

Jan. 19, 1954

M. S. SUTTON

2,666,299

REFRIGERATOR DEFROSTING CONTROL

Filed April 8, 1950

FIG. 1

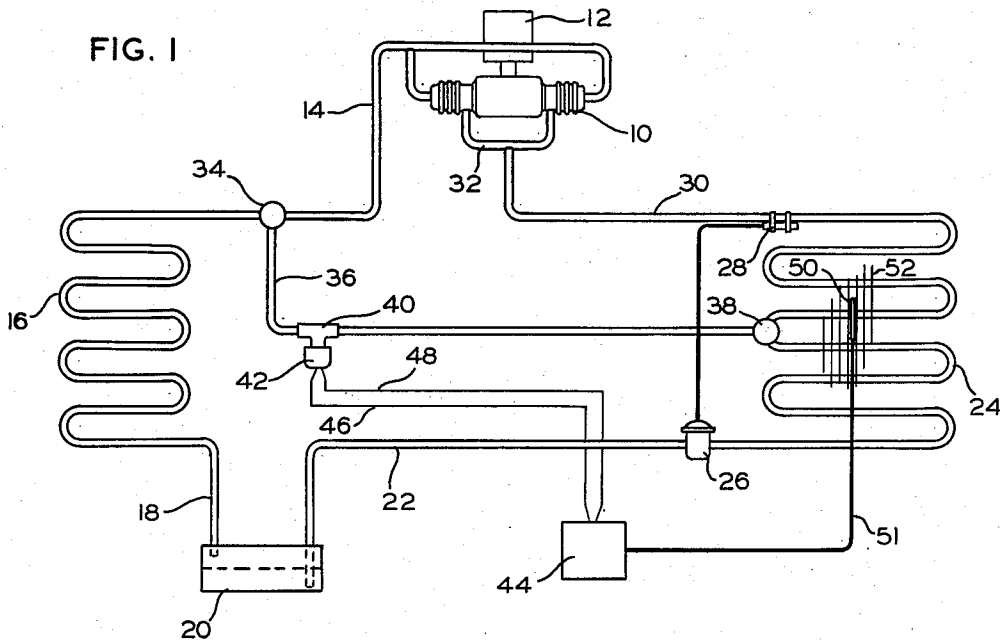
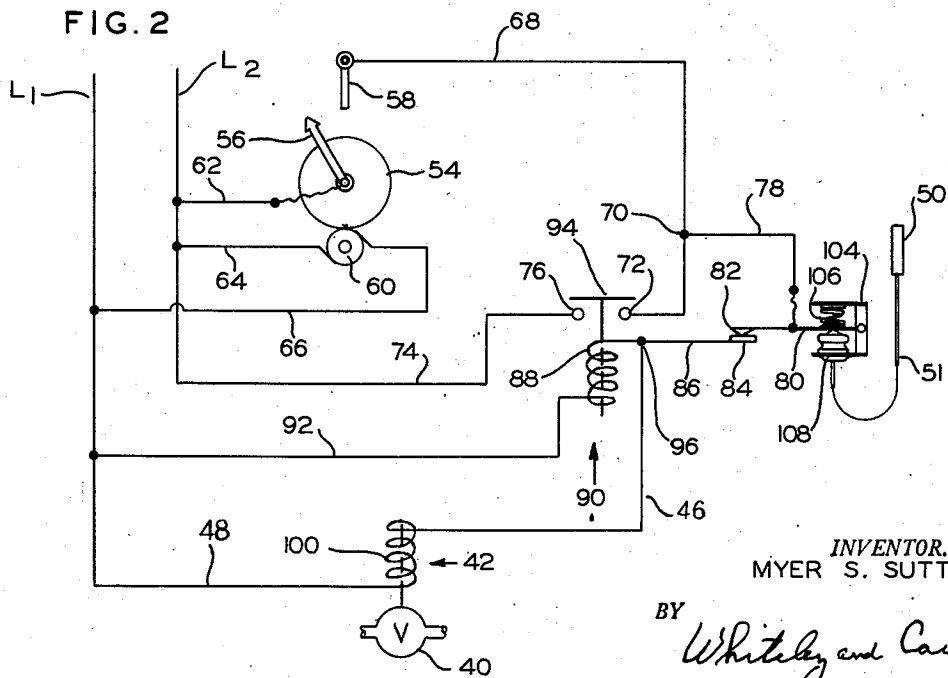


FIG. 2



INVENTOR.
MYER S. SUTTON

BY

Whiteley and Caine

ATTORNEYS

UNITED STATES PATENT OFFICE

2,666,299

REFRIGERATOR DEFROSTING CONTROL

Myer S. Sutton, Minneapolis, Minn., assignor to
The U. S. Thermo Control Co., Minneapolis,
Minn., a corporation of Minnesota

Application April 8, 1950, Serial No. 154,780

3 Claims. (Cl. 62-4)

1 My invention relates to a control system adapted for use with a cold diffuser on which a progressive accumulation of frost occurs and which, if not removed, becomes excessive to the point where efficiency of diffusion is undesirably reduced.

In refrigerating systems to which the present invention is applicable, the air within an enclosed space, on coming into contact with a cold diffuser, gives up its moisture which adheres to the diffuser in the form of a progressive accumulation of frost and if not periodically removed, materially reduces the efficiency of the diffuser. To defrost the diffuser it is customary to use a medium for transferring energy from a source of heat to the diffuser to bring about melting of the accumulated frost layer. In the prior art relating to defrosting, it has been customary to use any one of several mediums for this purpose, such as hot gas from the high pressure side of a closed refrigerating system, hot water, or in some instances, electrical energy which is passed through a resistance heater that is in contact with or adjacent the cold diffuser. In any of the applications, however, the heating medium flows through a conductor and it is essential to provide a suitable flow control to initiate and terminate the flow of the medium. Heretofore the operation of the flow control device has been effected by a system which generally includes a timing device which is capable of actuating the flow control device for a predetermined period of time after which the flow control device is made inoperative to terminate the defrosting operation.

The handicap of this prior art arrangement has been that the layer of frost accumulated on the cold diffuser would vary in depth depending on the moisture content of the air coming into contact with the cold diffuser and which might result from variation in the moisture content of materials maintained within a storage space in which the cold diffuser is situated. Thus the timing mechanisms used in the prior art were not effective to adjust the defrosting period in accordance with the variation of the thickness of the frost layer. While it is true that most timing mechanisms heretofore provided were of an adjustable character, such adjustment depending on manual setting, and not infrequently the operator would not be able to gage the correct period of time required for defrosting. Furthermore, such arrangements are not of an entirely automatic nature and would require continuous manual adjustment. Thus according to the prior art practice the setting of the defrosting timer was either inadequate to provide for

2 the complete removal of the frost, or else the defrosting period was permitted to extend for a period of time which was greater than was actually necessary to completely remove the frost. This latter condition is the one which must be most carefully guarded against because it can be extremely harmful, particularly when the cold diffuser is used in conjunction with a storage space in which perishable products such as severely frozen foods are stored. This is true because if the cold diffuser is heated after the frost has been removed and even for a moderate length of time, it will heat the storage space to the extent of thawing or even partially thawing the perishable products which will depreciate the natural flavor and the keeping qualities of such products even though the temperature may still be in the range immediately below the freezing temperature of water. Recent tests have established that severely frozen foods which are normally maintained at temperatures of 0° F. or lower are damaged in their taste, keeping qualities and possibly in their vitamin content, if during storage the temperature of the products is permitted to rise to as much as 20° F. Thus the important feature in regulating the defrosting of cold diffusers by the use of a heating medium is to terminate the flow of heating medium to the diffuser immediately after the frost has been removed so that the diffuser will not radiate heat to raise the temperature of the surrounding space.

The invention disclosed in this application is a modification of the disclosure shown in the co-pending application of Frederick M. Jones, Ser. No. 758,053, now United States Patent No. 2,509,099, granted May 23, 1950, which is assigned to the present assignee.

In the present disclosure a more or less conventional timing device through the medium of a momentarily closed switch, initiates the operation of the flow control device and also sets up a holding circuit which maintains the flow control device in an operative condition to bring about defrosting. A normally closed switch which is opened by a temperature sensitive portion is provided in the circuit and this switch responds to the temperature of the diffuser to open the circuit to the flow control device when the temperature of the diffuser rises following the removal of the accumulated frost layer.

The principal object of this invention is to provide suitable defrosting control for a cold diffuser which is capable of periodically initiating a defrosting operation and thereafter terminating the defrosting operation substantially imme-

diately after the removal of the accumulated frost and without regard to the length of time required for the defrosting operation to occur.

Another object is to provide a simple electrical control system for supervising the operation of a defrosting control device, which regulates the flow of an energy transferring medium to a cold diffuser, in which the control device is made operative by the momentary closure of a normally open switch, and is terminated by the opening of a normally closed switch whose action is responsive to the temperature of the diffuser.

A further object is to provide a control system for a defrosting control device which includes a control circuit that is energized by a first switch in the circuit which establishes a holding circuit that is broken by the opening of a normally closed switch in the circuit which is responsive to a rise of temperature adjacent the cold diffuser when the frost accumulation has been removed from the latter by the application of heat.

Other and further objects may become apparent from the following description and claims, and in the appended drawings in which:

Fig. 1 is a schematic showing of one form of refrigeration system with which the present invention is adapted for use in controlling the defrosting of a cold diffuser; and,

Fig. 2 is a schematic diagram of a control system forming the present invention.

Referring now to the drawings and particularly to Fig. 1, is shown one form of refrigeration system to which the present invention applies. Reference numeral 10 indicates a conventional compressor which is driven by a prime mover 12. The prime mover 12 may be either an electric motor or an internal combustion engine, and its operation is independent of other portions of the system. While not shown, the prime mover 12 will generally be operated by control means which respond to a condition within an enclosed space whose temperature is to be controlled and, therefore, the prime mover will operate intermittently to maintain a substantially constant condition.

Extending from the high pressure side of compressor 10 is a conduit 14 which is joined to the upper end of a condenser 16. At its lower end condenser 16 is joined by a conduit 18 which extends to one side of a refrigerant receiver 20. Extending from the other side of receiver 20 is a conduit 22 which is joined to the lower end of an evaporator 24. Mounted in conduit 22 is a conventional expansion valve 26 whose operation is controlled by a thermostatic bulb 28. Extending from the upper end of evaporator 24 is a conduit 30 which at its other end is joined to a manifold 32 on the low pressure side of compressor 10.

Extending from a T 34 in conduit 14 is a conduit 36 which at its other end is joined to a T 38 connected in the evaporator 24. Mounted in conduit 36 is a flow control device or valve 40 whose operation is controlled by a motorizing mechanism 42, hereinafter disclosed as a solenoid operator.

A control box indicated at 44 contains the necessary mechanism for operating the motorizing portion 42 of valve 40 through a pair of conductors 46, 48. A thermostatic bulb 50, having a connected tube 51 which extends to the control box 44, is supported on fins 52 which are secured to the outer surface of the evaporator 24 so that in effect bulb 50 is in thermal contact with evaporator 24.

Referring now to Fig. 2 is schematically shown the control circuit, the major portion of which is normally contained within the control box 44, shown in Fig. 1, together with valve 40 and its motorizing portion 42. A timing device indicated at 54 has connected thereto a rotating switch member 56 which is adapted on rotation to engage a stationary contact member 58. The parts just described may take any one of a number of forms wherein after the passage of a predetermined period of time the movable switch 56 is suitably brought into engagement with the fixed contact 58, and it should be understood that the movable switch 56 may be adjustably positioned with respect to the timing mechanism 54 so as to engage the fixed contact 58 at regular predetermined intervals and there may, if necessary, be one or more of the movable members 56 which will engage the fixed contact 58 at predetermined intervals even though these intervals be less than twelve or twenty-four hours in which the normal clock mechanism will make a complete rotation. As here shown, the timing device is actuated by a motor 60.

Reference characters L₁ and L₂ are line conductors extending from a conventional source of power, not shown. A conductor 62 extends from conductor L₂ to the moving switch contact 56. A conductor 64 extends from conductor L₂ to one side of motor 60 and conductor 66 extends from the other side of motor 60 to conductor L₁ to provide for the operation of the electric motor 60.

A conductor 68 extends from the fixed contact 58 through a junction 70 to a contact 72. A conductor 74 extends from a contact 76 to the line conductor L₂. A conductor 78 extends from junction 70 to a movable switch blade 80 which supports a contact 82 that is adapted to normally engage a fixed contact 84. A conductor 86 extends from stationary contact 84 through an induction coil 88 of a relay indicated at 90. From the other end of the induction coil 88 a conductor 92 extends to the line conductor L₁. Relay 90 carries an armature controlled switch 94 which when the induction coil 88 is energized engages the contacts 72, 76. Extending from a junction 96 on conductor 86 is a conductor 45 which connects to an induction coil 100 heretofore designated as the motorizing portion 42 of the valve 40, shown in Fig. 1. A conductor 48 extends from the other side of the induction coil 100 to the line conductor L₁.

The movable switch 80 is connected to a bracket 104. On one side of the switch 80 is a coil spring 106 which is adapted to resiliently hold contact 82 in engagement with contact 84. A bellows 108 is mounted on the other side of switch 80 and is connected through tube 51 to the thermostatic bulb 50, being the same which is shown in Fig. 1. While switch 80 is here shown as being actuated by an independent fluid thermostat, the switch may be composed of a bimetallic element contained within a cartridge-like casing.

The operation of the refrigeration system shown in Fig. 1 is conventional but for a further understanding, the evaporator 24, which may be regarded as a cold diffuser, would normally be situated within an enclosed space whose temperature is to be controlled. The prime mover 12 will, through control means not shown, be responsive to the condition within the enclosed space in which the cold diffuser is mounted and such control means will periodically call for the

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operation of the prime mover in order to maintain the temperature within the enclosed space substantially constant. The refrigeration circuit is also conventional to the extent that liquid refrigerant within the receiver 20 and whose level is indicated by a dotted line, will flow through the conduit 22 to the lower side of evaporator 24. The actual flow of refrigerant liquid into the evaporator is controlled by the expansion valve 26 whose operation is controlled by the thermostatic bulb 28 in contact with the conduit 30.

In general practice the evaporator will be filled with liquid refrigerant to about one-third of its capacity, which liquid is vaporized by heat, and the reduced pressure maintained by the compressor. The vaporized refrigerant passes off through the conduit 30 to the header 32 on the low pressure side of the compressor. On entering the compressor the vapors are compressed and forced out through conduit 14 to the condenser 16 from whence the condenser vapors will return to the receiver 20.

To effect defrosting of the evaporator or cold diffuser 24, valve 40 is opened by its motorizing mechanism 42 to permit hot gases from the high pressure side of the refrigerant system to flow from T 34 through the conduit 36 and T 38 into evaporator 24. In practice, the prime mover 12 will be operating during the defrosting operation because the evaporator will very likely be coated with a sufficient layer of frost so as to insulate the diffuser from the enclosed space to such an extent that the refrigerating needs of the enclosed space will require operation of the prime mover.

Referring now to Fig. 2, the moving contact 56 will be adjustably mounted with respect to the timing device 54 so as to bring about a defrosting operation after a predetermined period of time from the last defrosting operation. Assuming now that the movable switch 56 has engaged contact 58, a circuit will be established which may be traced as follows. From the conductor L₂ through conductor 62, switch 56, contact 58, conductor 68 to junction 70, thence through conductor 78 to switch 80, and thence through the closed contacts 82, 84 and the conductor 86 to the junction 96, thence through the induction coil 88 and conductor 92 to the line conductor L₁. Current will also flow from junction 96 through the conductor 46 and induction coil 100 into conductor 48 to the line conductor L₁. This will complete a circuit to cause simultaneous closing of the relay 90 and opening of the motorizing portion 42 of the valve 40. When relay 90 is energized, the armature connected switch 94 engages the contacts 76, 72 to establish a holding circuit which may be traced as follows. From the line conductor L₂ through conductor 74 to contact 76, thence through switch 94 to the contact 72, and thence through conductor 68 to junction 70. From junction 70 current will flow through the conductor 78, switch 80, contacts 82, 84, conductor 86 to and through the induction coils 88 and 100 and thence to the line conductor L₁ through conductors 92 and 48. The last named circuit is a holding circuit because the movable switch 56 will only make a momentary brushing engagement with the stationary contact 58 and as the timing device 54 continues its operation the circuit will be broken through the switch 56, 58 so that the holding circuit through relay 90 maintains the motorizing device 42 of valve 40 in operative condition. While the diffuser 24 is coated with frost, the thermostatic

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bulb 50 will reflect a cold condition and the bellows 108 will be deflated, however, when the frost is removed from the diffuser 24 as by melting, the bulb 50 will immediately respond to a rise in temperature of the diffuser which is occasioned by the hot gas that is entering the diffuser through T 38. The rise in temperature of the diffuser will cause the fluid system within the thermostat to effect expansion of the bellows 108 against spring 106 to move the switch blade 80 upwardly to break engagement between the normally closed contacts 82, 84. When these contacts are opened, the circuit to and through the induction coils 88 and 100 will be broken, and this is equally applicable to the initial circuit established through contacts 56, 58 or through the holding circuit which includes the relay 90. Thus, if at the time that defrosting would normally occur by reason of engagement of contacts 56, 58, there is little or no need for defrosting, the thermostatic device will quickly respond to a rise in temperature in the diffuser to break the defrosting circuit. Whereas if a heavy coating of frost has been established on the diffuser, the thermostatic device will not respond to a change of conditions until all of the frost has been removed from the outer surface of the diffuser.

The advantages of the present invention reside in providing a simple circuit for controlling the operation of a flow control device wherein a holding circuit is established after a normally open switch is momentarily closed and wherein the holding circuit which operates the control device is broken by a normally closed thermostatic switch which is also in the circuit. By this simple arrangement variations in the thickness of the layer of frost on the diffuser will have no effect and need not be compensated for by adjustment of the timing means. The circuit will always be broken as soon as a slight rise in temperature occurs at the diffuser, which will follow removal of the frosted layer. Under these circumstances the diffuser will not radiate damaging heat into the enclosed space since the normal refrigerant fluid circuit will again be established as soon as the flow control device is closed and the diffuser will again be rapidly cooled by evaporation of refrigerant fluid.

My invention is defined in the terms of the appended claims.

I claim:

1. A system for controlling the operation of a defrosting control device, comprising a first circuit including a motor operatively connected to the control device and which when energized activates the control device to initiate defrosting of a cold diffuser, a source of power, a normally closed switch in the circuit between the source of power and the motor, a normally open switch in the circuit between the source of power and said first named switch, said second named switch which when closed being effective to energize said motor, a relay solenoid in said circuit which is energized simultaneously with the motor and concurrently closes a pair of relay contacts, and a second circuit including the source of power, said relay contacts, said first named switch, the relay solenoid and said motor, said second circuit being effective to maintain energization of the motor independent of the second named switch, said first named switch on opening being effective to de-energize either of said circuits.

2. A system for controlling the operation of a defrosting control device, comprising a first circuit including a motor operatively connected to

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the control device and which when energized activates the control device to initiate defrosting of a cold diffuser, a source of power, a normally closed switch in the circuit between the source of power and the motor, a normally open switch in the circuit between the source of power and the first named switch, said second named switch which when closed being effective to energize said motor, a relay solenoid in said circuit which is energized simultaneously with the motor and concurrently closes a pair of relay contacts, a second circuit including the source of power, contacts of said relay, said first named switch, said relay solenoid and said motor, said second circuit being effective to maintain energization of the motor independent of the second named switch, and temperature responsive means operatively connected to said first named switch being effective to open said switch and de-energize either of said circuits to terminate operation of the control device.

3. A system for controlling the operation of a defrosting control device, comprising a first circuit including a motor operatively connected to the control device and which when energized activates the control device to initiate defrosting of a cold diffuser, a source of power, a normally closed switch in the circuit between the source of power and the motor, a normally open switch in the circuit between the source of power and said first named switch, said second named switch which when closed being effective to energize said

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motor, timing means operatively associated with said second named switch being effective to momentarily close the second named switch and thereafter move the same to an open position, a relay solenoid in said circuit which is energized simultaneously with the motor and concurrently closes a pair of relay contacts, a second circuit including the source of power, said relay contacts, said first named switch, the relay solenoid and said motor, said second circuit being effective to maintain energization of the motor after the timing means has again opened the second named switch, and temperature responsive means operatively connected to said first named switch being effective to open said switch to de-energize either of said circuits in response to a change of temperature.

MYER S. SUTTON.

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