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(54) **Refrigeration system.**

(57) A defrost monitor (24) comprises a thermistor probe (26) located adjacent to the evaporator (14) of a refrigeration system (10) which is connected to a programmable controller (28) located within the monitor (24) to which is connected a second thermistor probe (30) for detecting temperature rises above a preset value entered into the controller (28) and during defrost of the refrigeration system (10) the programmable controller (28) assesses the rate of change of temperature between given preset values and if the rate of change indicates defrost will activate a valve (22A) and heater (32) thereby assisting defrost or initiate an alarm or the like where the rate of change is irregular or the temperature remains between the two preset values thereby indicating a refrigeration fault.

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Description

REFRIGERATION SYSTEM

This invention relates to a refrigeration system and particularly to temperature monitor apparatus for a refrigeration system.

In refrigeration systems temperature monitoring of refrigerant fluid is used in the effective running of the system. Particularly in a system of the type described in U S Patent No. 3 343 375, it is important to detect the onset of a "defrost" situation, achieved by reverse fluid flow to the evaporator, so that appropriate consequential action, such as the correct instant for defrost termination, may be determined locally to the evaporator. A conventional method of detecting the onset of defrost is to measure the temperature of the refrigerant in the suction line (normal output from the evaporator) of the system. In normal running, the temperature of refrigerant in the suction line only increases above a predetermined value during the defrost cycle. However, this value may also be exceeded due to system failure and some actions appropriate during a defrost situation are most inappropriate if the system fails, eg. the activation of local electrical heating which is normally used during defrost to assist defrost or to keep drains clear of ice. Using the conventional temperature monitoring method the system cannot differentiate between normal defrost and refrigeration failure.

It is an object of the present invention to provide a refrigeration system having a new and improved form of temperature monitoring.

According to the present invention there is provided a refrigeration system having an evaporator located in a chamber, means for delivering refrigerant to the evaporator either in a first fluid flow direction to enable the chamber to be refrigerated or in a reverse fluid flow direction to enable the evaporator to be defrosted and a defrost monitor associated with the chamber, the monitor comprising means for measuring the temperature of the refrigerant fluid in the vicinity of the evaporator and means for assessing rate of temperature change of the refrigerant.

Said defrost monitor may assess the time taken for a change between a preset low temperature and a preset high temperature to be attained by the refrigerant and compare this time with a reference time predetermined for the same change in temperature occurring during a normal defrost process. The defrost monitor may include a thermistor probe located adjacent to the evaporator output (suction line) or incorporated into a section of the evaporator, the probe being connected to a programmable controller within the monitor which is connected to a second thermistor probe within the chamber and being capable of activating a valve or local electrical heater for the purpose of assisting defrost action during a defrost process or alternatively the monitor may initiate an alarm. Additionally a thermostat may be located in the chamber to be refrigerated and connected to control a valve for regulating refrigeration.

In another aspect the present invention provides a method of operating a refrigeration system having an evaporator which is either fed with cool refrigerant fluid for refrigeration or relatively heated refrigerant fluid for defrosting, in which the temperature of the refrigerant fluid at the output of the evaporator is monitored to determine its time rate of change between preset temperature values to assess whether the system is in fault, when the time rate of change exceeds a preset value, or whether the system is in defrost, when the time rate of change does not exceed the preset value.

An embodiment of the present invention will now be described by way of example and with reference to the accompanying schematic drawing.

In the schematic drawing a refrigeration system 10, comprises an evaporator section 10A having an evaporator 14, located within a chamber 16, connected through a conventional system of valves and pipework indicated at 12 to refrigerant delivery means 17 having a condenser and compressor (not shown). The evaporator 14 and condenser are thermal transfer devices the pipework containing a compressible thermal transfer refrigerant in fluid form, conveniently a Freon (R T M).

A number of valves are shown, including a first pair of valves 20A and 20B in the evaporator section 10A which are non-return valves constraining refrigerant flow in only one direction. Isolating valves 22A, 22B, are solenoid valves electrically operated as will be explained to provide either normal refrigeration or a defrost process within the evaporator section 10A.

A defrost monitor 24 comprises a thermistor probe 26 located adjacent to the evaporator 14 in the suction line of pipework 12A, probe 26 being connected to a programmable controller 28 provided in accordance with the present invention and located within monitor 24 to which is connected a second thermistor probe 30. The thermistor probe 30 detects air temperatures within chamber 16 and is arranged to activate valve 22A or a local electrical heater 32 to assist the defrost action during the defrost cycle. Conventionally a thermostat 22C is provided with a probe located within the chamber 16 and controls or regulates the valve 22B in on/off manner such that when refrigeration is temporarily to be terminated, the thermostat 22C will act to close valve 22B. Thermostat 22C and valve 22B may be interconnected via controller 28.

During normal refrigeration, circulating refrigerant from delivery means 17 enters the evaporator 14 from a line 12B from a heat exchanger 34, through solenoid valve 22B and a liquid-to-gas expansion valve 36. The slightly heated refrigerant leaves the evaporator 14 through line 12A, also known as the suction line, and through the heat exchanger 34 and the non-return valve 20A prior to returning to the means 17 via line 12C, the refrigerant removing heat from the region of the chamber 16 adjacent to the evaporator 14 and this heat being dissipated in the

refrigerant delivery means 17 mainly through the condenser thereof. The refrigerant is compressed in the compressor of the means 17 prior to the condenser.

During a defrost process valve 22A is opened and the evaporator 14 is heated. This is achieved by forcing relatively heated refrigerant fluid from refrigerant delivery means 17 in reverse flow along line 12C through solenoid valve 22A, into the suction line of evaporator 14 and out through non-return valve 20B returning to means 17 via line 12B. The relatively heated refrigerant fluid may be delivered in liquid form by the output of the compressor of means 17 or in saturated gas form from the defrost header of means 17 as explained in US 3343375.

Any change in temperature of refrigerant adjacent to the evaporator 14 is detected by the thermistor probe 26. Preset low and high temperature values are entered in the reprogrammable controller 28 and the temperature rise in the refrigerant between the low and high values is timed and compared with a preset time known to be that taken to indicate the onset of a normal defrost process and also stored in the controller 28. By way of example, for frozen food, a suitable indication of the onset of the defrost is that the measured temperature, ie. the temperature at thermistor probe 26, rises from -8° C to more than +2° C in less than two minutes. If the measured temperature remains above the preset low temperature but below the preset high temperature for longer than the preset time, (in the above example two minutes), then the system 10 may possibly not be undergoing a defrost cycle and is assumed to be at fault, as a result of which the controller 28 intiates an alarm. This condition happens before any detectable rise in the temperature of product within the chamber 16 so that timeous action may be taken such as removal of product to another refrigeration cabinet. If, however, the monitored temperature rises to the preset higher value in the preset time then a defrost condition has started and heater 32 will be switched on to assist defrost. When defrost terminator conditions are detected, eg., temperature at air probe 30 rises above a maximum preset value, the heater is switched off again and valve 22A closed to terminate the defrost condition.

Appropriate temperature values may be input into the controller 28 according to the type of frozen goods stored within chamber 16, eg. for meat and dairy products the time taken for the refrigerant to heat up from +3 to +8° C to be under three minutes is an acceptable standard.

It will be appreciated that the chamber 16 may be hermetically sealed or open to external conditions.

It will be further appreciated that the aforementioned refrigeration systems can be multi-branched ie. refrigerant delivery means 17 may drive a number of evaporators 14 or "stubs". For successful operation of these systems and to provide sufficient energy for defrost a number of "stubs" are in refrigeration mode whilst the stub requiring defrost is provided with the exchange in energy for successful defrost.

Claims

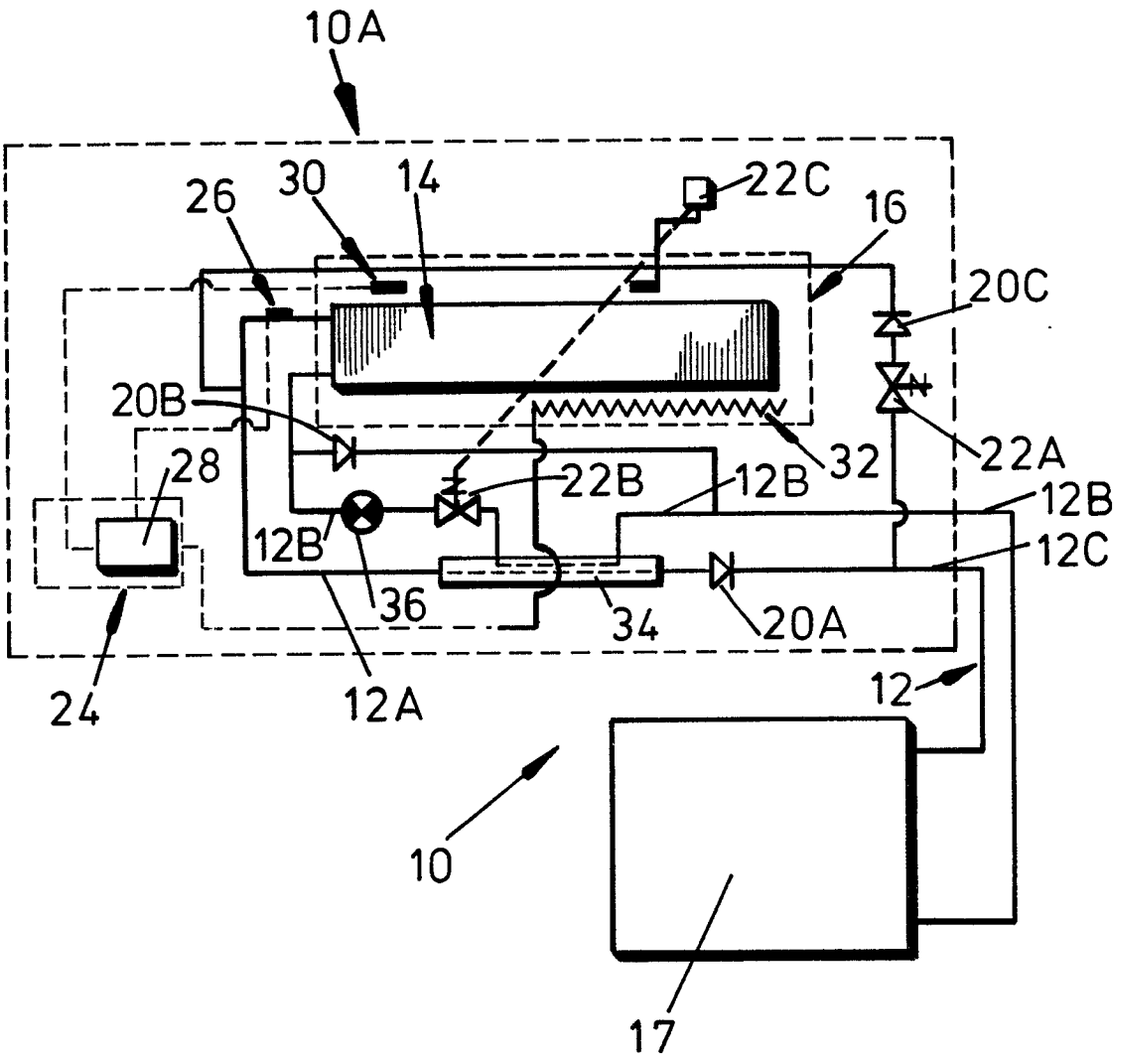
1. A refrigeration system (10) comprising an evaporator (14) located in a chamber (16), means (17) for delivering refrigerant fluid to the evaporator (14) either in a first fluid flow direction to enable the chamber (16) to be refrigerated or in a reverse fluid flow direction to enable the evaporator (14) to be defrosted and characterised by the provision of a defrost monitor (24) associated with the chamber (16), the monitor (24) comprising means (26, 30) for measuring the temperature of the refrigerant fluid in the vicinity of the evaporator (14) and means (28) for assessing rate of temperature change of the refrigerant fluid.

2. A refrigeration system (10) as claimed in claim 1 characterised by said defrost monitor (24) comprising means to assess the time taken for a change between preset low and high temperatures to be attained by the refrigerant fluid and means to compare this time with a preset time.

3. A refrigeration system (10) as claimed in either preceding claim characterised in that said defrost monitor (24) includes a thermistor probe (26) located adjacent to the evaporator output or incorporated into a section of the evaporator (14), the probe (26) being connected to a programmable controller (28) within the monitor (24) which is connected to a second thermistor probe (30) within the chamber (16) and being capable of activating a valve (22A) or local electric heater (32) for the purpose of assisting defrost action during a defrost process.

4. A refrigeration system (10) as claimed in any preceding claim characterised in that said monitor (24) activates an alarm during a refrigeration fault.

5. A method of operating a refrigeration system having an evaporator which is either fed with cool refrigerant fluid for refrigeration or relatively heated refrigerant fluid for defrosting, in which the temperature of the refrigerant fluid at the output of the evaporator is monitored to determine its time rate of change between preset temperature values to assess whether the system is in fault, when the time rate of change exceeds a preset value, or whether the system is in defrost, when the time rate of change does not exceed the preset value.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