Dec. 5, 1939. E. B. NEWILL 2,182,318

REFRIGERATING APPARATUS

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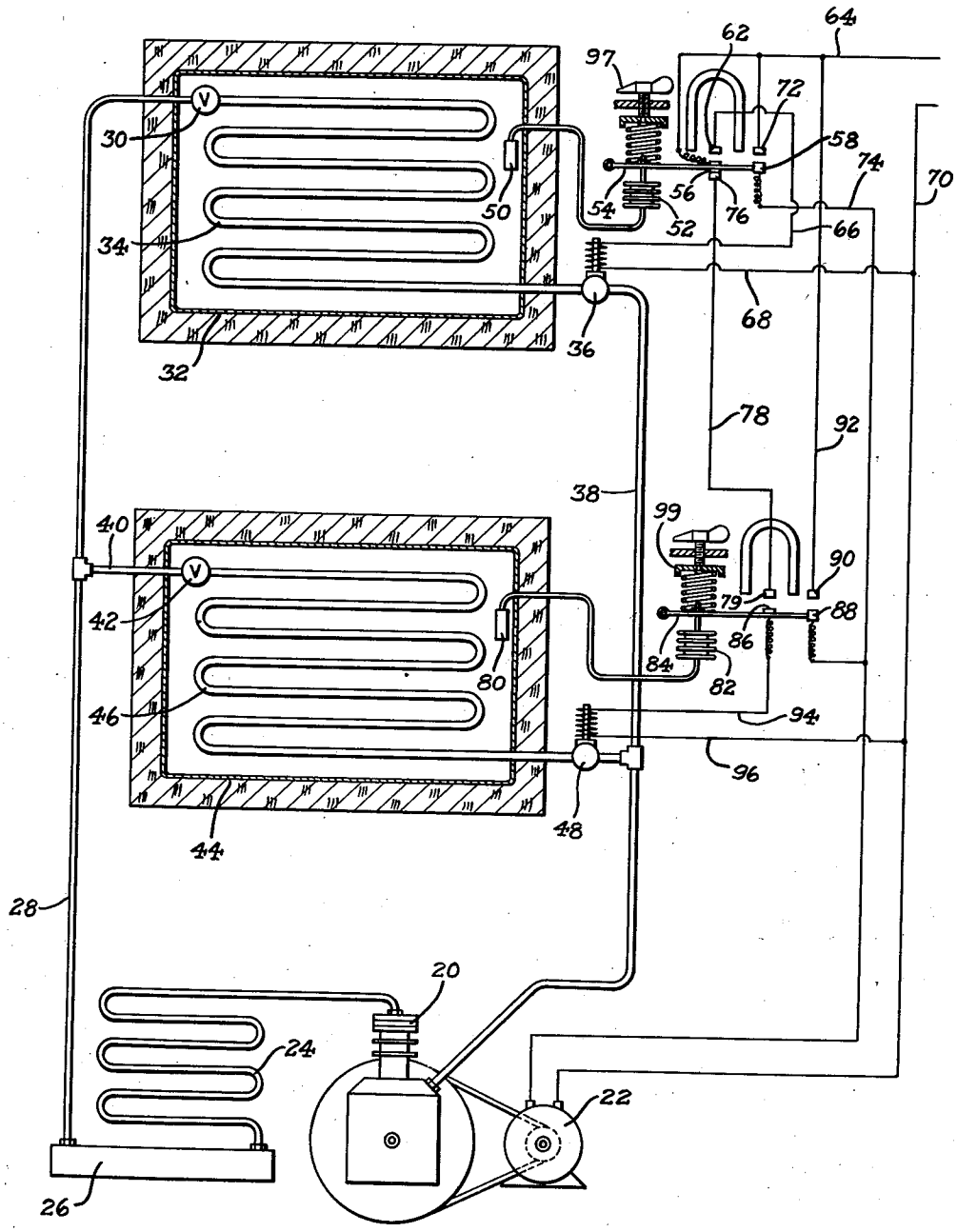


Fig. 1

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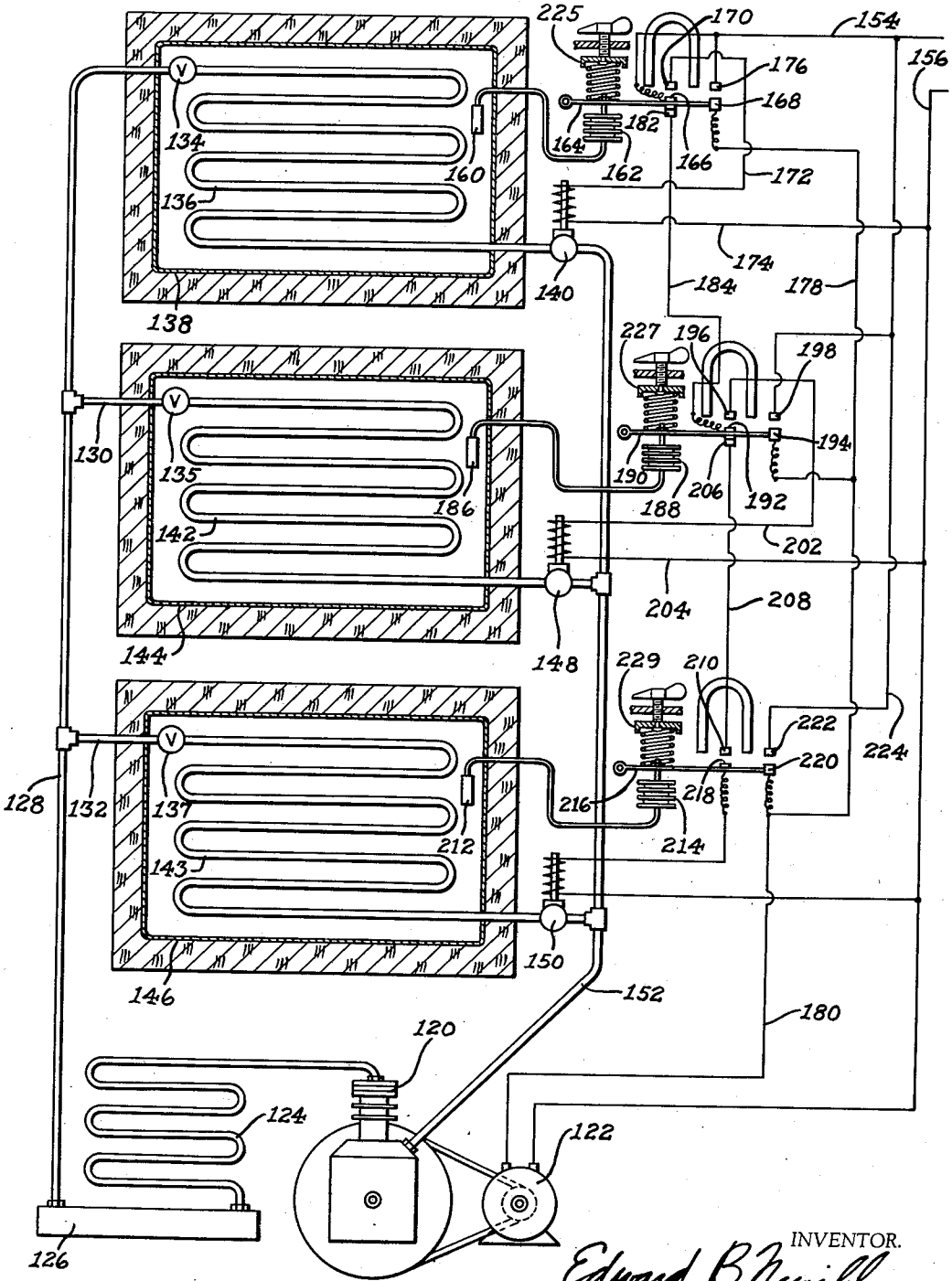


Fig. 2

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REFRIGERATING APPARATUS

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9 Claims. (Cl. 62—4)

This invention relates to refrigerating apparatus and more particularly to multiple refrigerating systems having a liquefying apparatus of small capacity having control means for individually controlling the supply of refrigerant to sections of the multiple system.

In refrigerating systems it is normally necessary in order to insure satisfactory refrigeration, to build the system sufficiently large and having sufficient capacity to take care of the heaviest possible load. Thus, in air conditioning, where the load is greatest during the middle of the afternoon, it is necessary to design this system with a sufficient capacity to take care of this peak load. From this it is evident that at other times of the day the system operates at considerably less than full load. If some means were provided for making use of this excess capacity in other parts of the day and storing it for use during the peak load capacity, the capacity of the system required to be installed could be considerably reduced.

The peak load condition, however, is not confined merely to air conditioning, but is present in nearly all refrigerating requirements, and in fact is not limited to refrigeration at all but in practically all situations where power is required.

It is possible to increase the hold-over capacity of the evaporator by surrounding it with a congealing solution or a brine which during periods of heavy loads gives up refrigeration upon the rising temperatures. However, it has been found objectionable to surround the evaporating means used for normal refrigeration, with brine or a congealing solution because of its bulk and cumbersomeness and because it reduces the heat transfer efficiency of the evaporating means.

It is therefore an object of my invention to provide a refrigerating system of limited capacity wherein a proper and adequate supply of refrigeration to a primary evaporating means is insured, and wherein the excess capacity of the system under light loads may be stored and made use of during peak loads.

It is a further object of my invention to provide a multiple refrigerating system wherein one evaporating means or a section of the evaporating means is given preference while a second evaporating means receives refrigeration as required after the refrigerating requirements of the preferred evaporator are taken care of.

It is a further object of my invention to provide a multiple refrigerating system having a refrigerant liquefying means of relatively small capacity which is provided with a control means for giving preference in the circulation and evaporation of refrigerant to certain sections of the evaporating means in a predetermined order.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a diagrammatic representation of a multiple refrigerating system embodying my invention; and

Fig. 2 is a diagrammatic representation of a multiple refrigerating system containing three evaporators embodying my invention.

Briefly, in my refrigerating system, I provide a relatively small compressor and condensing means connected in a closed circuit with a plurality of separate evaporators arranged in parallel refrigerant circuit relation, each of which are provided with a separate expansion valve at the inlet and a separate solenoid valve at the outlet, which opens when energized. A thermostat switch means is provided for each evaporator, the first of which insures that the preferred evaporator will be operatively connected to a compressor whenever it requires refrigeration. When the preferred evaporator does not require refrigeration, this same thermostatic means makes it possible for the second preferred evaporating means to obtain refrigeration. This second preferred evaporating means is likewise provided with a temperature responsive means which causes it to be operatively connected to the compressor and condensing means when the first preferred evaporator does not require refrigeration and when this second preferred evaporating means does require refrigeration. If desired, a third evaporator may be provided which will be able to receive refrigeration only when refrigeration is not required by a first and second preferred evaporator.

Referring now to the drawings, there is shown a compressor **20** driven by an electric motor **22** for compressing the refrigerant and for forwarding the compressed refrigerant to a condenser **24** where the refrigerant is liquefied and cooled in a receiver **26**. From the receiver **26**, the refrigerant is forwarded to a supply conduit **28** which extends to an expansion valve **30** located within an insulated enclosure **32**. This expansion valve **30** in turn is connected to an evaporating means **34** also located within the insulated enclosure **32**. At the outlet of the evaporating means **34** is an electric solenoid valve **36** which opens when ener-

gized to permit the flow of refrigerant from the evaporating means **34** into the return line **38** which returns the evaporated refrigerant back to the compressor.

From the supply conduit **28** a branch conduit **40** extends to an expansion valve **42** located within an insulated enclosure **44** which contains an evaporating means **46** connected to the expansion valve **42**. At the outlet of the evaporating means **46** there is provided an electric solenoid valve **48** similar to the valve **36** which opens when energized to permit the flow of evaporated refrigerant from the evaporating means **46** to the return line or conduit **38**.

The use of evaporating means **34** is such that it be supplied with refrigeration whenever desired. The use of the second evaporating means **46** is such that it is only necessary that it be supplied with refrigeration only at such times when refrigeration is not required by the evaporator **34**. The cost of this system is reduced by using a relatively small motor compressor condenser unit which is only of sufficient capacity to take care of the refrigerant requirements of one of the evaporating means **34** or **46** at a time.

There are any number of refrigerating situations where such a system might be used to advantage. As one example, the evaporating means **34** may be used in normal direct refrigerating relationship with some medium to be cooled such as air or a liquid wherein peak load conditions occur at intervals. In such an example, the second evaporating means would be used during light load conditions to cool a brine, or a congealing solution which should be arranged in such a way that it would supply refrigeration to the medium cooled by the preferred evaporator **34**, under peak load conditions so as to reduce the amount of refrigeration required under peak load conditions from the evaporator **34** to maintain the desired refrigerating conditions. Thus the refrigeration capacity of the system during light load conditions would be used to reduce the refrigerating requirements of both the compressor condenser means and the preferred evaporator during peak load conditions so that these portions of the system could be made of a considerable lesser capacity than the peak load to be encountered.

Another example of the use of such a system would be to use the preferred evaporator **34** to maintain foodstuffs such as ice cream at a proper temperature, while a second evaporator **46** might be used for less rigid refrigerating requirements such as to cool water for drinking purposes or even for cooling or air conditioning the store.

My invention contemplates the provision of an automatic control to properly control the application of refrigerant to the evaporators in such a system. In order to do this I provide two thermostatic control switches shown diagrammatically, of an unusual nature. The first of these switches is provided with a thermostat bulb **50** located within the medium in the insulated enclosure **32** containing the evaporating means **34**. This thermostat bulb **50** is connected to a bellows **52** which operates a flexible spring arm **54** of spring material which carries the contacts **56** and **58**. A horse shoe permanent magnet is provided which cooperates with the flexible spring arm **54** to provide a snap action thereof.

When refrigeration is required by the medium within the enclosure **32** the volatile fluid in the thermostat bulb **50** expands causing the bellows **52** to expand and move the flexible switch arm **54** upwardly to place the contact **56** into engagement with the contact **62** which permits the flow of electric energy through the electric conductor **64**, through the contacts **56** and **62** and through the electric conductor **66** to the solenoid valve **36** to open the solenoid valve **36** and thence through the electric conductor **68** back to the electric conductor **70** which connects to the opposite terminal of the electric supply. At the same time the contact **58** makes contact with a contact **72** which permits the flow of electric energy from the electric conductor **64** to the contacts **72** and **58** and the electric conductor **74** to the compressor motor **22** which connects to the opposite electric terminal.

Thus through the making of these contacts the solenoid valve **36** is opened and the motor compressor unit begins its operation. Liquid refrigerant is supplied to the evaporating means under the control of the expansion valve **30** and the evaporated refrigerant is withdrawn from the evaporating means in the normal manner by the compressor. Under such conditions the solenoid valve **48** remains de-energized and closed, thus preventing the operative connection of the evaporator **46** with the compressor unit.

In Fig. 1 however, the thermostat switch operated by the thermostat bulb **50** is shown in low temperature position in which the contact **56** makes contact with a contact **76** which is connected by an electric conductor **78** to a contact **79** forming a part of a switch mechanism operated by a thermostat bulb **80**. This thermostat bulb **80** is located within the medium enclosed in the insulated enclosure **44** which is cooled by the evaporating means **46**. This thermostat bulb **80** is operatively connected to a bellows **82** which operates a flexible switch arm **84** of spring material provided with a contact **86** for engaging the contact **79** and a second contact **88** for engaging a contact **90** which is connected by an electric conductor **92** to electric conductor **64**. A horse shoe permanent magnet **100** is provided for cooperating with the spring arm **84** to provide a snap action for preventing arcing at the contacts.

When the temperature of the thermostat bulb **80** is high the contacts **79** and **86** close to permit the flow of electric energy through the electric conductor **94** to the solenoid valve **48** to open the solenoid valve **48** providing the contacts **56** and **76** closed. The solenoid valve **48** is also connected by the electric conductor **96** to the electric conductor **70**. At the same time the closing of the contacts **88** and **90** permits the flow of electric energy from the electric conductor **64** through the conductor **92** and the conductor **74** to the compressor **22** to cause the compressor unit to operate and to supply refrigeration to the evaporating means **46** provided refrigeration is not required by the evaporating means **34**.

Thus in this system, the preferred evaporating means **34** always maintains the proper temperature within the insulated enclosure **32** as measured by the thermostat bulb **50** while the medium within the insulated enclosure **44** can receive refrigeration if required, provided refrigeration is not required by the preferred evaporating means **34**. The second insulated enclosure is fully protected from becoming too cold.

In Fig. 2 I have shown a multiple system in which three separate evaporating means are provided with refrigeration in a predetermined sequence according to the requirements. In this system, there is provided a compressor **120** driven by an electric motor **122** for compressing the refrigerant and for forwarding the compressed refrigerant to a condenser **124** where the com-

pressed refrigerant is liquefied and collected in a receiver 126. The liquid refrigerant is forwarded from the receiver through the supply line 128 and branch supply lines 130 and 132 to expansion valves 134, 135 and 137. The expansion valve 134 is connected to an evaporating means 136 enclosed within an insulated compartment 138 containing a medium to be cooled. The evaporating means 136 is provided with an electric solenoid valve 140, normally closed, which expands when energized.

Similarly the expansion valve 135 is connected to an evaporating means 142 enclosed within an insulated compartment 144 containing a medium to be cooled while the expansion valve 137 is connected to an evaporating means 143 enclosed within an insulated compartment 146 containing a medium to be cooled. The outlet of the evaporating means 142 is provided with an electric solenoid valve 148 normally closed, but which opens when energized and the outlet of the evaporating means 143 is provided with a similar solenoid valve 150. These electric solenoid valves 140, 148, 150 are connected to the return conduit 152 which conects to the intake of the compressor 120.

The evaporating means 136 and 142 are each provided with a thermostat control switch which is similar to that operated by the thermostat bulb 50, while the evaporating means 143 is provided with a thermostat control which is similar to that operated by the thermostat bulb 80. In Fig. 2 the electric conductors connected to the opposite sides of the power line are designated by the reference characters 154 and 156. Located within the medium to be cooled in the insulated enclosure 138 is a thermostat bulb 160 which operates a bellows 162 operably connected to a flexible switch arm 164 formed of a spring material provided with a contact 166 connected to the electric conductor 154 and a second contact 168.

When the bulb 160 is at a comparatively high temperature, the contact 166 makes contact with a contact 170 to connect the electric conductor 154 with the electric conductor 172 which connects with the electric solenoid valve 140 which in turn is connected by the electric conductor 174 to the electric conductor 156. At the same time the contact 168 makes contact with a cooperating contact 176 which connects electric conductor 154 with an electric conductor 178, which in turn connects to an electric conductor 180 connected to the compressor driving motor 122 which is also connected to the conductor 156.

Thus, under these conditions the compressor driving motor is energized to operate the motor compressor unit and the electric solenoid valve 140 is energized to open the outlet of the evaporating means 136 to cause refrigeration to be supplied to the evaporating means 136 to cool the medium contained within the enclosure 138. At the same time the electric solenoid valves 148 and 150 remain in a closed condition since they must receive their electric energy through a contact 182 which connects to an electric conductor 184. This contact 182 is engaged by the contact 166 to connect it to the conductor 154 only when the thermostat bulb 160 is at a low temperature and when the switch arm 164 is in its lower position indicating that no refrigeration is required by the medium within the enclosure 138. Fig. 2 shows the switch arm 164 in its lower or low temperature position.

Within the medium in the enclosure 144 is a thermostat bulb 186 connected to a bellows 188 which operates a flexible switch arm 190 provided with a contact 192 connected to an electric conductor 184 and a second contact 194 connected to the electric conductor 178. When refrigeration is required by the medium within the enclosure 144, the thermostat bulb 186 is at a relatively high temperature causing the bellows 188 to expand and to cause the contact 192 to engage the contact 196 and the contact 194 to engage the contact 198. The closing of the contacts 194 and 198 will close the circuit to the compressor driving motor 122. Should contacts 192 and 196 be closed, and the contacts 166 and 182 be closed, the circuit will be closed through the electric conductor 202 to the electric solenoid valve 148 which is connected by the conductor 204 to the conductor 156. Under such conditions the motor compressor unit will operate and be operatively connected only with the evaporating means 142.

When refrigeration is not required by the medium within the insulated enclosure 144, the contact 192 makes contact with a cooperating contact 206 connected by an electric conductor 208 to a contact 210 forming a part of the switch operated by the thermostat bulb 212 located within the medium to be cooled within the insulated enclosure 146. This thermostat bulb 212 operates a bellows 214 connected to a flexible switch arm 216 provided with a contact 218 adapted to make contact with the contact 210 and provided with a second contact 220 adapted to make contact with the cooperating contact 222 for closing the circuit through the electric conductor 224 to the compressor motor 122 to cause the operation of the motor compressor unit. Thus when refrigeration is required by the medium within the enclosure 146 and the other evaporating units require no refrigeration, then only the evaporated means 143 is placed in operative connection with the motor compressor unit. Thus in this system the evaporating means 136, 142 and 143 receive refrigeration preference in that order, according to their refrigeration requirements.

Such a system may be used where it is absolutely necessary that one refrigerating requirement be fully satisfied at all times, another where the refrigerating requirements should be satisfied most of the time but which is not absolutely necessary at all times, and a third where refrigerating requirements are not altogether necessary, but desirable. For example, the first preferred evaporator might be used to cool ice cream, the second to cool drinking water, and the third to provide air conditioning for the store. The second and third evaporating means might be provided with some sort of hold over arrangement to take care of their requirements during any peak load of the first preferred evaporator.

It should be noted that each of the switch means, both in Fig. 1 and Fig. 2, are provided with a spring opposing the expansion of the bellows and a screw thread adjustment for varying the tension of the screw, which screw thread adjustment is provided with a finger manipulator. In Fig. 1, the spring and finger manipulator adjusting means of the upper switch is designated by the reference character 97, while the spring and screw thread adjustment for the lower switch which is operated by the thermostat 80 is provided with a reference character 99. In Fig. 2, the spring and screw thread adjustment for the switch operated by the thermostat 160 is given a reference character 225 while the spring and screw thread adjusting means for the switches

operated by the thermostas 186 and 212 are given the reference characters 227 and 229.

Within limits the screw thread adjustment or finger manipulator may be adjusted to maintain any desired temperature limits within their respective evaporating means which they control. Thus, each of the evaporators may operate at different temperatures and one may operate at temperatures above freezing and another at temperatures below freezing. This is of a considerable advantage in air conditioning work where, for example, the evaporator 34 of Fig. 1 would be used to cool the air in the room and would operate at temperatures considerably above freezing such as between 35° F. and 45° F., while the second evaporator 46 might operate at temperatures considerably below freezing such as between 15° F. and 25° F., in order to freeze a congealing solution which would be used as a hold over to provide refrigeration for air conditioning during the peak loads of the day so as to reduce the peak load upon the refrigerating system. This will be of particular advantage since it is difficult to provide an inexpensive congealing solution which will operate satisfactorily at temperatures above freezing. By operating the two evaporators at different temperatures, the evaporator 34 could operate at the most desirable evaporating temperature for air conditioning while the second evaporator 46 might operate at temperatures most suitable for freezing a congealing solution.

Such a two-temperatures refrigerating system might also be used for other purposes such as one for preserving ice cream while the other might be used for cooling drinking water. In such a case the evaporator 34 which would be used for cooling the ice cream would operate at temperatures around 5° F., whereas the other evaporator 46 would operate probably at temperatures around 40° F.

The system shown in Fig. 2 might operate its evaporators at three different temperatures by suitable adjustment of the finger manipulator provided in the adjusting means 225, 227 and 229. Thus the evaporator 136 might operate at temperatures around 5° F. for preserving ice cream, the evaporating means 142 might operate at temperatures around 40° F. for cooling drinking water, while the evaporator 143 might operate at temperatures of 50° to 60° F. for cooling the syrup rail, or at temperatures suitable for air conditioning purposes for air conditioning a store. Thus, it will be appreciated that I have provided an extremely flexible system capable of a number of very desirable occupations.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. Refrigerating apparatus including refrigerant liquefying means and refrigerant evaporating means, said evaporating means having a portion provided with a temperature responsive means for operatively connecting said portion to the liquefying means when refrigeration is required by said portion, said temperature responsive means also including means for simultaneously controlling the operative connection of a second portion of the evaporating means with the liquefying means, a second temperature responsive means for controlling the operative connection of said second portion of the evaporating means with the liquefying means, said first mentioned temperature responsive means also including means for simultaneously controlling the operative connection of a third portion of the evaporating means with the liquefying means, and a thid temperature responsive means for controlling the operative connection of said third portion with the liquefying means.

2. Refrigerating apparatus including refrigerant liquefying means and refrigerant evaporating means, said evaporating means having a portion provided with a temperature responsive means for operatively connecting said portion to the liquefying means when refrigeration is required by said portion, said temperature responsive means also including means for simultaneously controlling the operative connection of a second portion of the evaporating means with the liquefying means, a second temperature responsive means for controlling the operative connection of said second portion of the evaporating means with the liquefying means, said first mentioned temperature responsive means also including means for simultaneously controlling the operative connection of a third portion of the evaporating means with the liquefying means, and a third temperature responsive means for controlling the operative connection of said third portion with the liquefying means, said second temperature responsive means also having means for controlling the operative connection of the third portion of the evaporating means with the liquefying means.

3. Refrigerating apparatus including a refrigerant liquefying means and a plurality of evaporating means connected in a closed refrigerant circuit, and temperature responsive means for insuring that the liquefying means is operatively connected to the outlet of only one of the evaporating means at a time, said temperature responsive means including individual means for closing the outlets of a plurality of evaporating means when no refrigeration is required by the said plurality of evaporating means.

4. Refrigerating apparatus including refrigerant liquefying means and a plurality of refrigerant evaporating means connected in a closed refrigerant circuit, control means for individually controlling the circulation of refrigeran through three of said evaporating means, said control means including means for preventing the circulation through a second and a third of said three evaporating means when refrigerant circulates through a first of said three evaporating means.

5. Refrigerating apparatus including refrigerant liquefying means and a plurality of refrigerant evaporating means connected in a closed refrigerant circuit, control means for individually controlling the circulation of refrigerant through three of said evaporating means, said control means including means for preventing the circulation through a second and a third of said three evaporating means when refrigerant circulates through a first of said three evaporating means, said control means also including means for preventing the circulation of refrigerant through a third of said three evaporating means when refrigerant circulates through the second evaporating means.

6. Refrigerating apparatus including in combination a plurality of evaporating means operatively connected to a refrigerant liquefying means, fluid control means individually positioned in the outlet conduit of each of said plu-

rality of evaporating means, and means in operative association with each of said fluid control means for controlling the opening and closing of each of said fluid control means, said means preventing at least one of said fluid control means from opening when the other of said fluid control means are in open position.

7. Refrigerating apparatus including in combination a plurality of evaporating means operatively connected to a refrigerant liquefying means, fluid control means individually positioned in the outlet conduit of each of said plurality of evaporating means, and means in operative association with each of said fluid control means for controlling the opening and closing of each of said fluid control means, said means opening not more than one of said fluid control means at any one time.

8. Refrigerating apparatus including in combination a plurality of evaporating means operatively connected to a refrigerant liquefying means, electrically operated fluid control means individually positioned in the outlet conduit of each of said plurality of evaporating means, and switch means in operative association with each of said fluid control means for controlling the opening and closing of each of said fluid control means, said switch means being provided with an electrical interconnection which prevents at least one of said fluid control means from opening when the other of said fluid control means are in open position.

9. Refrigerating apparatus including in combination a plurality of evaporating means operatively connected to a refrigerant liquefying means, fluid control means individually positioned in the outlet conduit of each of said plurality of evaporating means, and means in operative association with each of said fluid control means for controlling the opening and closing of each of said fluid control means, said means preventing said individually positioned fluid control means from opening when no refrigeration is required by said plurality of evaporating means.

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