Aug. 4, 1936. S. RUPPRICHT **2,049,625**

AUTOMATIC DEFROSTING DEVICE

Filed Dec. 16, 1930 2 Sheets-Sheet 1

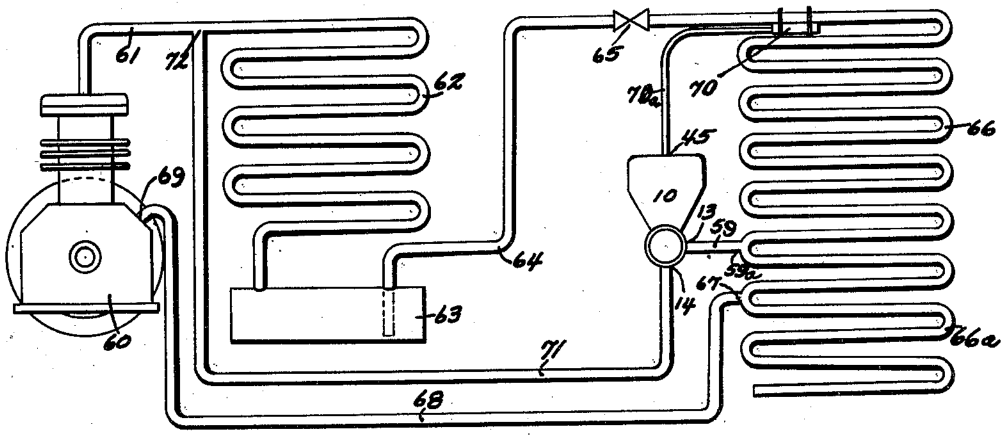

Fig. 2.

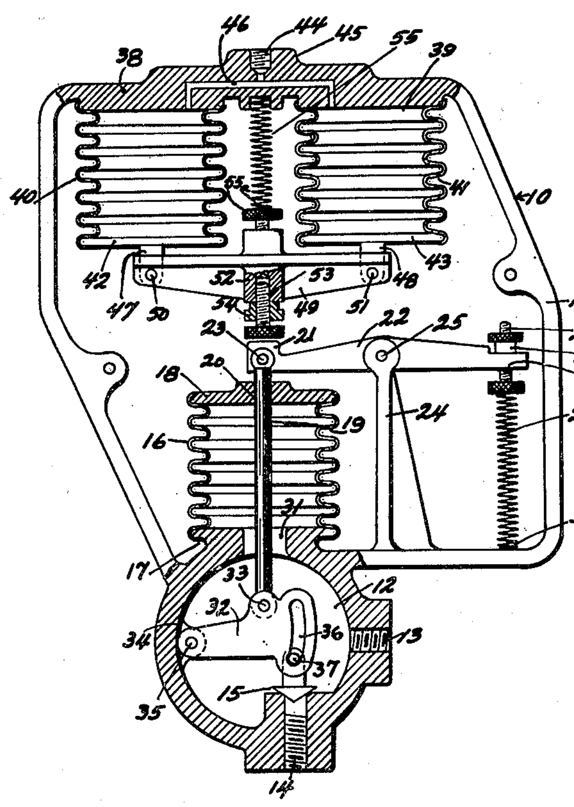

Fig. 1.

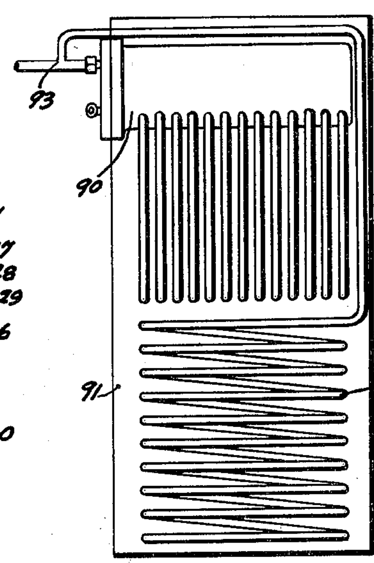

Fig. 7.

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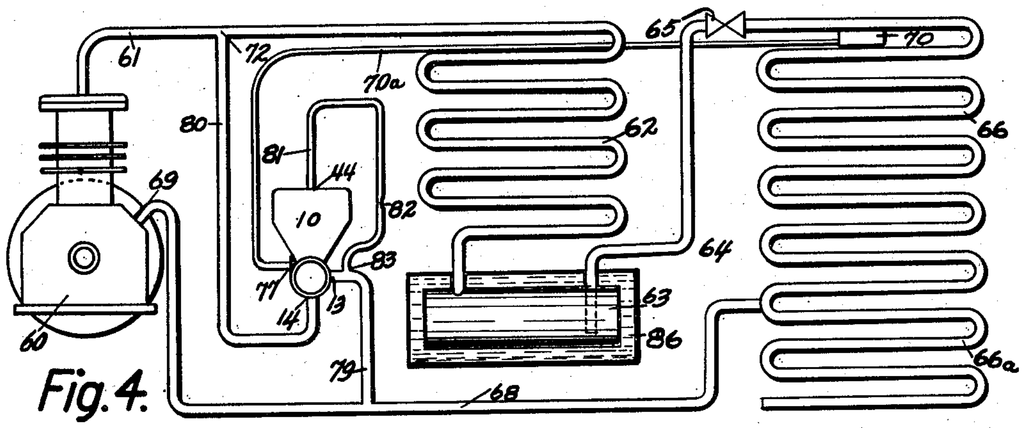

Fig. 4.

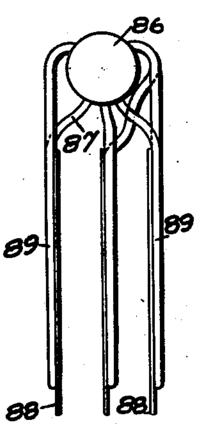

Fig. 6.

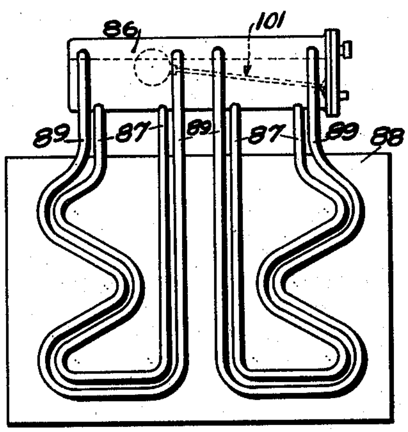

Fig. 5.

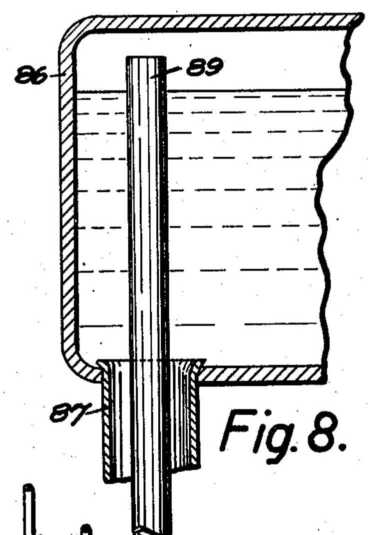

Fig. 8.

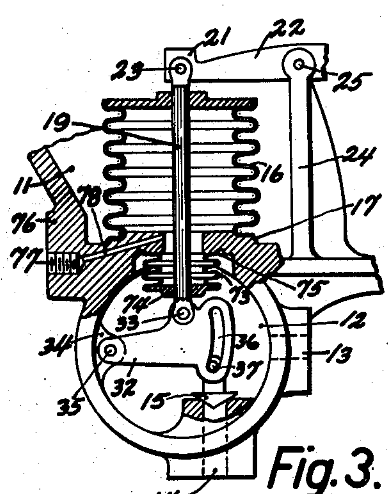

Fig. 3.

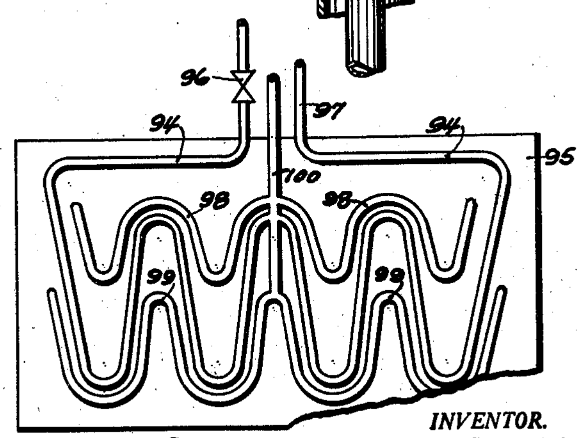

Fig. 9.

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Patented Aug. 4, 1936

UNITED STATES PATENT OFFICE

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AUTOMATIC DEFROSTING DEVICE

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Application December 16, 1930, Serial No. 502,677

17 Claims. (Cl. 62—2)

This invention relates to automatic defrosting devices for defrosting the cooling elements in refrigerators, cooling chambers, etc., and has for an object the provision of automatic means for admitting hot or uncondensed gases directly into the evaporator and condensing the same therein and utilizing the heat thereof to accomplish the defrosting.

Another object is to provide in a "dry" evaporator system a pocket or coil adapted to be used as a receiver for condensed liquid during any defrosting period.

A further object is to have a relatively larger evaporator heat absorbing surface immediately after a defrosting period to accelerate the cooling thereof and in a measure to compensate for the heat put in during the defrosting cycle.

Another object is to provide in a flooded system a series of chambers or pipes of suitable shape to hold condensed refrigerant accumulated in the evaporator during the defrosting cycle.

Another object is to surround the condenser receiver with a heat absorbing medium whereby during the running period of the machine some of the heat of the condenser is stored up to be utilized in boiling the liquid therein during the defrosting cycle. This boiling lowers the temperature in the receiver and the resultant cold is stored up to give a lower head pressure and lower temperature of liquid delivered to the expansion valve at the beginning of the working cycle.

Another object is to provide a device for controlling the defrosting cycle adapted to be actuated by pressure or temperature, and de-actuated by pressure or temperature, thus making available four combinations for control of the automatic operation thereof.

Still another object is to provide a refrigerating system having a plurality of evaporators with means for alternately defrosting one evaporator when the other one reaches a predetermined temperature, or the vapor pressure corresponding to a predetermined temperature.

Other objects will be apparent to those skilled in the art upon perusal of the following specification and claims.

The accumulation of frost on the surfaces of the evaporator or brine tank in refrigerators, cooling chambers, etc., insulates these surfaces and retards the absorption of heat from the air passing thereover. This reduces the efficiency of the system.

To get the maximum cooling effect, the cooling unit should be defrosted after each operating cycle and this is accomplished in this invention in a novel and simple manner.

An automatic control device is provided and is connected to the evaporator and to the compressor exhaust pipe at a point between the compressor and the condenser so that the warm gases from the compressor and/or the condenser are available for defrosting. A valve is located in the control device between the evaporator and the exhaust pipe connection. This valve is actuated or opened by pressure of the evaporator impressed against the interior of a single flexible metallic bellows.

When the defrosting has been effected the valve is closed by a double metallic bellows, in conjunction with a thermo-bulb, acting against the first mentioned single bellows.

The evaporator has preferably a pocket, a coil, or chamber that is not directly in the path of the refrigerant passing through the evaporator.

Now, for example, consider a system in which the compressor has been shut down by means of the thermostat (or pressure-stat) and when the rising pressure in the evaporator almost reaches the cutting in point of the compressor this pressure acting on the metallic bellows opens the valve aforementioned and the warm (or hot) gaseous refrigerant passes into the evaporator, gives up its heat to the evaporator and is condensed therein. The condensed refrigerant, now being liquid, settles into the pocket or coil provided for this purpose and the process continues until the evaporator reaches a predetermined temperature (for example 33° F.) at which time the double bellows acts against the single bellows and closes the valve.

The compressor, via its own control having started at some time during this defrosting cycle, operates normally after the closing of the valve, and the cooling is accelerated because the pockets or coils in the evaporator present additional heat absorbing surfaces until the liquid refrigerant therein has boiled out, whereafter the normal surface of the evaporator is refrigerated. This is in connection with a "dry" system.

In flooded systems it is necessary to provide extra space for the refrigerant to condense in, due to the fact that not only the metal of the coils has to be warmed up but also the body of refrigerant contained therein, and in brine tank systems a substantially greater space must be provided so that the body of brine also may be warmed up to accomplish the defrosting.

In cases where water cooled condensers are used, a control such as is now used may be arranged inverted so that water will flow when the condenser falls below a certain point in which case, during the defrosting cycle, the refrigerant gas carries heat from the water to the evaporator.

Other arrangements will hereinafter be shown and described.

Referring to the drawings:—

Figure 1 is a view, partly in section and partly diagrammatic, of the preferred form of defrosting control device;

Figure 2 is a diagrammatic sketch of a refrigerating system showing one method of carrying out the invention;

Figure 3 is a sectional view, partly broken away, of a modification of the device shown in Figure 1;

Figure 4 is a diagrammatic sketch of a refrigerating system showing one method of using the modified device shown in Figure 3;

Figure 5 is a side view of a plate coil type of flooded evaporator provided with defrosting coils;

Figure 6 is an end view of the evaporator shown in Figure 5;

Figure 7 is a diagrammatic sketch showing an evaporator of the flooded type submerged in a brine tank and one arrangement of a coil in the brine for defrosting by this improved method;

Figure 8 shows a portion of an evaporator header in section with one end of a regular refrigerating coil secured therein, and a defrosting coil within the refrigerating coil and having its upper end above the liquid in the header, and

Figure 9 is a view of a plate coil for use in a dry system with the addition of the defrosting coils.

The control device, designated generally by the numeral **10**, has an upper frame **11** and a chamber **12**. The chamber **12** is sealed and has a threaded hole **13** for connecting a pipe or fitting thereto. A second threaded hole **14** also extends into the chamber **12** and has on its inner end a valve **15**, the operation of which will be described later.

In the upper frame **11** is mounted a flexible metallic bellows **16** which is secured in sealed relation to the lower chamber **12** at **17**.

The upper end of the bellows **16** is sealed by a disc **18** which has a push rod **19** also sealed thereto at **20**. The upper end of the push rod **19** is connected to a boss **21** on one end of a lever **22** by a pivot pin **23**. The lever **22** is supported on an arm **24** by a pivot pin **25** at a point near the center thereof.

A spring **26** is provided between the end **29** of the lever **22** and the casing at the point indicated by the numeral **30** and the tension of this spring may be varied by means of the nut **28** on the screw **27**. The pressure of the spring **26** acts against the bellows **16** via the lever **22**, and by means of the nut **28** the bellows **16** may be set to operate at any desired evaporator pressure.

An opening **31** provides communication between the lower chamber **12** and the interior of the bellows **16**, and the push rod **19** also passes through this opening and is operatively connected to the lever **32** by the pivot pin **33**.

The lever **32** is supported on a boss **34** in chamber **12** by a pin **35** passing therethrough and has in its other end a curved slot **36** which accommodates a pin **37** in the shank of the valve **15**.

Flexible metallic bellows **40** and **41** are sealed to the bosses **38** and **39** in the upper wall of the frame **11** and the closure discs **42** and **43** respectively complete the sealing off of the interior of the bellows **40** and **41**.

A boss **45** is provided with a threaded hole **44** for a pipe connection or fitting to be attached thereto and within the wall of the frame a duct **46** is provided which communicates with threaded hole **44** and the interiors of the flexible bellows **40** and **41**.

Bosses **47** and **48**, suitably secured to the closure discs **42** and **43** respectively are inter-connected by a bar **49** with pivot pins **50** and **51** passing therethrough. Bar **49** has a boss **52** made integral therewith and screw **53** threaded therein and is provided with a locknut **54**. This screw may be set at a predetermined distance away from boss **21** on lever **22** and secured in such position by the locknut **54**. A spring **55** is positioned between the bar **49** and the casing, and the tension of this spring may be adjusted by means of a nut **55a** thereby setting the double bellows **40**, **41** to operate at a predetermined pressure. This pressure may be imparted thereto by means of a volatile liquid in thermo-bulb **70** connected to **44** by means of tube **70a**. The pressure within the double bellows in this case depends upon the temperature of the object in contact with the thermo-bulb.

The method of operation of the control device will be described in connection with a dry refrigerating system as shown diagrammatically in Figure 2 wherein a compressor **60** which may be driven by a suitable prime mover, has a discharge pipe **61** leading to a condenser **62** which is in turn connected to a receiver **63**. A pipe **64** leads to an evaporator **66** via an expansion valve **65**.

The lower part **66a** of the evaporator **66** is dead ended and is adapted to receive condensed liquid refrigerant during the defrosting cycle. A suction pipe leads from the evaporator **66** at **67** and connects with the crank case of the compressor **60** at **69**.

A pipe **59** is connected to the evaporator at **59a** and connects to the control device **10** at **13**. The outlet **14** of the control device is connected via the pipe **71** to the compressor exhaust pipe **61** at **72**.

Any suitable thermostatic or pressure control may be provided for controlling the movement of the prime mover.

Assuming that the evaporator has cooled down to the point where the prime mover has stopped, the pressure in the evaporator slowly rises and when it almost arrives at the pressure necessary to cause the compressor to operate again, this pressure acting upon the interior of the bellows **16** causes the same to elongate, thereby opening the valve **15**. This allows comparatively warm gases to flow from the condenser and/or compressor via the pipe **71**, the chamber **12** and the pipe **59**, to the evaporator. As these gases pass into the evaporator they give up their heat thereto, become liquefied and settle in the dead ended coil **66a**. The temperature of the evaporator rises and causes the control to start up the compressor.

Meanwhile the heat absorbed from the gases in condensing raises the temperature of the evaporator to a point high enough to melt the frost (for example 33°). When this temperature is reached the thermo-bulb exerts pressure in the two bellows **40** and **41** sufficient to overcome the push of the lower bellows **16**, thereby closing the valve **15**.

The compressor having started meanwhile due to the temperature rise and increase in pressure in the evaporator, the refrigerating cycle starts as soon as the valve 15 has closed and for a few minutes the evaporator 66 has the additional refrigerating surface 66a to accelerate the cooling thereof, thus compensating to a substantial degree for the heat put therein to accomplish the defrosting.

As soon as the liquid has all boiled out of the coil 66a the machine is operating with its normal evaporating surface.

Figure 3 shows a modification of the lower bellows in Figure 1 wherein the interior of the bellows 16 is isolated from the chamber 12 by a small bellows 73 which is sealed to the casing at 75, and is capped by the disc 74 which is also soldered or otherwise sealed thereto and to the push rod 19. A boss 76 is added to the casing and a threaded hole 77 adapts it for connection to a desired part of a refrigerating system. A duct 78 communicates with the threaded hole 77 and the interior of the bellows 16 and 73.

A modification of Figure 2 is shown in Figure 4 wherein the pipe 71 is eliminated and the suction pipe 68 is used to admit the warm gases into the evaporator 66.

The modified control valve is shown in this system and the interior of the bellows 16 is connected via the threaded hole 77 and the pipe 70a to a thermo-bulb 70 which is in heat exchange relation to the evaporator 66.

The pipe 79 connects to the suction line 68, and to the control valve at 13, and the evaporator pressure is imparted to the interiors of the bellows 40 and 41 via the pipe 81 which is connected thereto at 44 and to the pipe 79 at 83. In some cases it may be desirable to have a restriction 82 in the pipe 80.

The pipe 80 connects to the control valve at 14 and to the compressor exhaust pipe 61 at 72.

The operation is the same as disclosed in the system shown in Figure 2 except that, during the defrosting cycle the warm gases pass into the evaporator via the pipes 80 and 79 and the suction pipe 68. In some installations this method of connection would save considerable length of piping, especially where all of the bellows are operated by the pressure in the suction pipe 68.

During the defrosting cycle the liquid in the receiver 63 boils and its temperature is thereby substantially reduced, and during the working cycle the liquid in the receiver heats up, and to conserve this the receiver is surrounded by a jacket, which may be filled with brine or other liquids, or cement, etc. Of the liquids suitable for use in this jacket, benzol is preferable as it has a specific heat of only .4, and offers 54 B. t. u. of latent heat at 42° F., excelling brine by approximately 40%. This heat stored during the working cycle boils the liquid refrigerant during the defrosting cycle and passes into the evaporator along with the gaseous refrigerant. As the boiling of the liquid progresses the liquid refrigerant, in the receiver, drops in temperature and this cold is stored by the material in the jacket resulting in a lower head pressure at the beginning of a running cycle of the system and the delivery of the liquid refrigerant to the expansion valve at a lower temperature, thus giving substantial economy in the operation of the system.

With a water cooled condenser any suitable storage core may be adopted to obtain a similar result.

In evaporators as used in the flooded system, extra space must be provided and adapted to contain the refrigerant as it condenses therein. In one form of evaporator such as shown in Figures 5 and 6, a float chamber 86 has a number of looped pipes 87 communicating therewith below the liquid therein. These pipes 87 are secured to radiating plates 88.

Now, to provide space for the liquid to condense into during the defrosting cycle, a series of looped pipes 89 are provided. These pipes 89 are similar in shape to the pipes 87 but have their ends communicating with the interior of the chamber above the normal liquid level therein.

During the defrosting cycle the warm gases enter the chamber and condense into the pipes 89. In this case one method of connecting the control valve is same as shown in Figure 4, except that the flooded evaporator with its internal float valve 101 is substituted for the evaporator 66, 66a and its expansion valve 65.

When the machine first starts its operating cycle after a defrosting cycle, the liquid in the coils 89 boils, giving greater refrigerating surface. As soon as all of the liquid in these coils 89 boils out the system is operating with normal surface and the coils 89 remain empty for reception of refrigerant during the next defrosting cycle.

The modification in Figure 8 shows the pipes 89 positioned within the pipes 87. This may be of advantage in some cases, and it saves labor in the construction thereof.

In a flooded system submerged in a brine tank, a greater amount of heat would be required to bring the temperature of the mass of brine up to the defrosting point, so a substantial space would be required to store the condensed refrigerant incident thereto. This would be taken care or by an arrangement such as is shown in Figure 7 where an evaporator 90 is shown submerged in a brine tank 91 and a coil of pipe 92 of substantial size is provided for the condensing refrigerant.

This coil is dead ended on one end and is connected to the suction line 93 of the evaporator. In some cases it may be desirable to have the lower end of the pipe communicate with a tank or cylinder (not shown) in the bottom of the brine tank. This may be connected to the system in the same manner as shown in Figure 4, or a hand operated valve may be substituted for the control valve 10 and the defrosting controlled manually.

Another form of evaporator is shown in Figure 9 wherein a plate coil 94 secured to a plate 95 is fed through an expansion valve 96 and the suction is connected to 97. Settling coils 98 and 99 for the condensing refrigerant are provided adjacent to the working coil 94 and all three of the coils are inter-connected at their mid-points by a pipe 100 which should be connected to the chamber 12 via the threaded opening 13.

While a double bellows 40, 41 is shown in the upper part of the control device in Figure 1, it is obvious that a single bellows of larger diameter than the one shown at 16 may be used to get the same result, and it is also obvious that the evaporator pressure may be used to control both the upper and lower bellows, the differential between actuating and de-actuating the valve being taken care of by properly adjusting the springs 26 and 55.

It is obvious that many modifications in the above described system may be made without departing from the spirit of the invention.

I claim:—

1. In a refrigerating system including a high side and a low side, the method of defrosting which consists of transmitting heat from said high side to the low side using a fluid medium as a vehicle and controlling the transmission thereof in accordance with the pressure in said low side.

2. In a refrigerating system, a high side, a low side, and means responsive to pressure in said low side for admitting gaseous refrigerant thereto from said high side for raising the temperature of said low side.

3. In a refrigerating system, a high side, a low side, means responsive to pressure in said low side for admitting gaseous refrigerant thereto from said high side for raising the temperature of the low side, and means responsive to a predetermined temperature in said low side for de-actuating said first means.

4. In a refrigerating system, a high side, a low side including an evaporator, means responsive to pressure in said evaporator for admitting hot gaseous refrigerant thereto from said high side, and a chamber communicating with said evaporator and in heat exchange relation thereto for receiving condensed refrigerant.

5. In a refrigerating system, a high side, a low side including an evaporator, means responsive to pressure in said evaporator for admitting hot gaseous refrigerant thereto from said high side, settling chambers communicating with said evaporator and in heat exchange relation thereto for receiving condensed refrigerant, and means responsive to a predetermined temperature in said evaporator for de-actuating said first means.

6. In a refrigerating system, a high side, a low side including an evaporator, a pipe leading from said high side to said low side, a valve in said pipe, means responsive to pressure in said low side for actuating said valve, means responsive to a predetermined temperature in said evaporator for de-actuating said first means.

7. In a refrigerating system, a high side, an expansion valve, a refrigerating coil, an auxiliary coil communicating with said refrigerating coil and in heat exchange relation thereto, and means responsive to temperature in said refrigerating coil for admitting gaseous refrigerant thereto from said high side and condensing the same into said auxiliary coil, thereby warming up the refrigerating coil.

8. In a refrigerating system, a high side, an expansion valve, a refrigerating coil, an auxiliary coil communicating with said refrigerating coil and in heat exchange relation thereto, means responsive to pressure in said refrigerating coil for admitting gaseous refrigerant thereto from said high side and condensing the same into said auxiliary coil, thereby warming up the refrigerating coil, and means responsive to pressure in said refrigerating coil for causing said first means to cease functioning whereby the system operates with both said coils, thereby giving increased refrigerating surface during the first part of the operating cycle.

9. In a refrigerating system, a high side, an expansion valve, a refrigerating coil, an auxiliary coil communicating with said refrigerating coil and in heat exchange relation thereto, means responsive to pressure in said refrigerating coil for admitting gaseous refrigerant thereto from said high side and condensing the same into said auxiliary coil, thereby warming up the refrigerating coil, and means responsive to temperature of said refrigerating coil for causing said first means to cease functioning whereby the system operates with evaporation in both said coils, thereby shortening the time required for effecting changes in the temperature of said refrigerating coil.

10. In a refrigerating system including a control valve of the character described, an evaporator comprising a header, a float valve for controlling a level of liquid in said header, looped pipes communicating with said header below the liquid level therein, and a second series of looped pipes communicating with said header above the liquid level therein and in heat exchange relation to said first looped pipes, said second series of looped pipes comprising a chamber for receiving condensed refrigerant during a defrosting cycle of said system.

11. In a refrigerating system including a control valve of the character described, an evaporator comprising, a header, a float valve for controlling a level of liquid in said header, looped pipes communicating with said header below the liquid level therein, and a second series of looped pipes within said first looped pipes and communicating with said header above the liquid level in said header, said second series of looped pipes comprising a receiver adapted to receive condensed refrigerant during a defrosting cycle of said system and adapted to have the liquid refrigerant exhausted therefrom during a normal operating cycle of the system.

12. In a refrigerating system, a high side including a condenser and a receiver, a low side, means for condensing refrigerant from said high side in said low side for defrosting the latter, and a heat absorbing medium surrounding said receiver adapted to store heat during a working cycle of said system and to store cold during a defrosting cycle of said system, whereby said stored heat may be utilized for expediting said defrosting.

13. In a refrigerating system including a condenser and an evaporator having refrigerant therein, the method of using said condenser as an evaporator and said evaporator as a condenser, between each normal working cycle of said system, the length of time of said use being controlled in accordance with the temperature of the refrigerant in said first evaporator.

14. In a refrigerating system, a high side, a low side, means for admitting gaseous refrigerant from said high side to said low side for raising the temperature of the latter, said admissions of gaseous refrigerant being directly controlled in accordance with said temperature.

15. In a refrigerating system including a high side and a low side, the method of defrosting which consists of generating heat in the high side, transferring said heat via a fluid medium to the low side for defrosting the latter, and controlling the transfer of said heat in accordance with the pressure in the low side.

16. In a control valve in a refrigerating system having a high side and a low side, a casing for said valve, a pipe connecting said valve to said high side of said system, a chamber formed in said casing adjacent to said valve and communicating with the low side of said system and adapted via said valve to communicate with said high side, and a pressure responsive device controlled by pressure in said low side for actuating said valve thereby admitting hot gaseous refrigerant to said low side for defrosting the same.

17. In a control valve in a refrigerating system having a high side and a low side, a casing for said valve, a pipe connecting said valve to said high side of said system, a chamber formed in said casing adjacent to said valve and communicating with the low side of said system and adapted via the valve to communicate with said high side, a pressure responsive device controlled by pressure in said low side for actuating said valve thereby admitting hot gaseous refrigerant to said low side for defrosting the low side and means controlled by temperature and resultant pressure in said low side adapted to de-actuate said valve.

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