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A. B. NEWTON

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REFRIGERATION CONTROL SYSTEM

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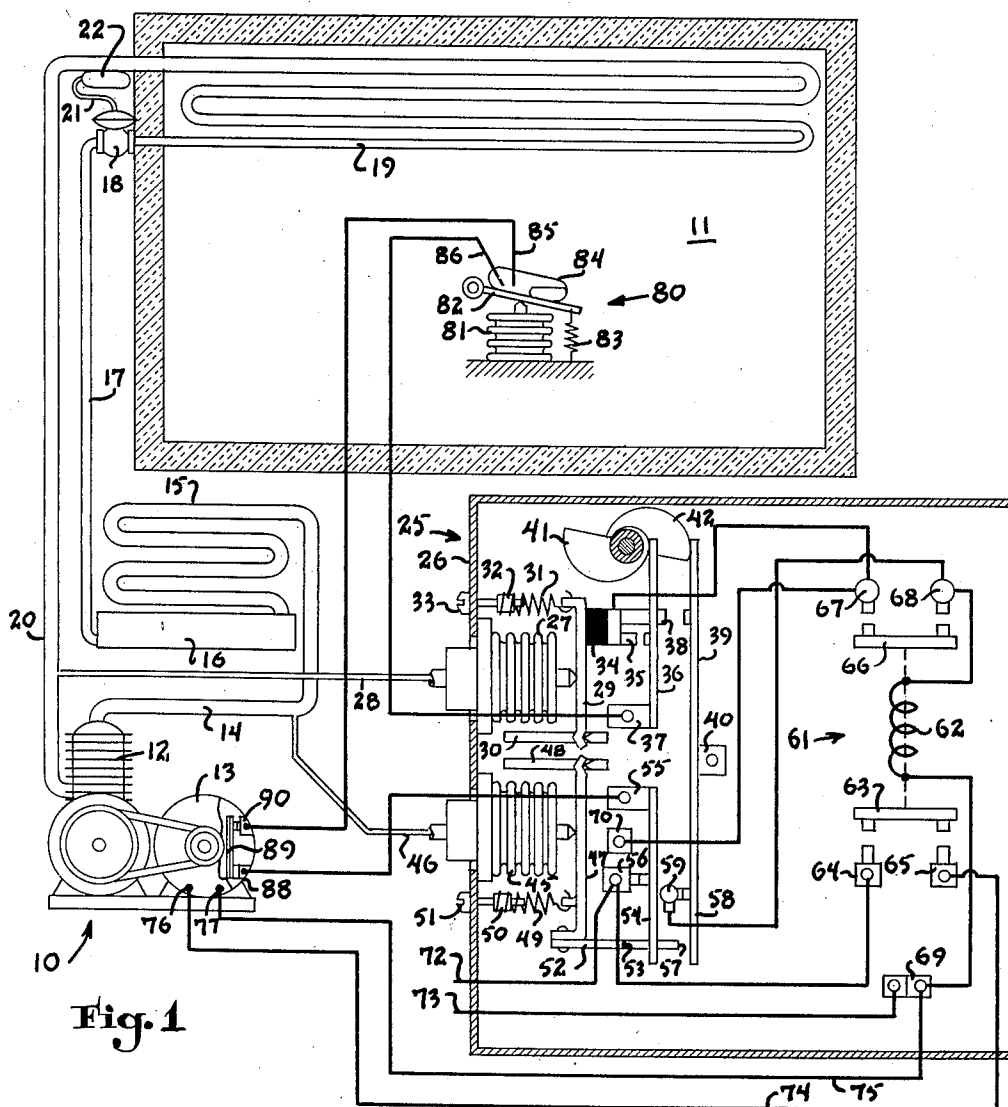


Fig. 1

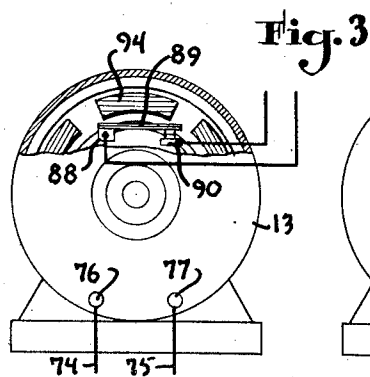


Fig. 3

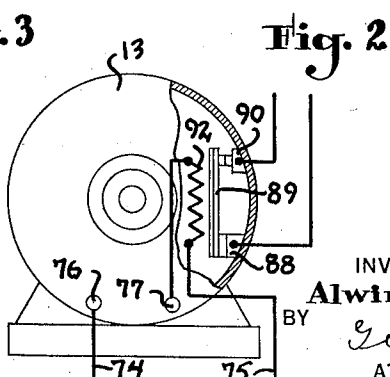


Fig. 2

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2,200,477

REFRIGERATION CONTROL SYSTEM

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Application March 17, 1938, Serial No. 196,451

18 Claims. (Cl. 62-4)

This invention relates to control systems for mechanical refrigerating apparatus and more particularly to such a control system embodying an overload cut-out operated upon overloading of the compressor motor.

In conventional refrigerating systems it has been impractical in the past to utilize an automatic resetting overload cut-out. For example, in a refrigerating control system having switching means operated in response to changes in temperature, suction pressure and high pressure and an automatic resetting overload cut-out in series therewith it has been found that (1) the compressor may be caused to cycle on and off on the overload cut-out with the evaporator temperature below freezing whereby frost continually builds up on the evaporator in greater and greater amounts which greatly decreases the cooling effect of the evaporator and hence the efficiency of the refrigerating apparatus, (2) the overload cut-out may be caused to stop the compressor upon the occurrence of high head pressures and if automatic in operation it may try to restart the compressor against the high head pressure conditions with the result that an extremely high starting torque is placed on the motor to again trip the overload cut-out, this operation, which may continue indefinitely, being extremely detrimental to the compressor motor, and (3) unless the automatic resetting overload cut-out is of the snap action type there will be a rapid succession of starting and stopping of the compressor which needless to say is also extremely detrimental to the compressor motor. To eliminate these difficulties manually reset overload cut-outs have been resorted to which must necessarily require personal attention.

It is therefore the prime object of this invention to provide a control system embodying an automatic resetting overload cut-out for a mechanical refrigerating apparatus which obviates the above objections.

In carrying out this invention it is contemplated to utilize a refrigeration control apparatus which may be of the type shown and described in application Serial Number 196,447 filed by Albert L. Judson and Carl G. Kronmiller on March 17, 1938, in combination with an automatic resetting overload cut-out. In this Judson and Kronmiller apparatus there is provided a starter or relay for controlling the operation of the compressor motor, the starter or relay having a control circuit including switching means operated in response to variations in suction or low pressure and high or head pressure, the arrangement being such that when the relay or starter is dropped out to stop the compressor motor, it cannot again be pulled in to start the compressor motor until the suction or low pressure has increased to a predetermined high value indicative of defrosting

and until the high or head pressure has decreased to a predetermined low value which will impose a minimum starting torque on the compressor motor. By locating an automatic resetting overload cut-out in the control circuit thereof the above outlined difficulties are obviated.

Accordingly, a more specific object of this invention is to provide a control system for a mechanical refrigerating apparatus embodying an automatic resetting overload cut-out in combination with a control apparatus which prevents starting of the compressor until defrosting has occurred and until the high or head pressure decreases to a minimum whereby (1) upon the occurrence of an overload condition the compressor motor cannot be restarted until defrosting of the evaporator has occurred whereby building up of frost on the evaporator with consequent decrease in efficiency of the refrigerating apparatus is prevented, (2) upon the occurrence of an overload condition the compressor motor cannot be restarted until the high or head pressure decreases to a minimum whereby the starting torque is decreased to a minimum which eliminates one of the main causes of overload shut-downs, and (3) rapid succession of starting and stopping of the compressor motor are entirely eliminated and the use of snap action overload cut-outs is not required.

Another object of this invention is to locate the overload cut-out of this invention in the compressor motor so that the rate of cooling or resetting of the same will be in accordance with the temperature of the compressor motor.

Other objects and advantages will become apparent to those skilled in the art upon reference to the accompanying specification, claims and drawing, in which

Figure 1 diagrammatically discloses one form of this invention.

Figure 2 is a diagrammatic illustration of a form of automatic resetting overload cut-out which may be substituted for that of Figure 1.

Figure 3 is a diagrammatic illustration of still another form of automatic resetting overload cut-out which may also be substituted for that shown in Figure 1.

Referring now to Figure 1, a mechanical refrigerating apparatus is generally designated at 10 for maintaining a desired condition in a space 11. The space 11 may be a walk-in box, a storage compartment, or any other space the condition of which is to be controlled. The mechanical refrigerating apparatus may comprise a compressor 12 operated by an electric motor 13. Refrigerant is compressed in the compressor 12 and passed through a high pressure line 14 to a condenser 15 where it is condensed. The condensed refrigerant passes from the condenser 15 into a receiver 16 and from there through a

liquid line 17 and an expansion valve 18 into an evaporator 19 located in the space 11. The refrigerant is expanded in evaporator 19 and is withdrawn therefrom by the compressor 12 through a suction line 20. The expansion valve 18 is shown for purposes of illustration to be a thermostatic expansion valve having a capillary tube 21 connected to a bulb 22 containing a volatile fluid and located at the discharge side of the evaporator 19.

The compressor motor 13 may be controlled by a unitary control arrangement generally designated at 25 which may be of the type shown and described in the above referred to Judson and Kronmiller application. This unitary control arrangement may comprise a base or casing 26 in which is mounted a bellows 27 connected by a pipe 28 to the suction or low pressure line 20. The bellows 27 operates a lever 29 pivoted on a fulcrum member 30 against the action of a tension spring 31. One end of the tension spring 31 is connected to the lever 29 and the other is connected to a nut 32 screw threadedly mounted on a screw 33. By rotating the screw 33 the tension of the spring 31 may be varied and hence the pressure setting of the bellows 27 may be adjusted at will. Lever 29 carries an insulating pad 34 upon which is mounted a contact 35 adapted to engage a contact member 36 suitably anchored to terminal 37 and a contact 38 adapted to engage a contact member 39 suitably secured to a terminal 40. The contact members 36 and 39 are adapted to be independently positioned by means of concentrically located cams 41 and 42. For purposes of illustration, it is assumed that the cams 41 and 42 are so adjusted that the contact 35 engages the contact member 36 when the suction pressure rises to 15 lbs. and that the contact 38 engages the contact member 39 when the suction pressure rises to a higher value of say 35 lbs., this value corresponding to the defrosting temperature of the evaporator. Hence the contact 38 can engage the contact member 39 only after defrosting of the evaporator 19 has occurred.

Also mounted in the casing 26 is a bellows 45 connected by a pipe 46 to the high pressure line 14 of the mechanical refrigerating apparatus. The bellows 45 operates a lever 47 fulcrumed on a fulcrum member 48 against the action of a tension spring 49. One end of the tension spring 49 is connected to the lever 47 and the other end is connected to a nut 50 screw threadedly mounted on a screw 51. By rotating the screw 51 the tension of the spring 49 is varied and hence the pressure setting of the bellows 45 may be adjusted at will. Lever 47 carries an abutment member 52 having an abutment surface 53 adapted to engage contact member 54 suitably mounted on a terminal 55. The contact member 54 engages and disengages a contact terminal 56. The abutment member 52 is also provided with an abutment surface 57 which is adapted to engage a contact member 58 also secured at terminal 40. Contact member 58 is adapted to engage and disengage a contact post 59. For purposes of illustration, it is assumed that the parts are so arranged that the contact member 58 and the contact post 59 engage and disengage at a head pressure of substantially 130 lbs. and that the contact member 54 and the contact terminal 56 engage and disengage at a head pressure of substantially 180 lbs.

The unitary control arrangement 25 also includes a relay or starter generally designated at

61 which may comprise an operating coil 62 for operating a bridge member 63 with respect to contact terminals 64 and 65 and for operating a bridge member 66 with respect to contact posts 67 and 68. When the operating coil 62 is energized the bridge member 63 is moved into engagement with the contact terminals 64 and 65 and the bridge member 66 is moved into engagement with the contact posts 67 and 68. When the operating coil 62 is deenergized, the bridge members 63 and 66 are moved out of engagement with their respective contacts by means of springs, gravity, or other means, not shown. The unitary control arrangement 25 is also provided with a load terminal 69 and a control terminal 70 which is electrically connected to the contact post 67. In this instance the control terminal 70 is not utilized.

Power is supplied to the compressor motor 13 and to the control apparatus by means of line wires 72 and 73 extending from some source of power, not shown, to the contact terminal 56 and to the load terminal 69 respectively. The compressor circuit includes conductors 74 and 75 extending from the contact terminal 65 and load terminal 69 to the compressor motor terminals 76 and 77 respectively.

For purposes of maintaining substantially constant conditions within the space 11, such as temperature conditions, a temperature controller responding to variations in space temperature is generally designated at 80. This temperature controller 80 may comprise a bellows 81 containing a volatile fluid for operating a lever 82 against the action of a tension spring 83. The lever 82 operates a mercury switch 84 having electrodes 85 and 86. The arrangement is such that when the temperature of the space 11 increases the bellows 81 expands to cause the mercury of the mercury switch 84 to bridge the electrodes 85 and 86, and upon a decrease in temperature the mercury is caused to separate from the electrodes 85 and 86. By suitably adjusting the tension in the spring 83 the temperature setting of the temperature responsive controller 80 may be adjusted at will. For purposes of illustration, it is assumed that the switch 84 is closed when the space temperature rises to 40° and is opened when the space temperature decreases to 38°.

The automatic resetting overload cut-out is shown to be located in the compressor motor 13 so as to be influenced by the temperature thereof. This overload cut-out means may comprise a terminal 88 upon which is mounted a bimetallic element 89 for opening and closing contacts 90. Upon the occurrence of an overload condition, the bimetallic element 89 is flexed to the left to separate the contacts 90 and when the overload condition has ceased to exist, the bimetallic element 89 moves to the right to re-close the contacts 90.

With the parts in the position shown in the drawing, the relay or starter 61 is deenergized and the compressor motor 13 is not operating. As a result, the suction pressure increases as does the space temperature and the head pressure decreases. When the space temperature rises to 40°, the suction pressure rises to 35 lbs. and the head pressure decreases to 130 lbs., a circuit is completed from the line wire 72 through contact terminal 56, contact member 54, terminal 55, terminal 88, bimetallic element 89 and contacts 90 of the overload cut-out, electrodes 85 and 86 of the temperature responsive controller 80, ter-

minal 37, contact member 36, contacts 35 and 38, contact member 39, contact member 58, contact post 59, contact post 68, operating coil 62 and terminal 69 back to the other line wire 73. Completion of this circuit causes energization of the operating coil to move the bridge member 63 into engagement with the contact terminals 64 and 65 and to move the bridge member 66 into engagement with the contact posts 67 and 68.

10 Movement of the bridge member 63 into engagement with the contact terminals 64 and 65 completes a load circuit for the compressor from the line wire 72 through contact terminal 56, contact terminal 64, bridge member 63, contact terminal 65, wire 74, compressor motor terminals 76 and 77, wire 75 and terminal 69 back to the line 73. Accordingly, when the operating coil 62 is energized the compressor motor 13 is placed in operation.

20 Upon movement of the bridge member 66 into engagement with the contact posts 67 and 68 as a result of energization of the operating coil 62, a maintaining circuit is completed from the line wire 72 through contact terminal 56, contact member 54, terminal 55, terminal 68, bimetallic element 89 and contacts 90 of the overload cut-out, electrodes 85 and 86 of the temperature responsive controller 80, terminal 37, contact member 36, contact 35, contact post 67, bridge member 66, contact post 68, operating coil 62 and terminal 69 back to the other line wire 73. Completion of this circuit maintains the relay or starter 61 energized and hence maintains the compressor motor 13 in operation even though the suction pressure decreases below 35 lbs. and the high pressure increases above 130 lbs.

If now either the space temperature decreases to 38°, the suction pressure decreases to 15 lbs., the high pressure increases to 130 lbs., or an overload condition occurs in the compressor motor 13, the relay or starter 61 is deenergized to stop operation of the compressor motor 13. The compressor motor then cannot be restarted until the above referred to starting circuit is completed, which can occur only when the suction pressure rises to a defrosting value of 35 lbs. and the high pressure decreases to a predetermined low value of 130 lbs. In other words, the compressor may not be restarted after a shut-down until the evaporator 19 has defrosted and until the high pressure has decreased to 130 lbs.

Assume that the temperature responsive controller 80 is calling for cooling and that the compressor motor 13 is operating. If an overload condition occurs in the compressor motor 13 the relay or starter 61 is deenergized since the overload cut-out is included in both the starting and maintaining circuits. When the overload condition no longer occurs the contacts 90 of the overload cut-out remake but the compressor cannot again be placed in operation until the suction pressure has increased to the defrosting value of 35 lbs. and the high pressure has decreased to the predetermined low value of 130 lbs. As a result, cycling of the compressor on the overload cut-out regardless of evaporator temperature cannot occur since the compressor motor 13 cannot be restarted until the evaporator 19 has defrosted. Accordingly, the building up of large amounts of frost on the evaporator 19 is entirely prevented. Also, when the load condition no longer occurs the compressor motor 13 cannot be placed in operation until the head pressure has decreased to a predetermined low value of

130 lbs. whereby the compressor cannot be restarted against a high head pressure. Since the starting of the compressor against a high head pressure is one of the main causes of overload conditions, this condition is entirely eliminated which makes feasible the use of an automatic resetting overload cut-out.

Since following the occurrence of an overload condition the compressor motor 13 cannot be restarted until the suction pressure has increased to a predetermined high value and the head pressure has decreased to a predetermined low value, rapid cycling of the compressor motor 13 by the making and breaking of contacts 90 of the overload cut-out cannot occur and hence the necessity of a snap action type overload cut-out is not required. Accordingly, a simple overload cut-out of the automatic resetting type may be utilized without any danger of short cycling of the compressor motor 13.

Preferably the automatic resetting overload cut-out is included in the compressor motor casing so that it will be influenced by the temperature of the compressor motor 13. Compressor motors are usually provided with air circulating means for cooling the same during operation thereof. When an overload condition occurs during operation so as to open the overload cut-out and stop the compressor motor, the air circulating means also stops and the temperature of the compressor motor increases to insure that the cut-out remains open for a given time interval until the compressor motor temperature decreases to a safe operating value. This further prevents short-cycling of the compressor motor by the overload cut-out and also eliminates the necessity of snap action overload cut-outs.

Various types of automatic resetting overload cut-outs may be utilized, such as those shown in Figures 1, 2 and 3. In Figure 1 the overload cut-out responds solely to compressor motor temperature. In Figure 2 the overload cut-out is not only responsive to compressor motor temperatures but is also controlled by the current flow through the compressor motor. In this connection, a heater 92 may be connected between the motor terminal 77 and the wire 75 to additionally heat the thermostatic element 89 of the overload cut-out. With such an arrangement, the overload cut-out may be made more responsive to instantaneous overload conditions, the thermostatic element 89 being additionally heated by the heater element 92.

In Figure 3 is shown another type of overload cut-out arrangement wherein the thermostatic element 89 may additionally be heated by inductance from the motor windings 94. The motor windings 94 usually extend outwardly from the core of the motor and by locating the thermostatic element 89 adjacent these windings an induced current is caused to take place in the thermostatic element 89 which heats the same in accordance with the value of the current passing through the motor windings. Accordingly, here as in the modification shown by Figure 2 the thermostatic element 89 of the overload cut-out is additionally heated in accordance with the current flow through the compressor motor.

From the above it is seen that I have provided a control system for a mechanical refrigerating apparatus embodying an automatic resetting overload cut-out in combination with a control apparatus which prevents starting of the compressor until defrosting has occurred and until the high or head pressure decreases to a

minimum value whereby (1) upon the occurrence of an overload condition the compressor motor cannot be restarted until defrosting of the evaporator has occurred, whereby building up of frost on the evaporator with consequent decrease in efficiency of the refrigerating apparatus is prevented, (2) upon the occurrence of an overload condition the compressor motor cannot be restarted until the high or head pressure decreases to a minimum whereby the starting torque is decreased to a minimum, which eliminates one of the main causes of overload shut-downs, and (3) rapid successions of starting and stopping of the compressor motor are entirely eliminated and the use of snap action overload cut-outs is not required.

Although for purposes of illustration one form of this invention has been disclosed, other forms thereof may become apparent to those skilled in the art upon reference to this disclosure and therefore this invention is to be limited only by the scope of the appended claims and prior art.

I claim as my invention:

1. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, comprising in combination, control means for starting and stopping the compressor motor, automatic resetting overload cut-out means for stopping the compressor motor and operated by an overload condition of the compressor motor and which allows restarting of the compressor motor when the overload condition no longer exists, and means responsive to a condition resulting from the presence of frost on the evaporator for preventing starting of the compressor motor until defrosting has been substantially completed whereby cycling of the compressor motor by the automatic resetting overload cut-out means with consequent continued building up of frost on the evaporator is prevented.

2. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, comprising in combination, control means for starting and stopping the compressor motor, automatic resetting overload cut-out means for stopping the compressor motor and operated by an overload condition of the compressor motor and which allows restarting of the compressor motor when the overload condition no longer exists, and means responsive to variations in suction pressure of the refrigerating apparatus for preventing starting of the compressor motor until the suction pressure has risen to a value such that defrosting of the evaporator has occurred whereby cycling of the compressor motor by the automatic resetting overload cut-out means with consequent continued building up of frost on the evaporator is prevented.

3. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, comprising in combination, control means for starting and stopping the compressor motor, automatic resetting overload cut-out means for stopping the compressor motor and operated by an overload condition of the compressor motor and which allows restarting of the compressor motor when the overload condition no longer exists, and means responsive to variations in a condition which is a measure of head pressure on the high pressure side of the refrigerating apparatus for preventing starting

of the compressor motor until the head pressure has decreased to a predetermined low value whereby the automatic resetting overload cut-out means cannot restart the compressor motor against a high head pressure.

4. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, comprising in combination, control means for starting and stopping the compressor motor, automatic resetting overload cut-out means for stopping the compressor motor and operated by an overload condition of the compressor motor and which allows restarting of the compressor motor when the overload condition no longer exists, means responsive to a condition resulting from the presence of frost on the evaporator for preventing starting of the compressor motor until defrosting has been substantially completed whereby cycling of the compressor motor by the automatic resetting overload cut-out means with consequent continued building up of frost on the evaporator is prevented, and means responsive to variations in a condition which is a measure of head pressure on the high pressure side of the refrigerating apparatus for preventing starting of the compressor motor until the head pressure has decreased to a predetermined low value whereby the automatic resetting overload cut-out means cannot restart the compressor motor against a high head pressure.

5. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, comprising in combination, control means for starting and stopping the compressor motor, automatic resetting overload cut-out means for stopping the compressor motor and operated by an overload condition of the compressor motor and which allows restarting of the compressor motor when the overload condition no longer exists, means responsive to variations in suction pressure of the refrigerating apparatus for preventing starting of the compressor motor until the suction pressure has risen to a value such that defrosting of the evaporator has occurred whereby cycling of the compressor motor by the automatic resetting overload cut-out means with consequent continued building up of frost on the evaporator is prevented, and means responsive to variations in head pressure on the high pressure side of the refrigerating apparatus for preventing starting of the compressor motor until the head pressure has decreased to a predetermined low value whereby the automatic resetting overload cut-out means cannot restart the compressor motor against a high head pressure.

6. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, comprising in combination, control means for starting and stopping the compressor motor, automatic resetting overload cut-out means for stopping the compressor motor and operated by an overload condition of the compressor motor and which allows restarting of the compressor motor when the overload condition no longer exists, and means responsive to variations in suction pressure and head pressure of the refrigerating apparatus for preventing starting of the compressor motor until the differential between suction pressure and head pressure has decreased to at least a predetermined minimum

whereby the automatic resetting overload cut-out means cannot restart the compressor motor until the starting torque has been reduced to or below a predetermined minimum.

5 7. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, comprising in combination, control means for starting and stopping the compressor
10 motor, automatic resetting overload cut-out means located in the compressor motor so as to be influenced by the temperature thereof for stopping the compressor motor when an overload condition of the compressor motor occurs
15 and allowing restarting of the compressor motor when the temperature thereof decreases to a predetermined value, and means responsive to a condition resulting from the presence of frost on the evaporator for preventing starting of the
20 compressor motor until defrosting has been substantially completed whereby cycling of the compressor motor by the automatic resetting overload cut-out means with consequent continued building up of frost on the evaporator is prevented.

25 8. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, comprising in combination, control means for
30 starting and stopping the compressor motor, automatic resetting overload cut-out means located in the compressor motor so as to be influenced by the temperature thereof for stopping the compressor motor when an overload condition
35 of the compressor motor occurs and allowing restarting of the compressor motor when the temperature thereof decreases to a predetermined value, and means responsive to variations in a condition which is a measure of head pressure
40 on the high pressure side of the refrigerating apparatus for preventing starting of the compressor motor until the head pressure has decreased to a predetermined low value whereby the automatic resetting overload cut-out means cannot
45 restart the compressor motor against a high head pressure.

50 9. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, comprising in combination, control means for starting and stopping the compressor motor,
55 automatic resetting overload cut-out means located in the compressor motor so as to be influenced by the temperature thereof for stopping the compressor motor when an overload condition of the compressor motor occurs and allowing
60 restarting of the compressor motor when the temperature thereof decreases to a predetermined value, and means responsive to variations in suction pressure and head pressure of the refrigerating apparatus for preventing starting of
65 the compressor motor until the differential between suction pressure and head pressure has decreased to at least a predetermined minimum whereby the automatic resetting overload cut-out means cannot restart the compressor motor until the starting torque is reduced to or below a predetermined minimum.

70 10. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, control means including means responsive to changes in a psychrometric condition in a space for starting and stopping the compressor
75 motor to maintain said condition in the space

within desired limits, automatic resetting overload cut-out means for stopping the compressor motor and operated by an overload condition of the compressor motor and which allows restarting of the compressor motor when the overload
5 condition no longer exists, and means responsive to a condition resulting from the presence of frost on the evaporator for preventing starting of the compressor motor until defrosting has been substantially completed whereby cycling of
10 the compressor motor by the automatic resetting overload cut-out means with consequent continued building up of frost on the evaporator is prevented.

15 11. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, control means including means responsive to changes in a psychrometric condition in a
20 space for starting and stopping the compressor motor to maintain said condition in the space within desired limits, automatic resetting overload cut-out means for stopping the compressor motor and operated by an overload condition of the compressor motor and which allows restarting
25 of the compressor motor when the overload condition no longer exists, and means responsive to variations in a condition which is a measure of head pressures on the high pressure side of the refrigerating apparatus for preventing
30 starting of the compressor motor until the head pressure has decreased to a predetermined low value whereby the automatic resetting overload cut-out means cannot restart the compressor motor against a high head pressure.

35 12. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, control means including means responsive to changes in a psychrometric condition in a
40 space for starting and stopping the compressor motor to maintain the condition in the space within desired limits, automatic resetting overload cut-out means for stopping the compressor motor and operated by an overload condition
45 of the compressor motor and which allows restarting of the compressor motor when the overload condition no longer exists, and means responsive to variations in suction pressure and head pressure of the refrigerating apparatus for
50 preventing starting of the compressor motor until the differential between suction pressure and head pressure has decreased to at least a predetermined minimum whereby the automatic resetting overload cut-out means cannot restart the
55 compressor motor until the starting torque is reduced to or below a predetermined minimum.

60 13. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, control means including means responsive to changes in a psychrometric condition in a space
65 for starting and stopping the compressor motor to maintain the condition in the space within desired limits, automatic resetting overload cut-out means located in the compressor motor so as to be influenced by the temperature thereof for stopping the compressor motor when an
70 overload condition occurs and allowing restarting of the compressor motor when the temperature thereof decreases to a predetermined value, and means responsive to a condition resulting from the presence of frost on the evaporator for preventing starting of the compressor motor until
75 defrosting has been substantially completed

whereby cycling of the compressor motor by the automatic resetting overload cut-out means with consequent continued building up of frost on the evaporator is prevented.

10 14. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, control means including means responsive to changes in a psychrometric condition in a space for starting and stopping the compressor motor to maintain the condition in the space within desired limits, automatic resetting overload cut-out means located in the compressor motor so as to be influenced by the temperature thereof for stopping the compressor motor when an overload condition occurs and allowing restarting of the compressor motor when the temperature thereof decreases to a predetermined value, and means responsive to variations in a condition which is a measure of head pressures on the high pressure side of the refrigerating apparatus for preventing starting of the compressor motor until the head pressure has decreased to a predetermined low value whereby the automatic resetting overload cut-out means cannot restart the compressor motor against a high head pressure.

30 15. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and a motor for operating the compressor, control means including means responsive to changes in a psychrometric condition in a space for starting and stopping the compressor motor to maintain the condition in the space within desired limits, automatic resetting overload cut-out means located in the compressor motor so as to be influenced by the temperature thereof for stopping the compressor motor when an overload condition occurs and allowing restarting of the compressor motor when the temperature thereof decreases to a predetermined value, and means responsive to variations in suction pressure and head pressure of the refrigerating apparatus for preventing starting of the compressor motor until the differential between suction pressure and head pressure has decreased to at least a predetermined minimum whereby the automatic resetting overload cut-out means cannot restart the compressor motor until the starting torque is reduced to at least a predetermined minimum.

16. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and an electric motor for operating the compressor, comprising in combination, a relay including an operating coil, a maintaining switch and a load switch for the compressor, the arrangement being such that when the operating coil is energized the maintaining switch and the load switch are closed, automatic resetting overload means including a first switching means and operable to open the same when an overload condition occurs in the compressor motor and to close the same when the overload condition no longer occurs, second switching means, means responsive to a condition resulting from the presence of frost on the evaporator for closing the second switching means when the evaporator has been substantially defrosted, a starting circuit for the operating coil of the relay including the first and second switching means for starting the compressor motor when both switching means are closed, and a maintaining circuit for the operating coil of the relay including the maintaining switch and the first switching means for

maintaining the compressor motor in operation, the arrangement being such that upon the occurrence of an overload condition the compressor motor cannot be restarted until defrosting of the evaporator has been substantially completed.

17. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and an electric motor for operating the compressor, comprising in combination, a relay including an operating coil, a maintaining switch and a load switch for the compressor, the arrangement being such that when the operating coil is energized the maintaining switch and the load switch are closed, automatic resetting overload means including a first switching means and operable to open the same when an overload condition occurs in the compressor motor and to close the same when the overload condition no longer occurs, second switching means, means responsive to a condition which is a measure of head pressure of the refrigerating apparatus for closing the second switching means when the head pressure decreases to a predetermined low value, a starting circuit for the operating coil of the relay including the first and second switching means for starting the compressor motor when both switching means are closed, and a maintaining circuit for the operating coil of the relay including the maintaining switch and the first switching means for maintaining the compressor motor in operation, the arrangement being such that upon the occurrence of an overload condition the compressor motor cannot be restarted until the head pressure decreases to the predetermined low value whereby starting of the compressor against high head pressure is prevented.

18. A control system for a mechanical refrigerating apparatus having an evaporator, a compressor and an electric motor for operating the compressor, comprising in combination, a relay including an operating coil, a maintaining switch and a load switch for the compressor, the arrangement being such that when the operating coil is energized the maintaining switch and the load switch are closed, automatic resetting overload means including a first switching means and operable to open the same when an overload condition occurs in the compressor motor and to close the same when the overload condition no longer occurs, second switching means, means responsive to variations in suction pressure for closing the second switching means when the suction pressure increases to a predetermined high value, third switching means, means responsive to variations in head pressure for closing the third switching means when the head pressure decreases to a predetermined low value, a starting circuit for the operating coil of the relay including the first, second and third switching means for starting the compressor motor when these switching means are closed, and a maintaining circuit for the operating coil of the relay including the maintaining switch and the first switching means for maintaining the compressor motor in operation, the arrangement being such that upon the occurrence of an overload condition the compressor motor cannot be restarted until the differential in pressure between the suction pressure and the head pressure decreases to or below a predetermined minimum.

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