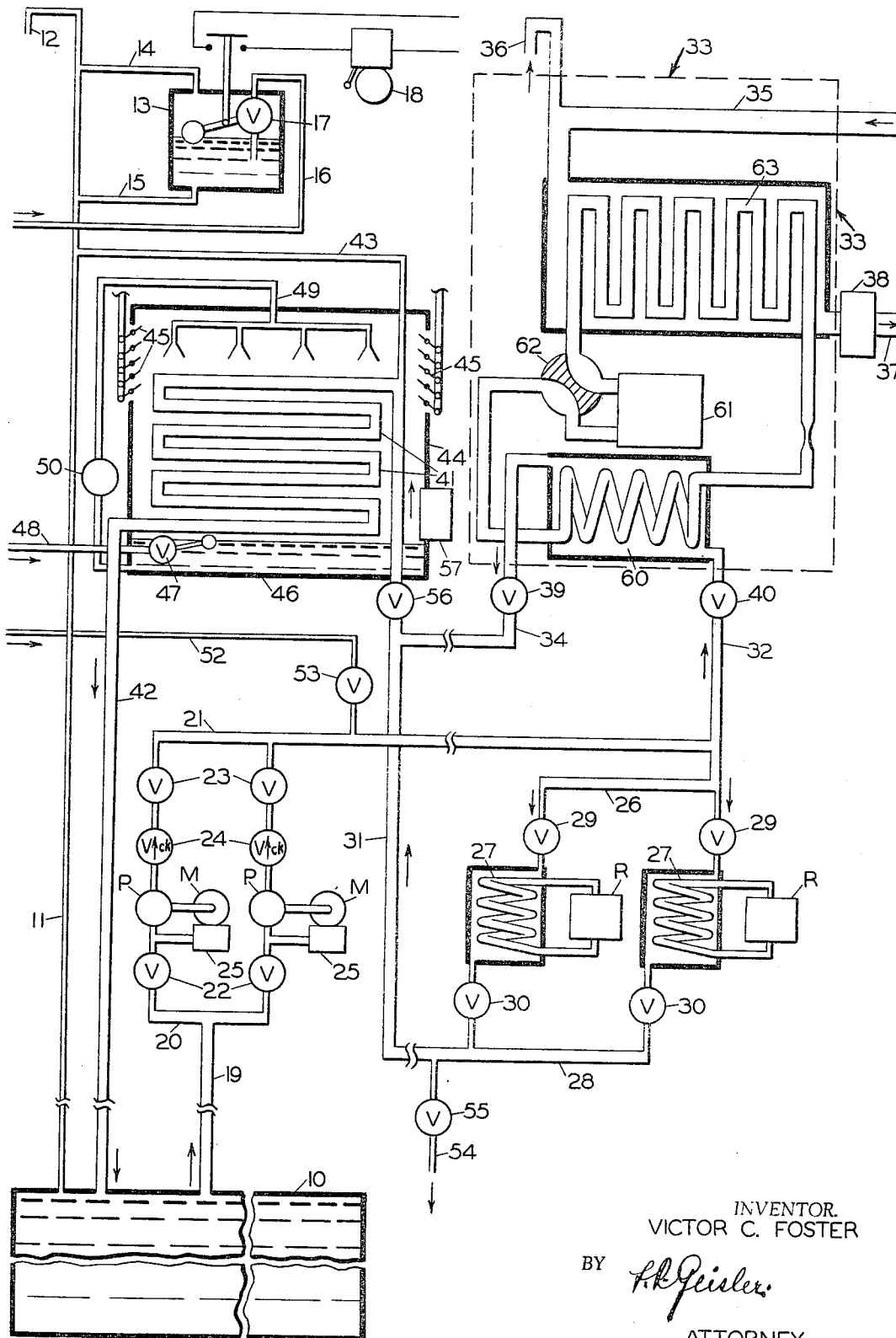


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CLOSED LIQUID CIRCUIT FOR A COMBINED REFRIGERATION
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1

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CLOSED LIQUID CIRCUIT FOR A COMBINED REFRIGERATION AND AIR CONDITIONING SYSTEM

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This invention relates in general to heat transfer systems in which utilization is made of the heat extracted in mechanical refrigeration.

More specifically, the present invention relates to a system wherein mechanical refrigeration units on the one hand and air conditioning means on the other hand are combined in such manner as to cooperate with each other and effect efficient utilization and dispensing of the heat collected by the refrigeration units.

One object of the invention accordingly is to obtain highly efficient and economical use of the heat dispensed by mechanical refrigeration units.

Another object of the invention is to provide an improved system and novel assembly in which the heat collected from refrigeration units is transferred, stored and utilized through the intermediary of a relatively large volume of circulating liquid not only acting as the transfer vehicle but also serving as a conservator of the heat and acting as a main factor in the maintenance of a stable temperature range throughout the entire system.

As is well known, in liquid-cooled refrigeration systems, wherein liquid, circulating through liquid-jacketed compressors and condensers, carries off the heat and, before being re-circulated is cooled by partial evaporation, a build-up of salts in the re-circulated liquid system occurs, with the resulting encrustations, which condition is undesirable from the standpoint of efficiency and maintenance costs. A further object of this invention accordingly is to provide an improved closed liquid re-circulating and heat transferring system in which only a relatively negligible loss and consequent replenishing of the circulating liquid takes place, thus making it possible for the system to operate over a long period without any build-up of salts in the re-circulating liquid.

A related object is to provide a closed liquid storage and recirculating system for simultaneously serving refrigeration units and air conditioning means which, when properly installed, will operate substantially with a minimum of care and maintenance costs.

The manner in which and the means by which these objects and other incidental advantages are attained with the closed system of the present invention, and the arrangement and function of the different parts of the system and of the particular elements in each part, will be readily understood from the following brief description with reference to the accompanying drawing, the drawing being in the form of schematic elevation of a closed liquid circuit for a refrigeration and air conditioning system embodying the invention.

Referring to the drawing, 10 indicates a large liquid storage tank, which preferably is sunk in the ground or is otherwise provided with suitable insulation against the atmospheric temperature. The size or cubic capacity of this tank is determined by the number and size of the condensers in the refrigeration units included in the system and from which the heat utilized in the system is obtained. The storage tank 10 is always completely full of liquid in the normal operation of the device as illustrated. This storage tank 10, together with the other portions of the assembly through which the liquid circulates are initially filled with liquid by any suitable means (not shown).

A vent pipe 11 is connected with the storage tank 10

2

and extends up above all the other portions of the liquid circulating system. The vent pipe has a top outlet 12.

A second tank 13, serving as a liquid expansion and liquid level control tank, is located below the top of the vent pipe 11, but is located above the height of the other portions of the circulating system. This tank 13 is considerably smaller than the main storage tank 10 and its size or cubic capacity is determined by the size of the tank 10.

Tank 13 has a vent connection at the top consisting of the pipe 14 which connects with the vent pipe 11. The bottom of the tank 13 is connected with the pipe 11 by a pipe 15. A pipe 16 connects the tank 13 with a suitable supply source of liquid, and the delivery of the liquid into the tank 13 is controlled by a float valve indicated at 17. Thus the float valve 17 automatically acts to prevent the liquid level in the tank 13, and thereby the supply of operating liquid for the entire system, from dropping below a proper operating level. An automatic signal, indicated at 18, is also preferably connected with the float valve 17 to call attention whenever there has been a drop in the liquid level in the system.

A delivery supply pipe 19, connected with the storage tank 10, leads to a suction manifold 20. A plurality of electrically-operated circulating pumps P draw the liquid from the manifold 20, pipe 19 and storage tank 10, and deliver it under pressure to a discharge header 21. Although only two such pumps are shown in the schematic drawing it is to be understood of course that the number and size of the pumps will also be determined by the number and size of the condensers in the refrigeration units in the system and thus by the volume of liquid circulation required. The two pumps shown may be arranged to operate simultaneously, or, if desired, one pump can serve as a standby pump and take over in the event of failure of the other pump.

As indicated in the drawing, a manually operable cut-off valve 22 is located between the suction manifold 20 and each pump P, and second cut-off valve 23 is located between each pump P and the discharge header 21. Thus each pump can easily be removed from operating connection with the system by the closing of the two cut-off valves. A check valve 24 is also placed on the discharging side of each pump in order to prevent any backing up of the liquid and to maintain constant pressure beyond the pump.

The motors for the pumps P are controlled by pressure sensitive means and temperature sensitive means located in switch boxes 25, which pressure sensitive means and temperature sensitive means are so arranged that drop in the liquid pressure below a predetermined point or increase in the temperature of the liquid beyond a predetermined point will close normally open switches in circuits to the motors. Such pressure sensitive means (for example, a Bourdon tube mechanism) or temperature sensitive means (such as a common thermal actuated switch) are not shown or described since such switch controls are well known and no claim of novelty is made for them.

The discharge header 21 is connected with the feeder manifold 26 from which the re-circulating liquid passes to the refrigerant heat transfer chambers 27 for the refrigeration units R, and thence to the receiving manifold 28 for the liquid heated in the heat transfer chambers 27. A manually operable cut-off valve 29 is located between the feeder manifold 26 and each heat transfer chamber 27, and a second manually operable cut-off valve 30 is located between each heat transfer chamber and the discharge receiving manifold 28, so that, if necessary, each refrigeration unit can be easily cut off from the system. As previously indicated, the heat transfer chambers 27

3

for the refrigeration units R supply the source of heat for the entire system. The discharge receiving manifold 28 leads to the cooler intake line 31.

The header 21 is also connected with the air conditioning device 33 by the pipeline 32, which enables part of the re-circulating liquid in the entire system to be delivered to the heat exchanger 60 for the air conditioning device 33 and thence to be returned to the system through pipe 34 which is connected to the cooler intake line 31, rejoining and mixing with the liquid which has in the meantime become heated in its passage through the heat transfer chambers for the refrigeration units.

Generally the air conditioning device 33 will be used for heating the air in the area served although it may also be used for cooling the air when the temperature of the atmosphere rises to the point where such cooling is desirable for comfort. The air conditioning device 33 is equipped with the customary compressor 61 which operates through a reversing control valve 62. When the air conditioning device is used for heating the air in the area served the "Freon" or other refrigerant used extracts heat from the liquid supplied to the heat exchanger 60 and, after being compressed in the compressor, passes through coils 63 which are then serving as heating coils for the air passing through the air conditioning device, whereupon the condensed refrigerant returns to the coils in the heat exchanger 60, is allowed to vaporize and in so doing again absorbs "heat of vaporization" from the liquid in the heat exchanger as the cycle is repeated. Such a heating system is well known and need not be described more in detail. In the air conditioning device indicated at 33 the returned air from the area served is drawn in through the air intake 35, mixed with some filtered fresh air drawn from the outside through the intake 36, and, after passing over the coils 63, is discharged through the outlet 37. Thus when the air conditioning device 33 is used for heating the air in the area served, the re-circulating liquid from the closed system, delivered to the heat exchanger 60 through the pipeline 32, in this way gives off some of its heat and returns to the system through the pipe 34 considerably cooled.

Under very cold atmospheric conditions the heat given off by the coils 63 in the air conditioning device 33 may not be sufficient to provide adequate heat for the area served by the device, and consequently an auxiliary heating unit, indicated at 38, would be provided as a supplemental source of heat for the air delivered through the outlet 37. The employment of such supplemental heat means would be controlled automatically or manually, as desired, and also the drawing of fresh outside air through the intake 36 would be controlled by suitable dampers (not shown) operated also either automatically or manually as desired. Manually operable valves 39 and 40, in the delivery and discharge pipelines 32 and 34 for the heat exchanger 60 of the air conditioning device 33, enable the latter to be disconnected from the system should this become necessary for any reason.

From the cooler intake line 31 the heated liquid from the refrigeration units, together with the cooled liquid discharged from the heat exchanger 60 of the air conditioning device 33 (when latter is used for heating the air of the area served), passes into a closed circuit cooler 41 and thence returns to the storage tank 10 by the pipe 42. The cooler 41 is connected with the vent pipe 11 by the pipe 43, and, due to the fact that the liquid level control tank 13 is also connected with the vent pipe 11, the cooler 41 will be kept filled at all times.

When the removal of heat from the circulating liquid in this system which takes place in the heat exchanger 60 of the air conditioning device 33 is sufficient to compensate for the heat delivered into the circulating system by the heat transfer chambers of the refrigeration units then no special cooling of the liquid passing through the cooler 41 is required. This would be the ideal operating condition contemplated for the invention. It is intended that,

4

due to the large volume of liquid contained in the storage tank 10 and other points of the closed circulating system the temperature of the liquid in the storage tank under normal conditions of operation of the system and without extreme temperature changes in the area served by the heat conditioning device will be kept within a moderate fluctuation range and thus in substantial balance. When the temperature in the area served by the air conditioning device 33 drops too low, supplemental heating of the air discharged from the device 33 would be required, as previously mentioned. On the other hand, should the temperature in the air in the area served by the device 33 rise considerably above normal, as in the case of very hot weather, then the air conditioning device 33 would operate to cool the air in the manner well known. Thus the circulation of the refrigerant in the air conditioning device would be reversed by the reversing control valve 62. The compressed heated refrigerant would be delivered to the heat exchanger 60 and then to the coils 63 and allowed to expand and vaporize in the latter which then serve as cooling coils for the air passing through the air conditioning device. When this takes place the re-circulating liquid in the system returns through pipe 34 heated instead of cooled. Consequently under such special circumstances considerable cooling of the circulating liquid in the system would then be required to take place in the cooler 41 in order to maintain the temperature of the liquid in the system, and more particularly the temperature of the liquid in the storage tank 10, fairly stable.

The cooler 41 is located in a housing 44 which is provided with shutters or dampers 45 which are opened when cooling is required, the adjusting of the dampers 45 taking place either through manually operated means or automatic thermal activated means (not shown). A sump 46 at the bottom of the cooler housing 44 has a float valve 47 by which the sump is connected through a pipe 48 to an outside source of cold liquid. A pipe 49 leads from the sump 46 to a pump 50 and thence to spray heads above the cooler 41 in the housing 44 so as to deliver sprays of cold liquid over the cooler 41 in the housing 44 and thus cause greater cooling to take place as a result of the evaporation of the sprayed liquid on the cooler 41 when the pump 50 is operated and when forced air is circulated through the cooler by means of a fan 57 either automatically or manually controlled.

Thus, with the cooler 41 available for cooling the liquid in the system as and when required, and with the system containing a relatively large volume of circulating liquid within the normally closed system, the fluctuation of the temperature of the liquid in the system is kept within a moderately small range. Under normal conditions the system, in addition to performing the necessary transfer of heat from the heat exchange chambers of the refrigeration units, contributes a useful amount of heat to the air conditioning device 33, while, under certain extreme conditions, the system may also absorb heat from the device and aid in cooling the air when high atmospheric temperature in the area served by the air conditioning device makes some cooling of the area desirable.

The discharge header 21 is also connected by a pipe 52 with an outside source of cold liquid, the delivery of liquid through the pipe 52 being controlled by the manually operable valve 53 which is kept closed except in case of emergency. Also the discharge receiving manifold 28 is directly connected with a waste drain line 54, controlled by the manually operable valve 55, which similarly is kept closed except in such emergency, and a manually operable shut-off valve 56 is provided in the pipe line 31.

Thus if the pumps P for some reason are not operable and it becomes necessary for the system to be shut down, the required cooling of the refrigerant in the heat exchange chambers of the refrigeration units can be maintained while repairs are being made simply by opening valve 53 and 55 and closing the valve 56.

Various minor modifications could be made in different parts of the system without departing from the principle of the invention. The closed system, constructed and operated substantially as herein described, has been found to be very satisfactory in a local supermarket equipped with numerous refrigeration units, and a considerable reduction in the cost of heating the enclosed area in the supermarket through this utilization of the heat removed from the refrigeration units has resulted.

I claim:

1. In a closed liquid storage and re-circulating system for simultaneously serving refrigeration units and air conditioning means, a liquid storage tank insulated from atmospheric temperature changes, a liquid delivery line leading from said storage tank, a liquid circulating pump operatively connected with said delivery line, means for disconnecting said pump and for shutting off said delivery line, a liquid supply header connected with said delivery line beyond said pump, a refrigeration unit including a heat transfer chamber, a branch line from said supply header connected with said transfer chamber, a discharge line leading from said transfer chamber, air conditioning means, a second branch line from said supply header connected with said air conditioning means, a return line from said air conditioning means, means for shutting off said second line and said return line, a cooler, a water coil in said cooler, an intake line for said coil, said discharge line from said transfer chamber and said return line from said air conditioning means connected with said coil intake line, operating control means for said cooler, and a return storage line leading from said coil of said cooler back to said storage tank.

2. The combination set forth in claim 1 with the addition of an emergency liquid supply line from an outside source connected with said liquid supply header, a control valve in said emergency supply line, an emergency drain line connected with said discharge line from said heat transfer chamber, and a control valve in said emergency drain line, whereby, in the event of failure of said circulating pump, the opening up of said emergency liquid supply line and the opening of said emergency drain line will enable said refrigeration unit and heat transfer chamber to continue operation independently of the liquid storage and re-circulating system.

3. The combination set forth in claim 1 with the addition of a liquid expansion and level control tank con-

nected with said liquid storage tank and located above said storage tank and other portions of the system, a liquid supply line connected with said control tank, and an automatic valve means controlling the intake of liquid into said level control tank.

4. A closed liquid storage and re-circulating system for simultaneously serving refrigeration units and air conditioning means, said system including a liquid storage tank sunk in the ground, a liquid delivery line leading upwardly from said storage tank, a liquid circulating pump operatively connected with said delivery line, means for disconnecting said pump and for shutting off said delivery line, a liquid supply header connected with said delivery line beyond said pump, an emergency liquid supply line connected with said header, a control valve in said emergency supply line, a refrigeration unit including a heat transfer chamber, a branch line from said supply header connected with said transfer chamber, a discharge line leading from said transfer chamber, an emergency drain line connected with said discharge line, shut-off valve means in said emergency drain line, air conditioning means, a second branch line from said supply header connected with said air conditioning means, a return line from said air conditioning means, means for shutting off said second branch line and said return line, a cooler, a water coil in said cooler, an intake line for said coil, said discharge line from said transfer chamber and said return line from said air conditioning means connected with said coil intake line, a shut-off in said coil intake line, operating control means for said cooler, a return storage line leading from said coil back to said storage tank, a liquid expansion and level control tank connected with said water storage tank and located above said storage tank and other portions of the system, a liquid supply line connected with said level control tank, valve means controlling the intake of liquid in said control tank, and a vent pipe connected with said control tank and re-circulating system.

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