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V. J. JOKELA
CONTROL APPARATUS

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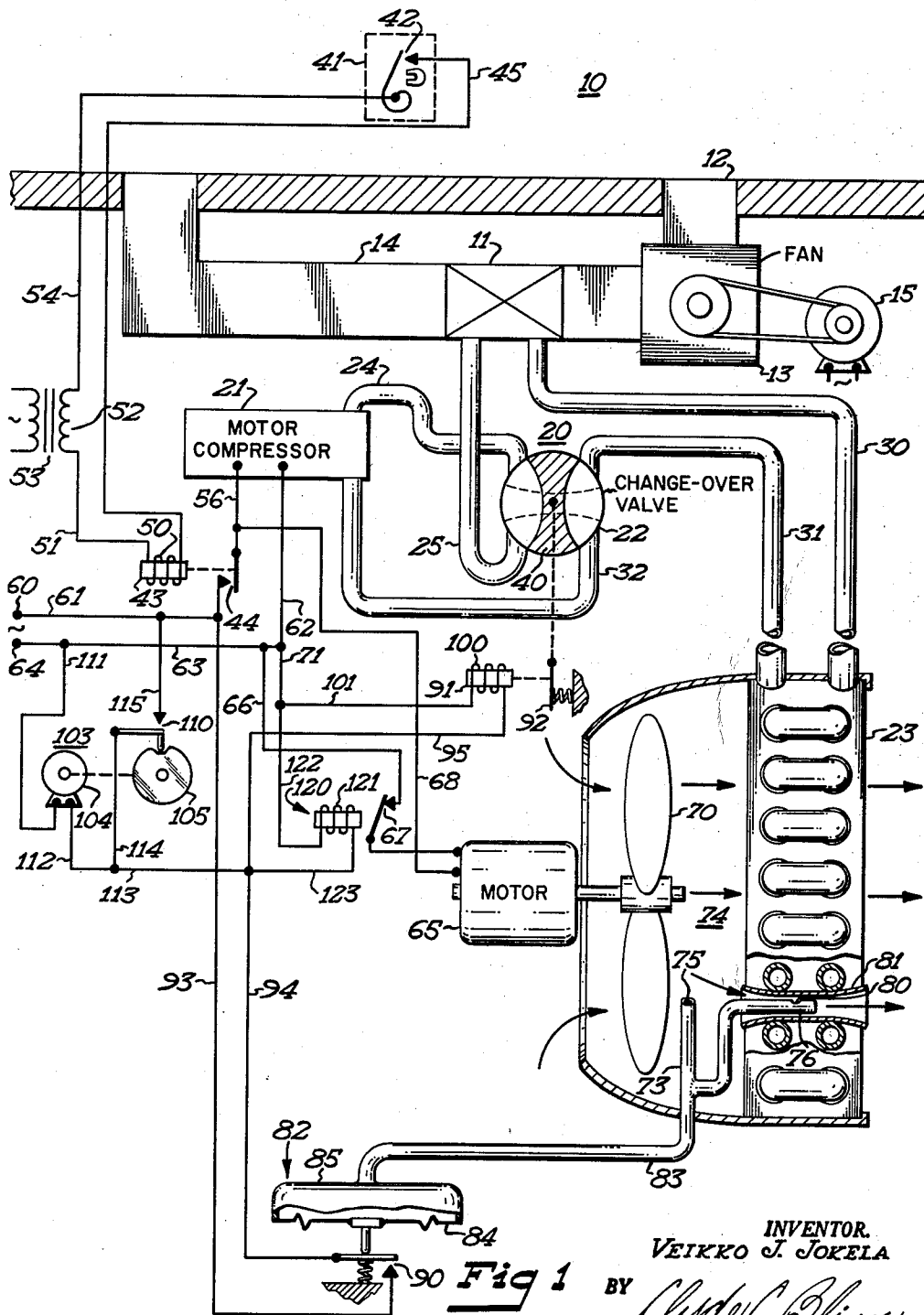


Fig 1

INVENTOR.
VEIKKO J. JOKELA

BY

Clyde C. Blinn

ATTORNEY

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CONTROL APPARATUS

Veikko J. Jokela, Plymouth Village, Minn., assignor to Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., a corporation of Delaware

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The present invention is concerned with an improved defrost control for refrigeration apparatus which removes heat from outdoor air by a heat exchanger through which outdoor air is passed; in particular, the improvement provides a conduit through which air is passed and upon an outlet in the conduit which is mounted adjacent the outdoor coil being restricted by the formation of frost on the coil, a responsive device initiates the defrosting cycle for the outdoor heat exchanger.

With the advent of air to air heat exchangers in refrigeration apparatus for removing heat from outdoor air to heat a dwelling, the need for an improved means of initiating a defrost cycle for the outdoor heat exchanger has arisen. While there are various ways of initiating a defrost cycle to melt the frost from the outdoor heat exchanger, at present there is a need for an inexpensive responsive device to respond to the presence of frost on the coil.

The present invention makes use of the pressure developed by the fan in forcing air through the outdoor heat exchanger. A conduit has air flowing therethrough when air is passed through the heat exchanger. An opening in the conduit is mounted adjacent the heat exchanger so the opening can be closed when a predetermined amount of frost develops on the heat exchanger. The conduit is connected to a responsive device which senses the reduction of air flow through the conduit upon the presence of frost on the coil to initiate a defrost cycle.

An object of the present invention is to provide an improved defrost control making use of the reduction of air flow through a conduit as caused by the presence of frost on a heat exchanger.

Another object of the present invention is to provide a means for initiating a defrost cycle of a refrigeration apparatus by responding to a change in pressure in a conduit through which air is directed when the conduit is closed by the development of frost on a heat exchanger.

These and other objects will become apparent upon the study of the following specification and drawings of which:

A single FIGURE is a schematic representation of a refrigeration system for obtaining heat for a dwelling from outdoor air with a means to respond to the need of a defrost operation of the outdoor heat exchanger:

Referring to the single figure, the temperature of the air in space 10 is maintained at a selected value by circulating the air through an indoor heat exchanger or coil 11 mounted in a duct system. Air from space 10 is circulated through a return duct 12 by means of a fan 13 to a supply duct 14. Fan 13 is driven by a motor 15 connected to a source of power. Heat exchanger 11 is part of a refrigeration system 20 which is made up of a motor driven compressor 21, a changeover valve 22, indoor heat exchanger 11, and an outdoor heat exchanger or coil 23. The refrigeration system is connected by pipes or conduits in the following manner: from compressor 21, pipe 24, valve 22, pipe 25, heat exchanger 11, pipe 30, heat exchanger 23, a pipe 31, valve 22, and by a pipe 32 back to compressor 21. As shown, the flow of refrigerant through the system upon operation of compressor 21 supplies heat to coil 11 and heat is removed from coil 23.

To provide a defrost operation of coil 23, valve 22 is operated so movable member 40 is rotated to a hori-

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zontal position as shown in dotted lines to reverse the connection of the refrigeration system and supply heat to coil 23. Such a defrost operation is commonly known as the hot gas method and the cooled coil of the refrigeration system is changed to be the heated coil to remove the frost from the coil 23.

A thermostat 41 has a bimetal operated switch 42 which is connected to a relay 43 to energize the relay and close a switch 44 whenever switch 42 closes upon the temperature of space 10 dropping below some predetermined value. Thermostat 41 is connected to relay 43 by circuit traced as follows: from switch 42, a conductor 45, a winding 50 of relay 43, a conductor 51, a secondary 52 of a conventional voltage stepdown transformer 53 connected to a source of power, conductor 54, and back to switch 42.

Motor compressor 21 is connected to a source of power by the circuit traced as follows: from one terminal 60 of a source of power, a conductor 61, switch 44, a conductor 56, motor compressor 21, a conductor 62, a conductor 63, and back to a terminal 64 connected to the other side of the source of power. When thermostat 41 calls for heat, relay 43 is energized to close switch 44 and bring about the operation of motor compressor 21. Connected in parallel with motor compressor 21 is a fan motor 65 for driving a fan 70. Motor 65 is connected by a circuit traced as follows: from conductor 63, a conductor 66, a switch 67, motor 65, a conductor 68, to conductor 56 and through switch 44 and back to terminal 60 of the source of power. Fan 70 forces outdoor air through coil 23 so that during the heating operation of the refrigeration system 20, the heat is removed from the outdoor air by coil 23.

A conduit or pipe 73 is placed in chamber 74 upstream coil 23 to be subjected to the air pressure developed by fan 70 as it blows air through coil 23. Pipe 73 has an inlet opening 75 exposed to the static pressure in chamber 74 for receiving air from chamber 74. An extension 76 of pipe 73 has an outlet opening 80. Extension 76 is thermally associated with coil 23 and located upstream of opening 75 so that air flows from inlet 75 through pipe 73 to exhaust from outlet 80. Pipe extension 76 is mounted in a passageway or channel 81 through coil 23. The channel is thermally connected to the coil to provide a good heat transfer so that as air passes through channel 81 during the operation of fan 70, frost will form in channel 81 substantially at the same time that the frost forms in the remaining part of coil 23.

A pressure responsive or flow responsive device 82 is connected by a pipe or conduit 83 to conduit 73. Responsive means 82 comprises a diaphragm 84 with a chamber 85 above the diaphragm which is connected to pipe 83. When a pressure develops in pipe 83 or pipe 73 as a result of outlet 80 being restricted by frost and the coil 23 being restricted by frost, diaphragm 84 moves downward to close a conventional switch 90.

Upon switch 90 being closed, a defrost operation of the refrigeration system 20, or in particular coil 23, is initiated. A relay 91 controls movable member 40 of valve 22 so that upon energization of relay 91, member 92 moves clockwise to move the member 40 to the horizontal position as shown in dotted lines. Relay 91 is energized when switch 90 closes through a circuit traced as follows: from terminal 60, conductor 61, a conductor 93, switch 90, a conductor 94, a conductor 95, a winding 100 of relay 91, a conductor 101, and back to the other terminal 64 of the source of power through conductors 71 and 63.

Channel 81 is designed to have a venturi effect as air passes through the channel from one side of the coil to the other. A suction pressure is developed on the

outlet 80 due to the air flow through channel 81 to help to keep the pressure in pipe 83 low even though an air pressure in chamber 74 forces air into inlet 75.

In order to maintain the defrost cycle for a predetermined period, a conventional timer device 103 is effective to maintain relay 91 energized for a predetermined period. Device 103 comprises a motor 104 which drives a cam 105. Cam 105 is designed to close a switch 110 when the cam is rotated slightly in a counter-clockwise direction maintaining switch 110 closed until the cam is rotated 360 degrees to the position shown. Motor 104 is connected to a source of power by a circuit traced as follows: from terminal 64, a conductor 111, motor 104, a conductor 112, a conductor 113, conductor 94, switch 90, conductor 93, and back to the other terminal of the source of power 60 through conductor 61. Once motor 104 is energized, a holding circuit is provided through switch 110 to maintain the motor energized through a circuit traced as follows: from terminal 64, conductor 111, motor 104, conductor 112, conductor 114, switch 110, conductor 115, and back to the source of power through conductor 61 and terminal 60. As long as switch 110 is closed, relay 91 is energized to cause the refrigeration apparatus to heat coil 23.

Relay 91 is maintained in an energized condition through a circuit traced as follows: terminal 60, conductor 115, switch 110, conductor 114, conductor 113, conductor 95, winding 100, conductor 101, conductor 71, conductor 63 and back to the source of power and terminal 64.

Fan 65 must be de-energized during the defrost cycle so the heat applied to coil 23 by the refrigeration system can be effective. A relay 120 which controls switch 67 has a winding 121 connected in parallel with winding 100 by a circuit traced as follows: terminal 64 of the source of power, conductor 63, conductor 71, a conductor 122, winding 121, a conductor 123, conductor 113, switch 110 and back to terminal 60 of the source of power. Upon relay 120 being energized, switch 67 opens to de-energize fan 65.

Operation

Upon a drop in temperature of space 10, thermostat 41 calls for heat by closing switch 42 and energizing relay 43. Motor compressor 21 is energized to heat coil 11. Motor 65 is energized to pass outdoor air through coil 23 and heat is removed from the outdoor air. Upon certain conditions existing, coil 23 will frost up. Upon the presence of frost on the coil and in channel 81, outlet 80 of tube 76 is restricted. The normal flow of air through tube 73 passing into inlet 75 and leaving outlet 80 is restricted and a pressure in tube 73 and 83 develops. The pressure pushes down diaphragm 84 to close switch 90. Upon the closing operation of switch 90, the defrost operation of the refrigeration apparatus is initiated. The defrost operation is accomplished by the energization of relay 91 to change the refrigeration system so coil 23 is heated. As heat is applied to coil 23 and the frost is melted from the coil, outlet 80 is opened and the normal flow of air through pipe 73 is allowed; however, since timer 103 maintains the energization of relay 91 and fan 65 de-energized, the defrost cycle will continue until coil 23 is heated sufficiently to melt off the frost from the complete coil.

By means of tube 73, the flow of air from inlet 75 through outlet 80 is normal as long as no frost exists to block outlet 80 and the pressure of responsive device 82 is such to keep switch 90 open.

As the air flows through channel 81 a suction action on outlet 80 assists in maintaining a greater pressure

differential in pipe 83 between a clear and frosted condition of coil 23. With the suction pressure on outlet 80, the possible differential pressure would be increased to insure the operation of responsive device 82.

Obviously, the means of obtaining the head pressure to provide the flow of air through tube 73 could be obtained by other ways such as a suction through the tube in a fan coil arrangement where the air was pulled through the coil by the fan instead of being pushed through as in the present disclosure. In such an arrangement, the restriction of the tube by the frost would prevent the flow of air into the tube and a decrease in pressure would be sensed to initiate the defrost cycle.

While the present invention is shown in one particular embodiment, other means could be used to obtain a change in pressure by the restriction of a tube to commence a defrost cycle for coil 23; therefore, the present invention is intended to only be limited by the appended claims in which I claim:

1. A defrost control system comprising, a refrigeration compressor driven by a motor in response to a space temperature responsive device, an indoor heat exchanger, an outdoor air heat exchanger having openings for air flow therethrough, means connecting said indoor and said outdoor exchanger to said compressor so that heat can be removed from outdoor air and delivered to said space by said indoor heat exchanger, said outdoor heat exchanger having a Venturi passageway parallel to said openings, a motor driven fan mounted adjacent said outdoor heat exchanger, said fan forming a pressure on the upstream side of said heat exchanger for forcing air through said openings, a conduit having an open inlet end in the vicinity of the upstream side of said outdoor heat exchanger, said conduit having another open outlet end mounted in said passageway so that normally during operation of said fan air flows through said conduit due to a pressure on said inlet and a suction on said outlet, a pressure responsive switch means, means connecting said switch means to selectively initiate a defrost cycle, and means connecting said pressure responsive means to said conduit so that upon the presence of frost on said outdoor heat exchanger to block the flow of air through said outlet opening a pressure develops in said conduit and said defrost cycle is initiated.
2. In a defrost control for a refrigeration system obtaining heat by forcing outdoor air with a fan through a heat exchanger, said exchanger collecting frost under certain conditions to block the flow of air therethrough, a conduit mounted in thermal relation on said exchanger in a passageway therethrough, said conduit having an opening in said passageway which is restricted by frost to reduce air flow through said conduit when frost forms on said exchanger, said passageway producing a suction on said opening of said conduit as air passes through said heat exchanger, and responsive means connected to said conduit to respond to a reduction of air flow through said conduit, said responsive means controlling a defrost cycle for said exchanger.

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