

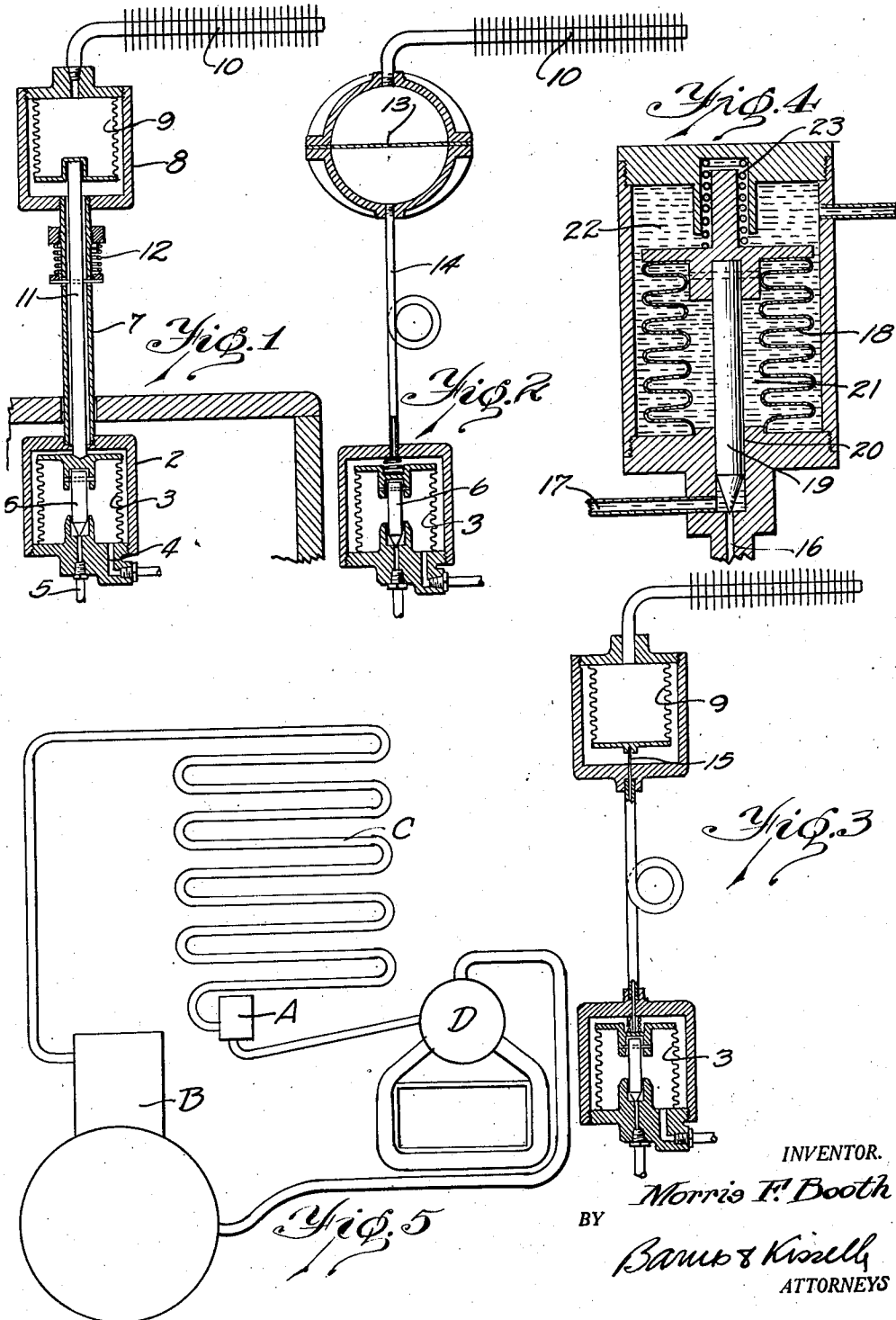
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DIFFERENTIAL PRESSURE CONTROL

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DIFFERENTIAL PRESSURE CONTROL

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This invention relates to a differential pressure control, and has to do particularly with a novel control for unloading a condenser and predetermining the effective head pressure in a refrigerating system.

The main object of the present invention is the elimination of the high side or low side float in refrigerating systems of the flooded type and substituting therefor a control for unloading the condenser into the lowside at a predetermined pressure which is directly proportioned to the temperature existing around the condenser or the control unit as the case may be.

Another feature resulting from the embodiment of the present invention is the elimination of the excessive head pressure in starting up a warm machine.

Still further features reside in the maintenance of a constant level in the cooling unit; the optional elimination of a receiver; the use of a relatively small amount of liquid in the condenser.

Other novel features reside in the combination of a novel oil return system for use with my high side control and other details of construction and operation as will be more clearly brought out in the specification and claims.

In the drawing:

Fig. 1 is a diagrammatic illustration showing the manner of connecting my control unit in a standard refrigerating system.

Fig. 2 is an enlarged sectional view of my control unit.

Fig. 3 is a view similar to Fig. 2, but illustrating a slightly modified form of the unit wherein liquid is the motion transmitting means instead of a rod as in Fig. 2.

Fig. 4 is an enlarged view similar to Figs. 2 and 3 but showing a modified manner of transmitting the movement of one bellows member to the other.

Fig. 5 is an enlarged fragmentary view illustrating the preferred manner of controlling the oil return from a lowside equipped with my novel control unit.

In the preferred form my control unit consists of a housing 2 enclosing a bellows member 3. The end of the housing is provided with a port 4 leading from the high side and an outlet port 5 leading to the lowside. A needle valve 6 controls the admission of a refrigerant from within the bellows member to the lowside outlet.

A tube 7 forms the connecting means between the housing 2 and a remotely positioned housing 8 and this housing 8 encloses a second bellows member 9 which is in direct communication with

a conduit or bulb 10 of relatively large surface area. A rod 11 connects the two bellows members and also controls the actuation of the valve 6.

In preparing the refrigerating system for operation, the air is preferably exhausted therefrom and the required amount of refrigerant placed in the cooling unit. Upon opening up the service valve in the usual manner, the machine being "warm", the compressor will start in response to whatever control might be used. It will be understood here that the operation of the compressor may be regulated by a pressure or temperature control in the ordinary manner.

If SO_2 is the refrigerant used in the refrigerating system I prefer to use SO_2 in the second bellows member, but I may use methyl chloride in the bellows member 9 and in the tube 10. The amount of pressure of methyl chloride is substantially identical numerically with the surrounding room temperature Fahrenheit and will increase or decrease accordingly, as the room temperature is varied. The pressure of SO_2 runs about ten pounds below the existing room temperature. In any case it will thus be seen that under ordinary conditions, the needle valve 6 will remain closed. A light spring 12 can be used to insure a positive closing action over and above the pressure differential in the two bellows members. The spring 12 acts against a suitable pin carried by the rod 11 and operating in a slot provided in the conduit 7. In the event that the needle should leak because of dirt or other sediment, it will be obvious that the high and low side will tend to equalize with the result that the pressure in the bellows member 9 will be relatively greater than the pressure in the bellows member 3, with the result that the top bellows member will tend to push the needle downwardly with a gradually increasing pressure as the high and lowsides equalize. This increased pressure will be found sufficient to clear away the dirt or sediment.

In starting up a "warm" machine, with the atmosphere around the condenser at, say, 70° , the needle valve 6 will remain closed until the pressure of the SO_2 in the bellows member 3 rises to a point slightly above seventy pounds and the small amount of refrigerant has been condensed and collected in the bottom of the condenser. When the needle valve opens a small amount of this refrigerant will be discharged into the lowside, decreasing the pressure and causing the needle valve to again close. It will be obvious that there will be a fluttering action of the control as long as the motor continues in operation. A receiver is not necessary in the system and but

a very small amount of liquid accumulates in the condenser. The condenser C is preferably provided with fins or other means to provide a large surface area with the result that the pressure in the high side will rapidly drop back towards absolute pressure after the motor has stopped and the needle valve closed.

The level or amount of liquid in the lowside will remain substantially constant for the reason that when a certain portion of the refrigerant is removed from the lowside by operation of the compressor, a pressure is immediately built up in the control, and a small amount of the liquid accumulated in the condenser, and receiver if used, is transferred to the lowside. The only time that any change takes place in the lowside is when the compressor is operating and this combined with the fluttering action will tend to the maintenance of a constant level or amount of refrigerant in the cooling unit.

The large surface area of the conduit or bulb insures the maintenance of a pressure within the bellows 9 which is highly sensitive to any change in temperature of the atmosphere surrounding the condenser. It will be understood that any gas may be used in the bellows 9, the pressure of which is responsive to changes in temperature and, if desired, the same refrigerant used in the refrigerating system may be used in the bellows 9. In this case I prefer to increase the diameter of the bellows member 9 as compared to the diameter of the bellows member 3 to obtain the desired differential pressure.

In Fig. 2 I have shown a modified form of the invention wherein the flat diaphragm 13 is substituted for the bellows member 9 and a tube 14 filled with a liquid serves as the power transmitting means instead of the rod 11.

In Fig. 3 I have illustrated a further modification of my invention wherein a flexible cable 15 surrounded by a reinforcing tube serves as the connecting means between the two bellows members.

In Fig. 4 I have illustrated a further modification of my invention wherein the complete regulating device is formed as a single compact unit. In this structure the lowside connection is at 16 and the high side connection at 17 and a single siphon 18 serves as a separating means between the two liquids or gases. A needle valve 19 preferably has a loose fit with the side walls 20 or may be a square needle so that the refrigerant in the system fills the interior of the bellows 18 as at 21. The refrigerant 22 on the outside of the bellows may be the same as the refrigerant in the system but this is not necessary as heretofore explained in connection with Fig. 1. The operation of the structure shown in Fig. 4 is substantially the same as the operation of the structure shown in Fig. 1 except that in most cases it will be impossible to locate the unit as shown in Fig. 4 adjacent the condenser. The spring 23 holds the needle 19 in closed position until the pressure in the high side more than equals the pressure of the liquid 22 plus the pressure of the spring 23, in which case the needle opens allowing the refrigerant from the high side 17 to flow to the lowside as at 16 until the pressure in the high side is not great enough to hold the needle open.

In Fig. 5 I have diagrammatically illustrated the preferred location of my regulating unit as at A in a refrigerating system wherein B is the compressor, C is the condenser, and D the cooling unit. The location of a portion of the control unit inside or outside of the box will depend

largely upon whether the type of unit shown in Fig. 1 or Fig. 4 is used.

What I claim is:

1. In a refrigerating system of the type having a condenser, compressor and lowside, a control unit having valve means for connecting and unloading liquid refrigerant from the high side into the lowside, thermostatically controlled means operatively positioned adjacent the condenser and connected to and normally tending to close said valve means whereby the pressure in the high side necessary to open the valve will vary according to the temperature existing around the condenser, and spring means positioned and arranged to resist or assist the operation of the thermostatic controlled means in the operation of the valve.

2. In a mechanical refrigerating system of the flooded type, an unloading valve positioned between the condenser and evaporator, said valve including a valve stem for controlling the flow of liquid from the condenser to the evaporator, a bellows member surrounding the valve stem and in continuous communication with and filled by refrigerant liquid from the condenser, thermostatic means including a housing surrounding said bellows member and filled with temperature responsive liquid, a conduit connected to said housing and filled with liquid, said conduit being exposed to atmospheric air, said temperature responsive liquid surrounding the bellows member and the effective exposed surface of said bellows member being such that said valve stem will normally remain closed to shut off the flow of liquid to the evaporator until the development of the required amount of pressure in the high side of the system.

3. A control valve for regulating the unloading of liquid in the condenser into the lowside of a refrigerating system as liquid, comprising a bellows enclosed and normally closed valve member subject to high side pressure, a second bellows member having temperature responsive means positioned adjacent to but spaced from the circulating refrigerant in the condenser and containing a medium adapted to expand or contract with changes in atmospheric temperature, said bellows members being connected together whereby the high side pressure necessary to open the valve in the first bellows member will be directly predetermined by the temperature existing around the second bellows member.

4. In a mechanical refrigerating system of the flooded type, an unloading valve positioned between the condenser and evaporator, said valve including a valve stem for controlling the flow of liquid from the condenser to the evaporator, a bellows member operatively connected to the valve stem and in continuous communication with and actuated by refrigerant liquid from the condenser, thermostatic means positioned to be affected by the temperature of the air and the temperature of the condenser when running, said thermostatic means being operatively connected to said valve stem, the head pressure in the liquid coming from the high pressure side of the system being the sole means for opening said valve.

5. In a mechanical refrigerating system of the flooded type, an unloading valve positioned between the condenser and evaporator, said valve including a valve stem for controlling the flow of liquid from the condenser to the evaporator, a bellows member operatively connected to the valve stem and in continuous communication

with and adapted to be operated by refrigerant liquid from the condenser, thermostatic means positioned to be affected by the temperature of atmospheric air and the temperature of the liquid passing through the condenser and including refrigerant liquid having a portion of its body positioned adjacent said condenser and a portion enclosed in a chamber whereby to be normally operative against and tending to close said valve stem, the vapor pressure of said refrigerant forming a part of the thermostatic means varying in accordance with the temperature of the atmospheric air and the temperature of the liquid passing through the condenser whereby the point at which said valve stem may be opened by the pressure of the liquid from the high side will vary according to said temperatures.

6. In a refrigerating system of the type having a condenser, compressor and lowside, a control unit interposed between the condenser and lowside and having valve means for connecting and unloading liquid refrigerant from the high side into the lowside, a bellows member confined within a housing operatively connected to the valve means, said bellows member being in communication with and actuated by liquid from the condenser, and means tending to always move the valve towards closed position including atmospheric temperature responsive means for exerting a closing pressure on the valve means proportionate to atmospheric temperature conditions.

7. In a refrigerating system of the type having a condenser, compressor and lowside, a control unit interposed between the condenser and lowside and having valve means for connecting and unloading liquid refrigerant from the high side into the lowside, a bellows member confined within a housing operatively connected to the valve means, said bellows member being in communication with and actuated by liquid from the condenser, and means tending to always move the valve towards closed position including atmospheric temperature responsive means for exerting a closing pressure on the valve means proportionate to atmospheric temperature conditions, said second named means also including resilient means positioned to resist or assist the operation of the temperature responsive means in the operation of said valve means.

8. In a refrigerating system of the type having a condenser, compressor and lowside, a control unit interposed between the condenser and lowside and having valve means for connecting and unloading liquid refrigerant from the high side into the lowside, a bellows member confined within a housing operatively connected to the valve means, said bellows member being in communication with and actuated by liquid from the condenser, and means tending to always move the valve towards closed position including atmospheric temperature responsive means for exerting a closing pressure on the valve means and through the bellows member proportionate to atmospheric temperature conditions.

9. A pressure valve for a refrigerating system including an evaporator, a compressor, and a condenser, comprising a valve body formed with a refrigerant inlet port, a metallic bellows member in said valve body, a body of liquid in said valve body contacting with one surface of said bellows member and of different volatility than the refrigerant, said inlet port being in communication with the condenser to supply a constant body of refrigerant liquid against the other

surface of said bellows member, a needle valve projecting downwardly from said bellows member, a seat in said valve body against which said needle valve member is adapted to be pressed by the expansive action of the liquid of different volatility against the bellows, said valve body being provided with a portion adjacent the bottom thereof and between the bellows and the seat and apertured to receive the needle valve member and provide a passageway through which the refrigerant passes to permit the same to contact with one side of said bellows member and to pass through said seat.

10. A pressure valve for a refrigerating system including an evaporator, a compressor, and a condenser, comprising a valve body formed with a refrigerant inlet port, a metallic bellows member in said valve body, a body of liquid in said valve body contacting with one surface of said bellows member and of different volatility than the refrigerant, said inlet port being in communication with the condenser to supply a constant body of refrigerant liquid against the other surface of said bellows member, a needle valve projecting from said bellows member, a seat in said valve body against which said needle valve member is adapted to be pressed by the expansive action of the liquid of different volatility against the bellows, said valve body being provided with a portion adjacent one end thereof and between the bellows and the seat and apertured to receive the needle valve member and provide a passageway through which the refrigerant passes to permit the same to contact with one side of said bellows member and to pass through said seat, and a spring within said valve body positioned to resist or assist the operation of said bellows member in controlling the operation of said valve.

11. A pressure valve for a refrigerating system including an evaporator, a compressor, and a condenser, comprising a valve body formed with a refrigerant inlet port, a metallic bellows member in said valve body, a body of liquid in said valve body contacting with one surface of said bellows member and of different volatility than the refrigerant, said inlet port being in communication with the condenser to supply a constant body of refrigerant liquid against the other surface of said bellows member, a needle valve projecting from said bellows member, a seat in said valve body against which said needle valve member is adapted to be pressed by the expansive action of the liquid of different volatility against the bellows, said valve body being provided with a portion adjacent one end thereof and between the bellows and the seat and apertured to receive the needle valve member and provide a passageway through which the refrigerant passes to permit the same to contact with one side of said bellows member and to pass through said seat, said liquid of different volatility being so positioned as to be affected by the temperature conditions of the atmosphere.

12. A pressure valve for a refrigerating system including an evaporator, a compressor, and a condenser, comprising a valve body formed with a refrigerant inlet port, a metallic bellows member in said valve body, a body of liquid in said valve body contacting with one surface of said bellows member and of different volatility than the refrigerant, said inlet port being in communication with the condenser to supply a constant body of refrigerant liquid against the other surface of said bellows member, a needle valve

projecting downwardly from said bellows member, a seat in said valve body against which said needle valve member is adapted to be pressed by the expansive action of the liquid of different volatility against the bellows, said valve body being provided with a portion adjacent the bottom thereof and between the bellows and the seat and apertured to receive the needle valve member and provide a passageway through which the refrigerant passes to permit the same to contact with one side of said bellows member and to pass through said seat, and a conduit leading from said valve body and having a portion thereof positioned adjacent the condenser, said conduit being filled with and in communication with said liquid of different volatility.

13. A differential pressure control for regulating the delivery of liquid from the condenser to the lowside of a refrigerating system during operation of the compressor comprising valve means for normally separating the liquid in the condenser and lowside, atmospheric temperature responsive means positioned adjacent to but spaced from the circulating refrigerant in the condenser and tending to move the valve towards closed position, means subject to the pressure existing in the high side tending to counteract said first named means, and opening said valve only upon accumulation of sufficient pressure in the high side to overcome the pressure exerted by said first named means.

14. A control valve for regulating the unloading of the liquid in the condenser into the lowside of a refrigerating system, comprising a bellows enclosed valve member, said bellows being connected to the high side of the system, a second bellows member connected to temperature responsive means positioned adjacent to but spaced from the circulating refrigerant in the condenser and containing a medium adapted to expand or contract with change in atmospheric temperature, said bellows members being connected together whereby the high side pressure necessary to open the valve in the first bellows member will be directly predetermined by the temperature existing around the second bellows member, and adjustable resilient means normally tending to close the valve member.

15. A refrigerating system comprising, in combination, a high pressure side, a low pressure side, means responsive to the pressure of the refrigerant in the high pressure side for controlling the admission of refrigerant to said low pressure side, and means responsive to changes in temperature of the ambient air which cooled the high pressure side for controlling the operation of said controlling means.

16. Refrigerating apparatus comprising, in combination, an evaporator, means for circulating refrigerant through the evaporator including a condenser, means responsive to the pressure of the refrigerant in said condenser for controlling the flow of refrigerant to the evaporator, and means arranged in heat receiving relation to but spaced from said condenser for controlling the operation of said second named means.

17. Refrigerating apparatus comprising, in combination, an evaporator, means for circulating refrigerant through the evaporator including heat dissipating means arranged to increase in temperature when refrigerant is circulated, said heat dissipating means being cooled by a medium flowing thereover, means responsive to the pressure of the refrigerant in said circulating means for controlling the flow of refrigerant to the evaporator, and means arranged in heat receiving relation to but spaced from said heat dissipating means and subjected to the temperature of the cooling medium for varying the operation of said controlling means.

18. Refrigerating apparatus comprising, in combination, an evaporator, means for circulating refrigerant through said evaporator including a condenser, means responsive to the pressure of the refrigerant in said condenser for controlling the flow of refrigerant to the evaporator, and means containing a refrigerant whose pressure is higher than the refrigerant in said condenser at the same temperatures and being arranged in heat receiving relation to said condenser for controlling the operation of said second named means.

19. A refrigerating system comprising a high pressure side, a low pressure side, an expansion valve operable to pass liquid refrigerant only from the high pressure side to the low pressure side during one period of operation and to pass both liquid and gaseous refrigerant to the low pressure side during another period of operation and means for actuating said expansion valve.

20. A refrigerating system comprising a condensing element, an evaporating element, expansion valve means operable to pass only liquid refrigerant from the condensing element to the evaporating element during normal cycling operation of the condensing element, and to pass liquid and gaseous refrigerant to the evaporating element during abnormal operation of said condensing element and temperature responsive means for actuating said valve.

21. The method of refrigeration in a system having high and low pressure portions which consists in supplying refrigerant from the high to the low pressure portion under the influence of the pressure exerted in the high pressure portion and modifying the passage of refrigerant to the low pressure portion in response to changes in temperatures prevailing in the cooling medium adjacent the high pressure portion.

22. The method of refrigeration in a system having high and low pressure portions which consists in supplying refrigerant from the high to the low pressure portion under the influence of the pressure exerted in the high pressure portion, circulating a cooling medium for cooling the high pressure portion, and modifying the passage of refrigerant to the low pressure portion in response to temperature changes of the cooling medium which is at variance with respect to the pressure temperatures in the high pressure portion.

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