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HOT GAS DEFROSTER CONTROL FOR REFRIGERATORS

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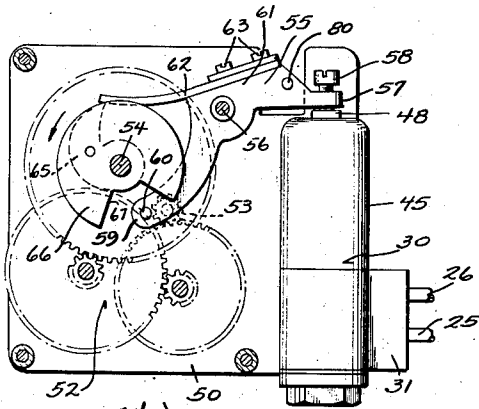


Fig. 3

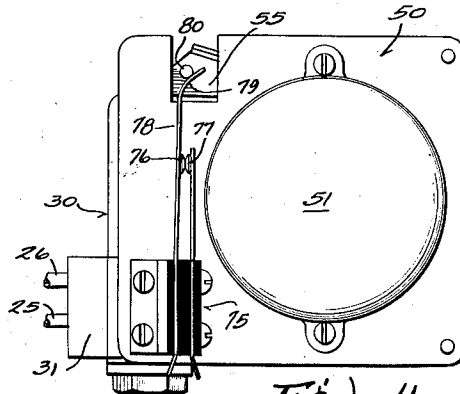


Fig. 4

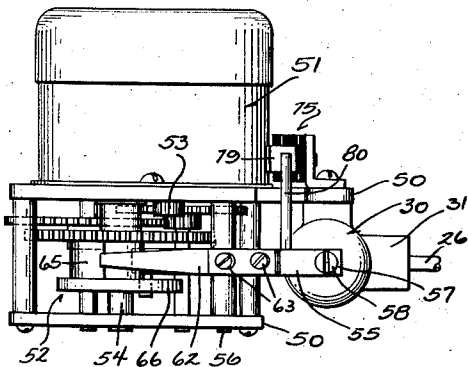


Fig. 2

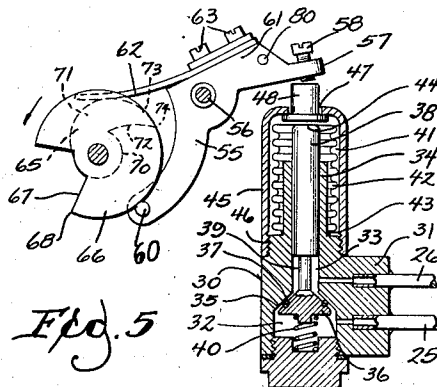


Fig. 5

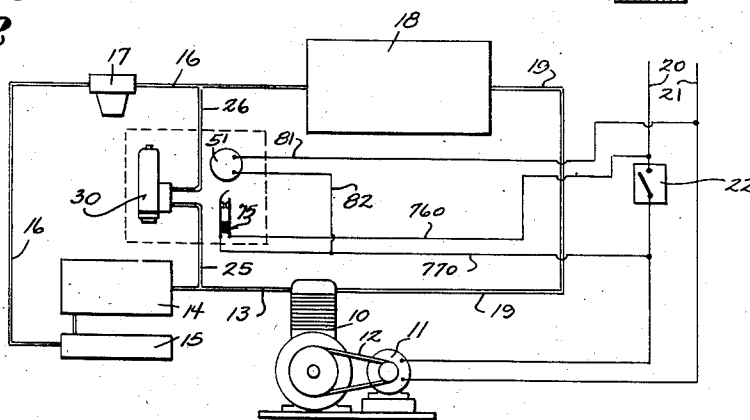


Fig. 1

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HOT GAS DEFROSTER CONTROL FOR REFRIGERATORS

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11 Claims. (Cl. 62—4)

This invention relates to a hot gas defroster control for refrigerators.

It is common to free a refrigerator evaporator of its accumulation of ice and snow by diverting hot refrigerant directly to the evaporator from the compressor in a typical refrigeration cycle, and, as shown in U. S. Patent No. 2,463,027 issued to George Frie March 1, 1949, it is most practical to operate a hot gas defrosting apparatus in accord with a predetermined duration of compressor operation thus assuring sufficiently frequent defrosting operations so that at no time is the accumulation of ice and snow upon the evaporator surface in the refrigerator so thick that a hot gas defrosting period of greater duration than five minutes is needed. Into such a hot gas defrosting apparatus, my control valve and control valve operator is specially adapted.

More particularly stated, my invention relates to a control wherein a hot gas defrost valve is moved to defrost position with a mechanical snap action, moved to closed position by a mechanical snap action, and all of the operating mechanism is adapted for energization by a small synchronous clock-type motor of modest power.

Furthermore, my invention includes a novel timing circuit for a hot gas defrost control.

In the drawings:

Fig. 1 is a schematic arrangement showing the environment in which my defroster control is mounted and showing diagrammatically the location of my control and the wiring diagram including my control and the refrigerator compressor motor.

Fig. 2 is a plan view of my complete control device and showing fragmentarily the hot gas delivery connection from my control valve.

Fig. 3 is a section on line 3—3 of Fig. 2.

Fig. 4 is a back or timer motor elevation of my control device showing particularly the switch for maintaining the refrigerator compressor in operation during a defrost cycle.

Fig. 5 is a detail in vertical section of my valve and showing the immediate valve operating parts and the cams for control thereof, these cams and control parts being shown in elevation.

Referring to Fig. 1 for the purpose of showing a typical environment in which my hot gas defrost control is useful, I have shown a conventional refrigerator compressor 10 motorized at 11 by an electric motor connected to the compressor by a belt 12. A hot refrigerant conduit 13 for the freshly compressed fluid extends from the compressor to the condenser 14 where the hot fluid is cooled and passed in the form of liquid into a receiver 15. From this receiver, the cooled refrigerant passes through conduit 16 to expansion valve 17 normally closely associated with evaporator 18, which, of course, is located in the space to be refrigerated. From the evaporator, the refrigerant passes in the form of gas through the gas refrigerant line 19 back to the compressor.

The motor 11 is energized electrically from a line

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voltage source as indicated through leads 20 and 21, and for the purpose of the diagrammatic showing in Fig. 1, I have indicated at 22 a switch of the type known as a cold control. In other words, 22 designates the thermostatically or otherwise operated switch which operates the compressor for normal refrigeration purposes. As to the apparatus and electrical leads thus far referred to, I only intend to indicate a popular and conventional refrigeration equipment and it will be understood that in accord with previously known hot gas defrosting practices, a hot gas defrosting conduit would be used to interconnect the hot gas conduit 13 and that portion of the conduit 16 which lies between the expansion valve 17 and the evaporator 18. It is to the automatic control of the passage of hot gases through such a hot gas defrosting conduit that my invention is directed.

In Fig. 1, I show the hot gas defrosting conduit at 25—26 and the connection between 25 and 26 includes my control valve generally designated 30 and which is shown in detail in vertical section in Fig. 5.

Automatically operated defrost valve 30 receives hot refrigerant through conduit 25, and when the valve is open, permits the hot refrigerant to pass under pressure from the compressor through outlet conduit 26. The valve has a body 31 enclosing a valve chamber 32. This comprises a counterbore for valve stem bore extending upwardly through that portion of the valve body which provides a sleeve 34. Between the counterbore 32 and the stem receiving bore 33, a tapered valve seat 35 is provided for the valve member 36. This valve member is provided with an O-ring 37 seated in a groove in the face of the valve member opposite the seat 35 and the valve member has a stem 38 guided in the bore of the sleeve 34, stem 38 being undercut at 39 to provide space in the form of chamber 33 for passage of hot refrigerant to the outlet 26 when the valve is open.

It will be noted that the valve member is urged to its seat by a valve closing spring 40 as well as by the pressure of hot refrigerant gases from the compressor 10.

Exteriorly of the sleeve 34 is a bellows chamber 41 for bellows 42 silver soldered to the sleeve at 43 and extending as a hermetic seal over the end 44 of stem 38 so that any leakage of refrigerant along the stem 38 is sealed against escape to the outside atmosphere. A protective bellows cap 45 is in threaded engagement at 46 with the body 31 of the valve and is apertured at 47 so that an internally headed valve actuator button 48 provides means for urging the bellows and the stem inwardly or downwardly to open the valve as will be readily understood from an examination of Fig. 5.

To automatically open and close the valve 30 with a snap action both for the opening and the closing, I provide the mechanism now to be described. The valve body is secured to a frame plate 50 and it is to this same frame plate that a timer motor 51 and a motor operated valve actuating mechanism 52 are also mounted. The motor 51 is typical of a number of such electrically operated devices now available and provided with internal gear train (not shown) so that a motor pinion 53 is power operated at one revolution per minute. Any form of gear train in the actuating mechanism 52 may be provided for the operation of cam shaft 54, the function of which is the cam actuation of valve 30 at sufficiently frequent intervals to defrost the evaporator 18 before the icy accumulations thereon have become objectionable or deleterious to the refrigerator operation as described above. In the particular mechanism which I have provided to meet the usual operational defrosting problems of a domestic refrigerator, I provide a gear train between pinion 53 and the cam shaft 54 to provide one revolution of the cam shaft for every two hours and twenty minutes of operation of motor 51.

In other words, the reduction between the pinion 53 and the shaft 54 is 140 to 1.

At one side of the gear train and mounted to move valve member 36, I provide valve lever 55 on valve lever shaft 56. One end 57 of the valve lever is positioned so that an adjusting screw 58 therethrough is in position to bear upon valve actuator button 48. The other end 59 is provided with a laterally extending locking pin 60. Intermediate the ends of the lever 55 is a saddle 61 upon which is mounted adjustably a biasing device such as the spring 62 held to the saddle 61 by screws 63. The biasing device 62 is aligned to bear upon cam 65 upon cam shaft 54 and the locking pin 60 on the end 59 of lever 55 is aligned to bear upon the exterior surface of cam 66 which is mounted upon cam shaft 54. The exterior surface of cam 66 has a sector thereof broken away at 67 but is otherwise a complete circular surface and when the locking pin is in contact with this surface, it is impossible to cause the adjusting screw 58 to bear upon valve actuator button 48 to accomplish a valve opening operation; but when the locking pin 60 passes over the lip 68 of cam surface 66, the lever 55 may oscillate in a valve opening direction under the bias of spring 62.

Cam 65 is so shaped with a small concentric portion 70 and cam wing 71 with an undercut surface 72 that the spring 62 bearing thereon moves through a complete cycle of operation, including a gradual stressing of the spring 62 during the time that locking pin 60 prevents movement of lever 55 and during the time just subsequent of the drop-off of the locking pin 60 from lip 68. Then for a period of approximately two to five minutes while the valve 36 is open, the spring 62 "rides" upon the high point at 73 with maximum lift against the spring and at the lip 74 of cam 65, the spring drops off of the high point 73 and snaps down upon the "lower" concentric portion 70 of this cam thus removing most of the bias of spring 62 and permitting spring 40 to return valve 36 to its closed position as shown in Fig. 5.

Thus it will be seen that the lever 55 goes through the following sequence as the cams go through one complete operation in each 140 minutes or such other period of time as the gear train at 52 may provide:

1. With the valve closed and spring 62 in stressed position approaching the highest point at 73 on cam 65, locking pin 60 still riding upon surface of cam 66, the lever 55 cannot be moved to valve opening position.

2. Lip 68 reaches the position where locking pin 60 rides free of the surface of cam 66 and lever 55 is snapped to valve opening position by spring 62 which still rides upon the high point of cam 65 at 73 (see Fig. 3).

3. Lip 74 of cam 65 passes under the extended end of spring 62 and, because of the undercut shape at 72 of cam 65, the spring 62 snaps down upon the concentric surface 72 of cam 65.

4. Spring 40 being relieved of the opposition of spring 62 snaps the valve to closed position.

5. Cam 66 continues its rotation so that it assumes a position to prevent the lever 55 from opening the valve.

6. Cam 65 moves under spring 62 and commences a prestressing of the spring in readiness for the next valve opening operation.

To assure compressor operation for the two to five minutes of hot gas defrosting immediately following the drop-off of pin 60 as it leaves the lip 68, I provide a switch 75, shown most clearly in Fig. 4, the points 76 and 77 of which are normally open, but one of the points, 76, is mounted upon a spring leaf 78 which extends in the form of a cam follower at 79 in the path of movement of switch pin 80 secured to valve lever 55. Thus when valve lever 55 oscillates under the bias of spring 62, it moves against the portion 79 of lever 78 and urges the points 76 and 77 into contact with each other.

As shown most clearly in Fig. 1, switch 75 completes a circuit from electrical lead 20 at one side of the switch 22 to the compressor connected to the other side of switch

22, and I have indicated the leads that are connected to the points 76 and 77 by designating them as 760 and 770. The switch 75 and the leads 760 and 770 therefore comprise a jumper around the switch 22 effective from the time the valve lever opens the valve 36 until the valve lever snaps to the position in which the valve 36 may close. The electrical leads to the clock 51 are shown at 81 and 82 and the clock is therefore directly across the line 20—21 at all times when the cold control 22 is calling for compressor operation or when points 76—77 are held in closed position by pin 80.

Thus switch 75 assures compressor operation in continuous hot gas supplying operation and I avoid the possibility that the two to five minute defrosting portion of the cycle of operations might be interrupted or divided into two parts in which the second portion might find the hot gas line 13 somewhat cooled and less able to provide sufficient hot gas for a practical defrosting interval.

I claim:

1. In a control device a controlled member biased to one position, a control arm positioned and normally biased contrary to the controlled member but with insufficient bias to prevent the controlled member moving to said one position under its own bias, a biasing member for the control arm and means for increasing the bias thereof so as to overcome the bias of the controlled member and move it to a second position, a cam positioned to prevent such movement to said second position and shaped for sudden release of the controlled member, said cam and said means for increasing bias being mounted for cyclic movement, and apparatus for effecting such cyclic movement.

2. In a refrigeration equipment having a compressor energized by an electric motor and an electric circuit therefor, a condenser and evaporator in a refrigerant circuit including the compressor, said refrigerant circuit having a bypass whereby to directly connect the compressor with the evaporator; a normally closed valve for said bypass and an electrically operated mechanism for the opening and closing thereof, said mechanism including a cam shaft with a spring biasing cam thereon, a valve operating arm mounted for oscillation between valve opening and valve closing position, a spring connected to said arm to bias the arm toward valve opening position and aligned with the cam, said cam having a drop-off, a second cam on the cam shaft and provided with a drop-off, interconnecting means between the second cam and the valve operating arm to prevent the arm from moving to valve opening position until the spring is prestressed by the first mentioned cam, and electric connections to the compressor motor circuit including a switch responsive to the equipment in valve opened position whereby to assume compressor operation.

3. The subject matter of claim 2 wherein the cam shaft is operated by an electrically motorized mechanism the electric connections for which are included in the compressor motor circuit.

4. The subject matter of claim 2 wherein the cam shaft is operated by an electrically motorized mechanism the electric connections for which are included in the compressor motor circuit, the compressor motor electric circuit having a cold control switch and the electrically operated mechanism for opening and closing the valve includes a switch and circuit connections comprising a jumper around the cold control switch, and having a normally open switch of its own provided with mechanical means connected to the valve control arm whereby to close said last mentioned switch when the valve is open.

5. The subject matter of claim 2 wherein the normally closed valve is biased to closed position by a relatively weak spring and the spring attached to the valve closing arm when in contact with the drop-off portion of the cam is overcome by said relatively weak spring, but the spring attached to the valve closing arm when prestressed by the cam biases the arm to valve opening position with

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snap action immediately prior to the drop-off movement of the cam.

6. A control including a control arm positioned to oscillate from a first position to a second position against a contrary biased means, said arm having a locking pin and an arm biasing spring divergently extended therefrom, a cam shaft positioned between the divergent spring and pin and provided with a pair of cams comprising a spring stressing cam and a locking pin cam respectively, the locking pin cam being in contact with the pin and substantially concentrically shaped as to its locking pin contacting portion but being provided with a drop-off sector demarked by a drop-off lip, the spring stressing cam being in contact with the spring and having a small diameter concentric portion and a prestressing portion with a drop-off lip, and mechanism to rotate the cam shaft, the lips of the cams being positioned to pass the lip of the locking cam from the locking pin before the spring leaves the lip of the prestressing cam.

7. A control for the purpose described including a valve normally biased to closed position, a valve control arm positioned to oscillate from a valve closed position to a valve opened position, said arm having a locking pin and an arm biasing spring divergently extended therefrom, a cam shaft positioned between the divergent spring and pin and provided with a pair of cams comprising a spring contacting and stressing cam and a locking pin contacting cam respectively, the locking pin cam being substantially concentrically shaped as to its locking pin contacting portion but being provided with a drop-off sector demarked by a drop-off lip, the spring stressing cam having a small diameter concentric portion and a prestressing portion with a drop-off lip, a clock operating timer mechanism to rotate the cam shaft, the lips of the cams being positioned to pass the lip of the locking cam from the locking pin a predetermined time before the spring leaves the lip of the prestressing cam, said valve being in a control position in a hot gas defrost bypass in a refrigerant circuit of an electrically motorized refrigerator mechanism having an electric energizing circuit and the clock timer mechanism being electrically energized concomitantly with the refrigeration mechanism, said clock energization circuit being provided with a switch for energization thereof under control of the valve operating arm for continuous energization of the clock mechanism while the valve is in open position.

8. A cyclically operative mechanism for snap action of a controlled device in two opposite actions in which the device has inherent means biasing it to a first position, a pair of cams mounted for movement concomitantly in a complete cycle, one of the cams being a prestressing cam provided with a cam follower having a biasing member connected to the controlled device for movement in one action, the other cam being a locking cam, a locking pin connected to the cam follower positioned to prevent the controlled device from moving in such one action, each of the cams having a drop off lip, the lip of the locking cam being positioned for drop off of the pin for snap action in the one action in prior sequence to the drop off of the cam follower from the lip of the prestressing cam, said prestressing cam being shaped to hold the biasing member in partially stressed position after the cam follower has dropped off its lip, but insufficiently stressed to overcome the inherent bias of the controlled device.

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9. A controlled member provided with means for normally urging it to an extreme position, a control arm pivotally mounted in position to move the controlled member from said extreme position to an opposite extreme position, said control arm having a spring mounted thereto in position for opposing said means only when the spring is prestressed, a locking pin extending from the arm in position to prevent movement of the arm in response to the prestressed spring, and cam means mounted for cyclic movement contiguous with the spring and locking pin, said cam means being shaped to periodically prestress the spring and to periodically hold the locking pin.

10. A valve mechanism having a valve stem, valve head and valve seat and a spring for moving the valve and stem in a valve operating direction, means mounted for operation of the valve in a direction contrary to its spring, said means including a valve lever, one end of which is positioned to bear against the valve and its stem and the other end having a locking pin and a prestressing spring in forked relation, cam means mounted for cyclical movement between the locking pin and the prestressing spring shaped to prestress the spring and simultaneously lock the valve lever against movement, said cam means being further shaped to suddenly release the pin for valve lever movement under bias of the prestressed spring and shaped to immediately thereafter release the prestressing of the spring to permit movement of the valve to its extreme position under bias of its own spring.

11. In a device of the character described, a refrigerant circuit and an electrically motorized refrigerator mechanism therefor having an electric energizing circuit, a clock timer mechanism electrically energized concomitantly with the refrigerator mechanism, a hot gas defrost bypass for the refrigerant circuit having a valve and valve arm for the actuation thereof connected to the clock timer mechanism for the opening and closing of the valve, and a switch for said electric energizing circuit responsive to the position of the valve operating arm for continuous energization of the clock mechanism and refrigerator circuit while the valve is in open position.

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