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REFRIGERATION

Original Filed June 25, 1938

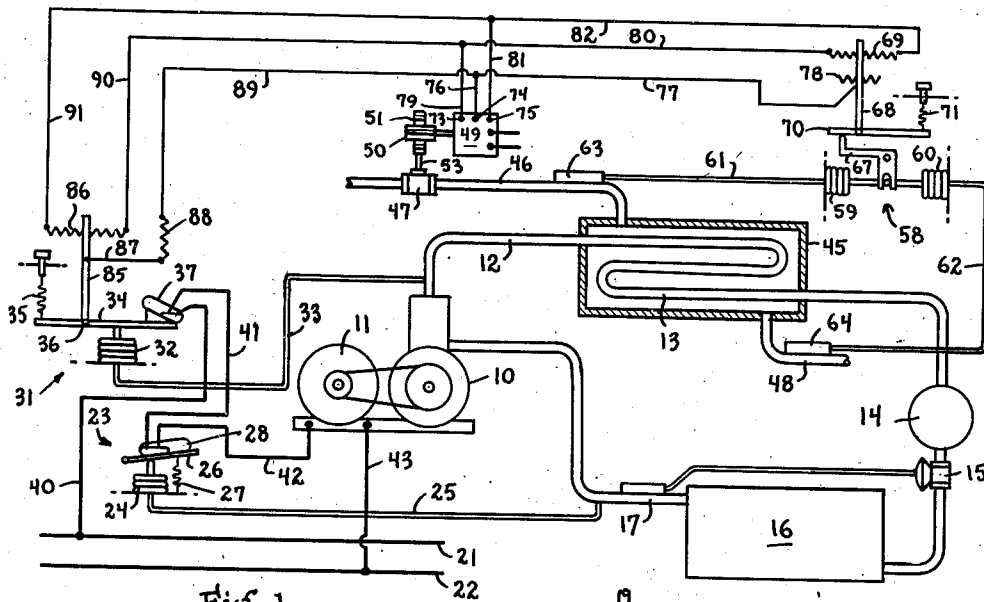


Fig. 1

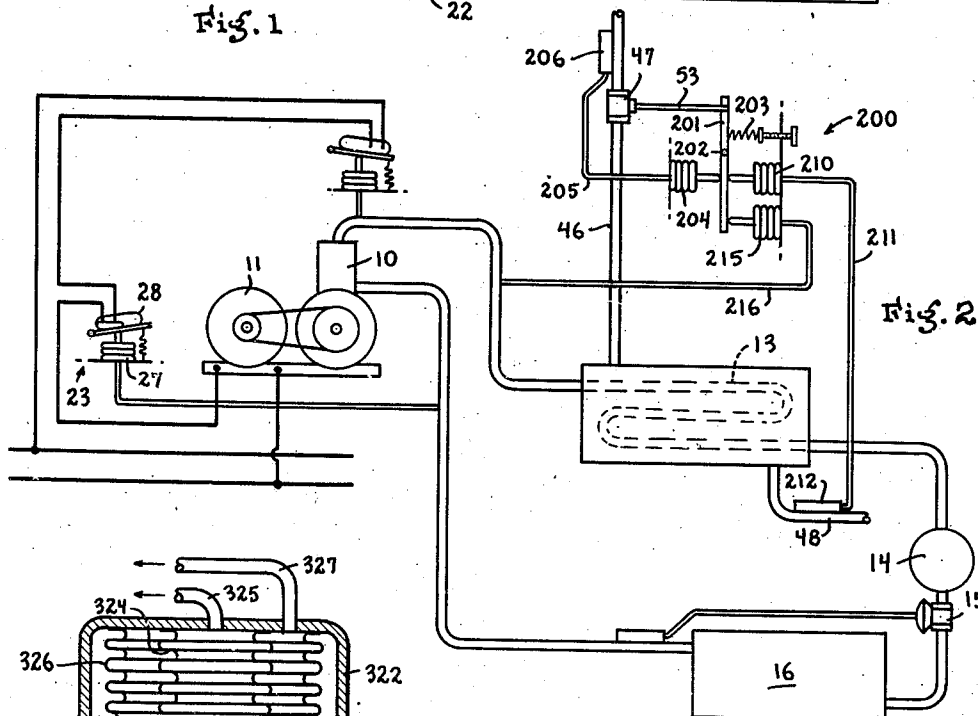


Fig. 2

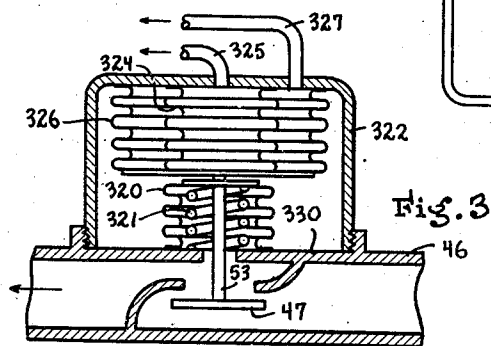


Fig. 3

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REFRIGERATION

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215,796. Divided and this application March 25,
1942, Serial No. 436,064

6 Claims. (Cl. 62—3)

The present invention relates to refrigerating systems employing condensers and the invention has to do particularly with control of the cooling of the condenser.

The primary object of the invention is to provide an improved control arrangement for controlling the flow of cooling water in heat exchange relationship with the condenser of a refrigeration system so as to effect economies in the use of cooling water.

More particularly, the object of the invention is to provide a control arrangement for controlling the cooling of a refrigeration condenser whereby the flow of cooling water is controlled so as to maintain a predetermined differential in temperature of the water as it passes the condenser, which differential may be compensated in response to the load on the system as measured by compressor discharge pressure.

This application is a division of my previously filed application, Serial No. 215,796 filed June 25, 1938, now Patent No. 2,299,335, issued October 20, 1942.

Further objects and advantages of my invention will become apparent from the following detailed description and annexed drawing, wherein

Figure 1 is a diagrammatic representation of a refrigeration system embodying one form of my invention;

Figure 2 is a diagrammatic representation of a second form of my invention, and

Figure 3 is a third modified form of the invention.

Referring to Figure 1, my invention is illustrated in connection with a refrigeration system for controlling the supply of cooling water to the condenser thereof. This system may include a compressor 10 driven by a motor 11, the outlet of the compressor being connected by a pipe 12 to the condenser coil 13, the outlet of the condenser being connected to a receiver 14, there being a thermostatic expansion valve 15 for controlling the flow of refrigerant from the receiver 14 to an evaporator 16. Refrigerant flows from the evaporator 16 through a pipe 17 to the inlet of the compressor 10. The operation of such a system will be apparent to those skilled in the art. Lines 21 and 22, which may be connected to a suitable source of power not shown, are provided for supplying power to the motor 11. For controlling the operation of the compressor a suction pressure controller 23 may be provided, this controller including a bellows 24 connected by means of a pipe 25 to the compressor suction

pipe. A lever 26 is biased by means of a spring 27 into engagement with the top of the bellows 24 and this lever carries a mercury switch 28. A head pressure controller 31 may also be provided for controlling the operation of the compressor. This controller may include a bellows 32 connected by means of a pipe 33 to the outlet of the compressor. An arm 34 is biased by means of an adjustable spring 35 into engagement with the bellows 31, this arm being pivoted at 36 and carrying a mercury switch 37 at one end thereof. The circuit through the motor 11 is as follows: from the line 21 through wire 40, mercury switch 37, wire 41, mercury switch 28, wire 42, motor 11, and wire 43 back to line 22. It will now be apparent that the motor 11 will operate as long as the suction pressure is above a predetermined value and the discharge pressure is below a predetermined value. Should the suction pressure drop to a low enough value, the switch 28 will be tilted in the opposite direction from that illustrated and interrupt the circuit to the motor 11. Should the discharge pressure reach a predetermined high value the switch 37 will be tilted by the bellows 32 in the opposite direction from that illustrated, and break the circuit to the motor 11.

For cooling the condenser 13 water may be supplied to a tank 45 housing the coil 13 by means of a pipe 46 controlled by a valve 47. The water may leave the tank 45 by means of a pipe 48. A motor 49 of the type shown in the patent of D. G. Taylor, No. 2,028,110 is connected by means of a pinion 50 to a rack 51 connected to the valve stem 53 whereby the position of the valve is controlled in accordance with the operation of the motor 49. The motor 49 is controlled by a differential pressure controller 58 which includes a bellows 59 and a bellows 60 connected by means of capillary tubes 61 and 62 to bulbs 63, and 64 respectively mounted in intimate contact with the inlet pipe 46 and outlet pipe 48 respectively, the tubes, bulbs, and bellows elements being provided with a suitable volatile fill. A pivoted lever 67 is operated in accordance with variations in temperature differential at 46 and 48 by the bellows devices which are arranged to directly oppose each other as shown. The lever 67 operates an arm 68 with respect to a resistance 69 by means of another lever 70 which is normally biased in a counterclockwise direction by a coil spring 71. Upon an increase in temperature differential, the temperature at 48 of course being higher than that at 46, the arm 68 is moved to the right and upon a decrease in

temperature differential the arm 68 is moved to the left.

The motor 49 has three terminals 73, 74 and 75. The terminal 74 is connected by means of wires 76 and 77 to a center tapped resistance 78, across which the arm 68 moves. The terminal 73 is connected by means of wires 79 and 80 to the left end of resistance 69 and the terminal 75 is connected by means of wires 81 and 82 to the right end of resistance 69. As the temperature differential at 46 and 48 increases the arm 68 is moved towards the right, thus decreasing the resistance between the terminals 74 and 75 and causing the motor to move the valve towards open position an amount which is proportional to the increase in temperature differential.

The arm 34 carries a control arm 85 suitably insulated therefrom and forming the slider of a compensating potentiometer having a resistance 86. The arm 85 is connected by means of wire 87, resistance 88, wire 89, and wire 76 to the motor terminal 74. The right end of resistance 86 is connected by means of wires 90 and 79, to the motor terminal 73 and the opposite end of this resistance is connected by means of wires 91 and 81 to the terminal 75 of the motor 49. As the pressure on the discharge side of the compressor 10 increases the bellows 32 will expand and cause the control arm 85 to move to the left over resistance 86, which will decrease the resistance connected between the terminals 74 and 75 whereby the valve 47 will be moved towards open position. By reason of the resistance 88 connected in the circuit in the arm 85, this arm will have less effect on the motor than the arm 68 and will have the effect of shifting the control range of the arm 68 as the discharge pressure of the compressor 10 varies.

It will accordingly be seen that with the system shown in this figure, for given discharge pressure on the compressor the temperature differential between the inlet 46 and the outlet 48 for the condenser cooling water will be effectively controlled by controlling the amount of water supplied to the condenser whereby wasting of cooling water is eliminated. As the discharge pressure on the compressor increases a need for further cooling of the condenser is indicated and the control arm 85 is shifted towards the left, thus shifting the control range of the arm 68 to the left to maintain a lower differential in temperature between the inlet pipe 46 and the outlet pipe 48 so that the increased cooling of the condenser which is required will be effected.

Referring now to Figure 2, a refrigeration system generally similar to that of Figure 1 is illustrated, this system including the compressor 10, condenser 13, receiver 14, expansion valve 15, and evaporator 16. The circuit for controlling the operation of the compressor is shown as being identical to that of Figure 1 and further description thereof is unnecessary. It should be understood, however, that the control circuit for the compressor motor of Figures 1 and 2 may be modified in any of the ways well known in the art.

The control means for the valve 47 is shown to comprise a direct operating differential pressure controller 200 in place of the motor 49 controlled by the differential pressure controller 58 and the compensator 31 of Figure 1. The valve stem 53 of the valve 47 is connected to a lever 201 pivoted at 202 and biased by means of an adjustable spring 203 in a counter-clockwise direction. A bellows 204 connected by means of a

capillary tube 205 to a bulb 206 mounted in intimate contact with the inlet pipe 46, acts directly upon one side of the lever 201. A second bellows 210 is connected by means of a capillary tube 211 to a bulb 212 mounted in intimate contact with the outlet pipe 48 and it acts against the opposite side of the lever 201 in opposition to the bellows 204. It will be understood that both of these assemblies of bellows elements, tubes and bulbs will be filled with a suitable volatile fluid and it will be seen that the position of lever 201 will depend upon the relative pressures existing within the bellows elements 204 and 210 and therefore, upon the temperature differential between the inlet pipe 46 and the outlet pipe 48. As the temperature differential increases, the bellows 210 will exert an increasingly greater net force on the lever 201 and cause clockwise movement thereof and consequent opening of the valve 47 whereby an increased supply of water is permitted by the valve 47 to decrease the temperature differential at 46 and 48. Also acting on the lever 201 in opposition of the bellows 204 is a bellows 215 connected by means of a pipe 216 to the discharge side of the compressor 10. As the discharge pressure increases, the bellows 215 will expand and for a given temperature differential at the inlet 46 and the outlet 48 an increase in the discharge pressure on the compressor will have the effect of moving the lever 201 in a clockwise direction, thus further opening the valve 47.

It will be apparent that with this system, the valve 47 is operated in accordance with the differential in temperatures at the inlet 46 and the outlet 48, this movement of the valve being compensated by the pressure on the discharge side of the compressor so as to maintain a lower temperature differential as the discharge pressure increases and conversely, to maintain a higher differential as the discharge pressure decreases. This system is direct acting and eliminates the use of an electric motor as in Figure 1.

Figure 3 shows another form of self contained unit wherein the operating mechanism may be built right into the valve mechanism. The water inlet pipe to the condenser is illustrated at 46 and controlled by the valve 47. The valve stem 53 is connected to the upper wall of a small bellows 320, this valve being biased towards closed position by means of the spring 321. A cap 322 is suitably secured to the upper portion of the valve casing and forms an enclosed chamber which may be provided with a suitable volatile fill. The temperature of the water flowing past the valve 47 will be communicated to the volatile fill enclosed by cap 322 by the wall 330. Depending from the upper wall of the casing 322 is a small bellows 324 whose lower end is connected to the valve stem 53, the upper end of this bellows being sealed to the upper wall of the casing 322. A pipe 325 may connect this small bellows to the high pressure side of the compressor. Also sealed to the top of the casing 322 is a large bellows 326 which may be concentric with the bellows 324 and also suitably connected at its lower end to the valve stem 253. A capillary tube 327 may connect this large bellows to a bulb mounted on the discharge side of the condenser, this large bellows, tube, and bulb being filled with a suitable volatile fluid.

The bellows 326 will be expanded upon an increase in temperature at the discharge side of the condenser by reason of an increase in pressure of the volatile fill therein and will be con-

tracted by reason of an increase in pressure of the volatile fill surrounding this bellows upon an increase in temperature at the inlet side of the condenser. This bellows will accordingly cause the valve 47 to assume positions depending upon the differential in temperature at the inlet and the outlet side of the condenser to increase the supply of water when the differential increases to reduce the supply of water as the differential decreases. As the pressure on the high pressure side of the compressor increases, the force exerted by the bellows 324 will increase and its effect is added to the effect of the bellows 326 whereupon a lower differential in temperature will cause an equal opening of the valve. In other words, to open the valve a given amount it will take a smaller differential in temperature if the discharge pressure of the compressor is higher than is required when the discharge pressure is low.

Having described the preferred forms of my invention many modifications and many adaptations may become apparent to those skilled in the art and it should be understood that my invention is limited only by the scope of the appended claims.

I claim as my invention:

1. In a refrigeration system including a compressor, a condenser, and an evaporator, means for circulating a cooling medium through said condenser, a valve in control of the flow of cooling medium through said condenser, an electric motor controlling the position of said valve, circuit controlling means controlling the operation of said motor, means responsive to the temperature differential at the inlet and outlet of said condenser in control of said circuit controlling means, and means responsive to the pressure on the high pressure side of the compressor for varying the effect of said circuit controlling means on the motor in such manner that a lower differential in temperature at the inlet and outlet of the condenser is maintained as the pressure on the high pressure side of the compressor increases.

2. In a system of the class described, a cooling unit, a valve for controlling the flow of a cooling medium through said cooling unit, said valve comprising a valve chamber having a valve seat and a valve member cooperating therewith, said valve member having a valve stem extending outwardly from said chamber, means biasing said valve towards closed position, a movable sealing member on the outside of said chamber and sealing the interior of said valve chamber from the space surrounding said valve stem, means forming a second chamber on the outside of said valve chamber and around said valve stem, said chamber being filled with a volatile fluid and subject to changes in temperature of the cooling medium passing through said valve, an expansible member within said second chamber and filled with a volatile fluid subject to the temperature of the cooling medium leaving the cooling unit, and a second expansible member within said chamber and filled with a volatile fluid, said fluid being subject to a condition indicative of a need for variations in the cooling effect of the cooling unit, said expansible members acting on the valve stem to open said valve in response to expansion of said members.

3. In a refrigeration system including a compressor, a condenser and an evaporator, means for circulating a cooling medium through the condenser, means in control of the flow of cooling medium through the condenser, means responsive to the temperature differential between the inlet and outlet of said condenser for controlling the flow controlling means, and means responsive to the pressure on the high pressure side of the compressor for also controlling the flow controlling means.

4. In a system of the class described, a cooling unit, a valve for controlling the flow of a cooling medium through said unit, said valve including a flow control member movable between positions of minimum and maximum flow, a pressure responsive device filled with an expansible fluid and responsive to the temperature of the cooling medium entering the cooling unit acting on said movable member to move said member to minimum flow position, a second pressure responsive device filled with an expansible fluid and responsive to the temperature of the cooling medium leaving the unit acting on said movable member to move said member to a maximum flow position, and a third pressure responsive device responsive to a condition indicative of a need for increased cooling by the cooling unit acting on said movable member to move said member toward maximum flow position as the need for further cooling by the cooling unit increases.

5. A control mechanism for a refrigeration system that includes a compressor for furnishing refrigerant to the system under high pressure and a condenser for the refrigerant cooled by the flow of a cooling fluid, comprising, in combination, a control valve for controlling the flow of cooling fluid, said valve including a means movable between positions of minimum and maximum flow, a temperature responsive device adapted to respond to the temperature of the fluid entering said condenser for moving said movable means towards minimum flow position upon rise in such temperature, a second temperature responsive device adapted to respond to the temperature of the fluid leaving said condenser for moving said movable means towards maximum flow position upon rise in the temperature of the fluid leaving the condenser, and pressure responsive means adapted to respond to the pressure of the refrigerant flowing to said condenser for moving said movable means towards maximum flow position upon increase in such pressure.

6. In a refrigerating system including a refrigerant condenser in the high pressure side of said system, in combination, means circulating a cooling fluid through said condenser for condensing said refrigerant, means controlling the rate of circulation of said fluid in response to the temperature change of said fluid as it passes through said condenser in such manner that the rate of flow is increased as said difference tends to increase, and means responsive to the demand for said cooling of the refrigerant in said condenser modifying the control exercised by said means controlling said rate of flow in such manner as to increase said rate of flow as said demand increases.

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