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DEFROST CONTROL SYSTEM USING A FLUID AMPLIFIER

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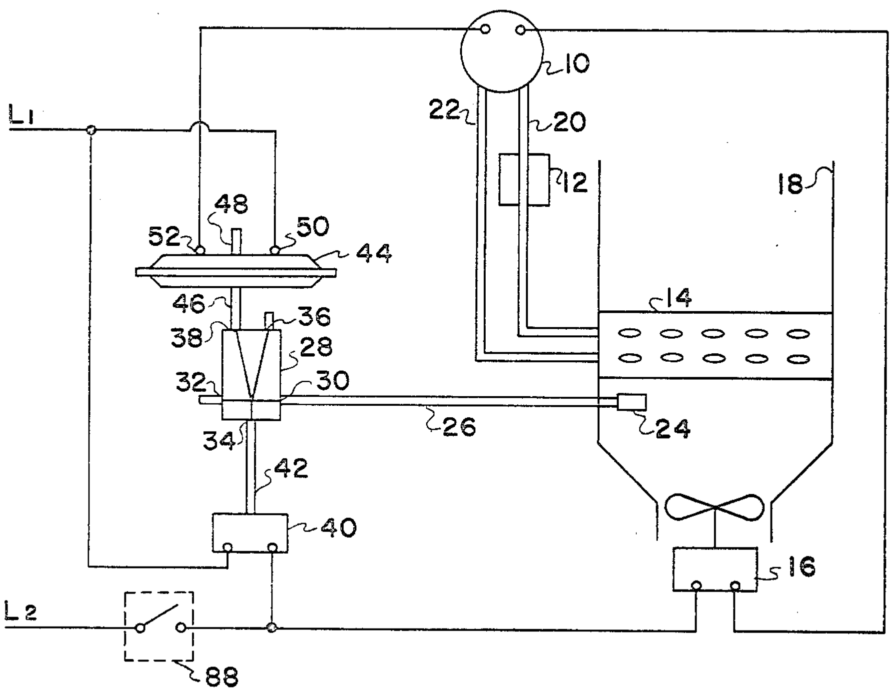

FIG. 1

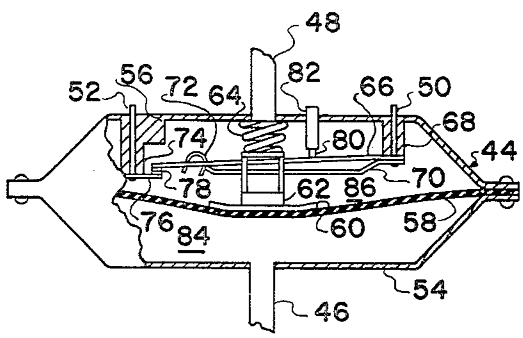

FIG. 2

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DEFROST CONTROL SYSTEM USING A FLUID AMPLIFIER

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ABSTRACT OF THE DISCLOSURE

A defrost control system having a pressure operated device controlling the operation of a compressor and a circulation fan in a cooling system and wherein the defrost control system includes a fluid amplifier for amplifying pressure sensed at an evaporator and communicating the amplified pressure to the pressure operated device.

BACKGROUND OF THE INVENTION

The present invention pertains to defrost control systems and more particularly, to pressure operated defrost control systems.

Conventional cooling systems for refrigeration systems, air conditioning systems and the like utilize a compressor for supplying a refrigerant through a condenser to an evaporator where the refrigerant absorbs heat and is then returned to the compressor to complete the cycle. A fan is conventionally employed to force air past the evaporator to cool it and then circulate the cooled air to the area to be cooled. During operation of such cooling systems, ice and frost accumulate on the evaporator due to condensation of moisture in the air being cooled, and this accumulation of ice and frost reduces the area of the evaporator available for heat exchange, thereby decreasing the efficiency of the system. The accumulation of ice and frost also reduces the passage of air over the evaporator which further decreases the efficiency of the system and increases the pressure differential across the evaporator by increasing the pressure upstream of the evaporator and decreasing the pressure downstream of the evaporator.

The pressure differential across the evaporator has been utilized in the past to control the defrosting of the evaporator. That is, the pressure at the evaporator is monitored, and when it obtains a predetermined value, the defrosting cycle commences. These pressure operated defrost control systems have not provided maximum efficiency, as yet, due to their insensitivity to small changes in pressure.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to construct a pressure operated defrost control system using a fluid amplifier to increase sensitivity.

Another object of the present invention is to use a pressure operated device in combination with a fluid amplifier in a defrost control system.

A further object of the present invention is to employ a fluid amplifier to communicate an amplified pressure at an evaporator to a pressure operated device in a defrost control system.

The present invention is advantageous over prior pressure operated defrost control systems due to its increased sensitivity to pressure changes which permits more accurate commencing of the defrost cycle to increase efficiency of the associated cooling system.

The present invention is generally characterized in that defrosting means for an evaporator in a cooling system is controlled by a pressure operated device which is controlled by the pressure at the evaporator as amplified by a fluid amplifier.

Other objects and advantages of the present invention will become apparent from the following description of the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a defrost control system according to the present invention; and

FIG. 2 is a side elevation with parts broken away and with parts in section of a detail of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 illustrates an embodiment of a defrost control system according to the present invention as used with a conventional cooling system having a compressor **10**, a condenser **12**, an evaporator **14** and a fan **16**. Evaporator **14** is disposed within duct work **18**, and a conduit **20** carries a refrigerant from compressor **10** to evaporator **14** through condenser **12**, and a conduit **22** returns the refrigerant to compressor **10**. A pressure sensor **24** is disposed upstream of evaporator **14** and communicates through a conduit **26** with a fluid amplifier **28** at a control nozzle **30**. As shown, fluid amplifier **28** includes control nozzles **30** and **32**, a power nozzle **34** and outlet passages **36** and **38**. A relatively high pressure air pump **40** communicates with power nozzle **34** through a conduit **42**. Control nozzle **32** is unconnected in the embodiment of FIG. 1 and is plugged; however, if differential action is desired, control nozzle **32** may communicate with a pressure sensor located downstream of evaporator **14**. Control nozzle **32** may also be the sole control for fluid amplifier **28** by allowing it to communicate with a pressure sensor located downstream of evaporator **14** and plugging control nozzle **30**. Outlet passage **36** is used as a dump for mainstream flow through fluid amplifier **28**, and the pressure at outlet passage **36** is the complement of the pressure at outlet passage **38** thereby providing a differential output. If desired, outlet passage **36** may communicate with a pressure sensitive switch to provide an indication when the system is in its defrost condition. Outlet passage **38** communicates with a pressure operated device **44** at a pressure sensing port **46**. The internal structure of the fluid amplifier used in the present invention is not critical, and any conventional fluid amplifier may be used provided its outlet passage pressure is proportional to the pressure at its control nozzle.

Any conventional pressure operated device may be used in the system of FIG. 1, and one such pressure operated device is shown in FIG. 2, generally indicated at **44**. Pressure operated device **44** includes a pressure sensing port **46** which communicates with outlet passage **38** of fluid amplifier **28**, a pressure sensing port **48** which is exposed to the atmosphere and terminals **50** and **52**. Port **46** is located in a lower casing **54**, and port **48** and terminals **50** and **52** are located in an upper casing **56**. Lower casing **54** and upper casing **56** are attached together at their peripheral flanges, and a flexible diaphragm **58** is secured at its periphery between the peripheral flanges of casings **54** and **56**. A diaphragm pan **60** is affixed to diaphragm **58** and a cylindrical member **62** has a lower portion attached to pan **60**. A spring **64** is mounted in compression between an upper portion of member **62** and upper casing **56**. The upper portion of member **62** is attached to a blade **66** and is supported by legs which extend from the lower portion of member **62** and are spaced to provide ample area for passage of a blade **66** which is supported by a mounting wall **68** along with a rigid support member **70**. Terminal **50** extends through wall **68** and connects with blade **66**. Member **70** extends in spaced parallel relation with blade **66** from wall **68** and has a shoulder portion that engages one end of a U-shaped roll spring **72** which is disposed in an opening in blade **66** to form a conventional snap acting switching mechanism. Terminal **52** extends through a mounting wall **74** and connects with a contact **76** which is secured to wall **74** and located so as to make contact with a contact **78** that is attached to the free end of blade **66.** Blade **66** is also attached to a rod **80** which extends from a housing **82**, and when pressure operated device **44** is in its second state the upward movement of blade **66** will cause rod **80** to extend above housing **82** to permit manual resetting of the device by pushing down on rod **80.** Port **46** communicates with a chamber **84** defined by lower casing **54** and diaphragm **58**, and port **48** communicates with a chamber **86** defined by upper casing **56** and diaphragm **58.**

The electrical circuitry and the operation of the system of FIG. 1 are described using the pressure operated device shown in FIG. 2; however, it is noted that the pressure operated device is shown in FIG. 2 as a basic design in order to more clearly describe the present invention and many complex mechanisms may be included therein to provide complete automatic operation.

The electrical circuitry of FIG. 1 includes power leads L_1 and L_2 which are adapted to be connected to a suitable source of electricity. L_2 is connected through a control switch **88**, fan **16** and compressor **10** to terminal **52** of pressure operated device **44** and through control switch **84** and air pump **40** to L_1 which is also connected to terminal **50** of pressure operated device **44.**

In operation, the cooling system of FIG. 1 is controlled by switch **88.** When cooling is desired, switch **88** is closed which energizes air pump **40**, fan **16** and compressor **10** to place the system in its normal cooling condition since pressure operated device **44** is in its first state in which contacts **76** and **78** are closed, as shown in FIG. 2. Compressor **10** forces the refrigerant through condenser **12** and evaporator **14** to cool the air forced past the evaporator by fan **16**, and the pressure sensed by pressure sensor **24** is communicated to control nozzle **30** of fluid amplifier **28** by conduit **26.** A relatively high pressure mainstream of air is forced through power nozzle **34** and outlet passages **36** and **38** by air pump **40**, and the flow of air in outlet passages **36** and **38** is controlled by control nozzle **30** which deflects the mainstream in accordance with the pressure communicated to it. Initially, the mainstream flows predominantly through outlet passage **36**; however, as the pressure upstream of evaporator **14** increases, control nozzle **30** increases deflection of the mainstream to outlet passage **38** which increases the pressure therein in proportion to the increase of pressure upstream of evaporator **14.** Consequently, increased pressure upstream of evaporator **14** due to accumulation of ice and frost thereon, causes increased pressure at outlet passage **38.**

The pressure in chamber **84** of pressure sensitive device **44** is directly responsive to the pressure at outlet passage **38**, and chamber **86** is at atmospheric pressure. Thus, the force above diaphragm **58** is provided by atmospheric pressure and the force from spring **64** and the force below diaphragm **58** is provided by the pressure at outlet passage **38.** As the pressure in chamber **84** increases, diaphragm **58** begins to deflect upward which causes an upward movement of blade **66**, and when blade **66** moves past the center of roll spring **72**, the free end of blade **66** moves with snap action to abut the top of wall **74.** Thus, contacts **76** and **78** open after the pressure upstream of evaporator **14**, as amplified by fluid amplifier **28**, reaches a predetermined value.

The opening of contacts **76** and **78** starts the defrost cycle since compressor **10** and fan **16** are deenergized. The ambient temperature of evaporator **14** causes the ice and frost accumulated thereon to melt, and when this process is completed the system is ready to return to its normal cooling condition. In order to return the system to its normal cooling condition, pressure operated device **44** must be returned to its initial state wherein contacts **76** and **78** are closed to allow energization of compressor **10** and fan **16**, and this may be accomplished either manually by pushing rod **80** or by including a mechanism within the pressure operated device responsive to the temperature of evaporator **14** as shown by U.S. Patent No. 3,299,237 assigned to Robertshaw Controls Company.

When the need for cooling has been satisfied, switch **88** is opened which deenergizes compressor **10**, fan **16** and air pump **40.** While the system is off, any ice and frost that has accumulated on evaporator **14** melts, and the system will be prepared to enter its normal cooling condition whenever switch **88** is closed again.

Faster defrosting of evaporator **14** may be accomplished by locating a heating element near evaporator **14**, placing a third contact on the top of wall **74** in pressure operated device **44** and connecting one terminal of the heating element to the third contact and the other terminal of the heating element to L_2 through switch **88.** Thus, when pressure operated device **44** is in its second state with contacts **76** and **78** open, the third contact and contact **78** are closed which completes a circuit from L_1 through the third contact, contact **78**, the heating element and switch **88** to L_1 to heat evaporator **14** and accelerate its defrosting.

The sensitivity of conventional defrost control systems using a pressure operated switch directly sensing the pressure at the evaporator can be increased four to five times by utilizing a fluid amplifier in accordance with the present invention.

Inasmuch as the present invention is subject to many modifications, variations and changes in details, it is intended that all matter contained in the specification or shown in the drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In a defrost control system, the combination comprising

cooling means including an evaporator,
means for defrosting said evaporator,
pressure sensing means located near said evaporator,
pressure operated means for controlling said defrosting means, and
fluid amplifying means including an air pump providing a source of air pressure, said fluid amplifying means being connected with said pressure sensing means and said pressure operated means whereby air pressure applied to said pressure operated means is an amplification of pressure sensed near said evaporator.

2. The combination as recited in claim **1** wherein said pressure operated means has a first state and a second state and includes a pair of electrical contacts which are closed when said pressure operated means is in its first state and open when said pressure operated means is in its second state.

3. The combination as recited in claim **2** wherein said cooling means includes a compressor for supplying a refrigerant to said evaporator and a fan for forcing air past said evaporator to cool it and circulating the cooled air and said defrosting means includes means connecting said compressor and said fan in series with said pair of contacts whereby said compressor and said fan are deenergized to permit said evaporator to defrost when said pressure operated means is in its second state.

4. The combination as recited in claim **1** wherein said cooling means includes a fan for forcing air past said evaporator to cool it and circulating the cooled air and said pressure sensing means is located between said fan and said evaporator whereby accumulation of frost and ice on said evaporator causes an increase in pressure sensed by said pressure sensing means.

5. The combination as recited in claim **1** wherein said fluid amplifying means includes a proportional fluid amplifier having a control nozzle communicating with said pressure sensing means and an outlet passage communicating with said pressure operated means.

6. The combination as recited in claim 5 wherein said pressure operated means is responsive to the pressure at said outlet passage of said proportional fluid amplifier to be in a first state when the outlet passage pressure is below a predetermined value and a second state to permit defrosting of said evaporator when the outlet passage pressure exceeds the predetermined value.

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