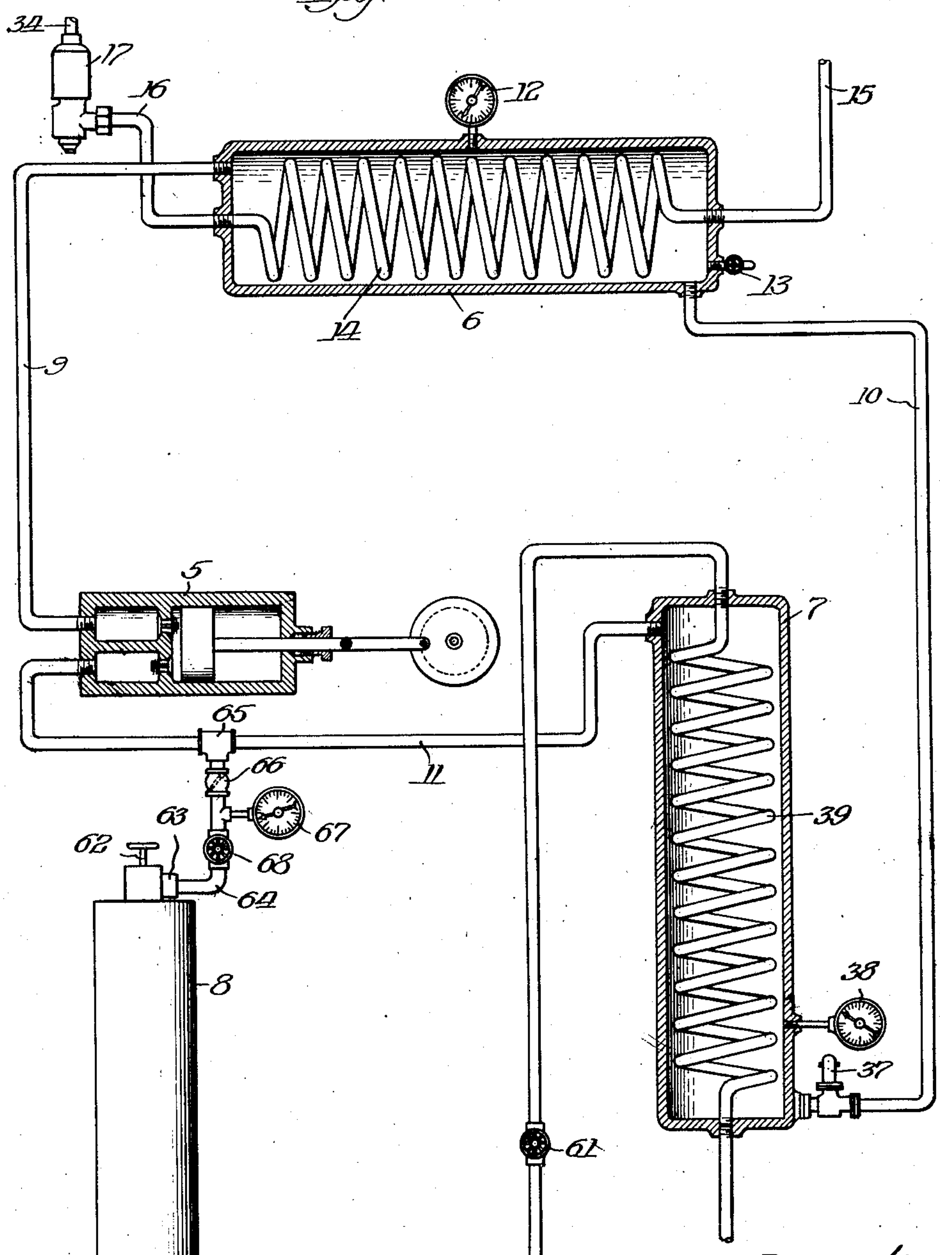
J. C. GOOSMANN.
REFRIGERATING APPARATUS.
APPLICATION FILED JAN. 24, 1921.

1,408,453. Patented Mar. 7, 1922.
2 SHEETS—SHEET 1.

Fig. 1.



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2 SHEETS—SHEET 2.

Fig. 4.

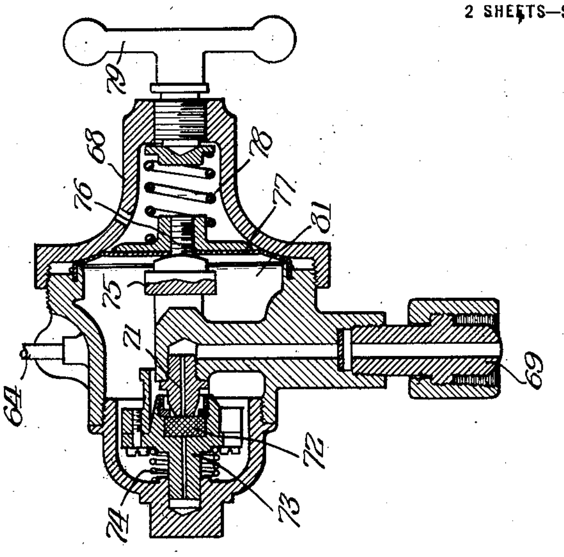


Fig. 3.

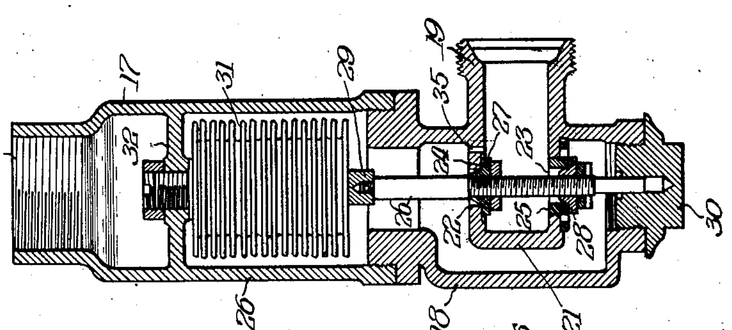
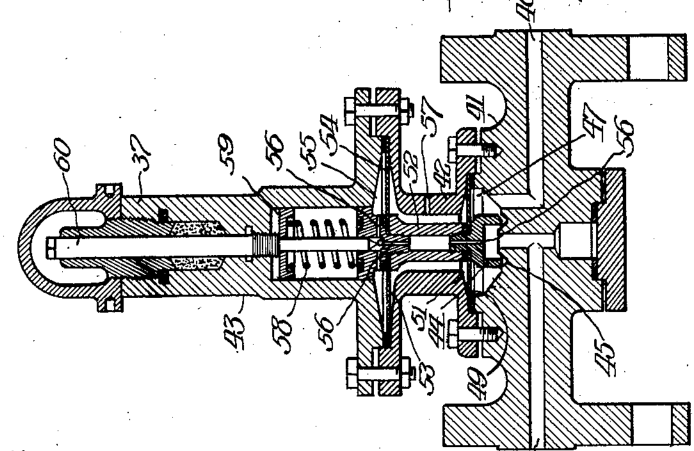


Fig. 2.



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UNITED STATES PATENT OFFICE.

JUSTUS C. GOOSMANN, OF PEORIA, ILLINOIS.

REFRIGERATING APPARATUS.

1,408,453. Specification of Letters Patent. Patented Mar. 7, 1922.

Application filed January 24, 1921. Serial No. 439,371.

To all whom it may concern:

Be it known that I, JUSTUS C. GOOSMANN, a citizen of the United States, residing at Peoria, in the county of Peoria and State of Illinois, have invented new and useful Improvements in Refrigerating Apparatus, of which the following is a specification.

This invention relates in general to refrigerating apparatus, and more particularly to the compression type, the present application being a continuation in part of my copending application, Serial No. 127,365 filed October 24, 1916.

In the use of refrigerating systems embodying apparatus of this character, it is highly desirable to maintain a substantially uniform, predetermined temperature of the evaporator or cooling element, which is either placed directly in the room or chamber to be cooled, or as is more usually the case, it is equipped with coils forming part of a circulating system through which brine or other cooling medium is circulated, to maintain the desired temperature in the compartment to be cooled.

In order to maintain a substantially predetermined temperature of the cooling element, irrespective of the amount of work being done, or in other words, irrespective of the number of heat units being absorbed and removed by the refrigerating system, it is desirable that the expansion valve between the condenser and the evaporator possess a certain amount of range or flexibility in its operation in order that more or less refrigerating medium may be passed through the evaporator, and furthermore, since the most satisfactory operation of the system involves the maintenance of a predetermined pressure ratio between the condenser and evaporator sides of the system, one of the primary features of my present invention resides in the provision of an automatically operated expansion valve which is adapted to produce and maintain a predetermined ratio of pressures between the condenser and the evaporator.

Assuming that the system is charged with the requisite amount of refrigerating medium such as CO_2 for instance, and that the compressor operates at a uniform speed, the pressure and temperature of the refrigerating medium on the condenser side of the expansion valve is controlled by the rate of cooling and condensation of the refrigerating medium in the condenser. For the purpose of producing and maintaining a substantially uniform temperature and pressure of the refrigerating medium in the condenser, my invention contemplates the employment of an automatic thermostatically-controlled valve by which the amount of water or other cooling medium supplied to the condenser is regulated and controlled so as to reduce the refrigerating medium in the condenser to the required temperature and pressure.

Since there is in refrigerating apparatus of this character an inevitable leakage of the refrigerating medium from the system, which of course, results in a decreased pressure, and an inefficient operation, my present invention aims to maintain the requisite pressure in the system by automatically supplying additional refrigerating medium, to compensate for that lost, whenever the pressure in the system falls below a predetermined point.

While I am aware that it has heretofore been proposed to deliver additional refrigerating medium into a system of this character for the purpose of compensating for loss by leakage, the supplying of this additional refrigerating medium of the low or evaporator side of systems heretofore employed does not remedy the difficulty, for the reason that with a set expansion valve, the pressure on the evaporator side may be below that which is desirable, while at the same time, the pressure on the high or condenser side may be greater than that which is desired. This condition may result from an insufficient opening of or through the expansion valve, which of course, assuming a constant speed of the compressor, unbalances the system so that the pressure is too high on the high side and too low on the low side, and this condition is not improved in the least by adding more refrigerating medium on the low side as has previously been done, but on the contrary, the difficulty is magnified some times to the extent that a dangerously high pressure is produced in the condenser side of the system.

Since my present invention embodies an automatic control which maintains at all times a predetermined ratio of pressures between the low and the high sides of the system, it will be manifest that additional refrigerating medium is never admitted to the system until the pressure throughout the entire system is below that required for efficient operation, and when this point is reached, additional refrigerating medium is delivered into the system to compensate for the loss and thereby restore the whole system to the desired pressure, but with no danger of creating an undesirable or dangerously high pressure in the high side of the system.

My invention therefore contemplates an automatically governed and controlled system in which additional refrigerating medium is delivered to the system to compensate for loss by leakage whenever the pressure in the whole system falls below a predetermined point, the provision of an automatic control by which a predetermined ratio of pressures is at all times maintained between the high and low sides of the system; and the provision of an automatic thermostatically-controlled device by which the temperature and consequently, the resultant pressure of the refrigerating medium in the condenser side are automatically maintained within substantially uniform limits.

For the purpose of facilitating an understanding of my invention and its mode of operation, I have illustrated on the accompanying drawings one preferred embodiment thereof, from an inspection of which when considered in connection with the following description, my invention and many of its inherent advantages should be readily understood and appreciated.

Referring to the drawings:

Fig. 1 is a somewhat diagrammatic illustration, partially in section, of a refrigerating apparatus embodying my invention;

Fig. 2 is a longitudinal, secional view through the automatic expansion valve;

Fig. 3 is a similar view through the device which automatically controls the temperature of the condenser; and

Fig. 4 is a similar view through the valve which automatically controls the admission of additional refrigerating medium into a system.

Referring now to the drawing more in detail, and particularly to Fig. 1 thereof, the compressor, which may be of any preferred construction but is herein illustrated as a single cylinder reciprocatory type, is indicated by reference character 5. 6 indicates the condenser, 7 the evaporator or cooling element, and 8 a reserve tank of refrigerating medium under pressure, such for instance as a drum of commercial CO_2. The compressor, condenser and evaporator are connected in series in a closed circuit, as is customary, by piping, the line leading from the compressor to the condenser being indicated by reference character 9, that from the condenser to the evaporator by 10, and that from the evaporator back to the compressor by 11. The condenser, which may be of the usual drum type equipped with a pressure gauge 12 and a blowoff cock 13, is customarily provided with the cooling coils 14 arranged within the drum in spiral formation so as to expose sufficient cooling surface to the surrounding refrigerating medium, the inlet end 15 of the coil being connected with any suitable source of cooling liquid or the like, such as water, and the delivery end 16 being equipped with a thermostatic controlling element indicated generally by reference character 17 by which the temperature of the coil 14 is automatically controlled.

While any type of controlling element capable of performing the desired functions may be employed, I have found that the element shown in Fig. 3 on an enlarged scale is well suited to the requirements of the present system. This element comprises a lower casing or body 18 provided at one side with an inlet nipple 19 to which the end of the pipe 16 leading from the condenser coil is attached by an ordinary coupling nut. The inner end of this nipple is closed, as indicated at 21, and its top and bottom walls are provided with alined openings 22 and 23 respectively, either shaped to provide a valve seat as indicated at 24, or equipped with a removable valve seat as shown at 25. A stem 26 projects upwardly through these valve openings and is threaded to carry the valves 27 and 28 which are adjustably mounted on the stem to seat against the seats 24 and 25 respectively. The lower end of the stem 26 is guided in a plug 30 through which the valve stem is introduced into position, and its upper end is connected at 29 with a sylphon 31 suspended at its upper end from a spider 32 extending transversely of the casing 23 threaded onto the upper end of the body 18. The upper end 33 of the casing is threaded for connection with the delivery pipe 34. The sylphon is of usual construction, adapted to expand and contract longitudinally under the influence of variations in temperature in the surrounding cooling medium flowing through the casing 26, and as will be apparent, expansion of the sylphon moves the valves 27 and 28 away from their respective seats, thus permitting an increased flow through the cooling coil 14, and contraction of the sylphon closes the valves. In order that the sylphon may be continually under the influence of the cooling medium from the coil 14 irrespective of whether the valves 27 and 28 are open or closed, the nipple is provided with one or more bleed passages 35, permitting a restricted flow from the coil past the sylphon even when the valves are closed.

Assuming that a predetermined minimum temperature is required in the condenser, the valves 27 and 28 are adjusted and set on the stem so that they will close when the sylphon is subjected to water or other cooling medium at this desired temperature. With the valves in closed position, a small quantity of the cooling medium will flow through the passage 35 to influence the sylphon and when the system is put in operation, the increase in temperature of the refrigerating medium delivered from the compressor to the condenser will raise the temperature of the cooling medium delivered from the coil with the result that the sylphon will expand, thus opening the valves and permitting an increased flow of cooling medium through the coil to reduce the temperature of the condenser. The greater the temperature in the condenser, the more the valves will be open and the greater the flow of cooling medium to counteract the rising temperature, and the result is that under normal operations, a balance will be reached between the temperature of the refrigerating medium delivered from the compressor and the quantity of cooling medium flowing through the coil, so that as the result of the exchange of temperature through the coil, the refrigerating medium will be delivered from the condenser at the predetermined desired temperature and consequently, at substantially a uniform pressure.

After flowing from the condenser through the pipe line 10, the refrigerating medium is delivered to the evaporator or cooling element 7 through an automatically controlled expansion valve 37, the structure of which will be later explained. The evaporator may be of any preferred construction, but I have shown, for purposes of illustration one of the drum type equipped with a pressure gauge 38 and provided with a coil 39 which is included in a brine circulating system through which the brine or other cooling medium circulates, absorbing heat from the articles or compartment to be cooled and giving up its heat in the coil 39 to the surrounding refrigerating medium which has been delivered through the expansion valve 37.

This expansion valve, shown in detail in Fig. 2 comprises a body 41 equipped with flanges adapted to be coupled in the pipe line 10, a diaphragm casting 42, and a bonnet 43. The valve itself, indicated by 44, is adapted to cooperate with a valve seat 45 formed on the body 41. The passage 46 communicates with the pipe line 10 and with the chamber 47 surrounding the valve 44 while discharge from the valve is delivered through passage 48 into the evaporator drum. Communication between the passages 46 and 48 is controlled, as will be apparent, by vertical movement of the valve relatively to its seat 45.

The chamber 47, within which the valve 44 is disposed, is closed at its upper end by a diaphragm 49 of relatively small diameter. The diaphragm casting 42 being countersunk on its lower surface to provide the upper portion 51 of the chamber for the diaphragm 49, the diaphragm is clamped at its periphery between the top of the body 41 and the bottom of the casting 42, and is centrally secured to the hollow valve rod 52 of the valve 44. The upper portion 51 of the diaphragm chamber communicates through the hollow casting 42 around the valve stem 52 with the lower portion 53 of a diaphragm chamber in which is disposed a diaphragm 54, the area of which is three times that of the diaphragm 49. The bottom of the bonnet 43 is countersunk to provide the upper portion 55 of the chamber for the diaphragm 54. This diaphragm is clamped at its periphery between the top of casting 42 and the bottom of the bonnet 43, and is also centrally secured to the valve rod 52. A passage 56 extends centrally through the valve to a point above diaphragm 54 and thence laterally into the upper portion 55 of the chamber above the diaphragm 54.

The low pressure of the evaporator 7 communicates directly with the upper side of diaphragm 54 at all times while the high pressure of the condenser is in constant communication with the lower side of the small diaphragm 49. The space between the exterior of valve rod 52 and the surrounding casting communicates with the atmosphere through a port 57. The relative areas of diaphragms 54 and 49 being approximately three to one and valve 44 being free to move in response to a differential of pressures exerted upon diaphragms 49 and 54, the pressure in conduit 46 will always be three times the pressure in conduit 48. This relative pressure may be varied by adjusting the tension of a spring 58 interposed between the top of valve rod 52 and a sliding block 59 mounted for vertical adjustment in the bonnet by means of an adjusting rod 60. It will be manifest, therefore, that with the parts proportioned as shown and described, a predetermined ratio of pressures will always be maintained between the condenser and the evaporator since when the condenser pressure exceeds three times the evaporator plus the resistance to movement to valve 44 offered by the spring 58, the valve will be open and pressure will flow to the evaporator until the predetermined ratio of pressures has been re-established. The circulation of brine or other cooling medium through the coil 39 may be controlled and shut off when desired by a hand valve 61 interposed in the circulating line.

As more or less leakage of the refrigerating medium inevitably occurs in the operation of an apparatus of this kind, I have made provision for replenishing the loss by automatically delivering to the system a quantity of refrigerating medium whenever the pressure in the system falls below a predetermined point. While the auxiliary supply may be connected to the system at any point, I prefer to connect it to the low pressure side so that more of the medium contained under pressure in the supply drum may be used than would be the case were it attached to the high pressure side of the system. A supply of refrigerating medium such as CO_2 is contained in the drum 8, which is equipped with the usual shutoff valve 62, the drum being equipped with a connection or head 63 adapted to be attached to a pipe 64, which in turn is connected by a T 65 with the low pressure line 11 leading from the evaporator to the compressor. In order to prevent the refrigerating medium from backing up from the line into the container 8 in case of leakage or in the event that the pressure in the container should drop below that in the line, I prefer to interpose in the pipe 64 a check valve 66, and for purposes of determining the amount of pressure in the container, the pipe 64 is preferably equipped with a pressure gauge 67.

The flow of refrigerating medium from the container into the line 11 is controlled by a pressure valve 68, shown in detail in Fig. 4. This valve comprises a casing, the intake end 69 of which is connected to the pipe 64 just above the elbow, and the delivery side is formed by a continuation of the pipe 64 attached to the upper side of the casing. A stationary nozzle 71 communicates with the intake side of the casing and this nozzle is closed by a seat or gasket 72, carried in a yoke 73 and normally urged into seated relation with the nozzle by an expansion spring 74. The upper end 75 of the yoke is connected by a screw bolt 76 with a diaphragm 77 and a spring 78, the tension of which may be regulated by a hand wheel 79, normally tends to force the seat 72 away from the nozzle to open the valve. When the pressure in the chamber 81 beneath the diaphragm is sufficiently great, the diaphragm is flexed upwardly against the force of the spring 78, thereby closing the valve and shutting off flow of refrigerating medium from the supply container 8 to the line. Should the pressure in the line 11 drop below a predetermined point for which the valve is set, the combined pressure of the medium acting through the nozzle against the seat 72 and the action of the spring 78 open the valve, permitting a flow of refrigerating medium from the container 8 into the line 11 until the pressure therein has been raised to the predetermined point under which the valve will again be seated, and further flow thereby shut off.

Since the pressures on the high and low side of the system are maintained at the predetermined ratio by the valve 37, and since the temperature and consequently, the pressure of the medium on the high or condenser side is maintained substantially constant by the thermostatically controlled device 17, and since the pressure in the whole system is maintained up to a predetermined point by the automatic replenishment from the container 8, the apparatus is therefore entirely automatic in its operation, and not only maintains a predetermined refrigerating temperature, but the system also possesses automatic flexibility, enabling it to take care of increased work in accordance with the demands. Furthermore, the automatic balancing of the pressures on the high and low sides of the system obviates any danger of a dangerous accumulation of pressure on the high side which is liable to occur in a system which provides for automatic replenishment but not for automatic balancing of the pressures.

It is believed that my invention, its mode of operation, and many of its inherent advantages will be understood from the foregoing without further description, and while I have shown and described a preferred embodiment of the invention, it should be understood that the details of construction which have been shown and described for purposes of illustration merely are capable of considerable modification and variation without departing from the essence of the invention as defined in the following claims.

I claim:

1. In a refrigerating apparatus, the combination of a compressor, a condenser and an evaporator connected in series in a closed circuit, and means for automatically maintaining a predetermined pressure in both the condenser and evaporator sides of said circuit.

2. In a refrigerating apparatus, the combination with a compressor, a condenser and an evaporator connected in series in a closed circuit, of a supply of refrigerating medium under pressure, and pressure-controlled means for maintaining a predetermined pressure in the complete circuit, said means including a device for automatically delivering to said circuit from said supply a quantity of refrigerating medium upon reduction of pressure in said circuit below a predetermined point and means for maintaining a predetermined pressure ratio between the high and low sides of the circuit.

3. In a refrigerating apparatus, the combination with a refrigerating system comprising a compressor, a condenser and an evaporator connected in series, of means for maintaining a predetermined ratio between the pressures in the condenser and evaporator sides of said circuit, and means for automatically supplying a refrigerating medium

to the system to compensate for leakage and thereby maintain a predetermined pressure in said entire system.

4. In a refrigerating apparatus, the combination of a compressor, a condenser and an evaporator connected in series, and means interposed between said condenser and said evaporator for automatically maintaining a predetermined ratio between the pressures in said condenser and in said evaporator.

5. In a refrigerating apparatus, the combination of a condenser, an evaporator, a connection between the same, and means for controlling the flow of a refrigerating medium through said connection so as to automatically maintain a predetermined ratio between the pressure in said condenser and the pressure in said evaporator.

6. In a refrigerating apparatus, the combination of a compressor, a condenser, an evaporator, means for maintaining a predetermined pressure ratio between the evaporator and condenser, and means for automatically maintaining a predetermined temperature in said condenser.

7. In a refrigerating system, comprising a compressor, a condenser and an evaporator connected in series, the combination of means for automatically controlling the temperature of the condenser, means for automatically maintaining a predetermined ratio of pressures between the condenser and the evaporator, and means for automatically maintaining a predetermined pressure in said system.

8. In a refrigerating apparatus, the combination of a compressor, a condenser, an evaporator, means connecting said elements in series, means interposed between the condenser and evaporator for maintaining a predetermined ratio of pressures between said elements, pressure-controlled means for automatically replenishing the apparatus with a refrigerating medium, and temperature-controlled means for automatically controlling the temperature of the refrigerating medium in said apparatus.

9. In a refrigerating apparatus, the combination with a compressor, a condenser, an evaporator requiring a given pressure, and piping connecting said elements in series, of a source of supply of refrigerating medium at high pressure, a conduit providing communication between the source of supply and the pipe connecting said evaporator and compressor, and a pressure regulated valve controlling passage of medium through the conduit, said valve being set to open only when the pressure between it and said pipe falls below that required in the evaporator.

JUSTUS C. GOOSMANN.