June 28, 1938. E. F. MILLER 2,122,210

COOLING APPARATUS

Filed May 22, 1934

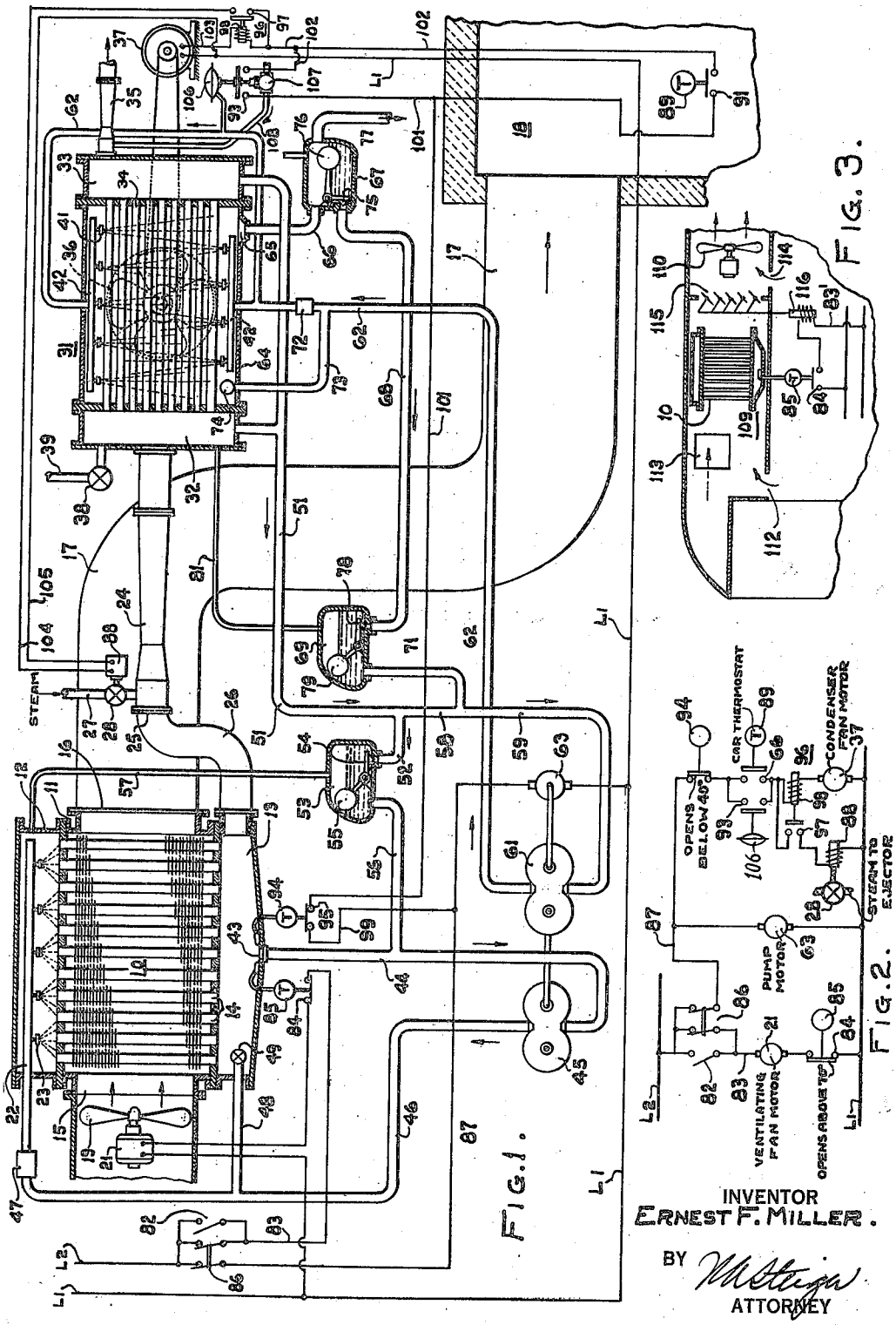


FIG. 1.

FIG. 2.

FIG. 3.

INVENTOR
ERNEST F. MILLER.

BY

ATTORNEY

Patented June 28, 1938 2,122,210

UNITED STATES PATENT OFFICE

2,122,210

COOLING APPARATUS

Ernest F. Miller, Prospect Park, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application May 22, 1934, Serial No. 726,939

14 Claims. (Cl. 62—6)

My invention relates to control mechanism, more particularly to control mechanism for vapor jet refrigerating apparatus, and it has for its object to provide improved control mechanism.

A further object is to provide mechanism for controlling the various operating devices of the refrigerating apparatus to provide automatic refrigerating action.

Another object is to provide vapor jet refrigerating apparatus for cooling air and means for shutting off circulation of air over the cooling element in the event that the jet in the ejector fails and causes heating of the cooling element.

A further object is to provide control mechanism, for vapor jet refrigerating apparatus, including automatic means for intermittently initiating and terminating cooling operation of the apparatus, a main switch for rendering the mechanism operable or inoperable, and means for establishing vacuum in the condenser as soon as the main switch renders the apparatus operable and independently of the action of the automatic means.

In accordance with my invention, I provide control mechanism including a main switch whereby the refrigerating apparatus may be either shut down or rendered operable. When this switch is positioned to render the apparatus operable, the control mechanism effects continuous operation of the pump for removing condensate from the condenser, and also of the pump for effecting circulation of chilled water through the evaporator when such pump is used. Thermostatic means responsive to refrigeration demand effects intermittent operation of the ejector and of the cooling fluid circulating means for the condenser. The thermostatic means is operable only when the main switch is positioned to render the apparatus operable.

I also provide means which operates, in case there is not sufficient liquid in the apparatus for cooling action when the main switch renders the apparatus operable, to provide the necessary liquid by condensing motive fluid supplied to the ejector.

I also provide means responsive to a high temperature of the liquid in the evaporator for terminating circulation of air over the cooling element, thereby preventing the delivery of heated air.

These and other objects are effected by my invention, as will be apparent from the following description and claims, taken in connection with the accompanying drawing forming a part of this application, in which:

Fig. 1 is a diagrammatic view, in elevation, of apparatus embodying my invention;

Fig. 2 is a straight line diagram of the control circuits; and,

Fig. 3 is a diagrammatic view of a modified air circulating arrangement.

Referring to the drawing in detail, I show an evaporator 10, which also serves, in this case, to cool air directly. The evaporator includes a casing 11, upper and lower headers 12 and 13, and cross finned tubes 14 extending between said headers and providing free communication therebetween. The interior of the headers and the tubes constitutes the evaporating chamber. The casing 11 is formed with an inlet 15 through which air to be cooled is conveyed to the evaporator and into contact with the outer surfaces of the tubes 14. The evaporator is also formed with an outlet 16, connected to a duct 17, through which the cooled air is delivered to an enclosure 18.

A fan 19, driven by an electric motor 21, is provided to effect said circulation of air. The enclosure 18 may be any enclosed space which is to be provided with cooled air; for example, it may be a space occupied by people, such as, the interior or passenger space of a railway passenger car.

Suitable spray means, such as a manifold 22 and a plurality of spray nozzles 23 mounted thereon, are provided in the upper header 12 and arranged to direct a spray of refrigerant liquid particles into the upper ends of the tubes 14. The refrigerant is usually water, which liquid will be referred to hereinafter without restricting the invention thereto. An ejector or thermal compressor 24 is provided to effect a reduced pressure within the evaporating chamber by removing vapor therefrom, and has its suction inlet 25 connected, in the illustrated embodiment, to the lower header 13 through a conduit 26. Vapor for motivating the ejector, usually steam, is supplied to the ejector through a conduit 27. A valve 28, operated by a solenoid 38, is provided to control the supply of steam through the conduit 27.

A condenser 31 is connected to the outlet of the ejector for condensing the vapor discharged therefrom, including the vapor withdrawn from the evaporator chamber and the expended motive fluid. The condenser includes headers 32 and 33, and tubes 34 extending therebetween. The headers and tubes contain the vapor to be condensed, the header 32 being connected to the ejector outlet. An auxiliary ejector 35 has its suction inlet connected to the header 33 for removing air and non-condensable gases from the condensing space of the condenser. The cooling fluid, which is preferably air, is circulated in contact with the outer surfaces of the tubes by a fan 36 driven by an electric motor 37. With the apparatus arranged as shown in Fig. 1, the fan 36 effects flow of air either forwardly or rearwardly.

The condenser is provided with a pressure relief valve 38, shown as connected to the header 32, and arranged to discharge steam through a conduit 39 to outdoors in the event that the pressure in the condenser assumes a dangerously high pressure, as by failure of the air removal means.

To increase the cooling effect, I provide evaporative cooling of the condenser tubes. Nozzles 41, carried by upper and lower manifolds 42, are provided to spray water into the circulating air stream and onto the outer surfaces of the tubes. The water is evaporated by the circulating air, thereby augmenting the cooling effect available for condensing vapor within the tubes.

The water circulating system provides circulation of water through the evaporator 10, a supply of condensate from the condenser 31 to the evaporator to relace evaporated water, and delivery under pressure to the condenser spray nozzles 41 of the remaining condensate and of unevaporated condenser spray water. The lower header 13 of the evaporator 10 is formed with a drain outlet 43 connected, through a conduit 44, to the inlet of a water circulating pump 45. The outlet of said pump is connected through a conduit 46 to the nozzle manifold 22. The conduit 46 is provided with a strainer 47. It may also be formed with a branch conduit 48 communicating with a pressure relief valve 49 disposed in the evaporating chamber, for example, in the lower header 13 of the evaporator. In the event of clogging of a number of nozzles 23 or of the strainer 35a sufficient to build up pressure within the conduit 46 to an undesirable point, the pressure relief valve 49 opens and discharges water into the lower header 13, thereby avoiding possible damage to the pump 45.

The condensate formed in the condenser 31 collects in the headers 32 and 33 which are connected to a drain conduit 51, through which the condensate flows downwardly by gravity. The conduit 51 is connected to the conduit 44, through parts presently described, for the purpose of supplying make-up water to the evaporator; that is, water for replacing that evaporated in the evaporator. The conduit 51 has a branch 52 which is connected to a float chamber 53. A float valve 54, actuated by a float member 55 within said chamber, controls the flow of liquid from the branch conduit 52 into the float chamber. The latter is connected through a conduit 56 with the conduit 44 for supplying liquid thereto. The float valve 54 serves to control the flow of condensate to the conduit 44 to maintain a predetermined level of liquid within the float chamber 53, the valve decreasing the flow of condensate as said level tends to rise and increasing said flow as the level tends to drop. The upper part of the float chamber 53 is connected to the evaporator, at any suitable point, such as, the header 12, through a vent pipe 57. The same level of liquid is maintained, therefore, within the conduit 44 and the float chamber 53.

The conduit 51 is also connected, through a connecting portion 58, to a conduit 59, which conveys the remaining condensate to the inlet of a circulating pump 61. The pumps 45 and 61 may be gear pumps, as shown, and are preferably driven by a common source of power, such as an electric motor 63. The pump 61 discharges water under pressure to a conduit 62, which conveys the same to the nozzle manifolds 42. Only a small portion of water sprayed onto the condenser tubes at one time is evaporated so that it is necessary to recirculate the unevaporated water. This water is collected by a drip pan 64 having a sump 65, from which it flows through a conduit 66, a float chamber 67, a conduit 68, a float chamber 69, and a conduit 71, to the conduit 59, in which it is added to the condensate flowing to the pump 61.

The conduit 62 is provided with a strainer 72. It is also provided with a branch conduit 73, located ahead of the strainer 72 and communicating with a pressure relief valve 74, which is arranged to discharge water onto the drip pan 64. The purpose of the pressure relief valve 74 is to prevent the building up of an undesirably high pressure, in the event of clogging of a number of nozzles 41 or of the strainer 72, which might damage the pump 61.

Within the float chamber 67 is a float valve 75 having a float member 76 controlled by the level of liquid in the float chamber. The purpose of the float valve 75 is to prevent the admission of air from the atmosphere to the condenser through the water-circulating conduits in the event that the quantity of unevaporated spray water in the float chamber 67 is insufficient to immerse the end of the conduit 68. As the water level in the float chamber 67 drops, due to any such insufficiency, the float member 76 moves the valve 75 in closing direction, thereby preventing drop in water level below a predetermined point. A drain conduit 77 is connected to the upper portion of the float chamber 67, to drain off excess water when the quantity of unevaporated spray water exceeds the quantity required by and admitted to the pump 61.

Within the float chamber 69, there is provided a float valve 78, the purpose of which is to limit the admission of unevaporated condenser spray water to the condenser 31 to an amount which, together with the condensate flowing thereto from the condenser, does not exceed the capacity of the pump 61, thereby assuring that all condensate will be removed from the condenser. The float valve 78 includes a float member 79 responsive to the level of liquid in the float chamber 69, which level is on the down stream side of the valve 78. Upon drop in water level, the valve 78 moves in opening direction to admit more water, tending to maintain said level substantially constant. The upper portion of the float chamber 69 is connected through a vent pipe 81 to the header 32 so that the liquid within the conduit 51 and the float chamber 69 will be at the same level. It will be apparent that condensate formed in the condenser 31 and not supplied to the conduit 44 may flow unrestricted to the pump 61. Any increase in the quantity of condensate will tend to raise the level of the liquid in the float chamber 69 and restrict the admission of unevaporated condenser spray water.

The operation of the refrigerating apparatus is as follows: The water sprayed from the nozzles 23 in the evaporator 10 flows downwardly through the interior of the tubes, a portion of said water being evaporated by the heat extracted from the air circulated over the tubes. The vapor is withdrawn from the evaporator by the ejector 24 and discharged, together with the expended motive fluid, into the condenser 31. The action of the ejector maintains a low absolute pressure in the evaporating chamber, thereby effecting cooling by evaporation of water. The unevaporated water collecting in the lower header 13 flows by gravity through the conduit 44 to the pump 45, by which it is circulated through the conduit 46 to the nozzles 23. The valve 54 is operated in response to the water level in the float chamber 53 to admit

a quantity of condensate from the condenser 31 which is sufficient to maintain said water level substantially constant and which replaces the water evaporated within the tubes 14.

The remainder of the condensate from the condenser flows unrestricted through the conduits 71 and 59 to the pump 61, by which it is circulated through the conduit 62 to the spray nozzles 41. From the latter, it is directed onto the exterior surfaces of the condenser tubes 34 to provide evaporative cooling of said tubes. The valve 78 is operated responsive to the level of water in the float chamber 69 to admit such quantity of unevaporated spray water as is required to maintain substantially a constant level, thereby providing the required amount of water to be circulated by the pump 61. When the supply of unevaporated spray water or other supply of additional liquid is less than the capacity of the pump 61, the valve 75 serves to prevent the entrance of air into the conduit 68, by closing in response to drop in level of water in the float chamber 67.

To the above described refrigerating apparatus, I supply the following control mechanism. Line conductors L_1 and L_2 provide a supply of electrical energy. A switch 82, preferably manually operated, is adapted to close a circuit 83 extending through the motor 21 which drives the ventilating fan 19. There is also interposed in the circuit 83 the contacts 84 of a thermostat 85, which is responsive to the termperature of water in the evaporator header 13, and which is constructed to open the contacts 84 when the temperature within the evaporator increases to a point where the air supplied to the enclosure 18 would be heated instead of cooled, which condition might occur if the ejector failed to establish ejecting action and permitted steam to flow into the evaporator. As will be apparent from the drawing, the circuit 83 extends from the line conductor L_2 through the switch 82, the contacts 84 and the motor 21 to the line conductor L_1.

There is also provided a two-pole main switch 86. This switch is adapted to render the refrigerating mechanism operable as long as it is closed and to render the apparatus inoperable when it is opened. It is also adapted to effect operation of the ventilating fan 19 as long as it is closed except when an excessively high temperature exists in the evaporator 10. One pole of this switch is in parallel with the switch 82 and is thereby adapted to effect operation of the ventilating fan 19 whenever the switch 86 is closed. The other pole of the switch 86 connects the line conductor L_2 to a conductor 87, through which current is supplied to the refrigerating apparatus. One terminal of the motor 63 is connected to the conductor 87 and the other terminal to the line conductor L_1 so that the motor 63 drives the pumps 61 and 45 as long as the main switch 86 is closed. The solenoid 88 which operates the valve 28 to supply steam to the ejector 24 and the motor 37 which drives the fan 36 for circulating air over the condenser are intended to be operated primarily in response to demand for refrigeration, in this case in response to a predetermined maximum temperature in the enclosure 18. Accordingly, a thermostat 89 is subjected to the temperature of the air in the enclosure, as by locating the thermostat at a point at which the temperature is representative of the average temperature in the enclosure. The thermostat is provided with contacts 91, which are adapted to be closed when the temperature reaches a predetermined maximum temperature indicating a demand for cooling action. Obviously, the thermostat 89 may be of any suitable type known in the art and may be adjustable to operate at different temperatures. There is also provided in parallel with the contacts 91 a set of contacts 93 actuated by a pressure-responsive element 106 in response to pressure in the conduit 62, the arrangement being such that the contacts 93 are opened when there is pressure in said conduit and closed in the absence of pressure therein. The purpose of this device is to admit steam to the ejector and condense the same in the condenser in order to provide the water necessary for operation of the apparatus, when there is not sufficient water, as will be further described hereinafter.

A thermostat 94 is responsive to the temperature of the water in the evaporator, and has contacts 95 which are arranged to open whenever the temperature of the water approaches the freezing point, for example, when the temperature of the water drops to 40° F., for the purpose of terminating the refrigerating action to prevent freezing.

In order to assure that there will be no steam flowing through the ejector except when the air circulating fan 36 for the condenser is operating, I may provide a relay 96 having contacts 97 in the circuit to the solenoid 88 and arranged to be closed by a solenoid 98 in the circuit to the motor 37 only when current is flowing to said motor.

The circuit for controlling operation of the condenser circulating fan includes the line conductor L_2, one pole of the switch 86, the conductors 87 and 99, the contacts 95, the conductor 101, the contacts 91 and 93 in parallel, a conductor 102, the solenoid 98, a conductor 103, the motor 37, and the line conductor L_1. The circuit for the solenoid 88 extends in common with the circuit for the motor 37 as far as the conductor 102, then through the contacts 97, a conductor 104, the solenoid 88, and a conductor 105 to the line conductor L_1.

I prefer to control the air ejector 35 in response to pressure within the conduit 62, for the reason that air leakage into the condensing space may take place through the pump 61 when the latter is not in operation. Accordingly, I arrange the pressure responsive element 106 to operate a valve 107 in the steam pipe 108 which supplies steam to the air ejector 35, said element being arranged to open said valve in response to pressure in the conduit 62 and to close said valve in the absence of pressure.

The operation of the above described apparatus is as follows: the fan 19 may be operated for ventilation of the closure 18, without any cooling, by closing the switch 82, which closes the circuit 83 to energize the motor 21.

If cooling action is desired, the switch 86 is closed, which also closes the circuit 83 to energize the motor 21. Thus, the fan 19 operates to circulate air through the evaporator and to the enclosure 18 during the full period that the switch 86 is closed to render the refrigerating apparatus operable, with the exception referred to when the temperature in the evaporator becomes too high, in which case the thermostat opens its contacts 84 to terminate circulation of the air. In the latter case, the delivery of heated air to the enclosure 18 is avoided.

Upon closure of the switch 86, the motor 63 immediately initiates operation of the pumps 45 and 61. Assuming the apparatus to contain sufficient water for cooling action, water is circulated through the evaporator 10 by the pump 45 and spray water is supplied to the condenser

by the pump 61. As soon as pressure is developed in the conduit 62 by the pump 61, the pressure responsive device 106 opens the valve 107 to supply steam to the air ejector 35, whereupon vacuum is established in the condensing space of the condenser. As soon as the necessary vacuum is established, the apparatus is ready for cooling action. At the moment that the switch 86 is closed, the contacts 93 will also be closed due to the absence of pressure in the conduit 62. Accordingly, the condenser fan 36 will be operated and steam will be momentarily admitted to the ejector 24. However, the pressure in the conduit 62 will be promptly established, whereupon the contacts 93 will be opened to discontinue operation of the fan 36 and admission of steam to the ejector 24, unless the thermostat 89 is calling for cooling.

The apparatus now operates in response to demand for cooling within the enclosure 9. When the temperature in the enclosure is above a predetermined temperature, the thermostat 89 closes its contacts to effect admission of steam to the ejector 24 and operation of the fan 36, whereupon the refrigerating apparatus operates in the manner above described to cool the air circulated over the tubes 14 by the fan 19. When the temperature in the enclosure has been brought to a sufficiently low temperature, the thermostat 89 opens its contacts 91 to discontinue cooling action. Circulation of water through the evaporator and the supply of water to the nozzles 41 continues, however, in order to maintain the pumps 45 and 61 sealed, that is, to prevent the admission of air from atmosphere into the vacuum spaces of the apparatus. The air ejector 35 also continues to maintain the condenser vacuum.

In the event that the temperature of the chilled water should, for some reason, decrease to 40° F., a thermostat 94 opens the contact 95 to discontinue refrigerating action until the temperature of the water in the evaporator increases to a temperature above 40° F.

Inasmuch as the present apparatus is adapted particularly to the cooling of railway passenger cars, the water may be drained from the apparatus when the car is subjected to cold weather, in order to prevent the possibility of freezing of the water and damage to the apparatus. The present apparatus is adapted to operate automatically to provide the necessary quantity of water upon the switch 86 being closed. As described, as soon as the switch 86 is closed, the pressure responsive device 106 closes the contacts 93 to effect admission of steam to the ejector and operation of the fan 36 to effect condensation of steam. If there is insufficient water in the apparatus, the pump 61 fails to build up sufficient pressure in the conduit 62, so that the pressure responsive element 106 maintains the contacts 93 closed. Consequently, admission of steam to the ejector and condensation thereof in the condenser continues until there is sufficient water, at which time pressure will be built up in the conduit 62. The pressure-responsive element then opens the contacts 93, whereupon further condensation ceases unless the thermostat 89 is calling for cooling. The ejector 35 is also started to establish vacuum in the condenser, as already described.

In Fig. 3, I show a modified arrangement for preventing the circulation of heated air in the event of entry of motive fluid into the evaporator. This construction is shown as applied to a railway passenger car. The evaporator 10, which is connected to an ejector and constructed similarly to the first embodiment, is disposed in a duct or passage 109 through which air is circulated by a fan 110. Air returned from the conditioned enclosure is admitted to the passage through an opening 112 and fresh air is admitted through an opening 113 into the left-hand end of the passage to be cooled by the evaporator 10. An opening 114 is also provided to admit air returned from the conditioned enclosure to the passage 109 between the evaporator 10 and the fan 110. A damper 115, which may comprise a series of louvers or vanes, is provided in the passage 109 between the evaporator 10 and the opening 114. This damper is adapted to be closed by a solenoid 116 disposed in a circuit 83'. The circuit 83' is controlled by the contacts 84 of a thermostat 85, which is responsive to temperature in the evaporator 10, similarly to the first embodiment.

In normal operation, the damper 115 is open, and return and fresh air is conveyed over the tubes of the evaporator 10 to be cooled and then conveyed by the fan 110 to the space to be air conditioned. Additional air from the enclosure may also be admitted through the opening 114 to provide the desired amount of ventilation. In the event that motive fluid for the ejector enters the evaporator 10, the thermostat 85 closes the contacts 84, whereupon the solenoid 116 closes the damper 115, thereby shutting off circulation of air over the heated tubes of the evaporator. The fan 110 continues to circulate air through the air conditioned space for ventilation, all of the air in this case being admitted through the opening 114. If desired, a damper may be provided for the opening 114, which damper would be closed when the damper 115 is open, and vice versa. The advantage of the embodiment of Fig. 3 is that ventilation of the air conditioned space is maintained while the circulation of heated air is prevented.

From the above description, it will be seen that I have provided apparatus whereby circulation of air over the evaporator and to the enclosure to be cooled is discontinued in the event that relatively hot motive fluid enters the evaporator 10; wherein operation of the air removal means for the condenser is normally initiated promptly after closing of the main switch; wherein the mechanism operates automatically to provide the necessary water in case the apparatus has been drained; and wherein the refrigerating action is discontinued temporarily in case of excessively cold temperature of the water in the evaporator.

While I have shown my invention in several forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be imposed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. In vapor jet cooling apparatus, the combination of an evaporator, an ejector having nozzles adapted to be connected to a source of condensable motive fluid, a condenser for said ejector for condensing fluid discharged by said ejector, means for supplying the liquid required in the apparatus from the condensate from said condenser, and means operating automatically in response to deficiency of liquid in the apparatus for effecting admission of motive fluid to said nozzles, not-

withstanding absence of sufficient vacuum in the condenser for cooling action, in order to provide the liquid required in the apparatus to initiate cooling action thereof.

2. In vapor jet cooling apparatus, the combination of an evaporator, an ejector having nozzles adapted to be connected to a source of condensable motive fluid, a condenser for condensing fluid discharged by said ejector, means for supplying the liquid required in the apparatus from the condensate from said condenser, control means for rendering the apparatus operable or inoperable, and means effective, whenever said control means renders the apparatus operable and the quantity of liquid in the apparatus is insufficient for cooling action, and notwithstanding absence of sufficient vacuum in the condenser for cooling action, to provide the required amount of liquid by condensing fluid from said motive fluid source.

3. In air cooling apparatus, the combination of a cooling element, means for circulating air in direct contact with said cooling element, and means responsive to a predetermined maximum temperature of said cooling element to prevent operation of said air-circulating means.

4. In vapor jet refrigerating apparatus, the combination of means including an evaporating chamber for cooling air, means for circulating air in direct contact with said air-cooling means, an ejector for removing vapor from said evaporating chamber to effect cooling therein, and means responsive to a predetermined maximum temperature in said evaporating chamber for terminating operation of said air circulating means.

5. In air cooling apparatus, the combination of a cooling element, means providing circulation of air in direct contact with said cooling element, and means responsive to a predetermined maximum temperature of said cooling element to discontinue circulation of air in heat-exchanging relation with said cooling element.

6. In air cooling apparatus for an enclosure, the combination of a cooling element, means for effecting circulation of air through the enclosure and in heat-exchanging relation with said cooling element, and means responsive to a predetermined maximum temperature of said cooling element to discontinue circulation of air in heat-exchanging relation with said cooling element while permitting circulation of air through said enclosure to continue.

7. In vapor jet cooling apparatus, the combination of an evaporator, an ejector having nozzles adapted to be connected to a source of condensable motive fluid, a condenser for said ejector for condensing fluid discharged by said ejector, means for supplying the liquid required in the apparatus from the condensate from said condenser, and means operating automatically in response to deficiency of liquid in the system for effecting admission of motive fluid to said nozzles in order to provide the liquid required in the apparatus to initiate cooling action thereof.

8. In vapor jet refrigerating apparatus, the combination of an evaporator, an ejector for withdrawing vapor from the evaporator, a condenser for the ejector, cooling fluid circulating means for the condenser, a condensate removal pump for the condenser, a switch adapted in a first position to render the refrigerating apparatus operable and to effect continuous operation of the condensate removal pump and in a second position to render the refrigerating apparatus and condensate removal pump inoperable, automatic means operable in response to cooling requirements, when said switch is in said first position and renders the apparatus operable, to effect admission of motive fluid to the ejector and to effect operation of said cooling fluid circulating means, and means operable automatically to effect admission of motive fluid to the ejector and to effect operation of said cooling fluid circulating means in response to a predetermined minimum pressure of fluid developed by said condensate removal pump and independently of the action of said automatic means, when said switch is in said first position to render the apparatus operable.

9. In vapor jet refrigerating apparatus, the combination of an evaporator, an ejector, a condenser, air removal means for the condenser, other means for removing condensate from the condenser, and means operable automatically upon effectiveness of the condensate removal means for effecting operation of the air removal means.

10. In vapor jet refrigerating apparatus, the combination of an evaporator, an ejector, a condenser, a mechanical condensate removal pump having its inlet connected to the condensing space of the condenser for receiving condensate therefrom, and means responsive to pressure developed by said pump for automatically effecting operation of said air removal means.

11. In vapor jet refrigerating apparatus, the combination of an evaporator, an ejector, a condenser, an ejector for removing air from the condenser, a mechanical condensate removal pump having its inlet connected to the condensing space of the condenser for receiving condensate therefrom, and means responsive to pressure developed by said pump for automatically controlling the supply of motivating fluid to said air removal ejector.

12. In air cooling apparatus, the combination of a refrigerant evaporator, means for removing vapor from said evaporator to effect cooling by vaporization of liquid therein, means providing circulation of air in direct contact with said evaporator, and means responsive to a predetermined maximum temperature of said evaporator to discontinue circulation of air in contact with said evaporator.

13. In air cooling apparatus, the combination of an evaporator, a vapor motivated ejector for withdrawing vapor from said evaporator to effect cooling by evaporation of liquid therein, and means responsive to a predetermined maximum temperature of said evaporator to discontinue circulation of air in contact with said evaporator.

14. In vapor jet refrigerating apparatus, the combination of an evaporator, a vapor motivated ejector connected thereto, a condenser for condensing the fluid exhausted from said ejector, a pump having its inlet connected to said condenser for removing condensate therefrom, control means for rendering said ejector operable or inoperable and for effecting operation of said pump simultaneously with rendering said ejector operable, and means operable automatically in response to a predetermined minimum pressure developed by said pump for effecting admission of motive fluid to said ejector to provide liquid by condensation of motive fluid in said condenser.

ERNEST F. MILLER.

DISCLAIMER

2,122,210.—*Ernest F. Miller*, Prospect Park, Pa. COOLING APPARATUS. Patent dated June 28, 1938. Disclaimer filed August 3, 1939, by the assignee, *Westinghouse Electric & Manufacturing Company*.

Hereby enters this disclaimer to claims 3, 5, and 12 in said specification.

[*Official Gazette August 22, 1939.*]