

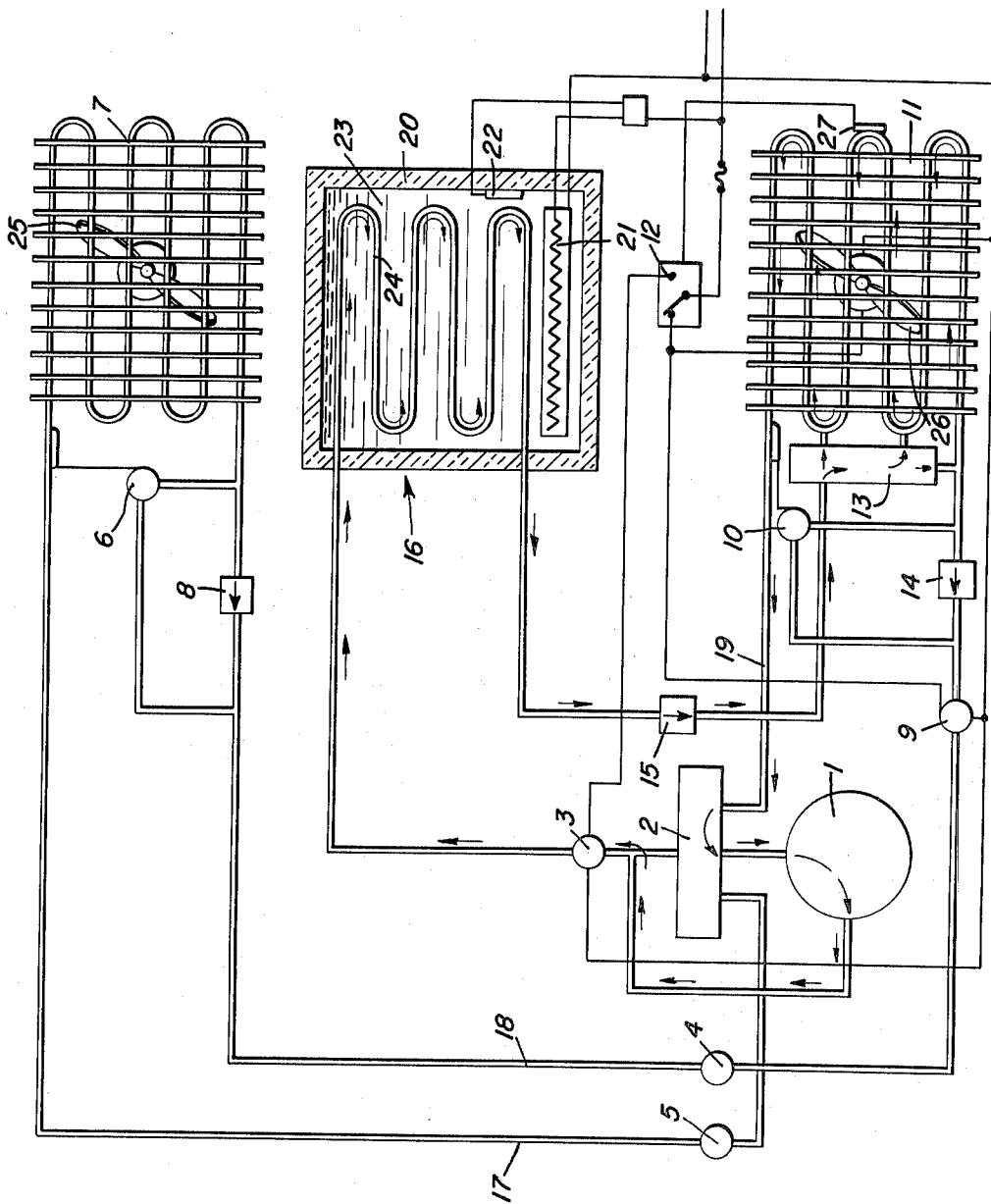
March 15, 1966

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3,240,028

HEAT PUMP DEFROSTING SYSTEM

Filed April 26, 1963



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3,240,028

HEAT PUMP DEFROSTING SYSTEM

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Filed Apr. 26, 1963, Ser. No. 275,859

6 Claims. (Cl. 62—156)

The present invention generally relates to improvements in air-to-air heat pumps and more particularly a novel method and apparatus for defrosting the evaporator coil of such a heat pump without changing the heat pump from the heating cycle.

One of the primary causes of compressor failure in all heat pumps is oil slugging during the heating cycle of the heat pump, that is, when the interior of a house or other enclosure is being heated by extracting heat from the cool outside air. The present invention has for one of its primary objects an apparatus which is incorporated into a heat pump system for eliminating the slugging of oil and will substantially eliminate compressor failures due to this cause during the heating cycle.

When the outdoor evaporator is being used during the heating cycle, under certain atmospheric conditions such as during high humidity conditions, ice will form on the coil of the outdoor evaporator. This build-up of ice renders the heat pump inefficient and also causes oil slugging of the compressor thus causing damage to the compressor. Accordingly, it is another object of the present invention to provide a device for heating the hot gas refrigerant before it is discharged into the frosted evaporator coil thereby quickly clearing the coil of ice or frost without changing the heat pump from the heating cycle. A further object of the present invention is to provide a defrosting system for an air-to-air heat pump in which there is provided a de-icing control which senses the presence and absence of frost or ice on the outdoor evaporator coil.

Still another feature of the present invention is to provide an assembly in which the heating device includes a heat exchange coil immersed in a bath of liquid maintained at a constant temperature thereby providing a heat source for heating the hot gas refrigerant to a superheated condition instantly without a delay in waiting for a heating apparatus to reach a predetermined temperature before operation.

Yet another important feature of the present invention is to provide a defrosting system and apparatus for heat pumps which is simple in construction, easy to incorporate into existing heat pumps and dependable in operation while yet being relatively inexpensive to manufacture.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawing forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

The figure of the drawing is a schematic view of the component parts of the present invention.

Referring now specifically to the drawing, the numeral 1 designates a compressor of any conventional type employed in an air-to-air heat pump. The compressor 1 is communicated with a reversing valve 2 and a hot gas solenoid valve 3. There is also provided a liquid line service valve 4 and a suction or discharge service valve 5. An indoor evaporator coil or heat exchange device is designated by the numeral 7 and is provided with the usual thermostatic expansion valve 6 and a check valve 8 which permits flow in the direction of the arrow but prevents flow in the other direction. There is also provided a liquid line solenoid valve 9 and an outdoor evap-

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rator coil or heat exchange device 11 controlled by an outdoor thermostatic expansion valve 10. A thermostatic de-icing control device 12 is provided for the outdoor heat exchange coil 11 and the outdoor coil 11 is communicated with a hot gas header 13. An outdoor check valve 14 is provided in the manner illustrated in the drawing and a hot gas check valve 15 is provided in one of the lines communicating with the hot gas defrosting unit 16. The line 17 is a cooling suction line while the line 18 is a cooling liquid line and line 19 is a cooling discharge line.

The defrosting unit 16 includes an insulated tank 20 having a low wattage heating element 21 disposed therein which is controlled by a thermostat sensing device 22 in a conventional manner, the heating element being connected to a suitable electrical source and controlled by the thermostat 22 to maintain a quantity of liquid such as refrigeration oil 23 at a predetermined temperature from 120° F. to 180° F. A heat exchange coil 24 is disposed in the refrigeration oil 23 for heating the hot gas refrigerant to a higher temperature for quickly defrosting the outdoor coil 11 in a manner described hereinafter.

When the heat pump is in a cooling cycle, the compressor pumps the hot gas through the reversing valve 2 which is in a position to pass the hot gas through the conduit 19 into the outside heat exchange coil which then is acting as an outside condenser coil. The refrigerant then passes back through the liquid line 18 to the indoor thermostatic expansion valve 6 where it is expanded into the inside evaporator coil 7 for cooling the same. The expanded gaseous refrigerant then proceeds back through suction line 17 to the compressor 1 thus completing the cycle. In this condition, the reversing valve 2 is in position for discharging the hot gas refrigerant to the outdoor coil where it is condensed and passes through the check valve 14, solenoid valve 9 and service valve 4, through the expansion valve 6 and indoor evaporator coil 7, through the service valve 5 back through the reversing valve 2 to the compressor 1. During this cycle, the hot gas solenoid valve 3 is closed and of course there is provided fans 25 and 26 for both heat exchange coils 7 and 11 and both fans are operating during the cooling cycle. Thus, the cooling cycle is completely conventional and not altered.

With the heat pump in the heating cycle, the reversing valve 2 is positioned by the system thermostat (not shown) for causing the flow of refrigerant to reverse in a conventional manner. Thus, the outdoor heat exchange coil becomes an evaporator coil and the indoor heat exchange coil 7 becomes a condenser coil. During the heating cycle, the hot gas solenoid valve 3 is closed and the liquid line solenoid valve 9 is open. Thus, the hot gas refrigerant is discharged from the compressor 1 through the reversing valve 2 through the line 17 and into the indoor heat exchange coil 7 where it gives up heat to the inside of a room or the like and is condensed. The condensed refrigerant then passes through line 18 into the outdoor heat exchange coil 11 which is now an evaporator coil. The condensed refrigerant passes through open valve 9 and passes through the expansion valve 10 for discharge into coil 11 thereby absorbing heat from the atmosphere. The evaporated refrigerant will pass back through line 19 into the reversing valve 2 and then into the compressor 1. Due to high humidity conditions and other atmospheric factors, the outdoor evaporator coil 11 sometimes becomes iced or frosted to a degree that no transfer of heat can be had and thus it then becomes necessary for the coil 11 to be defrosted.

When the airstream through the heat exchange coil 11 becomes restricted due to the ice or frost thereon, the de-icing control 12 senses this by the sensing bulb 27 and

breaks the electrical circuit to the fan 26 associated with the outside coil 11 and also breaks the circuit to the liquid line solenoid valve 9 and simultaneously completed a circuit to the hot gas solenoid valve 3. Thus, the fan 26 behind the outside coil 11 is cut-off, the solenoid valve 9 is closed and the solenoid valve 3 is opened.

Thus, with the valves 9 and 3 so positioned, the hot gas is directed from the compressor through the defrosting unit 16 where the hot gas refrigerant is superheated. The superheated hot gas refrigerant then is discharged into the header 13 and into the frosted outdoor coil 11 thus quickly clearing this coil of ice or frost. When the coil 11 is clear of ice or frost, the de-icing control 12 senses this condition by the temperature of the coil and returns the system to its normal heating cycle. During this defrosting period, it is not necessary to use a supplementary heater for the indoor heat exchanger 7 since the system is not switched to a cooling cycle thereby completely eliminating the time lag that would occur were the device switched to a cooling cycle for the purpose of defrosting the outside coil. Also, the fact that the system is not switched from a heating cycle to a cooling cycle substantially eliminates oil slugging which is a usual result from switching from a heating cycle to a cooling cycle when the outdoor coil is covered with ice.

It has been found that in order for the heat pump to operate properly without oil slugging, the defrosting should be conducted very rapidly, that is, in a time element extending from 2 to 5 minutes. Also, the refrigeration oil in the defroster unit eliminates any problem of freezing which may be encountered if other defrosting liquids are used. Also, the refrigeration oil eliminates the problem of evaporation.

When a conventional air-to-air heat pump is being employed for heating a room, it has been found that under certain atmospheric humidity and temperature conditions, frost and ice will form on the outdoor evaporator coil. Since such frost seriously reduces the efficiency of the outdoor evaporator coil, there must be some means for defrosting the outdoor evaporator coil. Conventionally, this has been accomplished by temporarily switching the heat pump into a cooling cycle whereby the hot gas refrigerant will be discharged into the outside coil for melting the frost and ice thereon. Inasmuch as the switch-over from the heating to cooling cycle would normally introduce cool air into the interior of the room, an auxiliary heating device is provided for heating the air circulated over the indoor coil which is temporarily serving as an evaporator for the refrigerant which was condensed by heating up the outside coil which is temporarily operating as a condenser. Moreover, it has been found that the switch-over from the heating cycle temporarily to the cooling cycle and then switching back into the heating cycle requires a considerable time lag in change-over of the system and also introduces "slugging" which is highly objectionable and sometimes causes failure of the compressor. In fact, this problem does exist in conventional air-to-air heat pumps and in an attempt to avoid this problem, rather complex controls have been provided in an effort to shorten the time lag between the efficient operation of the heat pump in the heating cycle to efficient operation in the cooling cycle and then back to efficient operation in the heating cycle. However, such complex controls do not effectively solve the problems which exist.

Accordingly, by employing the present invention, the operation of the heat pump when in the cooling cycle will be entirely conventional and operation in the heating cycle will be the same as in prior installations. However, there has been added the heating assembly including the insulated tank and quantity of oil therein together with a low wattage heating element which may be energized at all times when the system is in a heating cycle thereby maintaining the oil at a predetermined temperature level. Of course, if the outdoor evaporator coil does not become frosted or iced, the defrost unit 16 is not employed. If

the atmospheric conditions are such that it is practically impossible for the outdoor evaporator coil to frost or ice, the heating unit could be rendered inoperative by a suitable control device including a device to measure outside atmospheric temperature and humidity conditions thereby assuring that the low wattage heater in the defrost tank will operate when the atmospheric conditions are conducive to the formation of ice on the evaporator coil when the heat pump is in the heating cycle and also assuring that the defrost unit will be cut-off when the atmospheric conditions are such that it is substantially impossible for ice to form on the evaporator coil.

When using the defrost unit, the sensing element on the outdoor evaporator coil senses the presence of frost or ice and will cause the fan behind the outdoor coil to stop and at the same time permit valve 9 to close by de-energizing the solenoid associated therewith and open valve 3 by energizing the solenoid associated therewith. The hot gas refrigerant then will be passed directly through the coil 24 in the oil bath 23 and be heated to a relatively high temperature and discharged directly into the outdoor coil for defrosting the outdoor coil. No changes have taken place insofar as the indoor coil 7 is concerned which is still operating as a condenser coil. This eliminates any time lag in the changing of the state of the refrigerant in the inside coil 7 which is necessary when changing the operation from a heating cycle to a cooling cycle such as employed in a conventional defrosting operation of an air-to-air heat pump as presently available.

This also enables the compressor to continue operation without any possibility of slugging of oil thereby virtually eliminating compressor failure due to this cause. Also, the sensing element 27 produces a signal to the control 12 which may be of conventional structural arrangement for turning on the fan 26, opening the valve 9 and closing the valve 3 so that the conventional heating cycle may again be undertaken.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. A defrosting apparatus for an air-to-air heat pump having an indoor coil and an outdoor coil selectively employed as a condenser and evaporator respectively, a compressor and a reversing valve to switch the heat pump from a cooling cycle to a heating cycle, said defrosting apparatus comprising an auxiliary heater for hot gas refrigerant and control means for directing the hot gas refrigerant from the compressor into the auxiliary heater and then into the outdoor evaporator coil during the heating cycle independently of the indoor coil acting as a condenser when the outdoor coil has become frosted or iced thereby quickly removing the ice and restoring the efficiency of the outdoor coil without switching the indoor coil from the heating cycle.

2. The structure as defined in claim 1 wherein said defrosting apparatus includes an insulated tank, a quantity of oil in said tank, a heating element in the bottom of the tank, control means for maintaining the temperature of the oil within the tank at a predetermined temperature, and a heat exchange coil disposed in the tank and immersed in the oil for receiving the hot gas refrigerant whereby the hot gas refrigerant will be immediately heated during the defrost cycle thereby enabling the hot gas refrigerant to be superheated and discharged directly into the outdoor evaporator coil and then directly back to the compressor for quickly and rapidly defrosting the same without the heat pump system being switched from the heating cycle to a cooling cycle as is con-

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ventional when defrosting an outdoor evaporator coil.

3. The apparatus as defined in claim 2 wherein said control means includes a de-icer control having a sensing element sensing the temperature of the outdoor coil thus automatically directing hot gas refrigerant through the defrost unit and into the outdoor evaporator coil or through the indoor condenser coil in a conventional manner during the heating cycle.

4. A defrosting apparatus for a conventional air-to-air heat pump which includes a compressor, a reversing valve, an indoor expansion valve, an outdoor expansion valve, an indoor heat exchange coil and an outdoor heat exchange coil interconnected to selectively cool or heat an enclosure in which the indoor coil is disposed, a solenoid operated valve for directing hot gas refrigerant through a line into the outdoor evaporator coil and directly back to the compressor during the heating cycle for defrosting the outdoor coil, and a defrosting heater unit interposed in the hot gas refrigerant line for receiving hot gas refrigerant from the compressor and superheating the hot gas refrigerant and discharging it into the outdoor evaporator coil thereby reducing the time necessary to defrost the outdoor evaporator coil and enabling operation of the system during the defrost cycle without switching from the heating cycle to a cooling cycle thereby eliminating the time lag necessary to change the state of the refrigerant in the indoor coil when switching from a heating cycle to a cooling cycle.

5. The structure as defined in claim 4 wherein said superheating means for the hot gas refrigerant includes an insulated tank having a quantity of refrigeration oil therein, a heating element, a thermostat for maintaining the refrigeration oil at a constant predetermined temperature, a heating coil immersed in the refrigerant oil for receiving the hot gas refrigerant whereby the hot gas refrigerant will be superheated.

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6. A defrosting apparatus for a conventional air-to-air heat pump which includes a compressor, a reversing valve, an indoor heat exchange coil, an indoor expansion valve, an outdoor heat exchange coil, an outdoor expansion valve, a fan for circulating air over the outdoor heat exchange coil, a fan for circulating air over the indoor heat exchange coil, said components of the heat pump being interconnected to selectively cool or heat an enclosure in which the indoor coil is disposed, a solenoid operated valve for directing hot gas refrigerant through a line, a heat exchange coil in the line, said coil being communicated with the outdoor coil, a quantity of liquid surrounding the coil in said line, a tank for said liquid, a heating element for maintaining the liquid at a predetermined elevated temperature, sensing means for sensing the presence of ice on the outdoor coil, control means operative in response to sensing of ice on the outdoor evaporator for opening the solenoid valve in the hot gas refrigerant line and stopping the fan behind the outdoor coil thereby circulating hot gas refrigerant directly through the line where it is heated by the liquid surrounding the coil and then discharging it directly into the outdoor coil and subsequently directly back to the compressor for rapidly defrosting the outdoor coil thereby eliminating the use of the indoor coil as a cooling evaporator during the defrost cycle.

References Cited by the Examiner

UNITED STATES PATENTS

2,748,571	6/1956	Henderson	62—151
2,770,104	11/1956	Sweynor	62—278 X
2,801,524	8/1957	Fifield	62—156
2,928,256	3/1960	Nonomaque	62—156
3,041,845	7/1962	Trask	62—140

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