated as well according to the temperature of the cooling-chamber as by the pressure in the expansion-coil.

In my improved valve device it is intended that the port D' shall connect with a pipe passing through or located in the cooling-chamber, the said pipe and chamber D being filled with a fluid which expands and contracts readily under changes of temperature. The fluid forms a thermostatic column and should be so regulated in practice by quantity as to expand and exert a desired pressure in the chamber D whenever the temperature of the cooling-chamber rises above a predetermined degree. This pressure in the chamber D will exert itself against the inner faces of the plates n p, and, owing to the difference in area between the plates, it will tend to force the plate n upward and open the valve C^2. Presuming, for example, that it is desired to maintain a temperature of 30° Fahrenheit in the cooling-chamber, the fluid thermostatic column should be so regulated as to hold the valve open whenever the said temperature rises above 30° against a predetermined greater counter-pressure from the expansion-coil, in order that the standard of pressure in the latter for the time being may be raised to exert a desired greater refrigerating effect upon the cooling compartment or chamber.

The disks or plates n p, both secured to the valve-stem, as described, form together a differential movable diaphragm in the shell-chamber which operates to open and close the valve under variations of gas-pressure in the shell-chamber and avoids the use of a stuffing-box. In practice the springs p' n' may, if desired, be normally under little or no material tension and operate to hold the valve C^2 lightly closed or closed only with sufficient pressure to counterbalance the pressure of the liquid at the port s'. The spring i^3 may in practice be tensioned to hold the valve open with just the desired force which it is intended shall be overcome by the differential pressure against the movable diaphragm and cause closure of the valve when the pressure in the expansion-coil exceeds a certain normal predetermined standard. The thermostatic regulator feature is not essential to the working of the governing-valve, but when employed it operates merely under changes of temperature in the cooling-chamber to increase or diminish the resistance of the differential diaphragm against movement under the pressure from the expansion-coil. As the internal parts of the valve device, which should be of iron and steel, are exposed only to the refrigerating and thermostatic fluids, to the exclusion of air, the metals are free from all corroding influences and will last indefinitely.

While I prefer to construct my improvements throughout as shown and described, they may be variously modified in the matter of details of construction without departing from the spirit of my invention as defined by the claims.

What I claim as new, and desire to secure by Letters Patent, is—

1. In an expansion-valve for refrigerating apparatus, the combination of a shell or chamber having an inlet-port for the refrigerating liquid and an outlet-port for the gas, a valve, for opening and closing the inlet-port, having a stem in the chamber, a guide for the stem a spring tending normally to hold the valve open, and a differential movable diaphragm in the chamber carried by the stem and exposed on opposite sides to the gas-pressure in the chamber, to move and close the valve against the resistance of the spring under rise of said gas-pressure, substantially as and for the purpose set forth.

2. In an expansion-valve for refrigerating apparatus, the combination of a shell or chamber having an inlet-port for the refrigerating liquid and an outlet-port for the gas, a valve, for opening and closing the inlet-port, having a stem in the chamber, a guide for the stem a spring tending normally to hold the valve open, means for adjusting the tension of the spring, and a differential movable diaphragm in the chamber carried by the stem and exposed on opposite sides to the gas-pressure in the chamber, to move and close the valve against the resistance of the spring under rise of said gas-pressure, substantially as and for the purpose set forth.

3. In an expansion-valve for refrigerating apparatus, the combination of a shell or chamber having an inlet-port for the refrigerating liquid and an outlet-port for the gas, a valve, for opening and closing the inlet-port, having a stem in the chamber, a spring tending normally to hold the valve open, a stationary perforated diaphragm in the chamber having an opening through which the stem moves, plates of differential areas on opposite sides of the diaphragm and secured to the stem, and annular springs connecting the said plates respectively with the diaphragm, and forming with the plates a compartment within and insulated from the said chamber, the plates forming a differential diaphragm movable under gas-pressure in the chamber to close the valve, substantially as and for the purpose set forth.

4. In an expansion-valve for refrigerating apparatus, the combination of a shell or chamber having an inlet-port for the refrigerating liquid and an outlet-port for the gas, a valve, for opening and closing the inlet-port, having a stem in the chamber, a spring tending normally to hold the valve open, means for adjusting the tension of the spring, a stationary perforated diaphragm in the chamber having an opening through which the stem moves, plates of differential areas on opposite sides of the diaphragm and secured to the stem, and annular springs connecting the said plates respectively with the diaphragm, and forming with the plates a compartment within and insulated from the said chamber, the plates forming a differential diaphragm movable under gas-pressure in the chamber to close the valve, substantially as and for the purpose set forth.

5. In an expansion-valve for refrigerating apparatus, the combination of a shell or chamber having an inlet-port for the refrigerating liquid and an outlet-port for the gas, a valve, for opening and closing the inlet-port, having a stem in the chamber, a spring tending normally to hold the valve open, means for adjusting the tension of the spring, a stationary perforated diaphragm in the chamber having an opening through which the stem moves, plates of differential areas on opposite sides of the diaphragm and secured to the stem, annular springs connecting the said plates respectively with the diaphragm, and forming with the plates a compartment within and insulated from the said chamber, the plates forming a differential diaphragm movable under gas-pressure in the chamber to close the valve, and a passage extending from said inner compartment to the outside of the shell for connection with a fluid thermostatic column, substantially as and for the purpose set forth.

GEORGE F. KNOX.

In presence of—
R. T. SPENCER,
J. H. LEE.