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FREEZE-UP CONTROL FOR AIR HEATING AND COOLING SYSTEM

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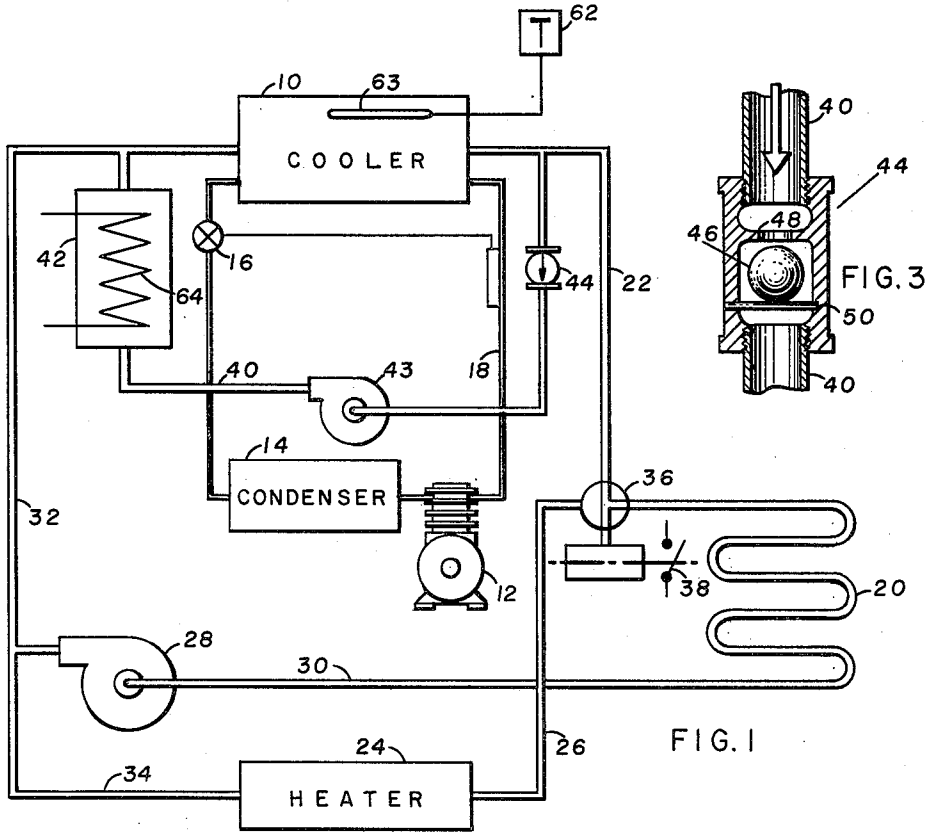


FIG. 1

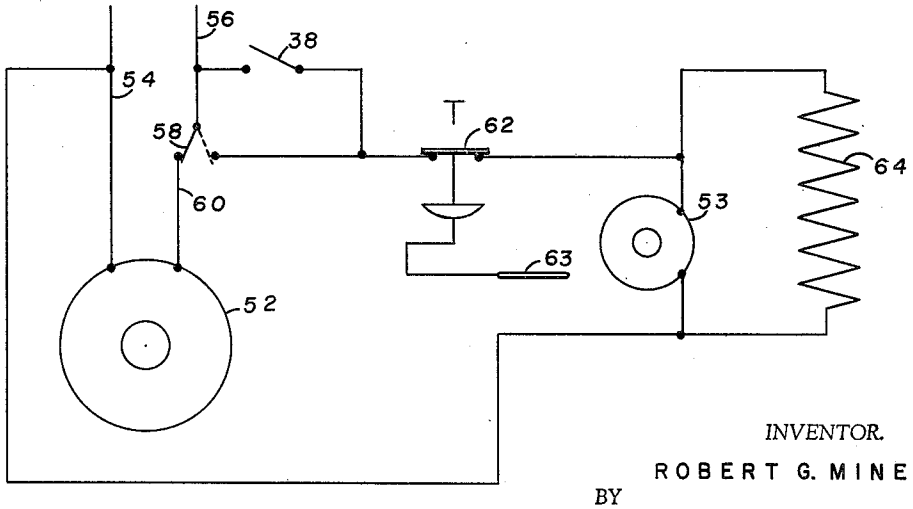


FIG. 2

FIG. 3

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FREEZE-UP CONTROL FOR AIR HEATING AND COOLING SYSTEM

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This invention relates generally to a refrigeration circuit and control therefor having a compressor, condenser, and evaporator and in particular to a refrigeration system in which the evaporator is located outdoors.

In recent years the air conditioning industry has found that outdoor installation of air conditioning equipment has many advantages. Such installation removes objectionable noise and vibration created by the air conditioning equipment to a position outdoors where such noise and vibration will not be transmitted to the conditioned area. At the same time some disadvantages not prevalent in indoor installation have been encountered. The basic disadvantage of an outdoor installation is that the heat exchange fluid tends to freeze when the outdoor temperature drops below 32° F. and the air conditioning equipment is not in use. Further, the compressor tends to cut out on low suction pressure when started up under lower ambient conditions such as in the wintertime.

It is therefore an object of the invention to provide an air conditioning system for outdoor installation which prevents freeze-up of the heat exchange fluid under low ambient conditions.

Another object of the invention is to provide an outdoor refrigeration system in which means are employed to prevent the compressor from cutting out on low pressure due to low ambient air conditions.

A third object of the invention is to provide a refrigeration system for outdoor installation which employs a gravity loop through the evaporator to prevent freeze-up of the heat exchange fluid under low ambient conditions.

A still further object of the invention is to provide a heating and cooling system in which the refrigeration system is installed outdoors and in which a heated gravity loop is employed to prevent the heat exchange medium from freezing up during periods of nonuse and low ambient air conditions.

Other objects and advantages of my invention will be clearly apparent as the specification proceeds to describe the invention with reference to the accompanying drawings, in which:

FIGURE 1 is a schematic representation of the heating and cooling system showing my new and improved freeze-up control;

FIGURE 2 is a wiring diagram of the freeze-up control of FIGURE 1; and

FIGURE 3 is an enlarged sectional view of the check valve shown in FIGURE 1.

In FIGURE 1 reference number 10 represents an evaporator of either the direct expansion or flooded type operatively connected to typical components of a refrigeration system, it being understood that the evaporator 10 or the complete refrigeration system is located outdoors. Basically the refrigeration system consists of a compressor 12 connected to a condenser 14, an expansion valve 16 connected to the condenser 14 and the evaporator 10, and a suction line 18 interconnecting the evaporator 10 and the compressor 12.

Heat exchanger 20 in the area to be conditioned is supplied cold heat exchange fluid from the evaporator 10 through conduit 22 or warm heat exchange fluid from heater 24 through conduit 26. A pump 28 connected to heat exchanger 20 by conduit 30 returns heat exchange fluid from the heat exchanger 20 to the evaporator 10 or

the heater 24 through conduits 32 and 34, respectively depending on the position of three way valve 36.

Three way valve 36 is shown schematically, and is mechanically connected to switch 38 which is open when cooling fluid, as shown, is being supplied to heat exchanger 20. Switch 38 will be closed when valve 36 is reversed to close off conduit 22 and allow passage of warm heat exchange fluid to flow to the heat exchanger 20. Operation of valve 36 may be either automatic or manual. It is further understood that two valves could be substituted for valve 36 to perform the same operation.

Interconnected between conduits 32 and 22 is a gravity loop 40. Heating means 42, preferably electrical, is positioned in heat exchange relationship with the heat exchange fluid in loop 40. A check valve 44 is interconnected in gravity loop 40 to prevent flow of heat exchange therein when pump 28 is supplying heat exchange fluid through evaporator 10. If desired, a pump 43 can be employed in the loop 40 for use when the liquid head is not sufficient to allow gravity circulation of the fluid in the loop when heater 42 is energized.

Looking at FIGURE 3 it can readily be seen that check valve 44 operates opposite to the normal check valve. In the normal check valve, the valve means closes by gravity. In valve 44 it can readily be seen that ball member 46 is forced upward to close valve port 48 when pump 28 is pumping heat exchange fluid to the evaporator. A pin member 50 is provided to prevent the ball member 46 from blocking the entrance of the pipe 40 when pump 28 is either idle or connected by the valve 36 to supply warm heat exchange fluid to heat exchanger 20.

A thermostatic switch 62 is provided to close when the temperature sensed by bulb 63 is below 40° F. Preferably bulb 63 is located within the evaporator 10 but obviously could be responsive to the ambient air temperature outside the evaporator.

Looking at FIGURE 2 it can readily be seen that temperature switch 62 can provide electrical energy to heater 64 only when either switch 38 is made or when pump motor 52 for pump 28 is shut down by placing switch 58 in the dotted line positon. In other words, temperature switch 62 is effective only when the air conditioning system is shut down or when the air conditioning system is calling for heat.

In the positions shown in FIGURES 1 and 2, temperature switch 62 is made but no electrical energy is being supplied to electrical heater 64 since switch 38 is open and switch 58 is energizing pump motor 52.

Assume now that either switch 58 is moved to the dotted line position in FIGURE 2 to shut down the pump motor 52 or switch 38 is made since valve 36 is positioned to pass warm heat exchange fluid to heat exchanger 20. If temperature switch 62 is in the closed position, as shown, heater 64 will be energized thereby supplying heat to the heat exchange fluid in gravity loop 40. The heat exchange fluid in loop 40 will circulate through the evaporator and back into the loop to prevent the evaporator from freezing as long as heater 64 is energized. As is well known in the art, this circulation is caused by the difference in density of the heat exchange medium being heated and the density of the heat exchange fluid not being heated. This circulation in gravity loop 40 will continue until such time that the evaporator temperature rises above the set temperature of temperature switch 62 or both of switches 38 and 58 are in the positions shown in FIGURE 2.

It should be noted that motor 53 for pump 43 is connected in parallel with heater 64 so that pump motor 53 will be energized any time that thermostatic switch 62 energizes the circuit to heater 64. As previously pointed out, in most instances pump 43 and its motor 53 can be

eliminated since the usual installation will be such that there will be sufficient liquid had to allow circulation in the loop 40 without the use of a pump.

As previously pointed out check valve 44 prevents circulation of heat exchange fluid through gravity loop 40 when the air conditioning system is calling for cool heat exchange fluid.

It should be pointed out that heater 64 maintains the temperature of the evaporator sufficiently high so that the compressor will not normally cut out because of low suction pressure upon start-up under low ambient conditions normally encountered in the winter.

It is obvious that the above described invention provides a positive and automatic control to prevent freeze-up of an evaporator when installed outside the area to be conditioned and exposed to the outside ambient air temperature. This control further provides for efficient start-up of the refrigeration cycle even though the ambient air temperature may be very low. My year around system provides efficient and reliable operation with a minimum of maintenance. It should be further noted that only a minor modification of the heat exchange conduit system is necessary to provide my new and novel system. Therefore, my system provides a simple and safe method of freeze control and at the same time requires only a small expenditure to obtain the advantages inherent in the use of an air conditioning system in which the refrigeration cycle or part thereof is installed outdoors.

Although I have described in detail the preferred embodiments of my invention, I contemplate that many changes may be made without departing from the scope or spirit of my invention.

I claim:

1. An air conditioning system comprising: a heat exchanger in the area to be conditioned, a refrigeration system including a compressor, a condenser, and an evaporator in operative relationship to cool a freezable heat exchange medium, first conduit means connected to said heat exchanger to supply cool heat exchange medium from said evaporator to said heat exchanger, second conduit means to return cool heat exchange medium from said heat exchanger to said evaporator, third conduit means interconnecting said first conduit means and said second conduit means, a first pump means connected to said first conduit means and to said second conduit means to circulate heat exchange medium therethrough, heating means in heat exchange relationship with the heat exchange medium in said third conduit means, a second pump means in said third conduit means, and thermostatic control means operably associated with said heating means and said second pump means to actuate said heating means and said second pump means in response to a certain predetermined low temperature, during periods of nonuse of said evaporator.

2. The structure of claim 1 wherein check means is provided in said third conduit means to prevent flow of heat exchange medium in said third conduit means when said first pump means is pumping heat exchange medium in said first and said second conduit means.

3. The structure of claim 2 wherein said thermostatic control means is responsive to a temperature sensed in said evaporator.

4. The structure of claim 3 wherein said heating means is an electric heater.

5. An air conditioning system comprising: a heat exchanger in the area to be conditioned, a refrigeration system including a compressor, a condenser, and an evaporator in operative reltionship to cool a freezable heat exchange medium, first conduit means connected to said heat exchanger to supply cool heat exchange medium from said evaporator to said heat exchanger, second conduit means to return cool heat exchange medium from said heat exchanger to said evaporator, third conduit means interconnecting said first conduit means and said second conduit means, a pump means connected to said first conduit means and to said second conduit means to circulate heat exchange medium therethrough, heating means in heat exchange relationship with the heat exchange medium in said third conduit means, and thermostatic control means operably associated with said heating means to actuate said heating means in response to a certain predetermined low temperature, during periods of nonuse of said evaporator.

6. The structure of claim 5 wherein check means is provided in said third conduit means to prevent flow of heat exchange medium in said third conduit means when said pump means is pumping heat exchange medium in said first and said second conduit means.

7. The structure of claim 6 wherein said thermostatic control means is responsive to a temperature sensed in said evaporator.

8. The structure of claim 7 wherein said heating means is an electric heater.

9. An air conditioning system comprising: a heat exchanger in the area to be conditioned, a refrigeration system including a compressor, condenser, and an evaporator in operative relationship to cool a freezable heat exchange medium, a first conduit means to supply cool heat exchange medium from said evaporator to said heat exchanger, a second conduit means to return heat exchange medium from said heat exchanger to said evaporator, a third conduit means interconnecting said first and second conduit means, a source of heat to heat a heat exchange medium, a fourth conduit means to supply hot heat exchange medium to said heat exchanger from said heat source, a fifth conduit means to return heat exchange medium from said heat exchanger to said heating means, valve means operably associated with said heat exchanger to selectively provide hot or cold heat exchange medium from said first and fourth conduit means to said heat exchanger, a heater in said third conduit means, and thermostatic control means operably associated with said heater to actuate said heater in response to a certain predetermined low temperature to circulate warm heat exchange medium in said third conduit means, during periods of nonuse of said evaporator.

10. The structure of claim 9 wherein check means is provided in said fifth conduit means to prevent flow of heat exchange medium in said fifth conduit means when said valve means is positioned to supply a cool heat exchange medium to said heat exchanger.

11. The structure of claim 10 wherein said thermostatic control means includes a switch means connected to said valve means to de-energize said heater when said valve means is supplying cool heat exchange medium to said heat exchanger.

12. The structure of claim 11 wherein said heater is electric.

13. An air conditioning system comprising: a closed fluid circuit for circulating a freezable heat exchange liquid therein; said circuit including a heat exchanger positioned in the area to be conditioned, a liquid cooler arranged in series with said heat exchanger in a position wherein it is subjected to temperatures below the freeze point of said liquid during periods of nonuse, and means for circulating said heat exchange liquid cyclically through said heat exchanger and said liquid cooler via said closed circuit; a refrigeration system including a compressor, a condenser and an evaporator; said evaporator being a part of said liquid cooler for chilling said liquid in said circuit; flow interrupting means for rendering said circulating means ineffective; a closed fluid conduit providing fluid connection from a point in said circuit between the outlet of said liquid cooler and the inlet of said heat exchanger to a point between the outlet of said heat exchanger and the inlet of said liquid cooler; means for heating the heat exchange liquid passing through said conduit and circulating it through said liquid cooler in response to the activation of said flow in-

terrupting means when said liquid cooler is subjected to a temperature below a predetermined limit.

14. An air conditioning system as defined by claim 13 wherein said heating and circulating means comprises a heater arranged to impart gravity convection flow to said liquid through said conduit toward the inlet side of said liquid cooler and wherein said conduit includes a normally open check valve means for permitting said last mentioned flow and which closes in response to fluid pressures tending to reverse the direction of said last mentioned flow.

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