

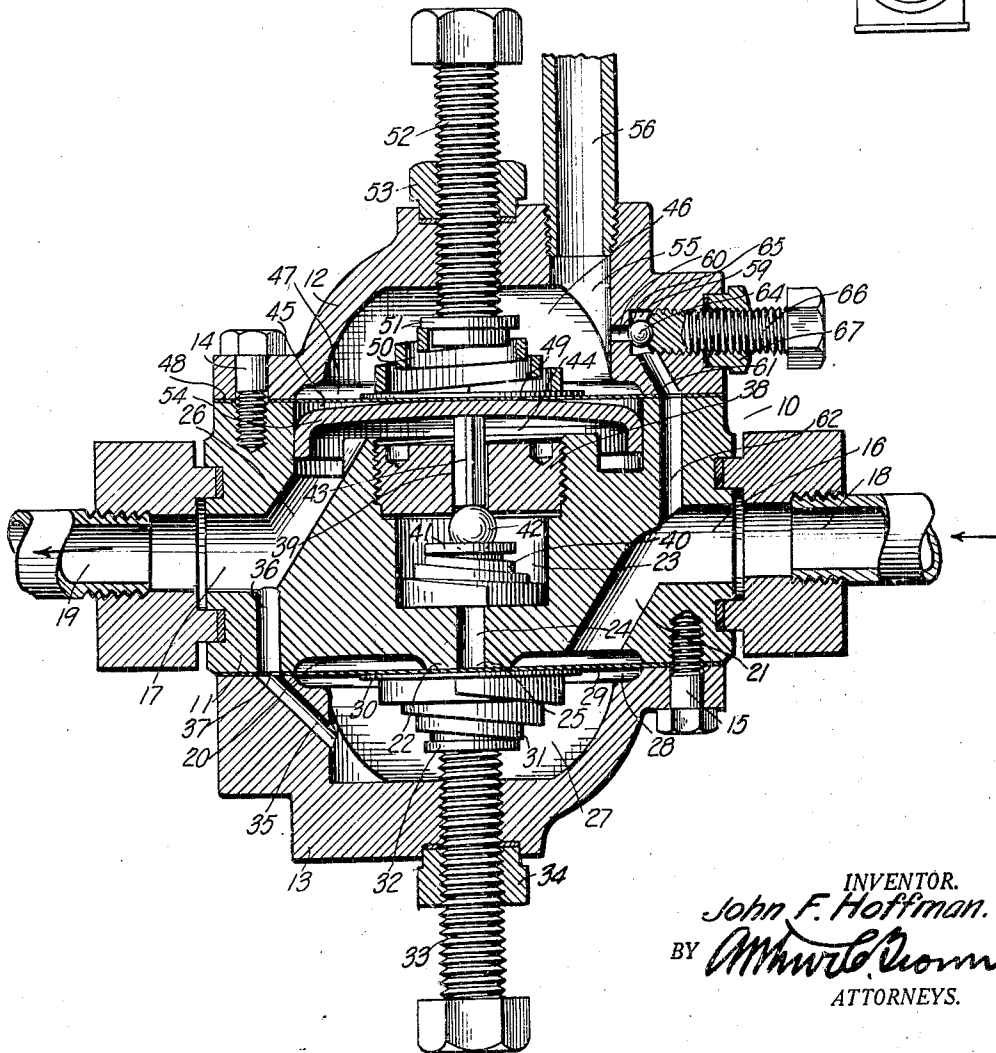
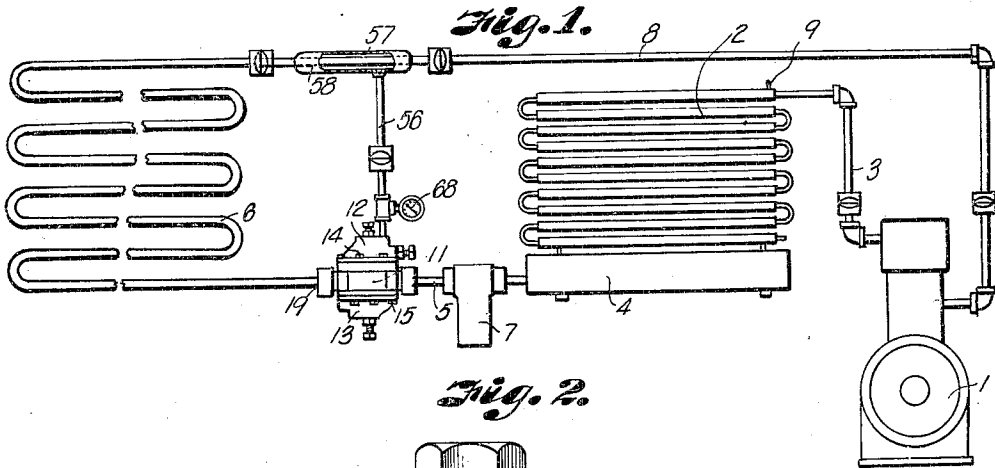
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J. F. HOFFMAN

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REFRIGERATING APPARATUS

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JOHN F. HOFFMAN, OF OMAHA, NEBRASKA, ASSIGNOR TO BAKER ICE MACHINE CO. INC., OF OMAHA, NEBRASKA, A CORPORATION OF NEBRASKA

REFRIGERATING APPARATUS

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My invention relates to refrigerating apparatus and more particularly to apparatus of that character in which the gas of a low boiling point liquid is compressed and condensed and circulated through cooling coils to effect temperature equalization by expansion of the refrigerating agent in the cooling coils, the principal objects of the present invention being to control the supply of the refrigerating agent to a cooling coil by differentials in temperatures at the ends of the coil and in pressures in the supply and return lines, to synchronize the control of the refrigerant supply with the movement of the compressor, and to provide a unitary structure for control of the supply subject to temperature and pressure conditions of the return line.

Means responsive to the temperature of the refrigerating agent at the outlet end of the coil may regulate flow while the agent is being circulated by the compressor, and may close the inlet when the compartment served by the coil has been cooled to a predetermined degree. Said means may however, be interfered with by temperature and pressure of the refrigerating agent at the inlet end of the coil; and, further, said means may not retain the inlet closed while the compressor is idle; nor prevent liquid refrigerant from entering the coil, upon resumption of work by the compressor, before suction has reduced pressure in the return line.

Further objects of invention therefore are to neutralize the influence of return line pressure on a thermal supply-regulating element, and to provide automatic means directly responsive to the pressure of the refrigerating agent in the return line for controlling flow of the refrigerating agent to said thermal regulating element, and to embody the several elements in a unitary structure for most effective use of temperature and pressure conditions.

It is also an object of the invention to effect the differential temperature and pressure control with a single stage expansion of the refrigerating medium in the supply line, whereby the thermal control element may be the more finely adjusted for regulating the

supply to the coil, and the embodiment of the pressure and thermal control elements in a unitary structure is made possible.

In accomplishing these and other objects of the invention, I have provided improved details of structure, the preferred forms of which are illustrated in the accompanying drawings, wherein:

Fig. 1 is a diagram of a refrigerating system embodying my improvements, some of the parts being magnified for better illustration and a thermal control housing being partly broken away to show its relation with the return line.

Fig. 2 is an enlarged, central, vertical section of a unitary valve structure constituting the unified control of the supply of the refrigerating agent.

Referring in detail to the drawings:

1 designates a compressor, 2 a condenser, connected with the compressor through a line 3; 4 a receiver at the outlet end of the condenser; 5 a line leading from the receiver through controlling mechanism to a cooling coil 6 and including a sediment trap 7; 8 a return line from the cooling coil to the compressor; and 9 a charging line all in accordance with common practice, the compressor being actuated and automatically or manually controlled by any suitable or conventional means not shown, the present invention relating to improved means and apparatus for automatically controlling and regulating supply from the condenser to the coil, and particularly for controlling the supply when actuation of the compressor is resumed after a period of idleness due to sufficient cooling of the coil.

I provide a unified and unitary valve device including a housing 10 interposed in the supply line 5 for regulating the supply of refrigerating agent to the coil and controlling the supply, and including a body 11, and upper regulating and lower control valve caps 12 and 13 respectively connected to opposite sides of the body by flange bolts 14 and 15.

The body has an inlet 16 and an outlet 17 connected to threaded ends 18 and 19 of the supply pipe on the compressor and coil sides of the housing respectively. In the lower

face of the body is a recess 20 communicating with the inlet through a channel 21, and a boss 22 extends centrally in the recess and terminates in a ground surface flush with the face of the body. Leading through the boss into a central chamber 23 of the body is a throat 24 having a port 25 in the end of the boss constituting the end of the boss a valve seat, said chamber 23 communicating with the outlet through a duct 26 as later described.

The cap 13 encloses a chamber 27 having an enlarged upper portion 28 substantially corresponding to the recess 20, and a diaphragm 29 separates the recess from the chamber, the periphery of the diaphragm being located between the body and lower cap flanges and held in place by the flange bolts 15.

A disk or spring rest 30 on the lower face of the diaphragm receives the upper end of an expansion spring 31 which yieldingly urges the diaphragm to contact the end of the boss 22 to close the inlet port 25 and interrupt flow from the receiver toward the coil.

The spring at its lower end bears against a guide plate 32 engageable by a set screw 33 threaded through the lower end of the cap 13 and held in adjusted position by a lock nut 34.

Opening from the chamber 27 is a duct 35 aligned with a duct 36 in the body which communicates with the outlet 17, the ducts 35 and 36 communicating through an aperture 37 in the diaphragm, whereby the pressure of fluid in the coil is exerted on the under surface of the diaphragm, to cooperate with the tension of the spring 31 against pressure of fluid in the supply line on the inlet side of the housing.

With this arrangement the inlet port 25 is normally closed under tension of the spring 31, but will open under pressure of the liquid in the supply line when the pressure of the liquid is sufficient to overcome combined tension of the spring and pressure in the coil, it being apparent that freedom of flow through the port may be regulated by adjustment of tension of the spring 31.

It is also apparent that the fluid entering the recess 20 and port 25 is liquid refrigerant since no valve is interposed between the housing 10 and the receiver and compressor, that a single stage of expansion is provided for by passage of the liquid refrigerant through the chamber 23 to the coil, and that the fluid which operates against the diaphragm 29 will be subject to conditions at the inlet end of the coil, for example, having a lower temperature than the evaporated refrigerant at the outlet end of the coil.

The upper port of the chamber 23 is enlarged to receive a threaded collar 38 having a central bore 39, and an expansion spring 40 supported on the bottom of the chamber 23

carries a seating plate 41 which supports a valve ball 42, and urges the ball to contact with the edges of the collar around the opening, thereby constituting said edges a valve seat.

Supported on the ball 42 and extending in the bore 39 of the collar is a squared pin 43, which projects into a chamber 44 formed in the upper side of the body 11 including an annular recess 45, the recess portion of the chamber communicating with the outlet 17 through said duct 26.

The cap 12 contains a chamber 46 enlarged at its lower end for substantial registry of the inner edge of the cap with the vertical wall of the chamber 44, whereby the lower portion 47 of the chamber 46, and the chamber 44, provide substantially equal areas of contact of fluid in said chambers with a diaphragm 48 interposed between the body 11 and the cap 12 and held in place by the bolts 14 which attach the cap to the body.

A disk 49 on the upper face of the diaphragm seats an expansion spring 50 engaging at its upper end a thrust plate 51 adjustable by a set screw 52 which extends through the top of the cap and is held in adjusted position by a lock nut 53. The spring tends to expand the diaphragm downwardly to push the pin 43 against the ball valve to open the valve and provide flow through the chamber 44 to the coil, the pin bearing against a spider-like plate 54 on the lower face of the diaphragm.

Opening through the cap 12 from the chamber 46 is a port 55 through which the chamber communicates with a line 56 leading to and communicating with an annular chamber 57 within a housing 58 on the return line 8 adjacent the outlet end of the coil 6.

The cap 12 also contains a valve chamber 59 communicating with the chamber 46 through a port 60, and with the inlet 16 through a duct 61 in the cap and a channel 62 in the body 11, the duct and channel communicating through an aperture 60 in the diaphragm 48, whereby fluid under pressure in the supply line may be passed to the chamber 46, under control of a valve 64 adjustable against the seat 65 by a screw stem 66 mounted in the cap and held in adjusted position by a lock nut 67. The refrigerant is admitted to the chamber 46 and thence through the line 56 into the chamber 57 to provide a body of fluid responsive to the temperature in the return line adjacent the outlet end of the coil for pressure control of the diaphragm 48 and valve 42. 68 indicates a pressure-indicator in the line 56.

Assuming the parts to be constructed and assembled as described, the system is charged in the usual manner, a vacuum being created and fluid being introduced through the charging line 9. The valve 64 is closed, however, after air removal and prior to charging of the

system with the refrigerating agent, so that a vacuum is indicated at 68.

The compressor is then put in operation and the valve 64 is opened to admit refrigerating fluid to the chambers 46 and 57. The valve is then closed when pressure in the chambers as indicated by 68 is a few pounds less than the pressure in the supply line, to trap the charge of fluid and retain it as a thermostatic medium for the purposes presently described.

Pressure of the retained fluid influenced by the temperature of the return line is sufficient to overcome the spring 40 and lower the ball 42 from its seat, opening a passage from the chamber 23 into the chamber 44 to permit flow of the refrigerating liquid into the coil and back through the return line to the compressor.

Meanwhile, the refrigerating liquid is being forced from the compressor against the diaphragm 29, and pressure in the return line and coil is being lowered; and when the inlet liquid overcomes both the spring 31 and the back pressure from the coil, the liquid flows over the diaphragm and through the throat 24 directly into the expansion valve portion of the housing and its flow to the coil is regulated by the valve 42.

Gaseous component of the liquid trapped in the line 56 and housing 58 is subject to temperature in the return line from the coil which originally is sufficient to expand the contents of the housing and line and exert a pressure on the diaphragm 48 sufficient to maintain the valve open and permit flow of refrigerant to the coil. As flow continues through the coil there is a temperature exchange tending to cool the compartment served by the coil, but as the temperature in the compartment is lowered, the temperature of the refrigerating agent is also lowered until eventually such decrease in temperature reacts on contents of the valve and permits the valve to move toward closed position, thus regulating the supply of refrigerant to the coil proportionally to cooling requirement.

When the desired low temperature is reached in the compartment cooled by the coil, the valve 42 is permitted to close entirely, thus suspending the flow of refrigerant through the housing 10. The compressor is then shut off, for example by causing the breaking of a circuit to the motor through thermostatic means located in the compartment.

When the temperature in the compartment rises to a degree requiring further refrigeration, and the compressor is again put into operation, such operation of the compressor creates pressure in the supply line tending to displace the diaphragm 29 and move refrigerating liquid into the expansion valve, and also reduces pressure in the return line.

Should the valve 42 be slightly open, at

the instant that the refrigerating liquid is subject to resumption of pressure from actuation of the compressor, the liquid would be admitted to the coil before the low pressure is developed on the return line, and the coil would be flooded.

The inlet valve device including the diaphragm 29 is therefore provided, whereby the refrigerating liquid under pressure from the compressor is opposed not only by the spring 31 but by the pressure of fluid in the coil, so that flow to the expansion valve and to the coil cannot take place until pressure in the supply and return lines have become unbalanced by suction of the contents of the return line to the compressor.

When reduction of pressure in the coil permits inlet of refrigerating liquid to the expansion valve chamber 27, flow to the coil is regulated by the thermostatic device.

The equal areas of contact with the diaphragm 48 by fluid in the chambers 44 and 46 provides for exchange of heat between the coldest portion of the expanded refrigerant and the confined refrigerant in the chamber 46, and thus neutralizes the offset of fluctuations in the pressure of the return line fluid to preserve a balance of pressures on the two sides of the diaphragm regardless of the evaporating pressure, whereby the thermostatic device is enabled to control the valve 42.

The efficiency of the thermostatic device is further improved by providing the relatively large chamber 46, and locating the housing 10 directly under the chamber 57, whereby maximum contact of condensed fluid with the upper face of the diaphragm 48 is provided for.

It is apparent therefore that, with the apparatus described, I provide a double control of the refrigerant supply, wherein free flow of liquid to the reducing valve is controlled by pressure of the refrigerant in the coil, and the reducing valve is regulated by temperature of the refrigerant departing from the coil, whereby fluid is admitted to the coil with but a single reduction of pressure.

It is also apparent that the inlet valve including the diaphragm 29 is quick opening or closing under pressure control and that when the diaphragm seats there is complete closure of flow.

It is further apparent that because of the supply control without pressure reduction, and embodiment of the supply control element in the unitary structure, a relatively small reducing valve structure may be provided which is subject to fine regulation, and loss due to two-stage reduction is avoided.

What I claim and desire to secure by Letters Patent is:

1. In refrigerating apparatus including a compressor, a cooling coil, supply and return lines connecting the compressor with the coil, synchronizing means comprising a multiple

valve including members respectively controlled by temperature in the return line and pressure in the return line and coil controlling flow through the supply line.

2. In refrigerating apparatus including a compressor, a cooling coil, and supply and return lines connecting the compressor with the coil, synchronizing means comprising a valve housing having an inlet and an outlet, a valve responsive to temperature in the return line for controlling the outlet, and a valve responsive to differential pressures in the supply line and coil for controlling the inlet.

3. In refrigerating apparatus including a compressor, a cooling coil, and supply lines connecting the compressor with the coil, a valve in the supply line having a through channel including an intermediate port, means responsive to differential pressures in the supply line and coil interposed in said channel for controlling flow of refrigerant through the channel, and means responsive to variable temperatures in the return line for regulating the flow through said port.

4. In refrigerating apparatus including a compressor, a cooling coil and supply and return lines connecting the compressor with the coil, a housing having a lower chamber in free communication with the compressor, an upper chamber in free communication with the coil, and a channel connecting said chambers, means in the upper chamber responsive to temperature in the return line for regulating flow of refrigerant to the coil, and means in said lower chamber responsive to differential pressures in the supply line and coil for controlling flow of refrigerant to said channel.

5. In combination with a coil and supply and return lines connected with the coil, means controlling delivery of refrigerant to the coil comprising a housing having an inlet from the supply line, an outlet to the coil, and a duct between the inlet and the outlet, means including a diaphragm responsive to temperature in the return line for regulating flow of refrigerant from said duct and means including a diaphragm responsive to pressure in the coil for controlling flow of refrigerant to said duct, the housing having a channel for admitting refrigerant in the coil to said last named diaphragm.

6. In combination with a coil, and supply and return lines connected with the coil, a housing in the supply line having a vertical channel, an outlet communicating with the upper end of said channel, an inlet communicating with the lower end of said channel, a free flow valve in the housing responsive to differential pressures in the supply line and coil for controlling flow of refrigerant into said channel, and a reduction valve responsive to variable temperatures in the return

line controlling flow from the channel to the coil.

7. In combination with a compressor, a cooling coil, supply and return lines connecting the coil with the compressor, and a reduction valve including a housing having a through channel and temperature responsive means for closing the channel, means including a diaphragm responsive to differential pressures in the supply line and coil controlling flow of refrigerant to said channel, the housing having a duct to admit refrigerant from the coil to said diaphragm.

8. In combination with refrigerating apparatus including a compressor, a cooling coil, and supply and return lines connecting the compressor with the coil, flow control means comprising a multiple valve interposed in the supply line and controlled primarily by differentials of pressure in the system, and secondarily by temperature in the return line for regulating flow of refrigerant to the coil.

9. In refrigerating apparatus including a coil, and supply and return lines for conducting refrigerant to and from the coil, a plurality of independently operable valves in the supply line responsive respectively to pressure of said refrigerant in the coil and to variable temperature of said refrigerant in the return line for controlling flow of refrigerant from the supply line to the coil.

10. In refrigerating apparatus including a coil, and supply and return lines for conducting refrigerant to and from the coil, a plurality of independently operable valves in the supply line responsive respectively to pressure of said refrigerant in the supply line and to variable temperature of said refrigerant in the return line for controlling flow of refrigerant from the supply line to the coil.

11. In refrigerating apparatus including a compressor, a coil, and supply and return lines connecting the compressor with the coil for circulating refrigerant through the coil, a pair of independently operable valves in the supply line controlled respectively by differential of pressures of said refrigerant in the coil and supply line and by temperature of said refrigerant in the return line for regulating flow of the refrigerant to the coil.

12. In refrigerating apparatus including a compressor, a cooling coil, and supply and return lines connecting the compressor with the coil, a multiple valve device in the supply line including a valve responsive to differential pressures in the supply line and coil for controlling flow of refrigerant from the compressor, and a valve normally obstructing flow of refrigerant from said first named valve to the coil and responsive to increases of temperature of refrigerant in the return line for permitting flow of refrigerant to the coil.

13. In refrigerating apparatus including a coil, and means including supply and return

lines for circulating refrigerant through the coil, a housing having an inlet from the supply line and an outlet to the coil, a valve at said outlet responsive to variable temperature in the return line for regulating flow of refrigerant from the housing to the coil, and a valve at said inlet responsive to differential pressures in the supply line and coil for controlling flow of refrigerant to the housing.

14. In refrigerating apparatus including a compressor, a cooling coil, a return line leading from the coil to the compressor, a housing having an upper chamber in free communication with the coil and a lower chamber in free communication with the compressor, and provided with a channel having an inlet from the lower chamber and an outlet to the upper chamber, a valve in said channel for regulating flow of refrigerant to the upper chamber, means responsive to changes of temperature of refrigerant in the return line controlling said valve, a diaphragm valve normally closing the inlet to the channel and responsive to differential pressures in the lower chamber and the coil for controlling flow of refrigerant into the channel.

15. In refrigerating apparatus including an evaporating member, a conduit for delivering refrigerant to the evaporating member, and an outlet line from the evaporating member, a housing having a channel including a portion communicating with the conduit and a portion having a supply inlet port, and recessed to provide a seat around said port and an annular chamber exterior to the seat, a constantly open supply line communicating with said annular chamber, an apertured diaphragm normally engaging said seat to close said port, a cap fixed to the housing having a recess to provide a chamber on the opposite side of said diaphragm from said annular chamber, and provided with a duct aligned with the aperture in the diaphragm affording constant communication between said second named chamber and the first named portion of said channel, a spring located in said second named chamber for urging the diaphragm into engagement with said seat, and a screw adjustably mounted in said cap for anchoring the spring.

In testimony whereof I affix my signature.

JOHN F. HOFFMAN.