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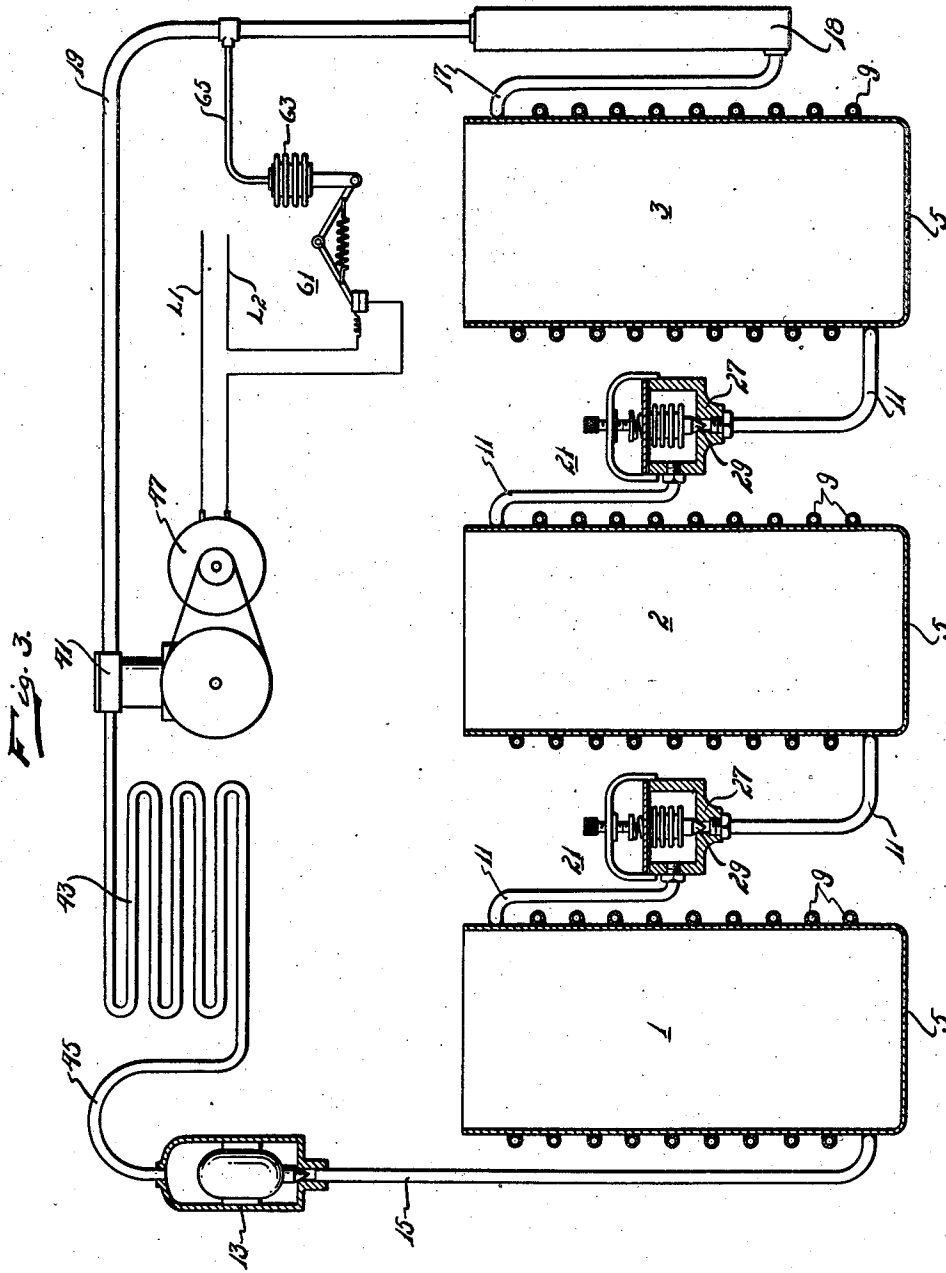
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REFRIGERATING APPARATUS

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## REFRIGERATING APPARATUS

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My invention pertains to refrigerating systems, and more particularly to series connected refrigerating systems for providing multiple temperatures.

It is an object of my invention to provide a refrigerating system for cooling a plurality of separated food storage receptacles at independently adjustable temperatures which comprises a plurality of refrigerant evaporators connected for receiving refrigerant in series relation through interconnecting pressure responsive relief valves, the refrigerant supply being controlled automatically in accordance with the condition of the last evaporator at the low pressure end of the series.

It is a further object of my invention to provide a multiple temperature refrigerating system comprising a plurality of refrigerant evaporators disposed in series conductive relation between a high pressure refrigerant line and a low pressure suction line with adjustable pressure relief valves interconnected therebetween for passing the refrigerant to each succeeding evaporator in accordance with the pressure in each respective preceding evaporator.

The invention itself, however, both as to its organization and its method of operation together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments, when read in conjunction with the accompanying drawings, in which:

Figure 1 is a diagrammatic view representing a multiple-temperature series connected refrigerating system arranged in accordance with one form of my invention;

Figure 2 is a sectional view illustrating the construction of one of the adjustable relief valves; and

Figure 3 is a diagrammatic view representing my refrigerating system arranged with a modified form of automatic control.

Although the principles of my invention are readily adaptable to various refrigerating systems, I have preferably disclosed my system as arranged for cooling a plurality of independent food storage receptacles 1, 2, and 3. As shown in Figure 1, the food storage receptacles may be enclosed by metallic sleeves 5 for holding food containing vessels such, for example, as ice cream cans (not shown). The refrigerant evaporator means for cooling each of the receptacles comprises a refrigerant receiving conduit disposed in coils 9 around each of the sleeves 5 to which it

may be secured in close coupled thermal association therewith, as by soldering or welding in any suitable manner.

The separated evaporator coils 9 are connected into a system in series conductive relation by suitable conduit means 11 interconnected therebetween. A high side float type reducing valve 13 receives high pressure liquid refrigerant from a suitable source and supplies it through suitable conduit means 15 to the evaporator coils 9 associated with the first receptacle 1 at one end of the series. From the evaporator coils 9 associated with the last receptacle 3, at the opposite end of the series, refrigerant vapor is withdrawn through a suitable conduit 17 which is connected to a suction line 19 through an accumulator receptacle 18 which is interposed therein for collecting any liquid refrigerant and preventing its return to the suction line.

The flow of refrigerant from each set of evaporator coils 9 in the series to the next succeeding set of evaporator coils 9 on the low pressure side is regulated by an adjustable relief valve 21 interposed in each interconnecting conduit 11. Each of the relief valves 21 is controlled by the pressure in the adjacent evaporator coils on the high pressure side, which at a predetermined pressure opens the valve and passes the refrigerant along to the next evaporator. In this manner any desired number of storage receptacles may be arranged for cooling by connecting their evaporator coils 9 in series conductive relation in my refrigerating system.

As shown in Figure 2, each of the pressure relief valves 21 comprises a corrugated flexible metal bellows 25 which is enclosed within a suitable casing 27. The innermost end of the bellows 25 carries a valve 29 in adjacent engageable relation to a valve seat and outlet orifice 31 in the adjacent end of the valve casing 27. The opposite end of the corrugated bellows 25 opens outwardly and is secured in hermetically sealed relation around the opposite end of the valve casing 27 in any suitable manner as by soldering or welding for example. The side of the valve casing 27 is provided with an inlet port 33 through which the controlled refrigerant enters from the interconnecting conduit 11 and applies pressure on the bellows 25 which tends to contract it.

A biasing spring 35 is provided within the flexible bellows 25 where it reacts between the closed end thereof and a stop member 37 which receives the opposite end of the spring. The biasing spring stop member 37 is adjustably supported on

the end of a screw threaded shaft 39 which screws through a threaded bracket 41 on the casing 27. By turning a knurled knob 43 on the end of the shaft 39, the position of the stop member 37 may be conveniently adjusted to vary the biasing pressure which is continuously applied by the spring 35 and which tends to expand the bellows and move the associated valve 29 to its seated, flow obstructing, position in opposition to the contracting force applied on the bellows by the pressure of the refrigerant in the valve casing 27.

To provide for regulating the operating characteristics of the system to maintain the desired relative vaporizing pressures and temperatures in the various evaporators, a similar adjustable relief valve 21 is interposed in the conduit 11 connected between each set of evaporator coils 9 with the outlet orifice 31 of each valve casing 27 connected to the inlet of the next set of evaporator coils on the low pressure side.

A refrigerant compressor 41 is operatively connected between the suction line 19 and the high pressure refrigerant line 15 for drawing the refrigerant vapor through the suction line, compressing the same, passing it into a condenser 43 where its latent heat is dissipated in the usual manner and the vapor is condensed to a liquid. From the condenser 43 the liquefied refrigerant passes through the high pressure refrigerant line 45 to the high side float type valve 13. The refrigerant compressor 41 is driven by an electric motor 47 which is energized from the service line conductors L1 and L2 the former being connected directly to one terminal of the motor. For controlling the compressor motor, the contacts 49 of a snap action switch 51 are connected in series in the motor energizing connection from the main line conductor L2. The switch 51 is actuated to its circuit making or breaking positions, in accordance with the demand on the refrigerating system by a flexible metal bellows 53 which is connected thereto through an interconnecting link.

Variable pressures are applied within the expansible switch actuating bellows 53 from a thermo-bulb 55 which is disposed in close coupled thermal relation with the last evaporator on the low pressure end of the series. The thermo-bulb 55 contains an expansible fluid, or a volatile refrigerant liquid, and it is connected into the switch actuating bellows 53 through a control conduit 57. The temperature response characteristics of the thermostatic control switch 51 may be readily predetermined in various ways as by adjusting or selecting a suitable biasing spring 59, or selecting a suitable volatile fluid, in a well known manner.

In operation the motor control switch 51 is automatically snapped to circuit completing position, whenever the temperature of the last receptacle 3 rises above a predetermined degree, thereby starting the compressor 41 and supplying liquefied refrigerant to the system. The refrigerant passes from the condenser unit 43 through the high side float type valve 13 which discharges only liquid refrigerant into the first evaporator coils 9 of the series, where it evaporates under pressure conditions which are predetermined by the adjustment of the adjacent relief valve 21. In response to vaporization of refrigerant in the first evaporator coils, or in response to the oversupply of high pressure liquid refrigerant therein under zero heat load conditions, a pressure is eventually built up which opens the adjacent relief valve 21 and discharges refrigerant there-

through to the succeeding set of evaporator coils 9. The system is preferably provided with sufficient refrigerant to simultaneously supply all of the evaporators with liquid refrigerant and in the event there is no heat load on the first evaporator of the series, refrigerant will be supplied to accommodate the demands of the succeeding evaporators of the series. A condition is eventually attained in the second set of evaporator coils 9 which in like manner causes the relief valve 21 connected with its outlet to be opened for passing the refrigerant to the last evaporator of the series.

When the refrigerant is supplied to the last set of evaporator coils 9, its vaporization therein absorbs heat from the storage receptacle 3 thus reducing the temperature, and the heat load demand is satisfied. The decreasing temperature reduces the pressure in the thermal bulb 55 associated therewith which causes the switch actuating bellows 53 to contract causing the snap switch to open and discontinue the operation of the compressor 41.

The automatic control of the compressor unit may, if preferred, be accomplished by a pressure responsive switch 61 associated with the suction line 19, as shown in Figure 3. In this arrangement the motor controlling switch is actuated directly by an expansible bellows 63 which is connected through a suitable conduit 65 to the suction line 19. When the heat load on the last evaporator has vaporized sufficient refrigerant to increase the pressure in the suction line 19 to a predetermined value, the flexible bellows 63 is sufficiently expanded to actuate the motor control switch 61 thereby starting the compressor 41. After the refrigerant compressor has operated a sufficient time the withdrawal of refrigerant vapor from the suction line 19 reduces the pressure therein to such an extent that the control switch 61 snaps open and stops the compressor 41.

By properly adjusting the pressure relief valves 21 in the manner above set forth, the vaporizing pressures and temperatures maintained in the respective evaporators may be automatically regulated, as desired in either system. Various degrees of temperature may be thus maintained in the respective food storage receptacles ranging from warm, and medium, to cold.

It will be apparent that I have provided a conveniently adjustable refrigerating system for cooling a plurality of separate, food storage, receptacles by refrigerant evaporators which are disposed in series conductive relation to receive refrigerant which is automatically supplied thereto in accordance with the condition of the last evaporator of the series whereby a system is provided which is simple and positive in its operation for accurately maintaining any range of temperature desired.

Aside from the specific embodiments of the invention herein shown and described, it will be understood that numerous details of the arrangement may be altered or omitted, and that the principle of my invention herein disclosed is applicable to various refrigerating systems without departing from the spirit and scope of the invention as disclosed and claimed, and that I do not desire to limit the invention to the exact constructions herein set forth.

I claim as my invention:

1. A refrigerating system comprising, in combination, a plurality of evaporators connected in series circuit relation, means for withdrawing gaseous refrigerant from the evaporators and for

condensing the gaseous refrigerant and for delivering the same to the evaporators, a liquid feed valve of the type adapted to feed liquid refrigerant from the means at a rate substantially in direct accordance with the rate of accumulation of liquid refrigerant condensed, said liquid feed valve being interposed between the said means and the inlet to the evaporator first to receive liquid refrigerant, and a second valve interposed between the outlet of the first evaporator and the inlet to the next evaporator for controlling the flow of both liquid and gaseous refrigerant from the first to the second evaporator, said second valve including a pressure element for moving the valve, and said pressure element being responsive to the pressure in the first evaporator and adapted to be assisted by the pressure in the second evaporator in the event of an abnormally high pressure in said second evaporator for supplying refrigerant from the first to the second mentioned evaporators in response to the pressure in the first evaporator.

2. A refrigerating system comprising, in com-

bination, a plurality of evaporators connected in series circuit relation, means for withdrawing gaseous refrigerant from the evaporators and for condensing the gaseous refrigerant and for delivering the same to the evaporators, a high side float type valve interposed between the said means and the inlet to the evaporator first to receive liquid refrigerant, and a second valve interposed between the outlet of the first evaporator and the inlet to the next evaporator for controlling the flow of both liquid and gaseous refrigerant from the first to the second evaporator, said second valve including a pressure element for moving the valve, and said pressure element being responsive to the pressure in the first evaporator and adapted to be assisted by the pressure in the second evaporator in the event of an abnormally high pressure in said second evaporator for supplying refrigerant from the first to the second mentioned evaporators in response to the pressure in the first evaporator.

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