May 25, 1937. E. J. DILLMAN 2,081,853

APPARATUS AND METHOD FOR CONTROLLING REFRIGERATION

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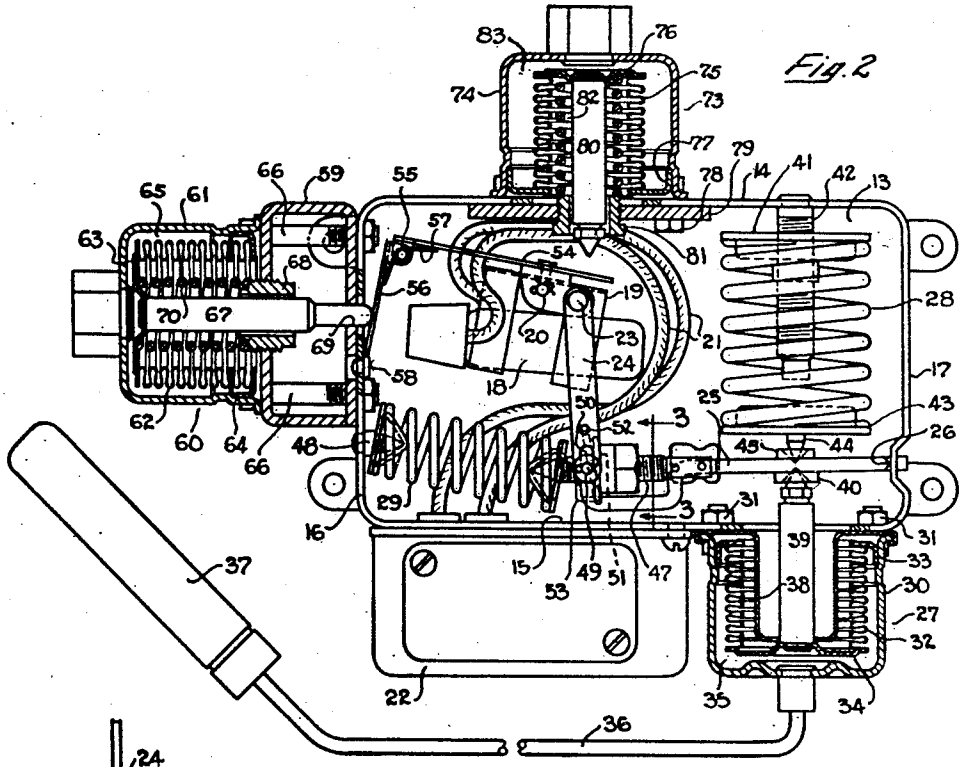


Fig. 2

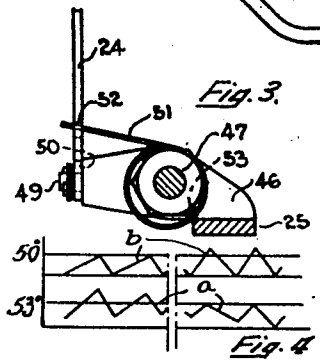


Fig. 3

Fig. 4

Fig. 1

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APPARATUS AND METHOD FOR CONTROLLING REFRIGERATION

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14 Claims. (Cl. 62—4)

My invention relates to new and useful improvements in a refrigerating system, to a method of controlling the operation thereof, and to a control device or apparatus for effecting the method. In certain installations such, for example, as those embodying a storage room or space to be refrigerated, it is desirable to defrost the refrigerant evaporating means or low side element or coils at each cycle of operation of the system. It is therefore one object of my invention to provide a method which will insure defrosting of a refrigerating system for each cycle of its operation.

Another object is to provide a control device or apparatus which is particularly adapted in connection with a refrigerating system for insuring such defrosting of the system.

The invention consists in the method of control and the device or apparatus for performing the same, to be more fully described hereafter and the novelty of which will be particularly pointed out and distinctly claimed.

In the accompanying drawing, to be taken as a part of this specification, I have fully and clearly illustrated a refrigerating system and the apparatus for controlling the same by which my method may be performed, in which drawing—

Figure 1 is a diagrammatic view of a refrigerating system embodying my invention;

Fig. 2 is a view partly in vertical central section of a control device forming a part of the system;

Fig. 3 is a detail view in section on the line 3—3 of Fig. 1; and

Fig. 4 is a graph showing in curve "*a*" a series of refrigerant medium temperatures and in curve "*b*" a corresponding series of air or box temperatures which might occur during the cyclic operation of the system.

Referring to the drawing by characters of reference, 1 designates an enclosed space or compartment, such as a cold storage room, to be refrigerated and containing an evaporating means or low side element 2, such as a pipe coil which is connected by a refrigerant return line 3 to the inlet of a compressor refrigerant medium supply means 4. The means 2 and the return line 3 comprise the low pressure side of the system. The outlet of the compressor is connected by suitable piping to a condenser 5 which discharges into a receiver 6. A refrigerant medium supply line 7 connects the receiver 6 to the evaporating means 2, the apparatus and structure between the compressor outlet and the means 2 comprising the high pressure side of the system. Admission of refrigerant medium to the evaporating means 2 is controlled by a thermostatic expansion valve 8 having its feeler leg or charged bulb element 9 clamped or otherwise secured in intimate heat exchange relation with the return line 3 adjacent the outlet of the means 2. The compressor 4 is driven or operated by an electric motor 10 controlled by a control device 11 electrically connected by suitable lead wires 12 to the current supply line and to the motor.

The device 11 comprises a casing or supporting member 13 preferably substantially rectangular having top and bottom walls 14, 15 joined by end walls 16, 17 and closed at its rear by a substantially vertical wall. Within the casing 13 there is an electric switch or control means 18, preferably of the mercury tube type, supported in a carrier 19 and movably supported for rocking or tilting movement on a horizontal shaft or pivot pin 20 rigidly secured to the rear wall of the casing and extending through bearing apertures in the carrier 19. The switch 18 is shown in circuit breaking position and is provided with lead wires 21 which extend into an outlet box 22 carried by the casing and within which the lead wires 21 are connected to the line lead wires 12. Pivotally secured to the carrier 19, as at 23, is one end of a link or connecting member 24 which at its other end is connected to the free end portion of an operating lever 25. The lever 25 extends substantially horizontally and is pivoted or fulcrumed, as at 26, on or against the inside face of the end wall 17 adjacent the bottom wall 15. The lever 25 is operated by automatically acting means comprising a temperature responsive power element 27, a range determining spring 28, and a differential determining spring 29. The element 27 includes a sealed casing 30, preferably substantially cup-shaped, secured at its rim by nuts and bolts 31, or the like, to the underside of the bottom wall 15 and having a movable wall 32, preferably a circumferentially corrugated, resilient, metal bellows having one end secured and sealed, as at 33, to the wall of the casing 30 adjacent its rim and having its other end closed and sealed by a head or end wall 34. The sealed chamber 35 formed within the casing 30 by the movable wall 32 is connected by a tube 36 to a substantially cylindrical metal bulb element 37. The chamber 35, tube 36, and element 37 are charged with a suitable volatile fluid responsive to temperature change. The element 37 is positioned within the compartment 1 at a point removed from the evaporating means 2 such that it will respond readily to changes in atmospheric temperature within the compartment 1. A stop

member 38 is preferably provided to limit expansion of the chamber 35 and collapse of the wall or bellows 32, and cooperates with the end wall 34. Secured to the bellows head 34 there is a plunger or thrust member 39 which extends upward through an aperture in the bottom wall 15 and which has a conical end portion seating in a socket member 40 rigidly secured to the underface of the lever 25. The lever 25 is moved downward and its upward movement under force of the power element 27 is opposed by the range spring 28, preferably of a helical coil type, seating at one end against an adjustable abutment member 41 screw-threaded on a post 42 rigidly secured to and depending vertically from the top casing wall 14. The other end of the spring 28 is provided with a follower member 43 having a bearing point or member 44 which seats in a socket member 45 rigidly secured to the top face of the lever 25 and preferably disposed directly opposite to the socket member 40. The free end of the lever 25 is provided with a transverse forwardly extending member 46 through which an abutment member or pin 47 is adjustably screw-threaded, the member 47 extending longitudinally of the lever 25 and projecting beyond the same toward the end wall 16. The differential determining spring 29 is preferably of the helical coil type and seats at one end on a conical abutment member 48 secured in the end wall 16 and at its other end seats against the projecting end of the pin 47, being held under compression therebetween. In the position shown, the force of the spring 29 acting on the lever 25 cooperates with the force exerted by the spring 28 to oppose the element 27.

The free end of the transverse member 46 terminates in a pin or post 49 which extends through a longitudinal slot 50 in the link 24 to provide a lost-motion connection between the lever 25 and the control means 18. The link 24 is normally urged upwardly to bring and hold the free end of the slot 50 in engagement with the pin 49 by means of a spring 51 which is coiled about the abutment member 47 and has one end secured to the link 24, as at 52, and has its other end secured to the lever 25, preferably being hooked under the transverse member 46, as at 53. Rigidly secured to the carrier 19 there is a plate member 54 extending transversely to the shaft 20 and projecting on opposite sides thereof. Hinged, as at 55, to the free end portion of the member 54 which projects toward the end wall 16 is a stop or abutment arm 56 which is normally urged at its free lower end into engagement with the end wall 16 by a light spring 57. The stop member 56 cooperates with a stop or lug 58 carried by the inside face of the end wall 16, the spring 57 serving to move the arm 56 into locking engagement with the stop 58, as shown in Fig. 2. Secured to the outside face of the end wall 16 there is a bracket member 59 to which a pressure operated power element 60 is secured. The element 60 preferably comprises a cup-shaped element casing 61 having a movable wall, preferably a cylindrical, corrugated, resilient, metal bellows 62 closed and sealed at its inner end by a head or end wall 63 and secured and sealed at its other end, as at 64, to the inside wall of the casing 61 so as to provide a sealed chamber 65 between the bellows and the casing. The element 60 and the bracket 59 are rigidly clamped to the wall 16 by nuts and bolts 66, or the like. A thrust member or push rod 67 is rigidly secured to the end wall 63 and extends through the bore of an adjustment sleeve or member 68 screw-threaded in an aperture in the bracket 59. The member 67 also extends through and is guided in an aperture 69 in the bracket 59 and projects through an aperture in the wall 16 for cooperable engagement with the arm 56. Movement of the member 67 is opposed by a spring 70 which surrounds the member 67 and is held under compression between the end wall 63 and the adjustment sleeve 68. The chamber 65 is in communication with the low pressure side of the system, being connected by a pipe or conduit 71 to a T fitting 72 in the return line 3 so that the movable wall 62 is subjected to the pressure of the refrigerant medium on the low pressure side of the system.

A safety means 73 is provided to stop operation of the compressor, and therefore of the system, should the pressure of the refrigerant medium in the supply line 7 and the high pressure side of the system become excessive. The means 73 provides a sealed casing 74 having a movable wall 75, preferably a cylindrical, corrugated, resilient, metal bellows which is closed and sealed at its inner end by a head or end wall 76 and which is secured and sealed at its other end, as at 77, to the casing 74. The casing 74 is clamped to the top wall 14 by nuts and bolts 78, or the like, which also serve to secure a clamping plate 79 to the inside face of the wall 14. A thrust member or plunger 80 is rigidly secured to the end wall 76 and extends downward through an aperture in the wall 14 and through the bore of an adjustment sleeve or member 81 adjustably screw-threaded in the plate 79. Surrounding the member 80 there is a helical spring 82 which is held under compression between the end wall 76 and the adjustment sleeve 81, the spring serving to oppose movement of the wall 75 in response to pressure in the chamber 83 formed between the casing 74 and the wall 75. The thrust member 80 cooperates with the end of the plate member 54 which projects toward the end wall 17 and is operable upon engagement therewith to move the control means 18 from circuit making to its circuit breaking position, as shown. The chamber 83 communicates with the high pressure side of the system and is connected by a conduit or pipe 84 to a T fitting 85 in the supply line 7. The power element 60 together with the spring 51 comprises an automatic means for moving the control means 18 and starting operation of the system.

The operation of my system and control device is as follows: The position of the parts shown in Fig. 2 is that which they will assume when the temperature of the atmosphere of the compartment 1 has been reduced to the desired low temperature. As the temperature within the compartment 1 increases, the pressure in the chamber 35 will increase until the desired high temperature of, say, 50° F., is reached at which temperature the force acting through the thrust member 39 on the lever 25 will overcome the combined opposing force of the range spring 28 and the differential spring 29. If the evaporating means 2, when the temperature in the compartment 1 reaches, say, 50° F., has defrosted which will occur when the temperature of the refrigerant medium rises to, say, 33° F., then the pressure of the refrigerant medium acting on the plunger 67 will have moved the arm 56 out of abutting relation to the stop 58 so that upward movement of the lever 25 will move the control means 18 to circuit making position. However, should it happen that the evaporating means has not defrosted, due for example to a rapid heating up of the compartment 1, then arm 56

will remain in locked position and when the desired temperature of, say, 50° F., is reached, the lever 25 will move upward against the force of the light spring 51 which it places under tension as the pin or post 49 moves upwardly in the slot 50. This lost-motion operation results because the control means 18 is locked in circuit breaking position and its movement is opposed by the arm 56 engaging the stop 58. The temperature in the compartment 1 will now continue to rise above the desired point or degree to, say, 51° F., corresponding to a temperature of, say, 33° F., of the refrigerant medium in the evaporating means 2 which will assure defrosting of the evaporating means. When this slightly higher degree of temperature in the compartment 1 and in the evaporating means 2 is reached, which is determined by the resistance of spring 70, adjustable by the sleeve 68, the pressure of the refrigerant medium exerted in the chamber 65 upon the wall 62 will move the thrust member 67 to release the arm 56 from a locking engagement with the stop 58, thereby overcoming the opposition of movement of the control means and permitting the spring 51 to force the link 24 upward until the bottom of the slot 50 engages the pin 49 which will rock or tilt the control means 18 about its shaft 20 to circuit making position and start operation of the compressor and system. Operation of the compressor will reduce the pressure in the low pressure side of the system, permitting the thrust member 67 to be retracted by the spring 70 to the position shown in Fig. 2. Then when the temperature of the atmosphere in the compartment 1 reaches a desired low point, the force exerted by the range spring 28 will move the lever 25 downward against the opposing force of the power element 27 and the differential spring 29, thereby moving the control means 18 to circuit breaking position and stop operation of the compressor. As the control means 18 is moved by the range spring 28, the arm 56 will be lifted to ride over the stop 58 snapping it into locking engagement therewith, as shown, under force of the spring 57. If during the operation of the compressor the pressure in the supply line 7 should increase to a point which would endanger the apparatus, the thrust member 80 will be moved downward into engagement with the plate 54 and move the control means 18 to circuit breaking position. This will occur irrespective of the position of the parts, the lost-motion connection between the link 24 and the lever 25 and the flexible arm 56 permitting such movement.

Although I have described the power element 60 as being pressure operated, it is to be understood that the thrust member 67 may be operated in response to the temperature of the refrigerant medium in the low pressure side of the system or return line 3.

What I claim and desire to secure by Letters Patent of the United States is:

1. The method of assuring defrosting of a cyclically operating refrigerating system which comprises starting each cycle of operation of the system upon the occurrence of a predetermined high air temperature in the space to be refrigerated provided the temperature of the refrigerant medium has prior to the occurrence of the high air temperature reached a sufficiently high temperature to defrost the system, withholding starting of the system at the predetermined high air temperature when the high air temperature occurs prior to the defrosting temperature of the refrigerant medium and until the refrigerant medium temperature has increased sufficiently to defrost the system, and stopping each cycle of operation solely upon the occurrence in the space to be refrigerated of a predetermined low air temperature.

2. The method of controlling the operation of a refrigerating system which comprises starting operation of the system when a predetermined high temperature has been reached in the space to be refrigerated and the refrigerant medium has attained on the low pressure side of the system a predetermined high degree of temperature or pressure which will insure defrosting of the system, stopping operation of the system upon the occurrence of a predetermined low temperature in the space to be refrigerated, and stopping operation of the system upon the occurrence of excess pressure in the refrigerant supply line.

3. In a refrigerating system, refrigerant medium evaporating means for cooling a space to be refrigerated, means operable to supply refrigerant medium to said means, means responsive to the temperature or pressure of the refrigerant medium in the return line from said evaporating means and operable to start operation of said supply means, means responsive to excess pressure of the refrigerant medium to stop said supply means, and means responsive to the temperature of the atmosphere in the refrigerated space and operable to stop operation of said supply means.

4. A defrosting control device for refrigerating systems, comprising a supporting member, a control means carried by said member and operable to start and to stop operation of the system, means operable in response to predetermined temperatures in the space to be refrigerated to move said control means to stop and to start operation of the system, means acting upon the stopping movement of said control means to oppose the starting movement of said control means by said responsive means, and means operable to overcome said opposing means in response to a predetermined high temperature or pressure in the low pressure side of the system which will insure defrosting of the system.

5. A defrosting control device for refrigerating systems, comprising a supporting member, a control means carried by said member and operable to start and to stop operation of the system, means operable in response to predetermined low temperature in the space to be refrigerated to move said control means to stop operation of the system, means acting upon the stopping movement of said control means to lock said control means against starting movement, and means operable to release said locking means and to move said control means to start operation of the system in response to a predetermined high defrosting temperature or pressure in the low pressure side of the system.

6. A defrosting control device for refrigerating systems, comprising a supporting member, a control means carried by said member and operable to start and to stop operation of the system, means operable in response to predetermined low temperature in the space to be refrigerated to move said control means to stop operation of the system, means operable to move said control means to start operation of the system in response to a predetermined high temperature or pressure in the low pressure side of the system which will insure defrosting of the system, and

safety means operable to move said control means to stop operation of the system upon excess pressure in the high pressure side of the system.

7. A refrigerator control device, comprising a supporting member, a control means carried by said supporting member, automatically acting means operable on movement in one direction to move said control means, means to oppose movement of said control means in the opposite direction by said automatic means, a lost-motion connection between said automatic means and said control means whereby said automatic means may move in the opposite direction without moving said control means, a spring placed under stress upon movement of said automatic means and operable to move said control means in said opposite direction, and means operable to overcome said opposing means whereby said spring can move said control means.

8. A refrigerator control device, comprising a supporting member, a control means carried by said supporting member, automatically acting means operable on movement in one direction to move said control means, means to oppose movement of said control means in the opposite direction by said automatic means, a lost-motion connection between said automatic means and said control means whereby said automatic means may move in the opposite direction without moving said control means, said connection including a spring placed under stress upon movement of said automatic means in said opposite direction and operable to move said control means in said opposite direction, and means operable to overcome said opposing means whereby said spring can move said control means.

9. A refrigerator control device, comprising a supporting member, a control means carried by said supporting member, automatically acting means operable on movement in one direction to move said control means, means operable upon movement of said automatic means in said one direction to lock said control means against movement in the opposite direction by said automatic means, a lost-motion connection between said automatic means and said control means whereby said automatic means may move in the opposite direction without moving said control means, a spring placed under stress upon movement of said automatic means and operable to move said control means in said opposite direction, and means operable to release said locking means whereby said spring can move said control means.

10. A refrigerator control device, comprising a supporting member, a control means carried by said supporting member, automatically acting means operable on movement in one direction to move said control means, a stop member carried by said supporting member, an abutment arm carried by said control means and automatically operable upon movement of said automatic means in said one direction to engage said stop member and lock said control means against movement in the opposite direction by said automatic means, a lost-motion connection between said automatic means and said control means whereby said automatic means may move in the opposite direction without moving said control means, a spring placed under stress upon movement of said automatic means and operable to move said control means in said opposite direction, and means operable to move said arm out of engagement with said stop member whereby said spring can move said control means.

11. The method of controlling the operation of a refrigerating system which comprises establishing cycles of operation, starting each cycle when the refrigerant medium has attained on the low pressure side of the system a predetermined high degree of temperature or pressure sufficient to defrost the system but only upon the occurrence of a predetermined high temperature in the space to be refrigerated, stopping each cycle of operation upon the occurrence of a predetermined low temperature in the space to be refrigerated, and stopping operation of the system during any cycle upon the occurrence of excess pressure in the refrigerant supply line.

12. In a refrigerating system, refrigerant medium evaporating means for cooling a space to be refrigerated, means operable to supply refrigerant medium to said means, control means movable to start and to stop said supply means, means to oppose operation of said control means to start said supply means, means operable in response to predetermined high temperature or pressure of the refrigerant medium on the low pressure side of the system to overcome said opposing means and to move said control means to start operation of said supply means, and means responsive to temperature in the space to be refrigerated to move said control means to stop operation of said supply means independently of operation of said first-named responsive means.

13. A defrosting control device for refrigerating systems, comprising a supporting member, a control means carried by said member and movable to start and to stop operation of the system, resisting means movable into position to oppose starting movement of said control means, means operable in response to predetermined desired low temperature in the space to be refrigerated to move said control means to stop operation of the system and to move said resisting means into opposing position, and means operable to move said resisting means out of opposing position and to move said control means to start operation of the system in response to a predetermined high temperature or pressure in the low pressure side of the system which will insure defrosting of the system.

14. A defrosting control device for refrigerating systems comprising a control means movable to one position to stop operation of said system and movable to another position to start operation of said system, means operable in response to a predetermined low temperature in the space to be refrigerated to move said control means to said one position, said responsive means acting upon occurrence of a predetermined higher temperature to move said control means to said other position, means acting automatically to hold said control means against movement by said responsive means to said other position upon each movement of said control means to said one position, and means responsive to a predetermined high refrigerant temperature or pressure which will insure defrosting of the system, said last-named responsive means cooperating with said automatic means at said predetermined refrigerant temperature to establish free movement of control means to said other position.

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