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DEFROSTING DEVICE FOR COMPRESSION REFRIGERATING MACHINE

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FIG.1

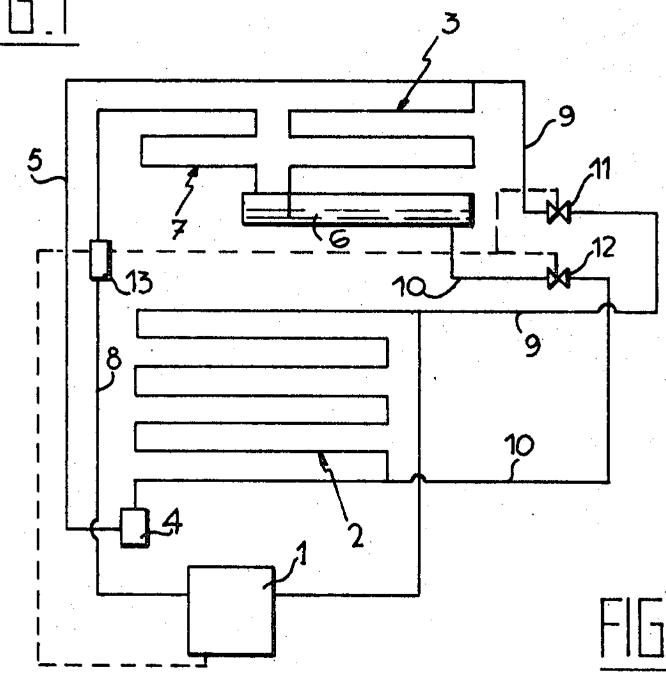
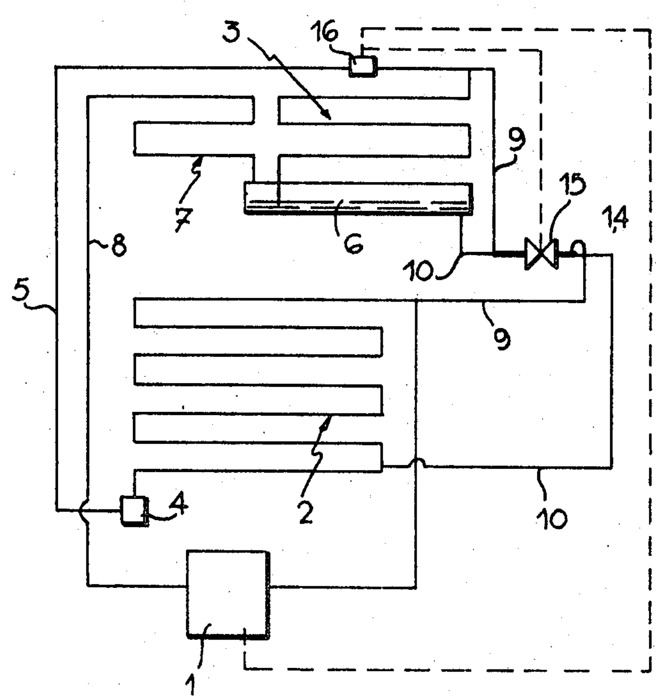


FIG.2



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DEFROSTING DEVICE FOR COMPRESSION REFRIGERATING MACHINE

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ABSTRACT OF THE DISCLOSURE

Defrosting apparatus for a refrigerating unit is provided with a compressor, condenser and evaporator connected in series. A defrosting by-pass arrangement is connected to the evaporator and condenser so that upon the detection of frost on the evaporator, by a suitable device, there is effected a closed flow path between the evaporator and condenser, which by-passes the compressor. The compressor is stopped during the entire defrosting period.

The present invention relates to compression refrigerating machines. More particularly, it concerns refrigerators for household use.

A compression refrigerating machine essentially comprises the following components: a compressor, a condenser, a capillary tube or the like and an evaporator. The evaporator comprises a cooler, a collector and a drier. These elements are successively connected in series so as to form a refrigerating circuit. In the latter, a refrigerant fluid is alternatively compressed and expanded to make refrigerating cycles each of which produces refrigerating zones.

The refrigerant fluid is compressed by the compressor and fed to the upper inlet of the condenser. In the latter, the refrigerant fluid is condensed. At the lower outlet of said condenser, the refrigerant fluid in liquid phase is fed through the capillary tube to the upper outlet of the evaporator cooler. In the latter, the refrigerant fluid in liquid phase is injected and at least partly vaporized to produce refrigerating zones. At the outlet of the cooler, the liquid phase portion of refrigerant fluid is collected in the collector. The gaseous phase portion of refrigerant fluid is conveyed through the collector and the drier, upon being sucked up by the compressor, so as to close the refrigerating cycle of the refrigerant fluid.

Generally, the compression refrigerating machines, whose respective drive motors have a high starting torque, are equipped with electrical resistances in the vicinity of the evaporator, said resistances being designed for allowing an electrical current to pass therethrough so as to generate calories capable of defrosting the outer walls of the evaporator. Such evaporator defrosting means substantially increase the production and operating costs of the refrigerating machine due to the expense of electrical energy used for defrosting, which latter is moreover relatively slow.

This procedure of electrical defrosting is inefficient since it produces in the useful volume of the refrigerating machine calories which should thereafter be removed under the action of the compressor.

On the other hand, the refrigerating machines of the household-refrigerator-type having a drive motor with a low starting torque do not have any practical and efficient defrosting means.

The present invention has for its object a new refrigerating machine having both simple and inexpensive defrosting means whatever its capacity, power and use.

This new refrigerating machine is of particular interest not only in view of its defrosting action but also in view of its operation during the refrigerating cycles. As a matter of fact, said machine allows the establishment of an equilibrium of refrigerating fluid pressures in the refrigerating circuit during the defrosting period. Consequently, the compressor motor is not subjected to any overloading at the moment of its restarting at the end of said defrosting period.

For this purpose, the refrigerating machine according to the present invention comprises a defrost line and a return line. The defrost line connects the upper inlet of the condenser to the upper inlet of the evaporator cooler and is provided with a defrost valve which is closed during operation of the compressor but open during arrest thereof to admit refrigerant in gaseous phase into the cooler and to defrost in that way the outer walls of the evaporator. On the other hand, the return line connects the evaporator collector with the lower part of the condenser and is provided with a return valve which is closed like the defrosting valve during operation of the compressor but open upon arrest of the latter, to provide for the return flow of the refrigerant fluid within the collector towards the condenser.

In order to further simplify the operation of the defrosting means in the refrigerating machine according to this invention, the defrosting line and the return line of this machine have a common part which has a greater inner section than the remaining parts and which is provided with a single valve serving both as a defrosting valve and as a return valve.

This single valve allows the simultaneous flow in different directions of refrigerant fluid in liquid phase and of refrigerant fluid in gaseous phase.

The defrosting valve and the return valve, or the single defrosting-return valve, as well as the compressor driving means, may be actuated either manually or mechanically.

In the latter instance, these valves and driving means are preferably actuated simultaneously. In addition, in this same instance, the actuation of said valve as well as the driving means of the compressor may be controlled by means of a manual contact or by means of device capable of sensing the thickness of ice formed on the outer walls of the evaporator, such as a thermostat, a pressostat or a thickness-testing device.

Other details and features of the present invention will appear from the following description made with reference to the accompanying drawings which show schematically and only as examples, two embodiments of this invention.

FIG. 1 is a schematic view of a first embodiment of a refrigerating machine according to this invention.

FIG. 2 is a similar schematic view of a second embodiment of such a machine.

In these two figures of drawing, the same reference numerals refer to similar parts.

The illustrated refrigerating machines are of the compression type and are perfectly suitable for household purposes.

Each refrigerating machine comprises main components which are connected in series so as to form a refrigerating circuit wherein a refrigerant fluid is alternatively compressed and expanded according to refrigerating cycles during which determined amounts of refrigerants are respectively produced.

In the refrigerating circuit of each considered refrigerating machine, the refrigerant fluid in gaseous phase is compressed by a compressor **1** up to a normal pressure of 5.8 kg./cm.^{2}.

This refrigerant fluid in gaseous phase is fed under pressure to the upper inlet of a condenser **2** and is forced to enter into and to circulate through the latter. The refrigerant fluid in gaseous phase is condensed in the condenser **2**.

The refrigerant fluid in liquid phase produced in the condenser **2** is fed from the lower outlet of the latter to the upper inlet of a cooler **3** of an evaporator, through a drier filter **4**. The conveyance of refrigerant fluid in liquid phase between the drier filter **4** and the cooler **3** is provided by a capillary tube **5** or by a similar tube having a smaller inner section. Advantageously, the inner section and the length of the capillary tube **5** are calculated and made to provide a desired pressure drop and to pass an amount of refrigerant fluid in liquid phase proportional to the capacity of the condenser **1**.

At the upper inlet of the cooler **3** of the evaporator, the refrigerant fluid in liquid phase is injected under a pressure of 1.5 kg./cm.^{2} which corresponds to a saturation temperature of $-20°$ C. and which is lower than the saturation pressure of 3.0 kg./cm.^{2} corresponding to the temperature of about 0° C. within the useful volume of the refrigerating machine. Thus, heat is transferred between the contents of said useful volume and the refrigerant fluid in liquid phase located within the cooler **3** of the evaporator, said refrigerant fluid being in this way transformed to the gaseous phase.

In this way, in the cooler **3**, the major part of the refrigerant fluid in liquid phase which is brought thereinto, passes into the gaseous phase.

The minor part of refrigerant fluid which remains in liquid phase in the cooler **3** is collected in a collector **6** of the evaporator. Said collector **6** is located below the cooler **3** in the selected examples.

The major part of refrigerant fluid in gaseous phase in the cooler **3** is sucked up by compressor **1** through collector **6**, a drier **7** of the evaporator and a connecting tube **8**. The drier **7** preferably is in the form of a coil.

Fine particles of refrigerant fluid in liquid phase are drawn with the gaseous phase of refrigerant fluid through the collector **6** and through the drier **7** wherein they are completely vaporized by the calories from the useful volume contents of the refrigerating machine. Consequently, the compressor **1** sucks up only superheated refrigerant fluid in the gaseous phase.

The refrigerant fluid in gaseous phase sucked up by the compressor **1** is thus recycled. The connecting tube **8** is placed against the capillary tube **5** so as to be in contact therewith substantially throughout its entire length. In this way, a heat exchange is obtained between these tubes which tends to equalize therein the temperature of the refrigerant fluid.

In the course of the refrigerating cycle, water vapor condenses on the outer walls of the evaporator and water solidifies on these walls to form a layer of ice which should be removed when it has a thickness which opposes the desirable transfer of heat between the evaporator and the useful volume of the refrigerating machine. It is thus necessary to defrost the evaporator periodically.

The inventive concept concerns a new particularly simple, rapid and efficient, defrosting means.

Said inventive concept is essentially based on the fact that into the cooler **3** of the evaporator, and preferably to its upper inlet, a gaseous phase of refrigerant fluid is admitted from the condenser **2** while a liquid phase of refrigerant fluid is extracted from the collector **6** of said evaporator and returned to the condenser **2**, preferably at a lower inlet of the latter, provided for this purpose.

The feeding of refrigerant fluid in gaseous phase into the cooler **3** of the evaporator and the simultaneous extraction of said refrigerant fluid in liquid phase from the collector **6** of said evaporator produce in the latter a heat transfer which provides for its defrosting.

It must be noted that the compressor **1** is stopped during the defrosting period of the evaporator.

In the first shown embodiment, said defrosting means essentially comprise a defrosting line **9** and a return line **10**.

The defrosting line **9** connects the upper inlet of the condenser **2** to the upper inlet of the cooler **3** of the evaporator. Said defrosting line **9** is provided with a defrosting valve **11** which, when open, allows the passage of refrigerant fluid in gaseous phase from condenser **2** to cooler **3**.

The return line **10** connects in its turn a lower outlet of the collector **6** to a lower inlet of the condenser **2**. Said return line **10** is provided with a return valve **12** which, when open, allows the transfer by gravity of liquid phase the refrigerant fluid from collector **6** to condenser **2**.

By passing its latent heat to the ice formed on the outer walls of the evaporator, the gaseous phase of refrigerant fluid is condensed into a liquid phase, flows by gravity into the collector **6** and passes into the lower part of the condenser **2** through the return tube **10** and the return valve **12** which is then open.

Since the pressure within the condenser **2** is weaker than the saturation pressure corresponding to the temperature of the ambient air in the vicinity of said condenser **2**, heat is transferred from said ambient air to the refrigerant fluid in liquid phase within said condenser **2** and the refrigerant is again transformed into the gaseous phase.

The refrigerant fluids transformed in this way into the gaseous phase continues its travel through the upper part of the condenser **2** where it is superheated and passes thereafter, through the defrosting tube **9** and the defrosting valve **11** up to the cooler **3** of the evaporator.

In this way, the cycle goes on without being interrupted until the ice is removed from the outer walls of the evaporator. Then, the refrigerant fluid pressure increases in the refrigerating circuit because condensation thereof in the cooler **3**, the collector **6** and the drier **7** takes place at a higher temperature than the temperature corresponding to the melting point of the ice. Thus, at a determined temperature and at a determined pressure, the defrosting valve **11** and the return valve **12** are closed and simultaneously the motor of the compressor starts again without any back-pressure and without being overloaded, accordingly with a low starting torque.

Advantageously, the drive member of the compressor **1** is stopped and respectively started again at the same time the defrosting valve **11** and the return valve **12** are open and respectively closed.

In the selected example, such a simultaneous drive of the driving means of the compressor **1**, the defrosting valve **11** and the return valve **12**, is effected by means of a pressostat **13**, which is branched in said connecting line **8** and operates according to the thickness of the layer of ice on the outer walls of the evaporator.

In the second shown embodiment, said defrosting means also comprise a defrosting line **9** and a return line **10**. However, in this instance, the defrosting line **9** and the return line **10** have a common part **14** which has a greater section than the remaining parts and thus simultaneously allows the circulation of the refrigerant fluid in gaseous phase from the condenser **2** to the cooler **3** and the flow of refrigerant fluid in liquid phase from the collector **6** to the condenser **2**.

In this second example, in the common part **14** of the defrosting and return lines **9** and **10** a single valve **15** is provided both as a defrosting and a return valve.

In the latter instance, the driving means of the compressor **1** also is stopped and respectively started again at the same time the single defrosting and return valve **15** is open and respectively closed. Such a control of said drive means of the compressor **1** and said single valve **15** is effected by means of a thermostat **16** which is branched in the upper part of the cooler **3** of the evaporator and also functions depending on the thickness of the ice layer formed on the outer walls of the evaporator.

In both selected examples, the actuation of the device means of the compressor **1** and the control of the valves **11** and **12** or the single valve **15** are effected mechanically under the automatic control of a device sensing the thickness of the ice formed on the walls of the evaporator. In both considered examples said device is either the pressostat **13** or the thermostat **16.** In other examples, said device may be different and comprise among others a thickness-sensing device. In still other modifications, the drive means of the compressor **1** and the drive means of the valves **11** and **12** or the single valve **15** may be controlled mechanically by a manual contact. Finally, the opening and closing of the valves **11** and **12** or the single valve **15** may be effected manually as well as the engagement of the drive means of the compressor **1.**

In normal period of operation of the machine, there is in the condenser **2** a relatively high pressure of about 12.0 kg./cm.², while there is in the cooler **3** of the evaporator, a relatively low pressure of about 1.5 kg./cm.². During the defrosting period, refrigerant fluid in gaseous phase passes from the condenser **2** to the cooler **3.** The pressure difference between the condenser **2** and the cooler **3** is accordingly progressively reduced. Consequently, at the end of the defrosting period, an equilibrium is established in the whole machine and the pressure therein is of about 3.5 kg./cm.². Under these circumstances, the restarting of the drive means of the compressor **1** is carried into effect without overloading and causes no difficulty.

It is obvious that the present invention is not exclusively limited to the two illustrated embodiments and that many modifications may be made to the form, the disposition and the arrangement of some elements taking part in the carrying into effect of the present invention, provided that these modifications don't oppose the object of any of the appended claims.

What is claimed is:

1. Defrosting apparatus comprising a compressor for compressing a refrigerant fluid in gaseous phase supplied thereto, a condenser connected to the outlet of said compressor for condensing the refrigerant fluid in gaseous phase supplied from said compressor, an evaporator connected to the outlet of said condenser for evaporating condensed refrigerating fluid in liquid phase supplied from said condenser, said evaporator having a vapor outlet and a liquid outlet, the vapor outlet of said evaporator being connected to the inlet of said compressor, defrosting piping connected to the inlet and liquid outlet of said evaporator and to the inlet and outlet of said condenser, valve means connected in said defrosting piping for determining refrigerant fluid flow in said defrosting piping, detector means connected to said evaporator for detecting the formation of frost on said evaporator, and means operatively conecting said detector means to said valve means and said compressor when said detector means detects frost on said evaporator and closing said valve means and said compressor for respectively opening

said valve means and stopping said compressor when said detector means detects frost on said evaporator and closing said valve means and starting said compressor upon the elimination of frost on said evaporator, the frost being eliminated in a defrosting cycle by the flow of said refrigerant fluid in a closed path through said evaporator, said condenser and asid defrosting piping, by-passing said compressor during the entire defrosting cycle.

2. Apparatus as claimed in claim **1,** wherein said defrosting piping includes a first line connecting the inlet of said condenser to the inlet of said evaporator, and a second line connecting the liquid outlet of said evaporator to the outlet of said condenser, the outlet and inlet of said condenser being constituted respectively as the inlet and outlet thereof during the defrosting cycle, said first and second lines each including a respective valve constituting said valve means.

3. Apparatus as claimed in claim **2,** wherein said detector means is a pressostate connected to the vapor outlet of said evaporator.

4. Apparatus as claimed in claim **1,** wherein said defrosting piping comprises a common line including branch lines connected respectively to the inlet and liquid outlet of said evaporator and to the inlet and outlet of said condenser, said common line including a valve constituting said valve means.

5. Apparatus as claimed in claim **4,** wherein said common line has a greater diameter than that of said branch lines.

6. Apparatus as claimed in claim **3,** wherein said detector means is a thermostat connected to the inlet of said evaporator.

7. Apparatus as claimed in claim **1,** wherein said detector means includes means for detecting the thickness of frost forming on said evaporator.

8. Apparatus as claimed in claim **1,** wherein said evaporator includes a collector having two outlets constituting respectively said vapor outlet and said liquid outlet.

9. Apparatus as claimed in claim **8** including a drier interposed between said vapor outlet of said collector and said inlet of said compressor.

10. Apparatus as claimed in claim **1** including a further drier interposed between said outlet of said condenser and said inlet of said evaporator.

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