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P. D. VAN VLIET

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THROTTLING VALVE FOR REFRIGERATION

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Fig. 1.

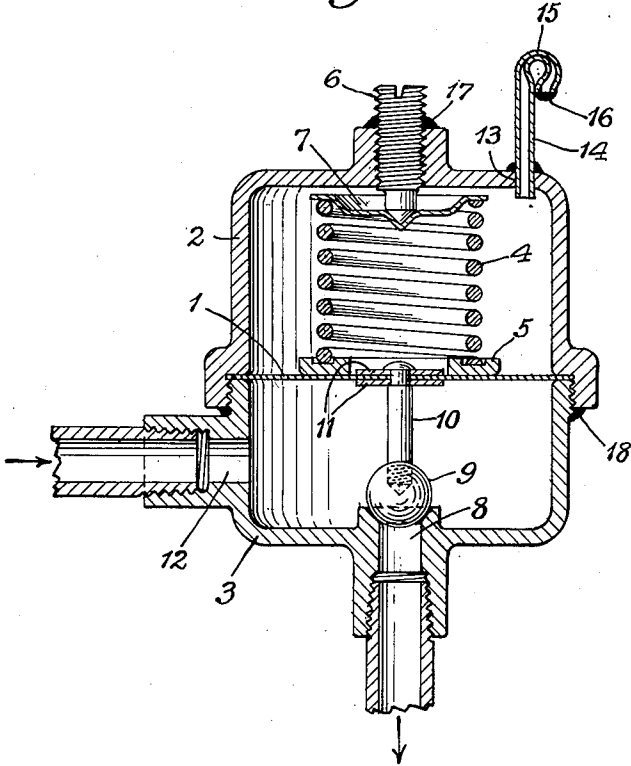
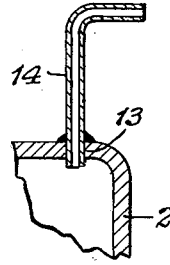


Fig. 2.



Inventor
Paul D. Van Vliet
by Parker & Luter
Attorneys.

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THROTTLING VALVE FOR REFRIGERATION

Paul D. Van Vliet, Chicago, Ill., assignor to Liquid Carbonic Corporation, Chicago, Ill., a corporation of Delaware

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5 Claims. (Cl. 137—510)

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My invention pertains to improvements in throttling valves for refrigeration use, of the type that maintains a constant evaporator.

One object of my invention is to increase the closeness of pressure control.

Another object is to prevent variation in controlled pressure with barometric pressure change.

Another object is to prevent variation in controlled pressure with valve body temperature changes.

Another object is to permit simple and rapid calibration by vacuum variation.

Another object is to reduce the differential between refrigerant temperature and the freezing temperature of water, thereby permitting a counter flow water cooler to deliver colder water.

Another object is to increase the temperature difference between refrigerant and water, thereby increasing the heat transfer rate.

My invention is applicable to a wide variety of constant pressure valve designs, using a flexible metal or rubber diaphragm, or a metal bellows, or its equivalent, and with the exit port closed by parts such as a movable needle or ball, or disc. In my description I have shown, for example, a valve with a metal diaphragm and a metal ball, closing the exit port, moving with the diaphragm. My invention is however applicable to any other diaphragm or bellows and any means for throttling at the exit port.

In refrigerating water to temperatures close to freezing, in structures which would be damaged by internal ice formation, it is necessary to control the refrigerant pressure closely, to prevent refrigerant temperature from going below 32° F. The commercial valves sold as constant pressure valves for this purpose are faulty. They include either a bellows or a diaphragm. Evaporator gas pressure is applied below and spring pressure above, with an adjusting screw to permit balancing spring pressure against evaporator unit pressure times the effective area of bellows or diaphragm. The diaphragm or bellows carries a needle or ball which seats over a vent orifice in the lower valve body, opening and closing as the diaphragm rises and falls. Another port into the body admits refrigerant gas from an evaporator to be held at a controlled pressure. Thus an increased evaporator pressure tends to lift the diaphragm, opening the valve and permitting gas

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to escape until the evaporator pressure is reduced to balance with spring pressure.

Refrigerant temperatures for several pressures are

	° F.
29 gage-----	30.8
30 gage-----	32.0
31 gage-----	33.1
32 gage-----	34.3
33 gage-----	35.5
34 gage-----	36.7

With a close regulating valve a pressure of 31 and a temperature of 33° F. would be desirable in the evaporator. But, since the space above diaphragm is air filled in the commercial valve, and not sealed, the pressure held on the evaporator will be at 31 only while used at a barometer reading identical with that at which the valve was calibrated. A low barometer due to weather change or use at a point of higher elevation will reduce the atmospheric pressure above the diaphragm, tending to open the vent port and reduce evaporator pressure and temperature. A valve calibrated to hold 31 at Detroit, elevation 500 ft., and average 29.42" barometer, may be used at Denver at 5000 ft. elevation and 25.6" barometer. The reduction of pressure would be 3.8" or 1.9 and evaporator pressure would be 29.1, with certainty of freezing. Since changing weather affects the barometer at any one elevation, the same dangerously low evaporator temperature may occur at times of low barometer due only to weather.

One method to prevent variations due to barometer changes is to seal the spring chamber. This, however, causes a variable air pressure above the bellows with changing valve body temperature. If the valve temperature under operating conditions is fixed, such a valve will give a fixed evaporator pressure. But, that condition will seldom occur on a refrigerating system. The variation may be 40° which would cause a change in occluded air pressure of 1.1 and an equal change in controlled evaporator pressure.

The invention covers the evacuation of air from the space above the bellows, and the sealing of this evacuated chamber, thus preventing change in evaporator pressure, whether by barometer or by valve body temperature change; but only carrying the vacuum to a point where

temperature change will have a negligible effect on evaporator pressure, thereby making it possible to make the final calibration by varying the vacuum until the desired safe evaporator pressure is obtained. This provides a simple and economic means of calibrating, and a valve safe to use at a setting very close to the pressure corresponding to 32° F.

Without this provision it is current practice for the installer of a water cooling system to reset a factory calibrated valve to compensate for the local elevation and for the minimum barometer change under standard due to weather. To do this he must have a correctly calibrated gage, and make a correction to its reading based on the current barometer reading, with a further allowance for the maximum reduction in barometer due to weather change. Practically this is impossible under installation conditions and a safe pressure is usually adopted, related to elevation, which results in the evaporator pressure being several degrees warmer than is permitted with the valve of my invention, in which the factory calibration is final for any altitude, weather or valve body temperature. Instead of a customary field adjustment to 34 pressure and 36.7° temperature, I am able to factory set at 31 or 33.1° temperature with certainty that this minimum pressure will be held at any altitude, weather or valve temperature condition.

With a refrigerant temperature 3 degrees colder, using my valve, the average temperature difference of refrigerant to water is increased, resulting in an increase in gallons per hour cooled, and a final water temperature 3 degrees colder in a counter flow cooler.

I illustrate my invention more or less diagrammatically in the accompanying drawings, wherein:

Figure 1 is an axial section;

Figure 2 is a detail illustrating a stage in adjustment.

Referring to Figure 1 a diaphragm 1 is sealed tightly between an upper casing 2 and a lower casing 3. A spring 4 applies pressure to the diaphragm 1 through an abutment ring 5 and may be adjusted for any pressure by a screw 6 through the centering disc 7.

In the lower casing 3 is an exit port 8 closed by a ball 9 which may be integral with a shaft 10, riveted to the diaphragm 1 with two discs 11 to spread the contact. An inlet port 12 admits gas from the evaporator where pressure is to be controlled.

In the upper casing 2 is a port 13 into which is secured a capillary tube 14.

In the calibrated valve, ready for use, the capillary tube 14 is pinched at 15 and solder sealed at 16. The adjusting screw 6 is soldered to casing 2 and upper and lower casings 2 and 3 are soldered as at 18. Where I speak of soldering, it will be understood that other suitable securing means may be used.

In Figure 2 the condition prior to calibration is shown, with capillary 14 open to a vacuum pump not shown. Other means may be used to permit evacuating casing 2 and sealing against reentry of air, the means not being a part of this invention.

A rigid analysis of all forces gives the following for a balanced diaphragm.

A¹—diaphragm or bellows net area (sq. in.) fixed

A²—Exit port net area (sq. in.) fixed

P¹—pressure to be controlled (p. s. i.) controlled

P²—suction pressure beyond valve (p. s. i.) variable

P³—occluded air pressure over diaphragm (p. s. i.) variable

W—spring force above diaphragm

$$P^1 A^1 = W + P^3 A' - P^2 A^2$$

The exit port area A² is in practice 2 to 3% of A¹ and variation in P² will cause relatively little effect on P¹. A reduction in P² will raise P¹, which increases safety against freezing.

P³ is variable with valve body temperature, but with an actual maximum variation of 40 degrees the maximum change in P³ is 0.1#, which is negligible.

The procedure to calibrate is in two steps, first with atmospheric pressure above the diaphragm. The capillary 14 is open to air as in Figure 2. The screw 6 is not sealed to the upper casing. The screw 6 is adjusted to give a value of P³ greater than 31# by the product of the decrease of occluded air pressure at evacuation times the diaphragm area. Then the seal 17 is made.

The second step is to attach the capillary tube 14 to a suitable vacuum source and evacuate until P³ is 31#. This will be between 27" and 29" hg., which are easily obtained vacuum limits. Capillary 14 is then pinched shut, cut off and sealed, for example, with solder. The specific means of sealing is not a part of this invention.

I find in practice that this procedure and means accomplish the results desired, as does no other valve available to the refrigeration industry. It maintains a practically fixed pressure on the evaporator, unaffected by barometer change or by valve body temperature change. The method of calibration is simple and rapid. Since the initial calibration is held under all operating conditions, it is possible to hold the refrigerant temperature close to the freezing temperature of water, which in a counter flow cooler permits delivering colder water, and with colder refrigerant the temperature difference to the water cooled is increased with an increase in heat transfer and cooling capacity.

Furthermore, the valve is safe even with loss of vacuum, since the effect of air entry is to raise the controlled pressure. Freezing cannot occur.

I have described my invention in connection with water cooling but I wish it to be understood that the valve is widely applicable where a close control of pressure is desirable and I have only described its application to a water cooler as a specific case where its value is apparent.

I wish my description and drawings to be taken as in a broad sense illustrative or diagrammatic, rather than as limiting me to the details of my showing herein.

I claim:

1. In a constant pressure valve, a housing, a flexible closure sealed to the walls of said housing and providing with said housing a closed spring chamber above said closure, said housing having inlet and outlet openings below said flexible closure and the chamber above said flexible closure being evacuated, a valve seat at the outlet opening, a valve carried by said flexible closure and movable towards said seat to close said outlet opening, a compression spring in said chamber urging said flexible closure towards said seat, said housing about said chamber being provided with an outlet passage through which said chamber is evacuated, and means for sealing said passage.

2. In a constant pressure valve, a housing, a

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flexible closure sealed to the walls of said housing and providing with said housing a closed spring chamber above said closure, said housing having inlet and outlet openings below said flexible closure and the chamber above said flexible closure being evacuated, a valve seat at the outlet opening, a valve carried by said flexible closure and movable towards said seat to close said outlet opening, a compression spring in said chamber urging said flexible closure towards said seat, means carried by said housing for adjusting the pressure of said spring, said housing above said chamber being provided with an outlet passage through which said chamber is evacuated, and means for sealing said passage.

3. In a constant pressure valve adapted for use with the evaporator of a refrigerating system, a housing provided with an inlet and outlet and having a valve seat at said outlet, a flexible closure sealed to the inner wall of said housing above said inlet and outlet and providing with said housing a closed evacuated chamber above said flexible closure, a valve carried by said flexible closure for movement towards said valve seat to close said outlet, a compression spring in said evacuated chamber normally urging said flexible closure towards said seat, a threaded member extending through said housing for adjusting the compression of said spring, said housing being provided with an outlet passage communicating with said chamber for the evacuation of said chamber, and means for sealing the passage about said threaded member and said outlet passage.

4. In method for setting a valve in a closed

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system in which a closed chamber is provided above a flexible closure and houses a spring urging the closure and a valve carried thereby toward a valve seat, the steps of compressing the spring to exert a force upon the flexible closure greater than that required to give the final valve setting, then evacuating the chamber above the closure to such a degree that the valve is brought to said final setting.

5. In a method for calibrating a valve to hold a desired fluid pressure in a closed system in which a closed chamber is provided above a flexible closure and a spring in said chamber urges the closure and a valve carried thereby downwardly to bring the valve toward a valve seat, the steps of compressing the spring to exert upon the flexible closure a force greater than that required to give the valve said desired final setting, and then evacuating and sealing the chamber above the closure to reduce the force upon said closure to such an extent that the valve is brought to said final setting

PAUL D. VAN VLIET.

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