July 16, 1940. A. C. SMITH 2,207,701

REFRIGERATION

Original Filed Nov. 1, 1935 3 Sheets-Sheet 1

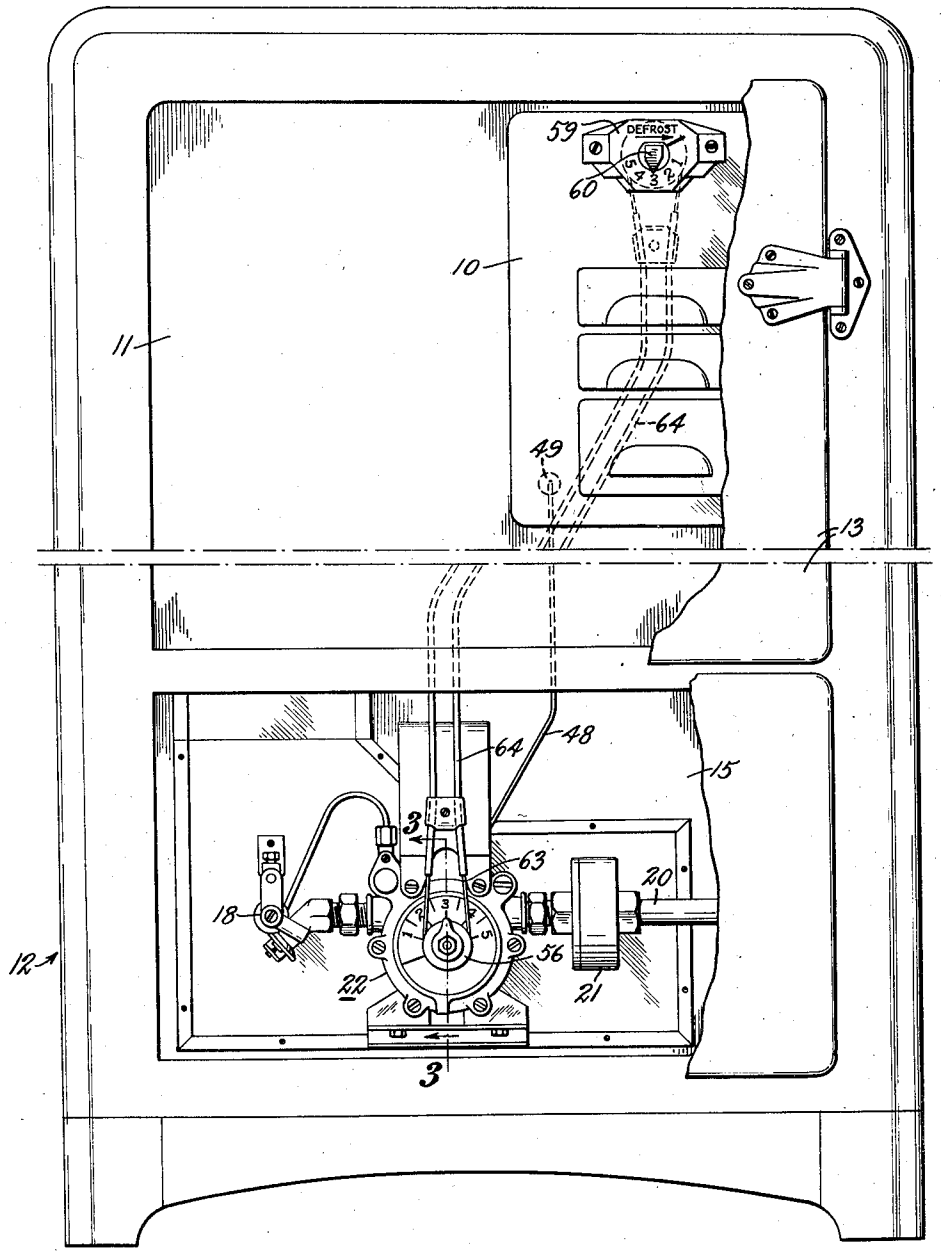


Fig. 1.

INVENTOR.
Albert C. Smith

BY

J. E. Heath
his ATTORNEY.

July 16, 1940. A. C. SMITH 2,207,701

REFRIGERATION

Original Filed Nov. 1, 1935 3 Sheets-Sheet 2

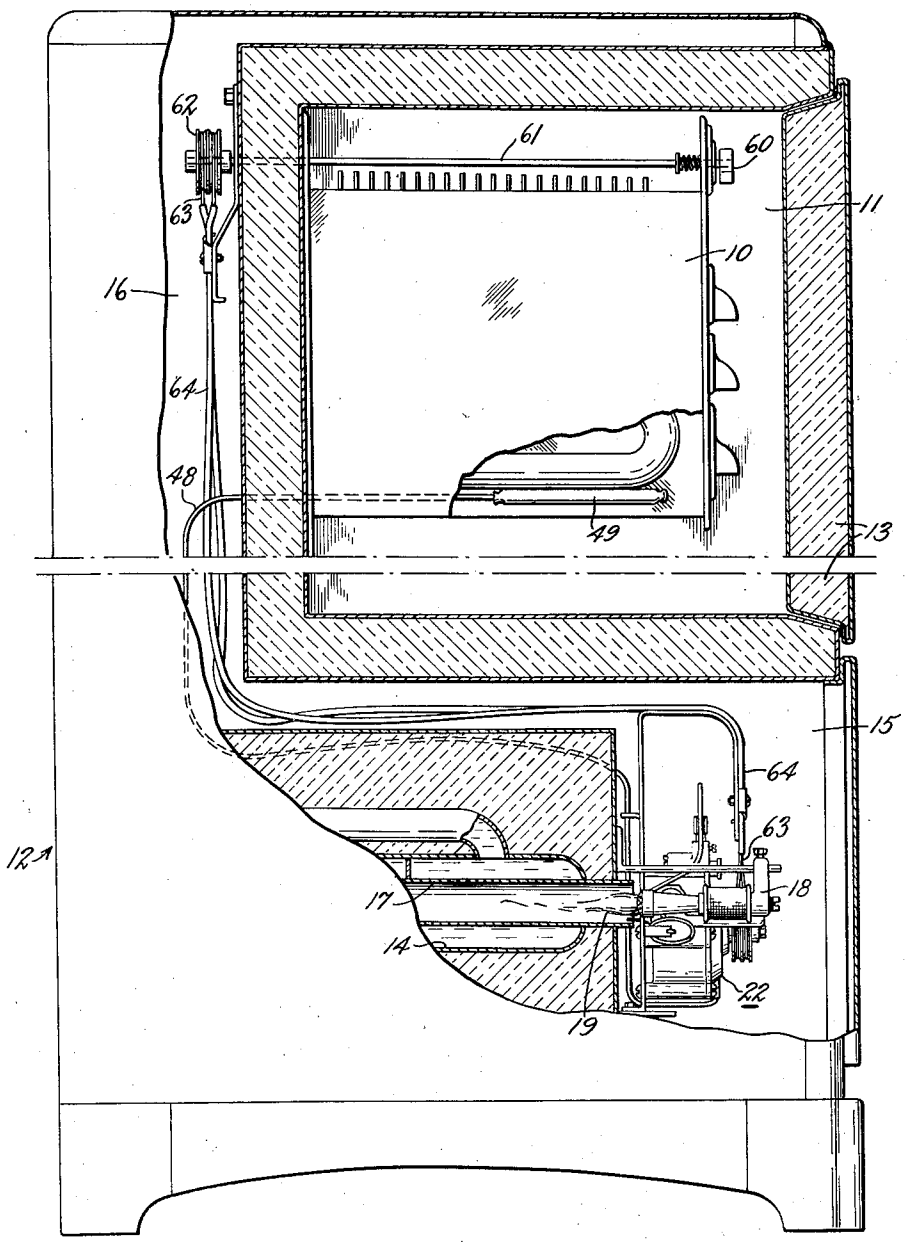


Fig. 2.

INVENTOR.
Albert C. Smith

BY

D. E. Heath
his ATTORNEY.

July 16, 1940. A. C. SMITH 2,207,701

REFRIGERATION

Original Filed Nov. 1, 1935 3 Sheets-Sheet 3

Fig. 3.

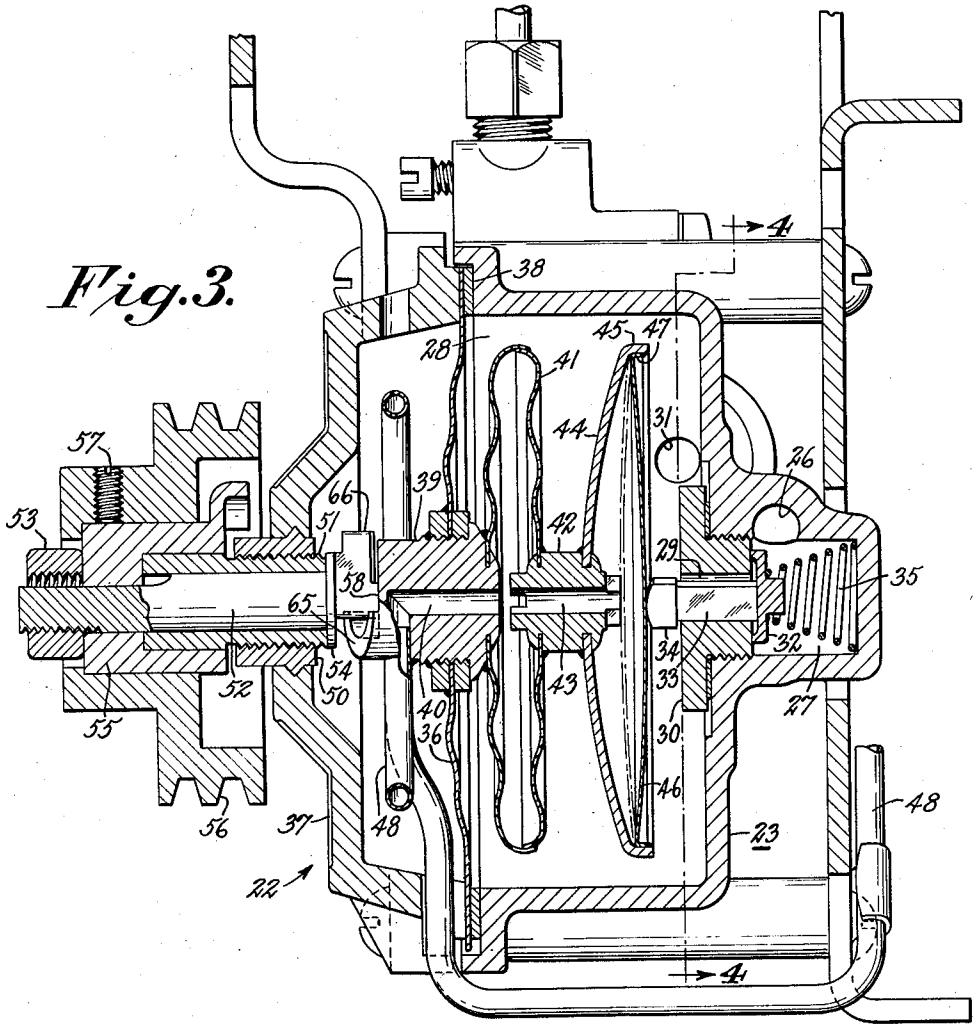


Fig. 4.

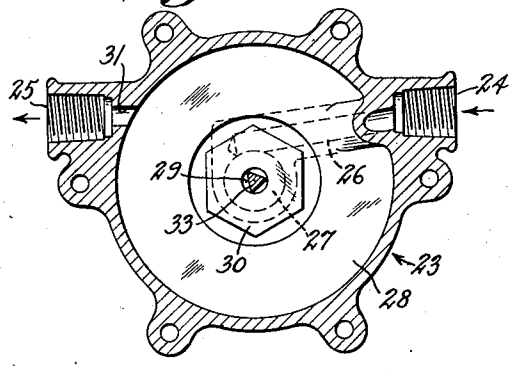
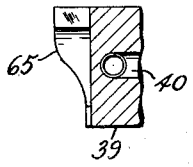


Fig. 5.



INVENTOR.
Albert C. Smith
BY
D. E. Heath
his ATTORNEY.

Patented July 16, 1940 2,207,701

UNITED STATES PATENT OFFICE

2,207,701

REFRIGERATION

Albert C. Smith, Evansville, Ind., assignor to Servel, Inc., New York, N. Y., a corporation of Delaware

Application November 1, 1935, Serial No. 47,783
Renewed February 12, 1937

8 Claims. (Cl. 62—5)

My invention relates to refrigeration, and more particularly to control mechanism for refrigeration apparatus of the continuous absorption type.

The object of my invention is to provide an improved control mechanism for initiating at will the defrosting of a refrigerator of the continuous absorption type, the control mechanism being operative to terminate the defrosting automatically.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with particularity in the claims forming a part of this specification.

For a better understanding of my invention reference may be had to the following description taken in connection with the accompanying drawings in which Fig. 1 is a front elevation, partly broken away, of a refrigerator embodying my invention; Fig. 2 is a side elevation, partly broken away and in section, of the refrigerator shown in Fig. 1; Fig. 3 is a view taken at line 3—3 of Fig. 1, and illustrates in section control mechanism shown in connection with the refrigerator illustrated in Figs. 1 and 2; Fig. 4 is a view, in section, taken at line 4—4 of Fig. 3; and Fig. 5 is a fragmentary view, in section, of a part of the control mechanism shown in Fig. 3.

Referring to Figs. 1 and 2 of the drawings, I have shown my invention in connection with an absorption refrigerator of the pressure equalized continuous type. This refrigerator comprises a cooling element or evaporator 10 disposed in a heat insulated chamber 11 which may form a food storage compartment in the upper portion of a cabinet 12 and into which access may be had by a door 13. The refrigerant fluid, such as ammonia, evaporates in the evaporator 10 and diffuses into an inert pressure equalizing gas, such as hydrogen. The resulting gaseous mixture of refrigerant and hydrogen flows from the evaporator 10 to an absorber (not shown) in which the refrigerant gas is absorbed by a suitable liquid absorbent, such as water. The inert hydrogen gas is returned to the evaporator 10, and the enriched absorption liquid is conducted to a generator 14 disposed in a lower apparatus compartment 15. By heating the generator 14 the refrigerant is expelled from the absorption liquid, condensed in a suitable condenser, and then returned to the evaporator 10 to complete the refrigerating cycle. The weakened absorption liquid from which the refrigerant has been expelled is conducted from the generator 14 to the absorber to absorb refrigerant gas.

At the back of the cabinet 12 a passage 16 extends upwardly from the lower compartment 15 and in the rear of the chamber 11, and the absorber, condenser, and other parts of the machine may be disposed in the lower compartment 15 and this vertical passage 16. In order to simplify the drawings the last-mentioned parts have not been shown, their illustration not being necessary for an understanding of my invention.

The generator 14 is provided with a heating flue 17 and is adapted to be heated by a gas burner 18 arranged so that the flame 19 produced thereby is directed into the lower end of the flue, and a suitable combustible gas is supplied through a conduit 20 and gas filter 21 to the burner 18.

In accordance with my invention the flow of gas to the burner 18 is controlled by control mechanism 22 interposed between the burner 18 and filter 21. Referring to Fig. 4, the control mechanism 22 comprises a casing 23 having apertured bosses 24 and 25 which form inlet and outlet openings, respectively, for the combustible gas. The gas flows from the inlet opening at the boss 24 through a passage 26 into a valve chamber 27, which is shown in Fig. 3. From the valve chamber 27 the gas passes into a diaphragm chamber 28 through a passage 29 formed in a bushing 30 which is threadedly secured at the open end of the chamber 27. The gas then passes from the diaphragm chamber 28 through a passage 31 to the outlet opening at the boss 25.

In this embodiment of my invention the right-hand side of the bushing 30 forms a valve seat which is adapted to cooperate with a valve 32 having a triangular-shaped stem 33. The stem 33 extends through the passage 31 into the diaphragm chamber 28 and is provided at its end with an enlarged head 34. The valve 32 is urged or biased toward its closed or seated position on the bushing 30 by a helical spring 35 disposed within the valve chamber 27. Means, hereinafter to be described, urges the valve 32 to an open position against the tension of the spring 35 to permit gas to flow from the valve chamber 27 through the passage 31 into the diaphragm chamber 28.

The diaphragm chamber 28 is enclosed by a flexible diaphragm 36 having the peripheral edge thereof secured between the open end of the casing 23 and a cover plate 37, a gasket 38 being provided to make the diaphragm chamber 28 gas-tight so that the flow of gas from this

chamber to the outlet opening at the boss 25 is insured. To the central portion of the diaphragm 36 is secured a hub member 39 having an opening 40 extending therethrough, and to the hub member is fixed one face of an expansible bellows or hollow diaphragm 41. A second hub member 42 provided with an opening 43 is fixed to the opposite face of the expansible bellows 41, and to this hub member is secured a concave-shaped annular shell 44 having a flange or rim 45. A disk or diaphragm 46 is adapted to be disposed at the open end of the shell 44 with its flange or edge portion 47 anchored and fitting tightly within the flange 45 and secured thereto in any suitable manner, as by welding or brazing.

The area of the diaphragm 46 is greater than the area of the open end of the shell 44, and is preferably formed of suitable material so that it is resilient and can be snapped between the positions shown in solid and dotted lines, respectively, in Fig. 3. When the diaphragm 46 is bowed outward, as shown in solid lines, and a force is exerted thereon toward the left, the diaphragm 46 will snap inward after passing the dead center position and assume the position shown in dotted lines, the extent to which the diaphragm moves being limited only by the extent to which it is capable of flexing. Conversely, when the diaphragm 46 is bowed inward and a force is exerted thereon toward the right, the diaphragm will snap outward after passing the dead center position and assume the outwardly bowed position, the extent to which the diaphragm moves outwardly being limited only by the extent to which it is capable of flexing. This snap action of the resilient diaphragm 46 is utilized to alter or modify the control of the valve 32, as will be described hereinafter.

It will be noted that the shell 44 sealed by the diaphragm 46, the opening 43 in the hub member 42, the expansible bellows 41, and opening 40 in the hub member 39 form a completely enclosed space. To the opening 40 of the hub member 39 is secured one end of a capillary tube 48, the opposite end of which is secured to a thermal bulb 49 positioned in thermal contact with the evaporator or cooling element 10, as shown in Fig. 2. The expansible bellows 41, capillary tube 48, and thermal bulb 49 constitute what is termed an expansible fluid thermostat which is filled with a suitable fluid that expands with an increase in temperature and becomes reduced in volume with a decrease in temperature. The shell 44 and cooperating diaphragm 46 form a hollow member which is in communication with the expansible fluid thermostat by means of passage 43 in hub member 42.

During normal operation of the machine the diaphragm member 46 is bowed outwardly and adapted to cooperate with the enlarged head 34 of the valve 32 to control the flow of gas to the burner 18. Thus, when the temperature of the evaporator 10 increases the expansion of the fluid within the bellows 41 will cause the latter to expand so as to move the diaphragm 46 to the right and move the valve 32 away from its seat at the bushing 30. Conversely, when the temperature of the evaporator 10 decreases the decrease in volume of the fluid within the bellows 41 will cause the latter to contract so as to move the diaphragm 46 to the left and permit the valve 32 to move toward its seat at the bushing 30.

In order that the capillary tube 48 will not appreciably affect any movement of the hub member 39 when the control mechanism is adjusted to its desired position, as will be hereinafter described, the portion thereof adjacent to the connection at the opening 40 of the hub member 39 is spiral-shaped, as shown in Fig. 3.

To adjust the expansible bellows 41 at any desired position to fix the position of the diaphragm 46 with respect to the head 34 of the valve 32, the cover plate 37 is provided with a central opening to receive a bushing 50 which is threadedly engaged to a sleeve 51. A pin 52 extends through the sleeve 51 and is provided with a threaded outer portion to receive a clamping nut 53 for drawing the inner flanged end 54 of the pin against the inner end of the sleeve and also secure a cap 55 over the outer ends of the pin 52 and sleeve 51.

A grooved pulley 56 is positioned over the cap 55 and secured thereto, as by a set-screw 57, and by rotating this pulley the pin 52 can be moved toward or away from the hub member 39 because of the threaded engagement of the sleeve 51 with the bushing 50. The inner end of the pin 52 is provided with a central protuberance 58 which is adapted to bear against or abut the end of the hub member 39. It will thus be seen that by rotating the pulley 56 to move the protuberance 58 toward the right it is operative to move the diaphragm 36 and expansible bellows 41 carried thereby toward the valve 32 and fix the diaphragm 46 at the desired position with respect to the head 34 of the valve 32. It will be noted that the diaphragm 36 is normally bowed or biased toward the cover plate 37 so that, when the protuberance 58 is moved toward the left, the flexible diaphragm 36 will of its own accord follow the protuberance until it is adjusted to its desired position to fix the position of the resilient diaphragm 46 with respect to the valve 32.

Although the temperature of the cooling element 10 may be controlled at the lower compartment 15 by providing a dial and employing a suitable control knob in place of the grooved pulley 56, it is preferred to employ the latter and provide suitable operating mechanism for controlling the machine at the upper compartment 11. As shown in Figs. 1 and 2, an indicating scale or dial 59 is mounted on the front of the cooling element 10 and a cooperating adjustment knob 60 provided which is fixed to a rod 61 that extends rearwardly through the rear wall of the chamber 11 into the vertical passage 16. To the rod 61 is secured a grooved pulley 62 which is similar to the grooved pulley 56 and operatively connected therewith by a flexible wire belt 63 having a guide tube 64. It will thus be seen that when the knob 60 at the front of the cooling element 10 is turned the rod 61 and grooved pulley 62 secured thereto are caused to rotate and effect, through the wire belt 64, rotation of the grooved pulley 56 associated with the control mechanism 22.

The control mechanism 22 is so constructed that only a half turn of the adjustment knob 60 is required to obtain full range adjustment of the thermostat for normal operation of the machine. To this end the hub member 39 is provided with a spiral cam 65 which extends about half-way or 180° around the periphery thereof, as shown most clearly in Fig. 5. Referring to Fig. 3, it will be noted that the inner end of the pin 52 is provided with a short radial arm 66 which is so positioned that it is adapted to ride on the cam 65 only when the pin 52 is moved more than a half-turn or 180°. A movement of more

than a half-turn is imparted to the pin **52** when the adjustment knob **60** is turned a like amount which, as shown in Fig. 1, will place the knob **60** in the position indicated at Defrost on the indicating scale **59**. When such a movement of more than a half-turn is imparted to the pin **52** the radial arm **66** rides on the cam **65** and causes the hub member **39** and flexible diaphragm **36** and parts carried thereby to move an abnormal distance toward the valve **32**. During this movement, the resilient diaphragm **46** contacts the head **34** which is stopped by the bushing **30**, and thus exerts a force on the diaphragm **46** which causes the latter to snap from its normally outwardly bowed position to an inwardly bowed position, as shown in dotted lines in Fig. 3. The adjustment knob **60** is then returned to a position at the lower half of the dial **59**, and in so turning the knob **60** the radial arm **66** is disengaged from the cam **65**.

With the resilient diaphragm **46** now in an inwardly bowed position, it will not be effective to open the valve **32** with a normal increase of the temperature of the cooling element **10**. As the temperature of the cooling element **10** increases, the bellows **41** expands and moves the diaphragm **46** toward the head **34** of the valve **32**. When the cooling element **10** reaches an abnormally high temperature, which temperature is preferably above the freezing temperature of water, the pressure of the fluid within the shell **44** is sufficiently great to force the diaphragm **46** to its outwardly bowed position so as to contact the head **34** and open the valve **32**.

During the period of time the diaphragm **46** is bowed inwardly and does not positively control the valve **32** the supply of gas to the burner **18** is reduced, thereby decreasing the heating of the generator **14** and permitting the temperature of the cooling element **10** to increase. When the temperature of the cooling element **10** increases to a value above the freezing temperature of water, frost that may have accumulated on the cooling element **10** will melt and can be collected in a suitable receptacle (not shown). The control mechanism is preferably adjusted so that, when the adjusting knob **60** is moved to initiate defrosting of the cooling element **10**, the latter will remain at a temperature above the freezing temperature of water sufficiently long to insure substantially complete melting of frost which has accumulated on the cooling element **10**.

When the diaphragm **46** is snapped to its outwardly bowed position, as described above, the valve **32** is immediately moved to an open position to permit heating of the generator **15** so that the temperature of the cooling element **10** will decrease to a value in the normal operating range of the machine. This normal value of temperature is determined, of course, by the position of the adjustment knob **60** at the lower half of the dial to which it has been returned after being moved momentarily to the upper half of the dial to initiate defrosting.

After the cooling element **10** reaches the normal temperature at which it is adjusted to operate, the control mechanism, with the diaphragm **46** in its outwardly bowed position, will be operative to control the valve **32** in response to temperature changes of the cooling element **10** to maintain the latter at a substantially constant temperature. When frost has again accumulated on the cooling element **10** to such an extent that defrosting is desired, the adjustment knob **60** is moved to the portion of the dial indicated Defrost and then returned to the lower half of the dial to a position at which it is desired that normal operation will resume after the defrosting has automatically terminated.

Although I have shown my improved control mechanism in connection with a particular type of refrigerator, I do not wish to be limited to the particular arrangement set forth, and I intend in the following claims to cover all modifications which do not depart from the spirit and scope of my invention.

What is claimed is:

1. Refrigeration apparatus including a thermostat operative responsive to a temperature condition affected by said apparatus and having a movable part, structure associating said movable part and said control device in a normal operative relation and including a flexible member anchored at opposite edge portions and flexed to a first position, means for flexing said flexible member to a second position to alter said normal operative relation, and means whereby said flexible member returns to said first position from said second position responsive to abnormal change in said temperature condition to restore said normal operative relation.

2. Refrigeration apparatus including a thermostat element operative responsive to a temperature condition affected by said apparatus, a device for controlling operation of said apparatus, a hollow member having a flexible snap-acting diaphragm anchored at its edge portions, and structure including said hollow member to provide a connection between said thermostat element and said control device so that the operative relation between said thermostat element and said control device is changed responsive to internal pressure on said diaphragm.

3. Refrigeration apparatus including an expansible fluid thermostat operative responsive to a temperature condition affected by said apparatus and having a movable part, a device for controlling operation of said apparatus, and structure for operatively associating said movable part and said control device and including a hollow member having a snap-action wall, the interior of said hollow member communicating with said expansible fluid thermostat to cause outward snapping of said wall to change the operative relation between said movable part and said control device responsive to pressure in said thermostat.

4. Refrigeration apparatus including a thermostat operative responsive to a temperature condition affected by said apparatus and having a movable part, structure adapted to connect said movable part and said control device and including a hollow member having a snap-action wall, said hollow member containing an expansible fluid affected by said temperature condition so as to cause outward snapping of said wall to change the operative relation between said movable part and said control device upon increase in said temperature condition.

5. Refrigeration apparatus including a cooling element, a device for controlling operation of said apparatus, a thermostat element operative responsive to a temperature condition affected by said cooling element, structure to provide a connection between said thermostat element and said control device and including a snap-acting flexible member anchored at opposite edge portions, means for snapping said flexible member in one direction to shorten the connection between said thermostat element and said control device, and

means responsive to change in said temperature condition for snapping said flexible member in the opposite direction to lengthen the connection between said thermostat element and said control device.

6. Refrigeration apparatus including a thermal element operative responsive to a temperature condition affected by said apparatus, a control member for controlling operation of said apparatus, structure associating said thermal element and said control member in a normal operative relation and including a flexible member anchored at opposite edge portions and flexed to a first position, means to bodily move said thermal element to cause said flexible member to flex to a second position to alter said normal operative relation, and means to return said flexible member to said first position to restore said normal operative relation.

7. Refrigeration apparatus including a thermostat element responsive to a temperature condition affected by said apparatus, a flexible member anchored at opposite edge portions and movable back and forth from a normally bowed position at one side of dead-center to a second bowed position at the opposite side of dead-center, structure associating said thermostat element and said control member in a normal operative relation and including said flexible member in said normally bowed position, and means for snapping said flexible member from its normally bowed position to said second position at the opposite side of dead-center to alter the normal operative relation of said thermostat element and said control member.

8. Refrigeration apparatus including a regulator operative responsive to a condition affected by said apparatus and including a movable part, a control member for controlling operation of said apparatus, structure associating said movable part and said control member whereby said regulator is capable of operating said control member, said structure including a flexible member limited in movement only by the extent to which it is capable of flexing and being so constructed and arranged that said movable part and said control member are associated in a normal operative relation when said flexible member is in a first position, means for flexing said flexible member to a second position to alter said normal operative relation, and means whereby said flexible member returns to said first position from said second position with rise of temperature to restore said normal operative relation.

ALBERT C. SMITH.