May 10, 1966 C. D. ORTH 3,250,083

FROST SENSING DEVICE

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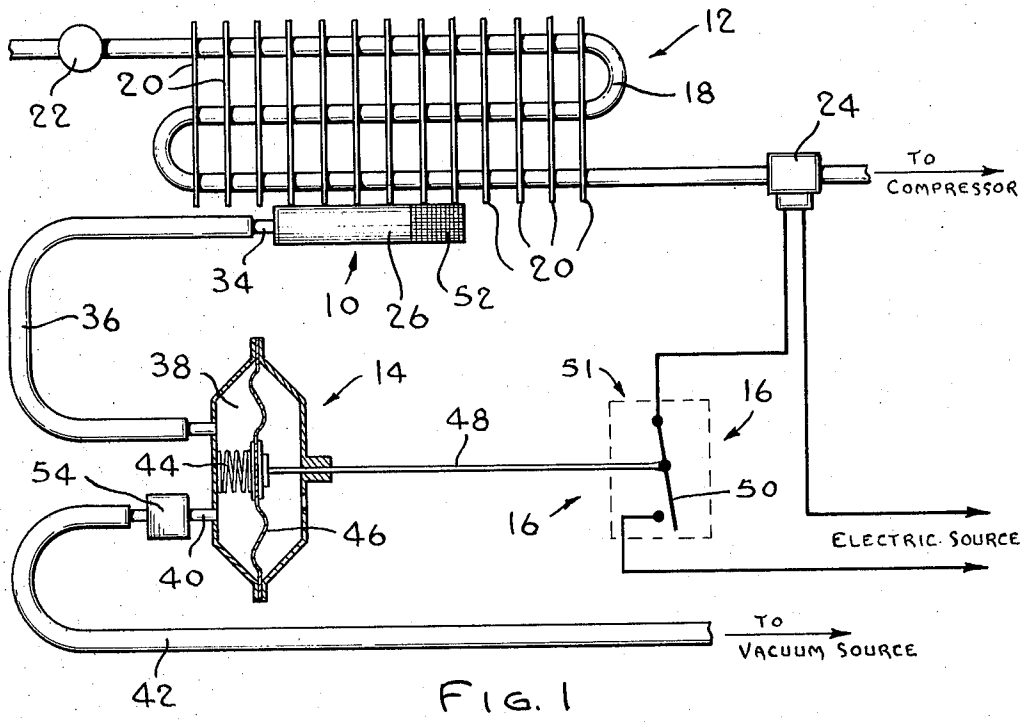


FIG. 1

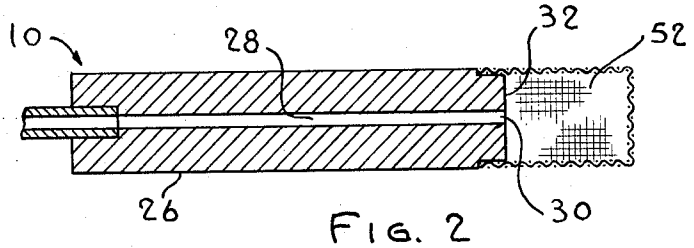


FIG. 2

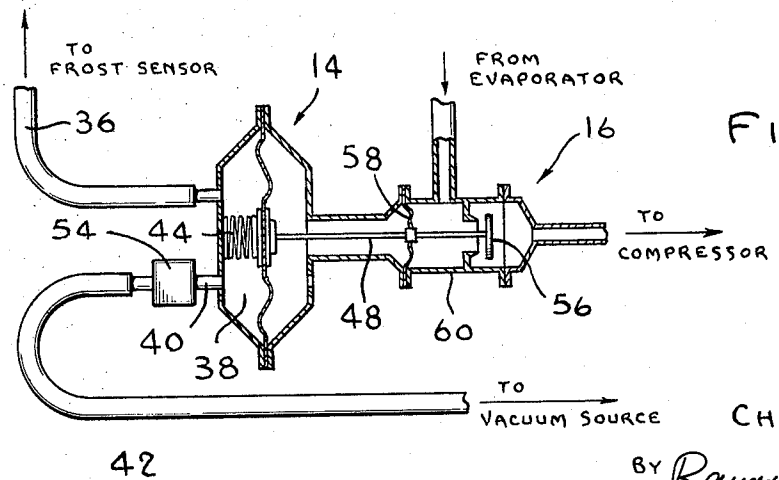


FIG. 3

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FROST SENSING DEVICE

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This invention pertains to improvements in the method of frost sensing and in frost sensing mechanisms of the type generally employed to control the defrost cycle of a refrigeration system.

In general, devices of this type have been comprised of a mechanism which reciprocally moves a sensing member into and out of contact with a frost forming surface of the system, and means responsive to the sensing member when it encounters a predetermined frost accumulation to initiate the defrost cycle. Some devices of this type have also incorporated means to terminate the defrost cycle. Others merely function to initiate the cycle and the cycle is terminated by a timer or other means independent of the frost sensing device.

One of the features common to most of the commercial sensing devices of this type is that the sensing member has to be reciprocated throughout the refrigeration cycle. The cycling is necessary in order to permit frost to build up on the frost forming surface when the sensing member is in a nonsensing position and to permit the same to sense the thickness of frost accumulations when it is moved into the sensing position.

The principal object of this invention is to provide a method and means for frost sensing which will not require the abovementioned reciprocal motion and which will therefore eliminate the mechanism employed for this purpose.

To attain this object I provide a stream of gas flow in the section of the refrigeration system in which frost is to be sensed and also provide a member which is adapted to accumulate frost so as to increasingly obstruct the gas flow with the increase in the frost accumulation. I utilize the variance in gas flow resulting from the obstruction to actuate a control and thereby initiate and/or terminate the defrost cycle of the system.

The gas flow is provided through an orifice in a surface which is positioned in a frost accumulating atmosphere. Frost will tend to form on the surface and will tend to block flow through said orifice. The defrost cycle is controlled by means responsive to the air flow through said orifice and therefore after a predetermined accumulation of frost thereon the flow will be altered to a degree at which the means responsive to such flow will actuate a control for initiation of the defrost cycle.

The orifice and surface may be part of a metal block which is of a size sufficient to provide a thermal lag during the defrost cycle. By virtue of the lag the frost covering the orifice will tend to remain in a restricting position to retain the control means in the defrost cycle condition until the frost accumulation on the parts of the system has melted. At such time the control means will respond to the change in flow to initiate the refrigeration cycle.

Other objects and advantages will be pointed out in, or be apparent from, the specification and claim, as will obvious modifications of the two embodiments shown in the drawings, in which:

FIG. 1 is a schematic view of the evaporator section of a refrigeration system showing the frost sensing mechanism and electrically responsive defrost control means;

FIG. 2 is an enlarged cross-sectional view of the frost sensing elements; and

FIG. 3 is a cross-sectional fragmentary view of another embodiment of this invention showing mechanically responsive defrost control means.

Referring to the drawings, the basic components of the frost sensing mechanism embodying the present invention are a frost sensing element **10**, which is positioned within the evaporator section **12** of a refrigeration system, a pressure responsive motor **14**, control means **16** responsive to said motor, and a source of vacuum or pressure (not shown) which is utilized to actuate the motor in response to the indication of a change in frost accumulation by the sensing element. The embodiments shown in the drawings are of the type which utilize a source of vacuum; however, as will be apparent from the further description in the specification, the basic principles of operation of the frost sensing mechanism are the same when utilizing a source of vacuum as when utilizing a source of pressure, and therefore the particular source is believed to be immaterial to the broad aspects of this invention.

The evaporator section **12** is comprised of an evaporator coil **18** having a plurality of fins **20** and being provided with an expansion valve **22** and an outlet valve **24** at the inlet and outlet of the section respectively.

The frost sensing element **10** is comprised of a metal block **26**, having a central bore **28** to define an orifice **30** on the sensing surface **32** of the block, and is connected to the source of vacuum by tubes **34** and **36** thereby creating an air flow through the orifice **30**. The particular position of the sensing element within the evaporator section is not critical; however, it should be positioned therein in such a manner as to assure that the surface temperature of the sensing surface, and preferably the entire block, will generally correspond to the average surface temperature of the evaporator section parts. Because of this position the frost accumulation characteristics on the sensing surface **32** will substantially correspond to those of the other evaporator parts.

As the front accumulates on the sensing surface it will gradually restrict the air flow through the orifice **30**, with the degree of restriction being dependent upon the amount of frost accumulation.

With the orifice being unrestricted, the pressure in chamber **38** of the pressure responsive motor **14** is at a predetermined level below the atmospheric pressure in the evaporator section by virtue of being in communication with the source of vacuum through tubes **40** and **42**. In this condition the compression spring **44** exerts a bias on the diaphragm **46** and the plunger **48** fixed thereto. The bias is sufficient to maintain the blade **50** of the control switch **51** in a switch-open position. As the flow through the orifice is increasingly restricted due to the frost accumulation, the pressure in chamber **38** will correspondingly decrease and thereby cause a corresponding inward travel of the diaphragm and the plunger. At a predetermined level of frost accumulation the pressure drop in chamber **38** will be sufficient to have caused the plunger to travel the required distance for closing the control switch **51**.

The closing of the control switch energized the outlet valve **24** causing the same to close and cut off the flow of refrigerant and thereby to initiate the defrost cycle. At this point is should be noted that there are various methods known in the art which may be utilized to initiate a defrost cycle, and that the above described method is thought to be merely illustrative of one method in which the defrost cycle is initiated by the actuation of an electrical control.

The above described mechanism can also be utilized to again initiate the refrigeration cycle. To attain this, the block **26** is made of a sufficiently large mass to provide a

thermal lag during the defrost cycle, which will assure that the frost accumulation on the sensing surface **32** will melt at a rate which will be indicative of the melting rate of the frost accumulation on the evaporator parts. During defrosting, of course, the restriction of orifice **30** will be decreasing, thereby providing a corresponding increase in pressure in chamber **38** and thus causing the plunger to progressively move outwardly to thereby move the switch to a switch-open position. The opening of the switch can be utilized to terminate the defrost cycle and to initiate the refrigeration cycle.

To provide the above described action the control switch should preferably be of the snap-action type so that it permits substantial plunger or blade movement before its snaps from the open to the closed position, and again permits substantial plunger movement in the opposite direction before it snaps from the closed to the open position. When employing this type of switch the frost accumulation on surface **32** will have to be at a predetermined level to cause sufficient plunger movement to close the switch; however, after closing the outward plunger movement, caused by the decrease in frost accumulation during the defrost cycle will not immediately open a switch, but the decrease will have to be sufficient to overcome the play of the switch before it will snap to the open position. Since this type of switch is well known in the art, a schematic illustration of the control switch **51** is only shown, it being thought that the selection of the particular switch will be within the ordinary skill of one versed in this field when made in accordance with the teachings of this disclosure.

In order to avoid false defrost cycles because of obstructions of the orifice by dust or dirt accumulation on the sensing surface, a screen **52** is provided to cover the same as shown in FIGS. 1 and 2.

The frost accumulation characteristics causing obstructions of the orifice **30** are effected by the air flow velocity through the orifice, which is primarily determined by the amount of vacuum created at the source and upon the nature of the flow restrictions in the pneumatic circuitry. Basically, the air velocity should be such as not to dislodge the frost particles as they form over the orifice. If the amount of vacuum at the source is too high to attain the desired velocity, a restrictor **54** may be provided in tube **40**. The velocity can be further reduced by using capillary tubes at **34** and **36**.

The only difference between the embodiments of FIGS. 1 and of 3 is that in the latter the plunger is directly connected to a valve **56** which comprises the control means **16** and which corresponds to valve **24** of the embodiment of FIG. 1. The pressure drop in chamber **38** caused by frost accumulation over the orifice **30** initiates the defrost cycle by causing plunger **48** to move the valve to the valve-closed position. Since the actuation of the plunger is dependent upon pressure differential across the diaphragm, a second diaphragm **58** is provided between the vacuum motor and the valve to thereby render the former independent of the pressure within the valve housing **60**.

From the above description it should be appreciated that one of the important features of the frost sensing

mechanisms embodying the present invention is the provision of air flow through the orifice and the actuation of a control means in response to variation in such air flow. For this reason the frost sensing mechanism would function equally well if a source of pressure were utilized as compared to a source of vacuum. The only other change required from the illustrated embodiment would be a change in the control means **16** so that the same would move to a closed position in response to an outward movement of the plunger as compared to the inward movement required in the illustrated embodiment. One possible advantage of utilizing a source of vacuum is that the air temperature of the air passing through the orifice is equal to the ambient temperature within the evaporator section and therefore will not affect the frost accumulation characteristics on the sensing surface.

The above described frost sensing mechanism is well suited for use in automotive air conditioning systems in which case the source of vacuum could be attained by suitable connection of tube **42** to the intake manifold of the automotive engine.

Although but two embodiments of the present invention have been illustrated and described, it will be apparent to those skilled in the art that various changes and modifications may be made therein without departing from the spirit of the invention or from the scope of the appended claim.

What I claim is:

A frost sensing mechanism for sensing the frost accumulation on the parts of a section of a refrigeration system, comprising, a frost sensing element having an orifice in a surface of said element, said element being adapted to be positioned in the section of the refrigeration system to thereby cause frost accumulation on said surface and restriction of said orifice indicative of the amount of frost accumulation on the parts, means to provide a gas flow through said orifice, said gas flow being changed by said restriction, motor means responsive to said change in gas flow to indicate the amount of frost accumulation; said frost sensing element being of metal and of a substantial size as compared to the size of the orifice so as to provide a thermal lag upon the increase in the temperature in the section of the refrigeration system during defrosting of the section to thereby cause said frost accumulation restricting said orifice to melt at a rate indicative of the rate of melting of the frost on the parts of the section.

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