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56,228

[56]

References Cited

UNITED STATES PATENTS

3,184,926	5/1965	Blake	62/278
3,138,007	6/1964	Friedman	62/278
3,150,498	9/1964	Blake	62/278

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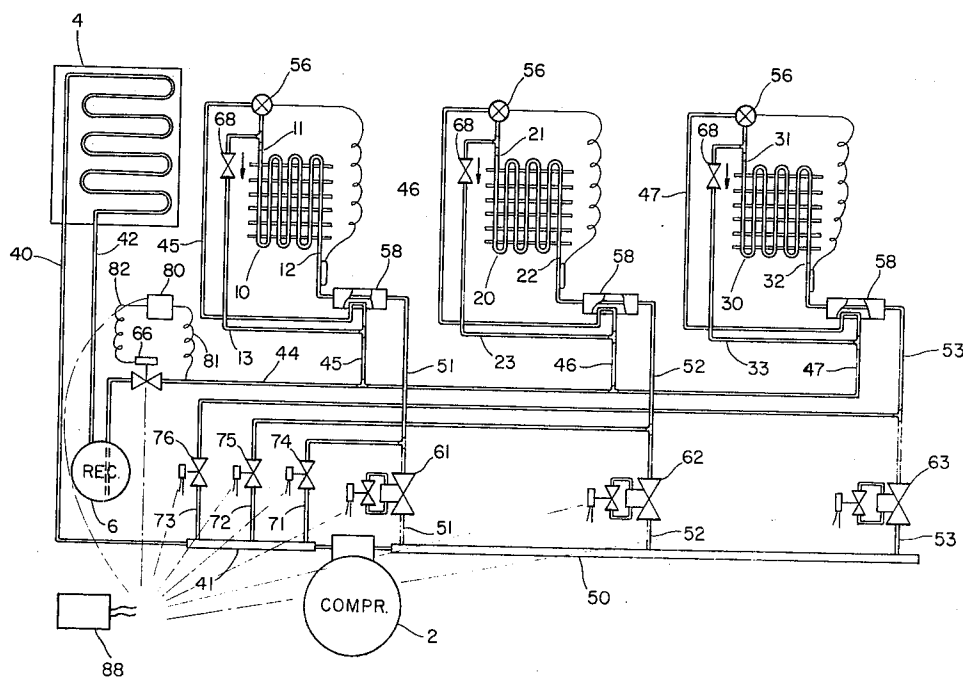
[54] HOT GAS DEFROSTING SYSTEM
2 Claims, 1 Drawing Fig.

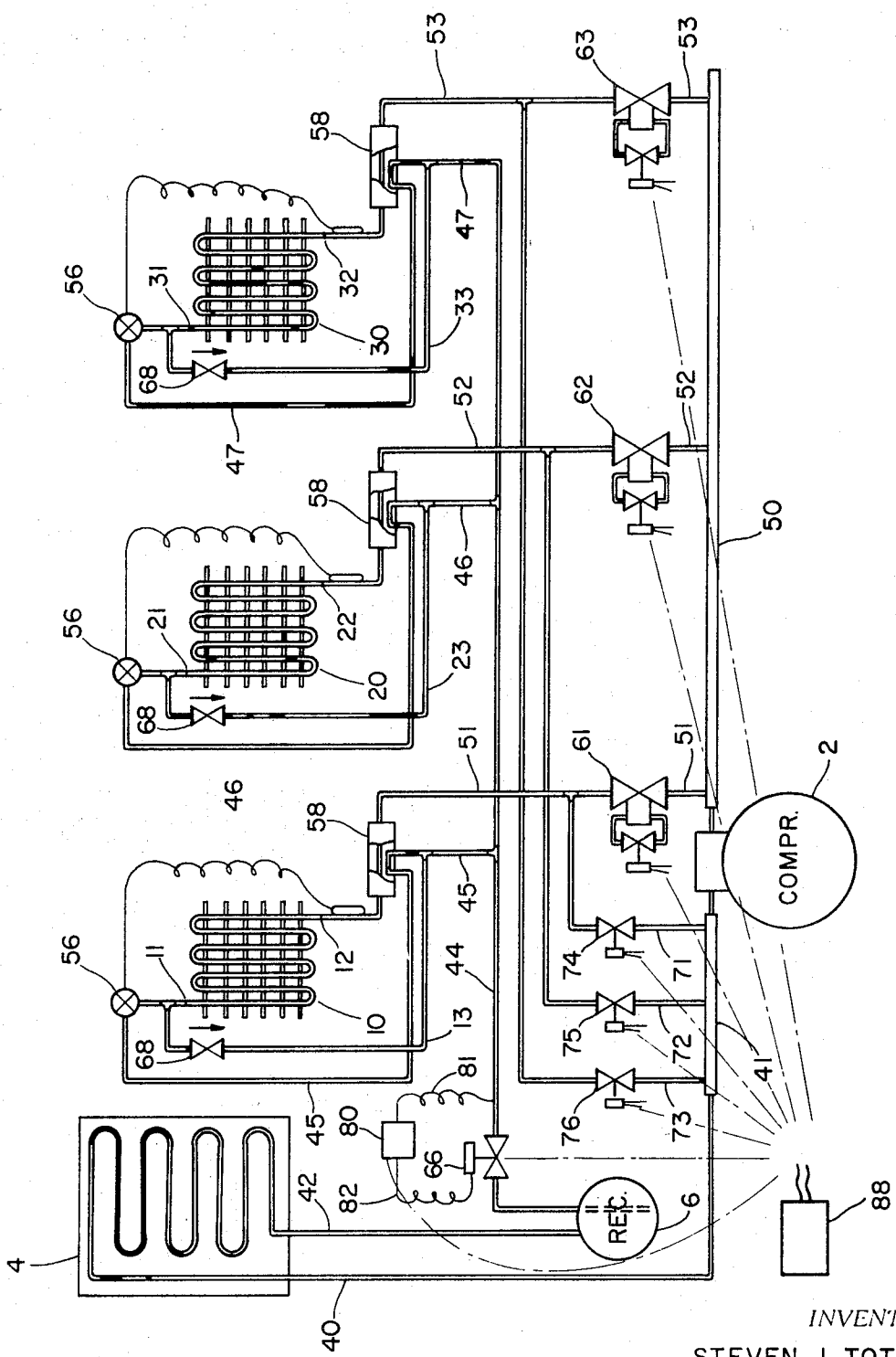
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[50] **Field of Search**..... 62/278, 196

ABSTRACT: The invention relates to a central-type of refrigeration system in which multiple evaporator coils are remotely located from the compressor and condenser. The system has hot gas defrosting means associated therewith which operates during a defrosting cycle in a manner so that all of the hot refrigerant gas delivered by the compressor is utilized for the defrosting operation except when abnormal or unusual heat load conditions are present. When the abnormal conditions are present the compressor is partially diverted from its defrosting function just sufficiently so that the primary cooling function of the system is sustained at a predetermined level.





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HOT GAS DEFROSTING SYSTEM

This application is a continuation of application Ser. No. 800,511 filed Feb. 19, 1969, titled "Hot Gas Defrosting System" and now abandoned.

The invention relates to a central type of refrigeration system in which multiple evaporator coils are remotely located from the compressor and condenser. More specifically, the invention relates to such a system having new and improved means associated therewith for effecting hot gas defrosting of the evaporator coils.

In prior art refrigeration systems of the type referred to it is conventional to bypass a portion of the hot gas delivered by the compressor for use in defrosting the evaporator coils. It is also conventional to utilize the condensate of the hot defrosting gas after it leaves an evaporator being defrosted as a cooling medium for evaporators not being defrosted at that time. The compressor in these prior art systems has the dual functions during the defrosting operation to supply a hot gas refrigerant directly to the evaporators being defrosted and to supply a cold liquid refrigerant directly from the condenser to the evaporators not being defrosted. A system which requires the compressor to have the dual functions during defrosting has one of two inherent characteristics. Either the compressor has a large enough capacity to adequately perform the dual functions or a smaller capacity such that the defrosting operation requires a relatively substantial amount of time. In the former case the compressor is larger than required for the primary refrigeration cycle. In the latter case the evaporators not being defrosted are being somewhat starved for cooling during the defrosting operation and cooling performance suffers accordingly.

A main object of the present invention is to provide a new and improved central type refrigeration system having new and improved hot gas defrosting means associated therewith.

A further object is that the hot gas defrosting means is constructed to operate in such a manner so that during the defrosting cycles the compressor is always or almost always devoted primarily to the defrosting function so that the defrosting is accomplished quickly and efficiently.

Another object of the invention is to provide auxiliary valve means for facilitating the supply of a predetermined and prerequisite amount of cooling refrigerant fluid to the evaporator coils not being defrosted during times when abnormal or rarely occurring heat load conditions are present.

Other objects and advantages of the invention will become apparent from the following specification, drawings, and appended claims.

The drawing is a schematic view illustrating a preferred embodiment of the refrigeration system of the present invention.

Referring to the drawing, there is shown a plurality of evaporator coil units 10, 20, and 30 which may be remotely located from each other and from the compressor and condenser of a central type refrigeration system. Coil units 10, 20, and 30 may, for example, be respectively disposed in refrigerated display cases of the general type commonly found in super markets.

The refrigeration system illustrated comprises, in series, a compressor 2, a condenser 4, and a liquid refrigerant receiver 6. A conduit 40 connects compressor 2 with condenser 4 and discharge header 41 is disposed in conduit 40. A conduit 42 connects condenser 4 to receiver 6.

Each of the evaporators 10, 20, and 30 has the form of a coil with ports or openings at opposite ends thereof, these ports being designated for convenience as first ports 11, 21, and 31 and second ports 12, 22, and 32. A refrigerant liquid supply line 44 has one end thereof connected to the receiver 6 and is connected through parallel branches 45, 46 and 47 thereof, respectively, to the ports 11, 21, and 31 of evaporators 10, 20 and 30.

The suction line of compressor 2 is provided with a suction header 50. The second evaporator ports 12, 22 and 32 are connected respectively with suction header 50 through parallel arranged conduits 51, 52 and 53. In the construction thus far described, it will be noted that the evaporators 10, 20, and

30 are connected in parallel between the liquid supply line 44 and the compressor suction header 50.

Each of the evaporators 10, 20, and 30 has the usual thermostatic expansion valve 56 associated therewith for regulating the amount of liquid refrigerant to be admitted through the evaporator ports 11, 21 and 31 during the normal refrigeration cycle. Heat exchangers 58 are provided respectively in the vicinities of each of the evaporators 10, 20, and 30. Referring to evaporator 10, for example, the liquid supply line 45 and the exhaust conduit 51 of evaporator 10 are disposed in a closely spaced, heat-exchanging relationship in the heat exchanger 58 associated with evaporator 10.

Conduits 51, 52, and 53 have solenoid-controlled valves 61, 62, and 63 disposed respectively therein which are normally open during the normal refrigeration cycle. Valves 61, 62, and 63 also are regulator valves which perform the functions of regulating the pressures and the corresponding temperatures in the evaporators 10, 20, and 30 but these functions of these valves have no bearing on the invention. Refrigerant liquid supply line 44 has a solenoid-controlled valve 66 disposed therein which is normally open during the normal refrigeration cycle.

With the apparatus described thus far the conventional refrigeration cycle is performed. Compressor 2 compresses a gaseous refrigerant which flows to the condenser 4 where the refrigerant is condensed to a liquid and flows through the liquid supply line 42 to the receiver 6. From the receiver 6 the liquid refrigerant passes through the normally open solenoid valve 66 through the liquid supply line 44 to the liquid supply line branches 45, 46, and 47. The liquid refrigerant flows through the branches 45, 46, and 47, through the heat exchangers 58, to the thermostatic expansion valves 56 associated respectively with the evaporators 10, 20, and 30. The liquid refrigerant is expanded through the expansion valves 56 and enters the evaporators through the evaporator ports 11, 21, and 31. The expanded and evaporated refrigerant leaves the evaporators through the evaporator ports 12, 22, and 32, passes through the heat exchangers 58, and is drawn through the conduits 51, 52, and 53, in gaseous form, to the suction header 50 and the suction inlet of the compressor 2. Valves 61, 62, and 63 are normally open and performing their pressure and temperature regulating functions, as mentioned above, during the refrigeration cycle described.

The defrosting cycle requires certain additional apparatus as will be described. Each of the evaporators is provided with a bypass around the thermostatic expansion valve and heat exchanger associated with the evaporator. These are bypass conduits 13, 23, and 33 with each conduit having a check valve 68 disposed therein. Branch 45 has one end thereof connected between the expansion valve 56 associated with evaporator 10 and the port 11 thereof, and the other end is connected to branch line 56 between the heat exchanger 58 associated with evaporator 10 and the liquid supply line 44. The branches 46 and 47 have the same constructional relationships to evaporators 20 and 30, respectively, that branch 45 has to evaporator 10.

Discharge header 41 has three hot gas conduits 71, 72, and 73 individually connected thereto. The opposite ends of the hot gas conduits are connected respectively to conduits 51, 52, and 53 at points between the heat exchangers 58 and the valves 61, 62, and 63. Respectively disposed in the hot gas conduits are solenoid operated valves 74, 75, and 76.

In association with liquid supply valve 66 there is provided a pressure sensing and responsive valve regulator 80. A sensing tube 81 is connected to and extends from regulator 80 to liquid supply line 44 on the downstream side of valve 66. Regulator 80 in turn is electrically connected to valve 66 with a wire 82 for operating valve 66 in a manner described further on.

A timing or clock unit 88 is provided which has electrical connections (not shown) with the solenoid operated valves 61 to 63, the solenoid operated valves 74 to 76, the solenoid-operated valve 66 and the valve regulator 80. The defrosting

operations in the illustrated embodiment of the invention are based on predetermined time intervals although other known methods for determining defrosting times could also be used within the scope of the invention. It may be assumed for purposes of illustration that the timing unit 88 is set to allow the refrigeration cycle described above to operate for a period of 2 hours and then selectively and sequentially effect defrosting of the evaporators 10, 20, and 30 for periods of 10 minutes for each evaporator. It is further assumed that the refrigerant used is R-12, which has a condensing pressure of about 117 p.s.i.g. at a condensing temperature of 100° F., and that the compressor pressure in the discharge header is about 117 p.s.i.g.

At a predetermined time when one of the evaporators is to be defrosted, such as the evaporator 10, for example, the timing unit 88 simultaneously effects the opening of the normally closed valve 74, the closing of the normally open valve 61, and the closing of the normally open valve 66. It will be understood that the use of the word "normally" is in the context that the valves referred to are "normally" open or closed during the normal or conventional refrigeration cycle at those times when none of the evaporators are being defrosted.

In the defrosting operation of the evaporator 10 which occurs when the timing unit 88 effects the operation of valves 74, 61, and 66 as stated above, the opening of valve 74 in the hot gas supply line 71 causes the hot gas developed by the compressor 2 to be directed from the header 41 to the line 51. The hot gas flows from line 71, through line 51, into evaporator 10 through port 12 thereof and out of the evaporator through port 11 thereof. While traversing the evaporator 10 the hot gas loses heat to the evaporator coil to cause defrosting thereof and in the process condenses and becomes a cold liquid. The liquefied refrigerant flows through line 13 and the check valve 68 thereof, and through line 45 into the main liquid supply line 44. Keeping in mind that the valve 66 is closed during the defrosting operation, except under certain conditions as noted hereinafter, the condensed refrigerant resulting from the defrosting of evaporator 10 which flows into line 44 is available to provide cooling for evaporators 20 and 30 in the same manner as the liquid refrigerant supplied through valve 66 during the normal refrigerating cycle during which time there is no defrosting operation. The liquid refrigerant from evaporator 10 thus does flow through branch lines 46 and 47 to evaporators 20 and 30, respectively, where the refrigerant is vaporized and returned to the suction header 50 through lines 52 and 53 in the same manner as during the normal refrigeration cycle.

The individual defrosting of the evaporators 20 and 30 would be analogous to the described defrosting operation for evaporator 10 and need not be separately described.

A primary purpose in having the main liquid supply valve 66 closed during the above-described defrosting operation is that the condensed liquid may be removed quickly from the evaporator being defrosted so that the defrosting can be accomplished very quickly and efficiently. At the same time, the condensed refrigerant from the evaporator unit being defrosted is utilized to provide cooling for the other two evaporators. The fact that the defrosting operation is so fast and efficient means that the refrigerated goods being serviced by the evaporator unit being defrosted is not adversely affected because of the relatively short period of time required for the defrosting operation.

In prior art refrigeration systems the procedure was to provide a generally uniform compromise during the defrosting operation during which time only a portion of the hot gas produced by the compressor was utilized for defrosting so that the evaporators not being defrosted would only be slightly deprived of their cooling capacities. The disadvantages of that mode of operation, however, is that the defrosting operation was drawn out over a comparatively longer period of time and the evaporators not being defrosted were thus operated at sub-par efficiencies for a much longer period of time until the defrosting operation was finally completed. In order to provide a satisfactory system in which the refrigerated goods were

not adversely affected during the defrosting operation it was necessary to provide a larger capacity compressor and motor than was actually needed for the normal refrigeration cycle. It is in this respect that the present invention is advantageous over prior art systems in that the defrosting operation can be efficiently accomplished without either adversely affecting the refrigerated goods or by requiring compressor and motor equipment larger than is necessary for the normal refrigeration cycle.

An added or supplemental feature of the invention relates to the providing of an additional function for liquid supply valve 66. It is a condition for any refrigeration system that the refrigerant supplied to an evaporator must have a pressure nearly as great as the normal condensing pressure of the particular refrigerant being used. The refrigerant R-12, for example, has a normal condensing pressure of about 117 p.s.i.g. and, if that is the refrigerant to be used, the pressure in the liquid supply line should not be allowed to drop too far below 117 p.s.i.g. during the defrosting operations. In the system of the present invention the pressure of the refrigerant in the liquid supply line 44 during a defrosting operation, when the valve 66 is closed, is dependent upon a number of variables such as the sizes of the evaporator units and the lengths of the piping runs, for example. It is contemplated that in some installations the defrosting cycle described above would always operate with the pressure in the line 44 being higher than the condensing pressure of the refrigerant being used. In other installations, however, the pressure in the line 44 may at times fall below the desired pressure of the liquid refrigerant and, in order to provide an antidote for that type of operating condition, the valve regulator 80 is provided. The sensing tube 81 senses the pressure in line 44 and the regulator 80, which is devised to override the effect of the timing unit 88 on the valve 66, is adjusted to open the valve 66 whenever the pressure in line 44 drops below the preset pressure of the refrigerant being used. In particular installations the regulating feature manifested by the regulator 80 may not be needed and in such instances that feature may be omitted. In other installations, where the regulating feature would be desirable, the regulation required will vary to the extent that the liquid supplied to the line 44 from an evaporator during a defrost operation will have to be supplemented by liquid supplied through the valve 66 only occasionally in some instances or, in extreme cases, during a substantial portion of the defrosting time period. Of importance with respect to the present invention is that the closing of the valve 66 permits the quickest and most efficient defrosting operation possible and the regulator 80 serves or functions to supply the barest or most minimum amount of supplementary liquid necessary through the valve 66 to maintain effective and operative cooling of the evaporators which are not being defrosted at that time.

I claim:

1. A refrigeration system comprising a compressor, a condenser, a compressor discharge line between said compressor and said condenser, a compressor suction line connected to said compressor, a liquid supply line connected to the downstream side of said condenser and having a plurality of branch passages, fully closable liquid supply valve means in said liquid supply line on the upstream side from said branch passages, a plurality of evaporators each having first and second ports at opposite ends thereof, a pair of parallel lines extending from each of said branch passages to each of said evaporator first ports respectively, each of said pairs of parallel lines having one line thereof with check valve means and the other line thereof with control valve means, a plurality of conduits connected to said compressor suction line and respectively to said second ports of said evaporators, a normally open conduit valve disposed in each of said conduits, a plurality of hot gas supply lines connected to said compressor discharge line and respectively to said evaporators at points respectively between said conduit valves and said second ports, defrost control means for completely closing said liquid supply valve means and for selectively closing one of said con-

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duit valves, and pressure sensing and responsive means connected to said liquid supply line downstream from said liquid supply valve means for regulating said liquid supply valve means to maintain a predetermined pressure in the downstream side of said liquid supply line.

2. A refrigeration system according to claim 1 having sole-

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noid means for operating said supply valve means connected thereto, said pressure sensing and responsive means including a pressure-operated valve regulator and a sensing tube, said tube being connected to said liquid supply line on the downstream side thereof from said liquid supply valve means.

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