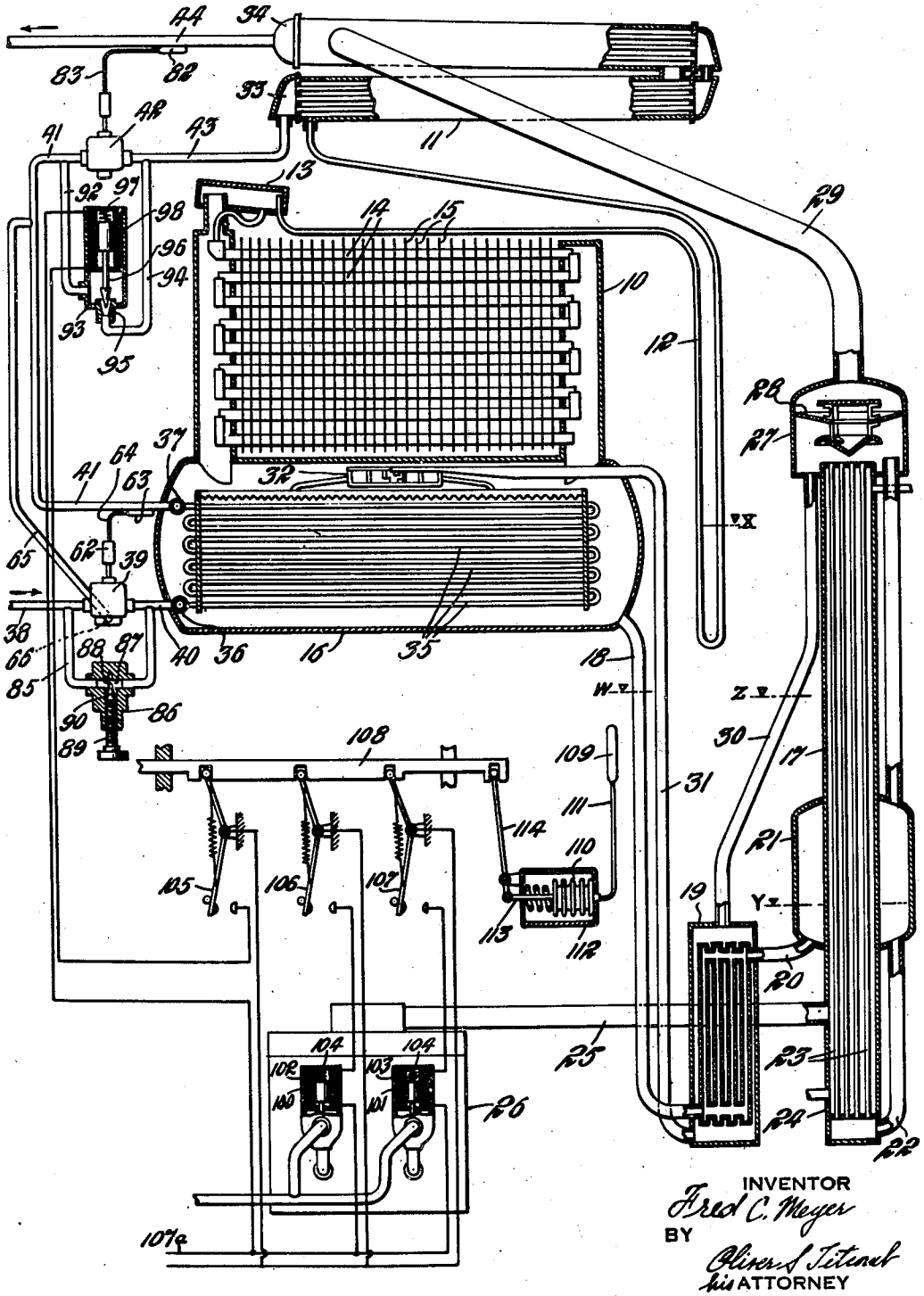
Aug. 30, 1949. F. C. MEYER 2,480,497

REFRIGERATION APPARATUS INCLUDING A SYSTEM FOR COOLING PARTS THEREOF

Filed July 28, 1945 2 Sheets-Sheet 1

Fig. 1.



INVENTOR
Fred C. Meyer
BY
Oliver J. Titcomb
his ATTORNEY

Aug. 30, 1949. F. C. MEYER 2,480,497

REFRIGERATION APPARATUS INCLUDING A SYSTEM FOR COOLING PARTS THEREOF

Filed July 28, 1945 2 Sheets-Sheet 2

Fig. 2.

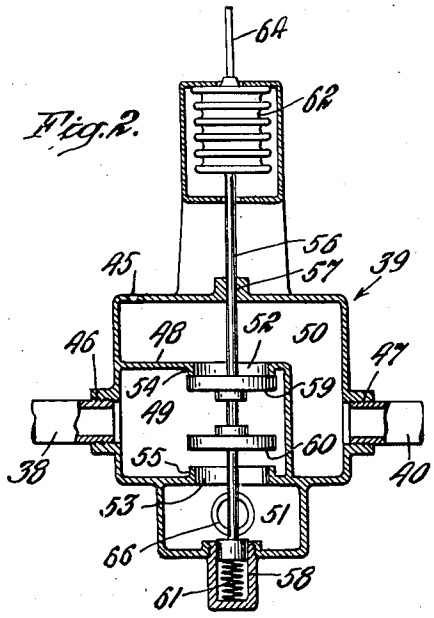


Fig. 3.

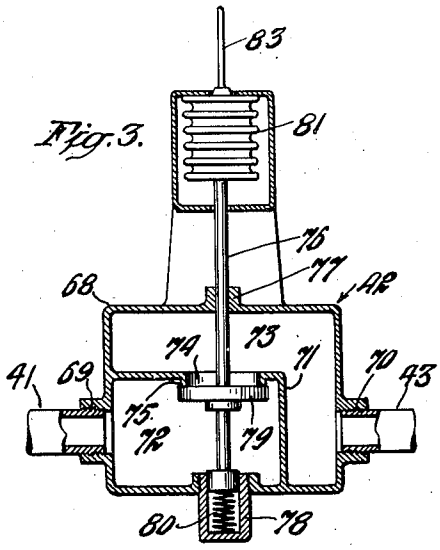
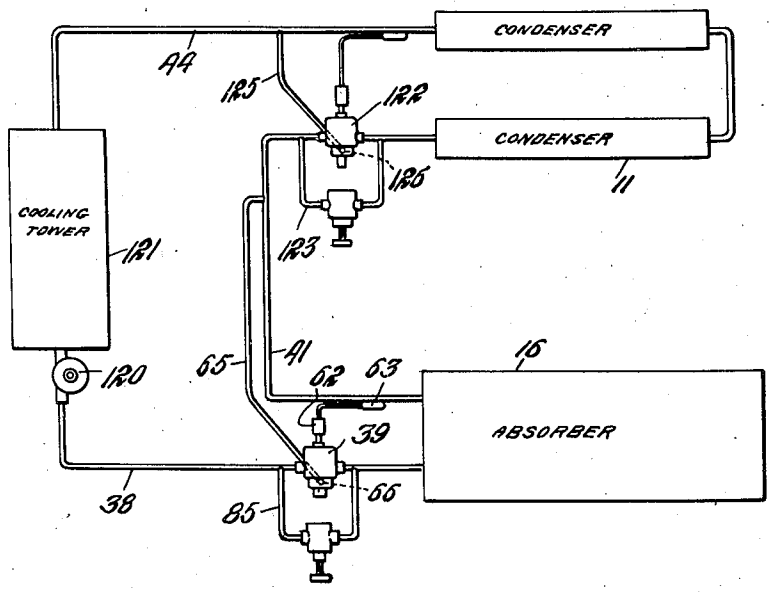


Fig. 4.



INVENTOR.
Fred C. Meyer

BY

Oliver & Titcomb
his ATTORNEY

Patented Aug. 30, 1949

2,480,497

UNITED STATES PATENT OFFICE

2,480,497

REFRIGERATION APPARATUS, INCLUDING A SYSTEM FOR COOLING PARTS THEREOF

Fred C. Meyer, Dayton, Ohio, assignor to Servel, Inc., New York, N. Y., a corporation of Delaware

Application July 28, 1945, Serial No. 607,574

18 Claims. (Cl. 62—5)

1

The present invention relates to refrigeration and more particularly to a "cooling water system" for supplying cooling medium to one or more elements of a refrigeration system as needed. The term "cooling water system" is used generically and is intended to include any cooling medium.

One of the objects of the present invention is to control the flow of cooling medium through an element of a refrigeration system in accordance with the temperature of the medium leaving the element.

Another object of the invention is to provide a cooling water system for causing the flow of cooling medium through a plurality of elements in succession and separately controlling the flow through each element.

Another object is to circulate a limited amount of cooling medium through each element so that each control is immediately responsive to temperature changes in the element.

Another object is to provide a cooling water system of the type indicated which is adapted to supply cooling medium to the second of a plurality of elements when the main path of flow through the first element is closed.

Still another object is to provide a system of the type indicated in which the flow of cooling medium is automatically stopped during an off cycle of the refrigeration apparatus and automatically started at the beginning of an on cycle of the refrigeration apparatus.

These and other objects will become more apparent from the following description and drawings in which like characters denote like parts throughout the several views. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and not a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawings:

Fig. 1 is a diagrammatic view of an absorption refrigeration system showing the cooling water system of the present invention applied to use with city water;

Fig. 2 is a sectional view of the valve for controlling the flow of cooling medium through the absorber;

Fig. 3 is a sectional view of the valve for controlling the flow of cooling medium through the condenser; and

Fig. 4 is a diagrammatic view of a modified cooling system to adapt it for use with a cooling tower.

While the present invention may be applied to use with any refrigeration system having an element or elements cooled by circulating water, it is illustrated in Fig. 1 as applied to an absorption refrigeration system of the type illustrated and described in the United States Letters Patent to Albert R. Thomas et al., No. 2,282,503 entitled "Refrigeration." In a system of this type liquid refrigerant such as, for example, water is introduced into the upper part of an evaporator or cooling element 10 from a condenser 11 through a path of flow including a U-shaped tube 12 and flash chamber 13. The liquid refrigerant evaporates at a low pressure and temperature in the evaporator 10 with consequent absorption of heat from the ambient, such as a stream of air flowing over the exterior surface of the tubes 14 and fins 15 of the evaporator. The refrigerant vapor formed in the evaporator 10 flows to an absorber 16 in which the vapor is absorbed into a liquid absorbent such as, for example, a water solution of lithium chloride, lithium bromide, or the like.

2

The absorption liquid enriched with refrigerant is conductedfrom the absorber 16 to a generator 17 in a path of flow including a conduit 18, liquid heat exchanger 19, conduit 20, vessel 21 and conduit 22. Within the generator 17, a plurality of riser tubes 23 are enclosed within a shell 24 forming a chamber to which steam is supplied through a conduit 25 from a boiler 26. The heating of the riser tubes 23 by the steam causes refrigerant vapor to be expelled from the absorption solution and the expelled vapor is effective to raise the absorption liquid by gas or vapor lift action.

The expelled vapor passes from the upper ends of the riser tubes 23 into a vapor separatnig chamber 27 having baffles 28 therein and thence flows through a conduit 29 to the condenser 11 in which the vapor is liquefied. The liquid refrigerant formed in the condenser 11 flows by gravity into the U-shaped tube 12 to the upper part of the evaporator 10 as explained above to complete the refrigerating cycle.

The raised absorption liquid from which refrigerant vapor has been expelled is conducted from the upper part of the generator 17 to the absorber 16 to absorb refrigerant vapor, this liquid being conducted to the absorber in a path of flow including a conduit 30, liquid heat exchanger 19 and conduit 31, which delivers the liquid to a distributor 32 in the top of the absorber.

The system operates in a partial vacuum with generator 17 and condenser 11 operating at one pressure and evaporator 10 and absorber 16 operating at a lower pressure. The pressure differ-

ential between the high and low pressure sides of the system is maintaned by liquid columns in the up-leg of the U-shaped tube 12 between the condenser 11 and evaporator 10 and in the conduits 18 and 31 connecting the absorber 16 and heat exchanger 19. The liquid level in the U-shaped tube 12 is indicated by the reference character X; the liquid levels in the conduit 18 and vessel 21 connected thereto through the heat exchanger 19 are indicated by the reference characters W and Y; and the liquid level in the conduit 30 connected to the conduit 31 through the heat exchanger 19 is indicated by the reference character Z.

In an absorption refrigeration system as described above, the heat of condensation must be removed from the condenser 11 and the heat of absorption of refrigerant vapor in the absorbent must be removed from the absorber 16. As illustrated in Fig. 1, a surface type condenser is provided having inlet and outlet headers 33 and 34 connected by tubes for circulating a cooling medium therethrough. In the absorber 16 a bank of pipes or coils 35 are provided for circulating a cooling medium and the bank of coils are connected by an inlet header 36 and an outlet header 37. The bank of coils 35 are positioned directly below the liquid distributor 32 in the absorber 16 so that absorption solution trickles over the exterior of the cooling coils to facilitate the transfer of heat.

In accordance with the present invention, a novel cooling water system and control is provided for supplying a cooling medium such as water to the bank of coils 35 in the absorber 16 and to the condenser 11 as needed. The cooling medium may be supplied from a city main as illustrated in the embodiment of the invention illustrated in Fig. 1 or may be supplied from a cooling tower as illustrated in Fig. 4.

Referring to the embodiment of the invention illustrated in Fig. 1, the cooling medium is supplied under pressure from a city main, or the like, to the inlet header 36 in the absorber 16 in a main path of flow including the conduit 38, valve 39 and conduit 40. The cooling medium flows from the outlet header 37 of the bank of coils 35 in the absorber 16 to the inlet header 33 of the condenser 11 in a path of flow including the conduit 41, valve 42 and conduit 43. Cooling medium flows from the outlet header 34 of the condenser 11 through a conduit 44 which may be connected to a waste pipe or the like. The flow of cooling medium through the coils 35 in the absorber 16 is controlled by the valve 39 and the flow of cooling medium through the condenser 11 is controlled by the valve 42.

The control valve 39, illustrated in detail in Fig. 2, comprises a valve body 45 having an inlet port 46 and an outlet port 47 for connection with the conduits 38 and 40, respectively. A septum 48 in the valve body 45 divides the interior into three separate chambers 49, 50 and 51. The septum has ports 52 and 53 connecting the chamber 49 with the chambers 50 and 51 and is provided with valve seats 54 and 55 surrounding the ports. A valve stem 56 slides in guideways 57 and 58 at the top and bottom of the valve body 45 and mounts valve plates 59 and 60. The valve stem 56 is moved to the position illustrated in Fig. 2 by a spring 61 in the guideway 58 to close the port 52 and is operated in the opposite direction by a thermostat to open the port.

The thermostat comprises a bellows 62 connected to the valve stem 56 and a bulb 63 connected to the bellows by a capillary tube 64, see Fig. 1. The bellows 62, bulb 63 and capillary tube 64 contain an expansible fluid which when heated expands the bellows to depress the valve stem 56. The bulb 63 of the thermostat is arranged in heat conducting relationship with the conduit 41 so that operation of the thermostat is responsive to the temperature of the cooling medium leaving the absorber 16. When the temperature of the cooling medium leaving the absorber 16 is sufficiently low, the valve plate 59 engages the valve seat 54 to close the port 52, see Fig. 2, but when the temperature of the cooling medium leaving the absorber increases to a predetermined value the thermostat operates the valve stem 56 to open the port 52.

Cooling medium also is supplied to the condenser 11 through a branch conduit 65 connected between an outlet port 66 in the valve body 45 and the conduit 41. When the valve stem 56 is in the position illustrated in Fig. 2, cooling medium entering the chamber 49 of the valve 39 from the inlet conduit 38 will flow through the port 53 and into the chamber 51. The cooling medium then will flow from the chamber 51 through the outlet port 66 and conduit 65 to the conduit 41. Thus, the cooling water system of the present invention includes a branch for delivering cooling medium through the absorber 16 and a branch for delivering cooling medium around the absorber for supplying it to the condenser 11 without first passing through the absorber. When the stem 56 of the valve 39 is first operated by the bellows 62, cooling medium may flow from the chamber 49 through both of the ports 52 and 53 to the chambers 50 and 51 and from the chambers through both branches. When the valve stem 56 is operated by the bellows 62 to engage the valve plate 60 with the valve seat 55 all of the cooling medium flows through the port 52 and conduit 40 to the banks of coils 35 in the absorber 16 and thence flows through the conduit 41 to the condenser 11.

The valve 42 for controlling the flow of cooling medium through the condenser 11 is shown in detail in Fig. 3. The valve 42 comprises a housing 68 having an inlet port 69, outlet port 70 and a septum 71 for dividing the interior of the housing into chambers 72 and 73. The septum 71 has a port 74 with a valve seat 75 surrounding the port. A valve stem 76 is slidably mounted in guides 77 and 78 in the valve housing 68 and mounts a valve plate 79 for engagement with the valve seats 75. The valve stem 76 is operated to the closed position illustrated in Fig. 3 by a spring 80 and is operated to open the valve by the bellows 81 of a thermostat. The thermostat comprises the bellows 81 connected to operate the valve stem 76 and a bulb 82 connected to the bellows through the capillary tube 83, see Fig. 1. The bellows 81, bulb 82 and capillary tube 83 contain an expansible fluid and the bulb is arranged in heat conducting relation to the conduit 44 so that the valve plate 79 is opened in response to a predetermined temperature of the cooling medium leaving the condenser 11. As the movement of the valve plate 79 is directly proportional to the temperature of the cooling medium leaving the condenser 11, it will supply cooling medium to the condenser in direct proportion to the need. It will be observed that in accordance with the cooling system as thus far described, the flow of cooling medium through the coils 35 in the absorber 16 and through the condenser 11 is controlled individually by the valves 39 and 42 in

accordance with the need, as determined by the temperature of the cooling medium leaving the elements.

The cooling water system of the present invention also provides for bypassing a small amount of cooling medium around the valves 39 and 42 to cause circulation in the absorber coils 35 and condenser 11. The purpose of such circulation is to render the thermostat bulbs 63 and 82 immediately responsive to temperature changes in the absorber 16 and condenser 11. The bypass around the valve 39 comprises a conduit 85 having its opposite ends connected to the conduits 38 and 40, see Fig. 1. A manually adjustable valve 86 is provided in the bypass conduit 85 for permitting the flow of a predetermined small amount of cooling medium through the coils 35 in the absorber 16. The bypass valve 86 has a passageway 87 therein with a conical valve seat 88 and a screw-threaded valve stem 89 provided with a tapered end 90 for cooperation with the valve seat 88. By turning the valve stem 89, the amount of cooling medium flowing through the bypass conduit 85 may be adjusted.

A similar bypass is provided around the valve 42 and comprises a conduit 92; a valve 93 and a conduit 94. One end of the conduit 92 is connected to the conduit 41 adjacent the valve 42 and its opposite end is connected to the inlet port of the valve 93. The conduit 94 is connected between the outlet port of the valve 93 and the conduit 43 adjacent the valve 42. Valve 93 is provided with a conical valve seat 95 and a valve stem 96 having a conical end for cooperation with the valve seat. A spring 97 operates the valve stem 96 to close the valve and a solenoid winding 98 surrounds the valve stem and is operative when energized to actuate the valve stem against the action of the spring 97 to open the valve.

The valve 93 is closed by the spring 97 to prevent the circulation of any cooling medium during an off cycle of the refrigeration system and is opened by the solenoid winding 98 to open the bypass during an on cycle of the refrigeration system. The solenoid winding 98 is connected in the electrical control circuit for the refrigeration apparatus including the electromagnetically operated fuel valves 100 and 101. The fuel valves 100 and 101 are similar to the valve 93 and include solenoid windings 102 and 103 for opening the valves and springs 104 for closing the valves. The energization of the solenoids 98, 102 and 103 of the valves 93, 100 and 101 is controlled by toggle switches 105, 106 and 107 arranged in parallel branch circuits connected to the line 107*a*. The switches 105, 106 and 107 are operated by a slidable bar 108 and the arrangement of the switches is such that the switches 105 and 106 will be closed simultaneously while the closing of the switch 107 requires additional movement of the bar. The bar 108*a* is actuated to open or close the switches 105, 106 and 107 by a thermostat including a bulb 109, a bellows 110 and a capillary tube 111 connecting the bulb and bellows. One end of the bellows 110 abuts the end of a casing 112 and its opposite end is connected by a rod 113 to one end of a lever 114 pivotally connected to the casing 112 intermediate its ends. The bulb 109 of the thermostat is responsive to the temperature of the air flowing through the evaporator tubes 15 and upon an increase in the temperature the thermostat bellows 110 will operate through the rod 113, lever 114 and bar 108 to close the switches 105 and 106. Upon a further increase in temperature, the thermostat is

operative through the rod 113, lever 114 and bar 108 to close the switch 107. One embodiment of the invention now having been described in detail the mode of operation of the cooling water system is explained as follows.

For purposes of description, let it be assumed that the refrigeration apparatus is on an off-cycle at which time the temperature of the air to be conditioned is at the desired low temperature, the switches 105, 106 and 107 are open and the bypass valve 93 is closed so that no cooling medium is circulating in the cooling water system. As no heat is being transferred in the absorber 16 and condenser 11 the temperature of the cooling medium in the conduits 41 and 44 is sufficiently low so as to maintain the valves 39 and 42 in the closed positions illustrated in Figs. 2 and 3.

Upon a predetermined increase in the temperature of the air to be conditioned the fluid in the thermostat bulb 109 will expand the bellows 110 which operating through the rod 113, lever 114 and bar 108 will actuate the switches 105 and 106 to closed position. Closing of the switch 105 will energize the solenoid winding 98 to open the bypass valve 93 against the action of the spring 97. When the bypass valve 93 is opened, a limited amount of the cooling medium will flow through the valve 86 in the bypass conduit 85 to cause a circulation of the cooling medium through the cooling coils 35 in the absorber 16. The cooling medium leaving the coils 35 in the absorber 16 will flow through the conduit 41, conduit 92, valve 93 and conduit 94 of the bypass around the valve 42 and then through the conduit 43 to the condenser 11. Flow of a limited amount of the cooling medium through the by-pass around the valve 42 will cause a circulation of cooling medium in the condenser 11. The cooling medium is circulated in the absorber 16 and condenser 11 so that the bulbs 63 and 82 of the valve operating thermostats will respond quickly to any temperature change in the absorber and condenser.

Simultaneously with the opening of the bypass valve 93 the solenoid winding 102 is energized by the closing of the switch 106 to open the fuel valve 100. When the fuel valve 100 has been opened, heat will be supplied to the boiler 26 to generate steam which will flow through the conduit 25 to the generator 17. Steam in the generator 17 expels refrigerant vapor from the absorption liquid in the tubes 23 which rises through the tubes to the separating chamber 27. The refrigerant vapor rising in the tubes 23 also acts to lift the absorption solution by a vapor lift action into the separating chamber 27. The refrigerant vapor then flows through the conduit 29 to the condenser 11 where it is condensed to a liquid by the transfer of heat to the cooling medium flowing therethrough. Liquid refrigerant in the condenser 11 then flows through the U-shaped tube 12 to the evaporator 10 where it evaporates at low pressure and temperature to produce the refrigerating effect. The refrigerant vapor in the evaporator 10 flows to the absorber 16 where it is absorbed in the weak absorption solution flowing thereto from the separating chamber 27 of the generator through a path of flow including the conduit 30, liquid heat exchanger 19, conduit 31 and liquid distributor 32. The heat caused by the absorption of refrigerant vapor in the weak absorption solution is transferred to the cooling medium in the coils 35 in the absorber.

The transfer of heat from the refrigerant vapor in the condenser 11 increases the temperature of

the cooling medium flowing therethrough and exhausting through the conduit 44. When the temperature of the cooling medium leaving the condenser 11 rises to a predetermined value, the fluid in the thermostat bulb 62 in contact with the conduit 44 will expand the bellows 81 of the thermostat, see Fig. 3, to depress the valve stem 76 against the action of the spring 80 to open the port 74. Cooling medium then will flow from the conduit 41 into the chamber 72 of the valve 42 and through the port 74 to chamber 73 and thence through the conduit 43 to the condenser 11. Cooling medium is supplied to the conduit 41 either through the absorber 16 or through the branch conduit 65 connected to the port 66 of the valve 39. It will be apparent that even though the port 52 of the valve 39 is closed an ample supply of cooling medium will be supplied to the conduit 41 through the conduit 65. Referring to Fig. 2 of the drawings, cooling medium from the supply main enters the chamber 49 of the valve 39 through the conduit 38 and thence flows through the port 53 to the chamber 51 and from the chamber 51 through the conduit 65 to the conduit 41. As the temperature of the cooling water leaving the condenser 11 continues to increase the valve 79 will continue to open the port 74 until the temperature of the medium leaving the condenser is reduced to a predetermined value. It will be apparent, therefore, that the valve 42 is modulated in response to the temperature of the cooling medium leaving the condenser 11 to supply the cooling medium to the condenser as needed.

When the temperature of the cooling medium leaving the coils 35 in the absorber 16 rises to a predetermined value the thermostat bulb 63 in contact with the conduit 41 adjacent the absorber will expand the bellows 62 to depress the valve stem 56 against the action of the spring 61 to open the port 52, see Fig. 2. Cooling medium then flows through the conduit 38 into the chamber 49 and through the port 52 to the chamber 50 and thence flows through the conduit 40 to the header 36 connecting the banks of coils 35. Simultaneously with the opening of the port 52 by the movement of the valve plate 59, the valve plate 60 on the valve stem 56 moves to close the port 53. As the temperature of the cooling medium leaving the coils 35 of the absorber 16 continues to increase the valve stem 56 of the valve 39 will be depressed until the port 52 is fully open and the port 53 is completely closed. As the thermostat bulb 63 is responsive to the temperature of the cooling medium leaving the absorber 16, the valve 39 will be modulated to supply cooling medium to the absorber as needed.

If the temperature of air to be conditioned continues to rise the thermostat bellows 110 will operate the bar 108 to close the switch 107 to energize the solenoid winding 103 and open the fuel valve 101. Upon an increase in the heat supplied to the boiler 26 more steam will be supplied to the generator 17, more refrigerant vapor will be expelled in the generator and more heat will be transferred in the condenser 11 and absorber 16. Such increase in the heat transfer in the condenser 11 and absorber 16 will increase the temperature of the cooling medium flowing from the absorber and condenser, respectively, and the thermostat bulbs 63 and 82 being responsive to the temperature of the cooling medium in the conduits 41 and 44 will operate the valves 39 and 42 to supply cooling medium to the elements as needed.

In Fig. 4, a cooling water system of modified arrangement is illustrated to adapt the present invention for use with a cooling tower. The modified arrangement in Fig. 4 is applied to the refrigeration system of Fig. 1, but in the illustrated embodiment only the absorber 16 and condenser 11 are shown. In this modification, however, the conduit 38 is connected to the outlet of a pump 120 for receiving liquid from a cooling tower 121 and the conduit 44 from the outlet of the condenser 11 is connected to return the cooling medium to the cooling tower. The conduit 38 is connected to the absorber through the valve 39 and bypass 85 in a manner identical with that illustrated and described in the embodiment of the invention illustrated in Fig. 1. The valve 39 is controlled by the same thermostat including the bulb 63 in heat conducting relationship with the conduit 41 and the bellows 62. The port 66 of the valve 39 is connected to the conduit 41 by the same branch conduit 65. In place of the valve 42, however, a valve 122 and bypass 123 identical with the valve 39 and bypass 85 are provided between the conduit 41 and conduit 44. A branch conduit 125 connects the outlet port 126 of the valve 122 with the conduit 44.

In the modified arrangement illustrated in Fig. 4, the cooling tower 121, conduits 38 and 44 together with the paths of flow through the absorber 16 and condenser 11 provide a closed circuit for the recirculation of the cooling medium. Cooling medium is supplied to the absorber through the bypass 85 and valve 39 in the manner as explained with respect to the embodiment of the invention illustrated in Fig. 1. Cooling medium is supplied to the condenser 11 through one or the other of the branch conduits 41 and 65 and thence through the bypass 123 and valve 122. If both of the valves 39 and 122 are closed a limited amount of cooling medium will merely circulate through the absorber 16 and condenser 11. The major portion of the cooling medium will continuously circulate through the conduit 38, conduit 65, conduit 41, conduit 125, conduit 44 and cooling tower 121. This continuous circulation of the cooling medium through the cooling tower 121 will reduce its temperature. As the transfer of heat in either the condenser 11 or absorber 16 increases, the valves 122 or 39 will progressively open to supply cooling medium to the particular element as needed. Simultaneously with the increase in flow of cooling medium through the valves 39 and 122 the flow through the branch conduits 65 and 125 will decrease. This operation will continue until all of the flow is through the absorber 16 and condenser 11 at which time no flow will occur in the branch conduits 65 and 125.

It will now be observed from the foregoing description that the present invention provides for stopping the flow of any cooling medium through the cooling water system during an off-cycle and for permitting the circulation of a limited amount of cooling medium through the elements during an on-cycle. It will further be observed that the present invention provides for individually controlling the amount of cooling medium flowing through each of a plurality of elements in response to the temperature of the cooling medium leaving the particular element. It will still further be observed that the present invention provides for supplying an adequate amount of cooling medium to each of the elements regardless of the rate of flow through another element.

While several embodiments of the invention are

herein illustrated and described it will be understood that further modifications may be in the construction and arrangement of the parts without departing from the spirit or scope of the invention. For example, the construction and arrangement illustrated in Fig. 4 may be further modified to adapt several refrigeration units to be supplied with cooling medium from a single cooling tower. In the claims the term "through" when used to define the flow of cooling medium with respect to an element such as the absorber or condenser is to be construed to mean in heat exchange relation with the element, whether internally or externally applied; and the term "around" when used to define the flow of medium with respect to such element is to be construed to mean by-passing or out of heat exchange relation with the element. Therefore without limitation in these respects, the invention is defined by the following claims.

What is claimed is:

1. In absorption refrigerating apparatus, a generator, a condenser, an evaporator, an absorber, conduits interconnecting the elements to provide circuits for the circulation of refrigerant and absorbent, a cooling system for flowing a cooling medium through the absorber and condenser successively, valves in the cooling system for controlling the flow of the cooling medium through the absorber and condenser, and a separate thermostat for operating each valve and so arranged as to be responsive to the temperature of the cooling medium flowing from the absorber and condenser respectively.

2. In absorption refrigerating apparatus comprising a generator, a condenser, an evaporator, an absorber, conduits interconnecting the elements to provide circuits for the circulation of refrigerant and absorbent, a cooling system for flowing a cooling medium through the absorber and condenser successively, valves in the cooling system for controlling the flow of cooling medium through the absorber and condenser respectively, a bypass around each valve to permit a limited flow of the cooling medium through the absorber and condenser, and thermostats so arranged as to be responsive to the temperature of the cooling medium flowing from the absorber and condenser and connected to operate the respective valves.

3. In absorption refrigerating apparatus comprising a plurality of elements interconnected to provide circuits for the circulation of refrigerant and absorbent, a cooling system for flowing a cooling medium through a plurality of the elements successively, said cooling system having a branch for delivering cooling medium through the first element and a branch for delivering cooling medium around the first element, a valve for simultaneously opening one branch and closing the other branch of the cooling system, and a thermostat so arranged as to be responsive to the temperature of the cooling medium leaving the first element for operating the valve.

4. In an absorption refrigerating apparatus comprising a generator, a condenser, an evaporator, an absorber, conduits interconnecting the elements to provide circuits for the circulation of refrigerant and absorbent, a cooling system for flowing a cooling medium through the absorber and condenser successively, said cooling system having a branch for delivering a cooling medium through the absorber and a branch for delivering cooling medium around the absorber, a valve for simultaneously opening one branch and closing the other branch, and a thermostat so arranged as to be responsive to the temperature of the cooling medium leaving the absorber for operating the valve.

5. In an absorption refrigerating apparatus comprising a plurality of elements interconnected to provide circuits for the circulation of refrigerant and absorbent, a cooling system for flowing a cooling medium through a plurality of the elements successively, said cooling system having a branch for delivering cooling medium through the first element and a branch for delivering cooling medium around the first element, a first valve for simultaneously opening one branch and closing the other branch, a second valve for controlling the flow of cooling medium through the last element in the cooling system, and thermostats so arranged as to be responsive to the temperature of the cooling medium flowing from the first and last elements for operating the first and second valves respectively.

6. In an absorption refrigerating apparatus comprising a generator, a condenser, an evaporator, an absorber, conduits interconnecting the elements to provide circuits for the circulation of refrigerant and absorbent, a cooling system for flowing a cooling medium through the absorber and condenser successively, said cooling system having a branch for delivering a cooling medium through the absorber and a branch for delivering cooling medium around the absorber, a valve for simultaneously opening one branch and closing the other branch, said valve controlling the flow of cooling medium through the absorber, a second valve in the cooling system circuit for controlling the flow of cooling medium through the condenser, and separate thermostats so arranged as to be responsive to the temperature of the cooling medium leaving the absorber and condenser for operating the first and second valves respectively.

7. In an absorption refrigerating apparatus comprising a plurality of elements interconnected to provide circuits for the circulation of refrigerant and absorbent, a cooling system for flowing a cooling medium through a plurality of the elements successively, said cooling system having a branch for delivering cooling medium through the first element and a branch for delivering cooling medium around the first element, a first valve for simultaneously opening one branch and closing the other branch, a second valve for controlling the flow of cooling medium through the last element in the cooling system, thermostats so arranged as to be responsive to the temperature of the cooling medium flowing from the first and last elements for operating the first and second valves respectively, a bypass around the second valve for permitting the flow of a limited amount of cooling medium through the last element, and means for closing the bypass.

8. In an absorption refrigerating apparatus comprising a plurality of elements interconnected to provide circuits for the circulation of refrigerant and absorbent, an electric circuit for controlling the operation of the refrigeration system, a cooling system for flowing a cooling medium through a plurality of elements successively, said cooling system having a branch for delivering cooling medium through the first element and a branch for delivering cooling medium around the first element, a first valve for simultaneously opening one branch and closing the other branch, a second valve for controlling the flow of cooling medium through the last element, thermostats so arranged as to be responsive to

the temperature of the cooling medium flowing from the first and last elements for operating the first and second valves respectively, a bypass around the second valve for permitting the flow of a limited amount of cooling medium through the last element, and an electromagnetically operated valve in the bypass and responsive to the energization and deenergization of the control circuit for controlling the flow of cooling medium through the bypass.

9. In an absorption refrigerating apparatus comprising a plurality of elements interconnected to provide circuits for the circulation of refrigerant and absorbent, an electric circuit for controlling the operation of the refrigeration system, a cooling system for flowing a cooling medium through a plurality of elements successively, said cooling system having a branch for delivering cooling medium through the first element and a branch for delivering cooling medium around the first element, a first valve for simultaneously opening one branch and closing the other branch, a second valve for controlling the flow of cooling medium through the last element, thermostats so arranged as to be responsive to the temperature of the cooling medium flowing from the first and last elements for operating the first and second valves respectively, a bypass around the second valve for permitting the flow of a limited amount of cooling medium through the last element, a valve in the bypass, an electromagnet in the electric control circuit for operating the valve to open the bypass when the control circuit is energized, and a spring for operating the valve to close the bypass when the electric control circuit is deenergized.

10. In an absorption refrigerating apparatus comprising a generator, a condenser, an evaporator, an absorber, conduits interconnecting the elements to provide circuits for the circulation of refrigerant and absorbent, a cooling system for flowing a cooling medium through the absorber and condenser successively, said cooling system having a branch for delivering a cooling medium through the absorber and a branch for delivering cooling medium around the absorber, a valve for simultaneously opening one branch and closing the other branch, said valve controlling the flow of cooling medium through the absorber, a second valve in the cooling system for controlling the flow of cooling medium through the condenser, separate thermostats so arranged as to be responsive to the temperature of the cooling medium leaving the absorber and condenser for operating the first and second valves respectively, a bypass around the first valve, a manually adjustable valve for permitting the flow of a limited amount of cooling medium through the absorber, a bypass around the second valve permitting the flow of a limited amount of cooling medium through the condenser, a valve in the last named bypass, an electromagnet for operating the valve to open the bypass, and a spring for operating the valve to close the bypass.

11. In refrigerating apparatus comprising a plurality of elements interconnected for the circulation of a refrigerant, a cooling tower, a cooling system including the cooling tower for circulating a cooling medium, said cooling system having a branch including at least one of the elements of the refrigerating apparatus for circulating the cooling medium therethrough and a branch for circulating the cooling medium around the element, a valve for simultaneously opening one of the branches and closing the other branch, and a thermostat so arranged as to be responsive to the temperature of the cooling medium leaving the element for the operating valve.

12. In absorption refrigerating apparatus comprising a plurality of elements interconnected for the circulation of refrigerant and absorbent, a cooling tower, a cooling system including the cooling tower for circulating the cooling medium through a plurality of the elements, said cooling system having a branch for circulating cooling medium through one of the elements and a branch for circulating cooling medium around the element, a first valve for simultaneously opening one of the branches and closing the other branch, a thermostat responsive to the temperature of the cooling medium leaving the first element for operating the valve, a second valve for controlling the flow of cooling medium through the last element, and a thermostat so arranged as to be responsive to the temperature of the cooling medium leaving the last element for operating the second valve.

13. In absorption refrigerating apparatus comprising a generator, a condenser, an evaporator, an absorber, conduits interconnecting the elements to provide circuits for the circulation of refrigerant and absorbent, a cooling tower, a cooling system including the cooling tower, absorber and condenser for circulating a cooling medium therethrough, said cooling system having branches through the absorber and condenser and branches around the absorber and condenser, valves in the circuit for controlling the flow through the absorber and condenser, and thermostats so arranged as to be responsive to the temperature of the cooling medium leaving the absorber and condenser for operating the respective valves.

14. In absorption refrigerating apparatus comprising a generator, a condenser, an evaporator, an absorber, conduits interconnecting the elements to provide circuits for the circulation of refrigerant and absorbent, a cooling tower, a cooling system including the cooling tower, absorber and condenser for continuously circulating a cooling medium, said cooling system having one set of parallel branches with one branch of said set located in the absorber and the other branch of said set by-passing the absorber and another set of parallel branches with one branch located in the condenser and the other branch by-passing the condenser, valves for controlling the flow of cooling medium through each set of the parallel branches of the circuit, each valve simultaneously opening one branch and closing the other branch, and thermostats so arranged as to be responsive to the temperature of the cooling medium leaving the absorber and condenser for operating the respective valves.

15. In refrigerating apparatus comprising a plurality of elements interconnected for the circulation of a refrigerant, a cooling system including a cooling tower and a plurality of elements of the refrigerating apparatus, said cooling system having a plurality of pairs of parallel branches connected in series, one of the branches of each pair being adapted to circulate cooling medium through one of the elements of the apparatus to be cooled and the other branch being adapted to circulate cooling medium around the element, a modulating valve for each pair of parallel branches for simultaneously opening one branch and closing the other branch, and a thermostat for each valve so arranged as to be

responsive to the temperature of the cooling medium flowing from the element to be cooled, each thermostat being connected to operate its respective valve.

16. In refrigerating apparatus comprising a plurality of elements interconnected for the circulation of a refrigerant, a cooling system including a cooling tower and a plurality of elements of the refrigerating apparatus, said cooling system having a plurality of pairs of parallel branches connected in series, one of the branches of each pair being adapted to circulate cooling medium through one of the elements of the apparatus to be cooled and the other branch being adapted to circulate cooling medium around the element, a modulating valve for each pair of parallel branches for simultaneously opening one branch and closing the other branch, a thermostat for each valve so arranged as to be responsive to the temperature of the cooling medium flowing from the element to be cooled, each thermostat being connected to operate its respective valve, and a by-pass around each valve for circulating a limited amount of the cooling medium through the elements to be cooled so that the thermostats will respond to an increase in the temperature in the elements.

17. In refrigerating apparatus having a plurality of elements interconnected to provide a circuit for refrigerant, a cooling system in addition to the refrigerant circuit and having a branch for delivering cooling medium through one of the elements of the refrigerant circuit and a branch for delivering cooling medium around the element, a valve for opening the branch for delivering cooling medium around the element, and a thermostat so arranged as to be responsive to the temperature of the cooling medium leaving the element and connected to operate the valve.

18. In refrigerating apparatus having a plurality of elements interconnected to provide a circuit for refrigerant, a cooling system in addition to the refrigerant circuit for flowing a cooling medium through a plurality of elements of the refrigerant circuit successively, said cooling system having a branch for delivering cooling medium through the first element to be cooled and a branch for delivering cooling medium around the first element, a valve for opening the branch for delivering cooling medium around the first element, and a thermostat so arranged as to be responsive to the temperature of the cooling medium leaving the first element and connected to operate the valve.

FRED C. MEYER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,133,962	Shoemaker	Oct. 25, 1938
2,282,503	Thomas et al.	May 12, 1942
2,356,638	Williams	Aug. 22, 1944
2,365,797	Bichowsky	Dec. 26, 1944
2,378,177	Bichowsky	June 12, 1945