June 13, 1944. A. O. GROOMS 2,351,038

REFRIGERATING APPARATUS

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Fig. 2

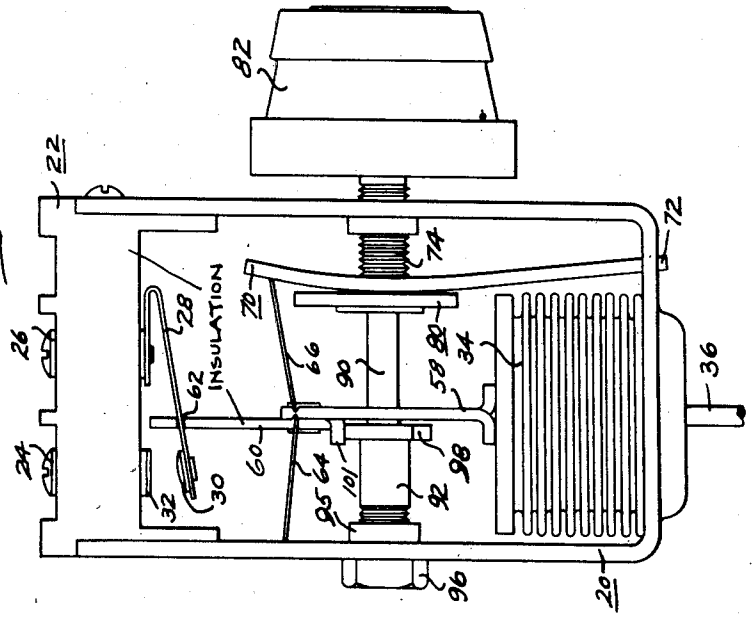
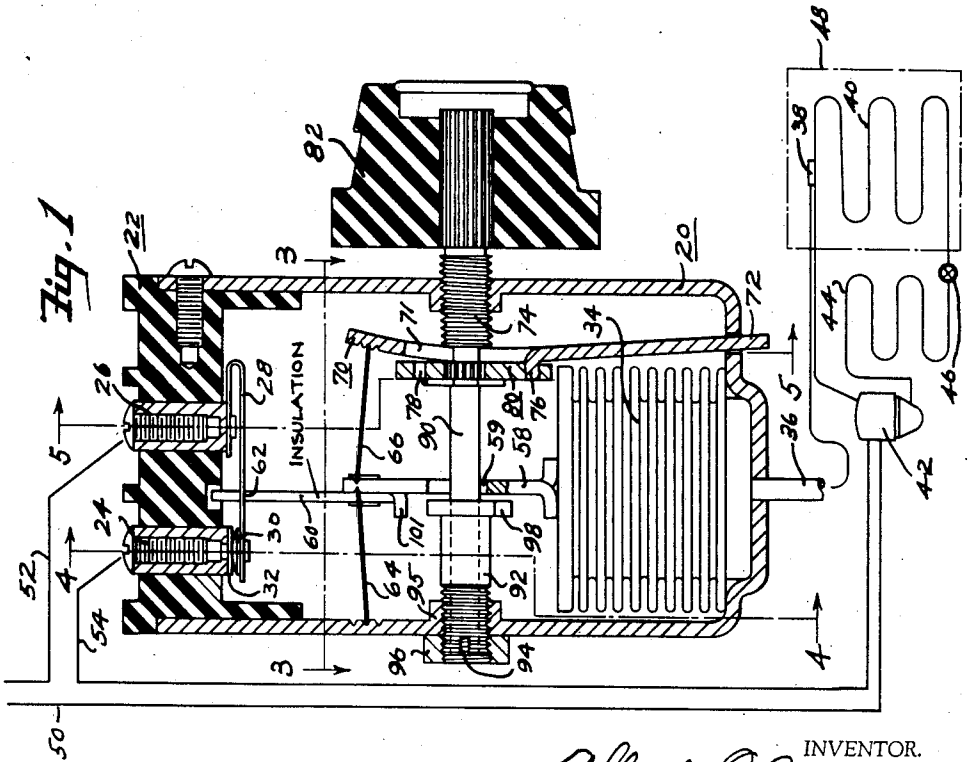


Fig. 1



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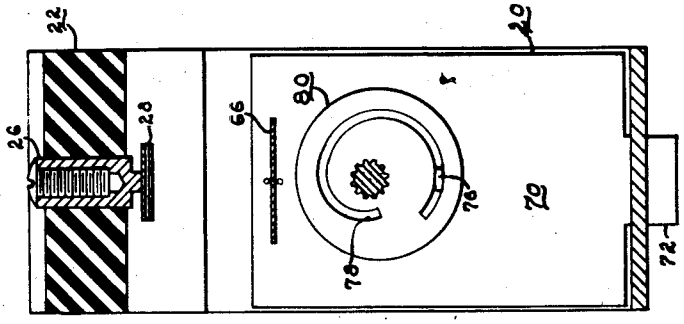


Fig. 5

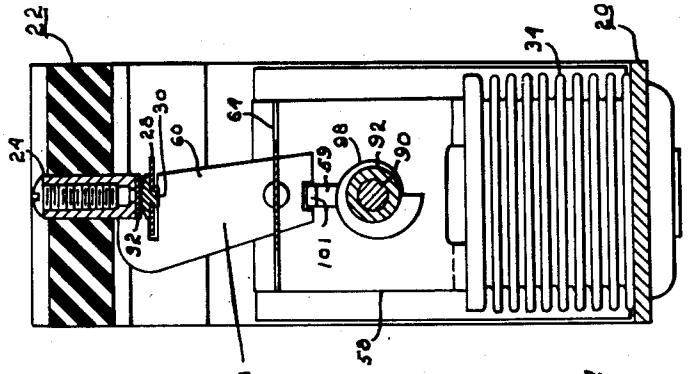


Fig. 4

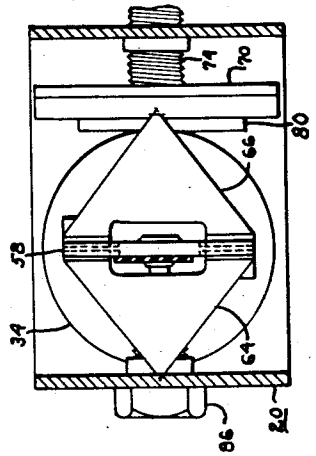


Fig. 3

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REFRIGERATING APPARATUS

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Application February 5, 1941, Serial No. 377,529

17 Claims. (Cl. 200—83)

This invention relates to temperature and/or pressure controls such as may be used for refrigerating apparatus as well as a large variety of other control applications.

Refrigerator control means formerly were huge cumbersome affairs which are expensive and unreliable. They have been constantly improved. I have found that one of the things which limit the improvement of refrigerator controls, particularly switches, is the use of a range spring for controlling the expansion of the bellows and for providing an adequate range adjustment. Also refrigerator switches have operated the contacts through a toggle mechanism which serve as the only connection between the bellows and the contacts. With such a construction the contact pressure was limited to the force provided by the toggle mechanism.

It is therefore an object of my invention to provide a control which has no conventional range spring.

It is another object of my invention to provide a snap switch in which the bellows provides contact pressure directly.

It is another object of my invention to provide a control and particularly a refrigerator switch which has the following advantages:

1. Simplicity
2. Few parts
3. A minimum of friction
4. A low differential
5. A wide differential adjustment
6. Adequate range adjustment
7. High contact pressure
8. High force to break or separate the contacts

It is another object of my invention to provide a control in which an adequate range adjustment is provided without the use of the conventional range spring.

It is still another object of my invention to provide a control with an improved differential adjustment.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a vertical sectional view through a refrigerator control embodying one form of my invention shown in the closed position with the range control in a low temperature position, together with a diagrammatic refrigerating system;

Fig. 2 is a similar view of the control shown in the open position with the range control in a high temperature position;

Fig. 3 is a sectional view taken along the lines 3—3 of Fig. 1;

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 1; and

Fig. 5 is a sectional view taken along the line 5—5 of Fig. 1.

Briefly, I have shown in the drawings a refrigerator switch which includes a bellows directly connected to the contacts. A pair of opposed toggle links act directly upon this direct connection and thereby control the movement of the direct connection to provide snap-action. The differential adjustment is controlled by a rotatable cam which limits the opening movement of the direct connection while the range adjustment is obtained by shifting the pivot point of one of the toggle links as well as by changing the force which tends to collapse the toggle links. The switch is prevented from closing at the highest point of the range adjustment. The direct connection moves mainly upon one side of the dead center position of the toggle and the bellows is mainly under compression but at times may be under a slight tension when the toggle goes over the dead center position.

Referring now more particularly to the drawings, there is shown a U-shaped metal frame member 20 which has a terminal member 22 of electrical insulating material connecting the two ends of the V-shaped frame member 20. This terminal member 22 is provided with two terminal posts 24 and 26 which extend through the terminal member. The inner end of the terminal post 26 has connected thereto a bent leaf spring contact-carrying member 28 which carries the movable contact 30. The terminal post 24 carries the stationary contact 32 which is electrically insulated from the movable contact 30 excepting when the contacts are in closed position.

The lower end of the U-shaped member 20 has the lower end of the flexible metal bellows 34 connected thereto. This bellows 34 is connected by a capillary tube 36 to a bulb portion 38 which for example, may be fastened in metal to metal contact with the evaporator 40 of a refrigerating system. This system also includes a sealed metal compressor unit 42, a condenser 44 and an expansion device 46 for controlling the expansion of the liquid refrigerant into the evaporator 40. The evaporator 40 may be used for cooling the compartment 48. One of the supply conductors 50 for the sealed unit is connected directly to the sealed unit 42 while the other supply conductor

52 is connected to the terminal post 26 while another conductor 54 connects the terminal post 24 to the sealed unit 42. While the switch is shown controlling a conventional refrigerating system for the purpose of illustrating one use thereof, the control may be used for controlling heating and other systems.

Fastened to the closed upper end of the bellows 34, which may be reinforced, if desired, is a metal follower member 58 provided at its lower end with a flange which may be soldered or welded to the upper closed end of the bellows 34. This follower member 58 has riveted to its upper end an insulated extension 60 provided with a slot 62 which receives an intermediate portion of the leaf spring member 28. On either side of the extension 60, the follower member is provided with V-shaped notches which receive the inner knife edges of the triangular shaped toggle links 64 and 66.

The pointed end of the toggle link 64 is preferably received in a conical shaped notch in the inner face of the U-shaped frame 20. Preferably notches are provided above and below the point for normal usage so that the range of the control may be extended in either direction for different applications without any replacement of parts. The toggle link 66 has its pointed end held within a small conical notch provided upon an adjustable spring bar 70. This spring 70 may likewise have a a series of notches above and below the normal position so as to extend the range of usage of the switch without the replacement of parts.

This spring bar 70 has a tongue 72 at its lower end which extends through an opening in the bottom of the U-shaped frame 20. This bar is acted upon by a shoulder upon the end of the threaded portion of an adjusting screw 74 threaded in a boss provided in the wall of the U-shaped frame member 20. This spring bar 70 also has a tongue 76 which extends into a spiral slot 78 which forms the cam surfaces of the cam 80 which is splined to the unthreaded portion of the threaded shaft 74. This threaded shaft 74 is provided with an adjustable knob 82. The spiral slot 78 limits the rotation of the knob 82 to slightly under one revolution.

The shaft 74, for the purpose of providing a proper support, extends to the opposite leg of the U-shaped frame member 20 which is provided with a bearing on the opposite side for this purpose. However, upon this opposite side of the control, an unthreaded portion 90 of the threaded shaft 74 telescopes within a cam shaft 92 which provides a bearing support and the cam shaft 92 in turn is rotatively mounted in the bearing 95 provided by extruding a flange from the side wall of the U-shaped frame member 20. The follower 58 is provided with an elongated aperture for providing clearance around the shaft portion 90 of the threaded shaft 74. Upon the outside of the frame member 20, the cam shaft 92 is provided with a screw driver slot 94 and a lock-nut 96 or some other suitable locking device. The cam shaft 92 at its inner end is provided with a spiral cam 98, located in the path of a follower projection 101 which is struck out from the bellows follower 58. This follower projection 101 strikes and rests upon the differential cam 98 when the switch contacts are moved to the open position.

The differential adjustment is made by rotating the cam 98 by a screw driver or similar device engaging the outer end of the cam shaft 92 so as to present a higher or lower portion of the cam 98 to the cam follower projection 101. This changes the open circuit position of the bellows follower 58 and also the open circuit position of the toggle links 64 and 66. This of course changes the angularity of the toggle pins when the contacts are open. The further the toggle links 64 and 66 are below the dead center position when the contacts are in open position the greater will be the differential. When the contacts are in the closed position the bottom of the clearance slot 59 rests against the unthreaded portion 90 of the screw 74. If desired, an adjusting screw may be provided in the terminal block for adjusting the closed position of the bellows follower 58.

It will be noted that the control has no range spring in the ordinary sense of the word. In order to provide a range adjustment the spring bar 70 is bodily moved upwardly or downwardly parallel to the bellows follower 58. This moves the pivot point at the outer end of the toggle link 66. At the same time, through the engagement of the screw 74 wih the spring bar 70, I change the tension of the spring pressure applied to the outer end of the toggle link 66. To set the range higher I raise the spring bar 70 and increase the tension of the spring bar 70 while to set the range lower I move the spring bar 70 downwardly and reduce its tension. This raising or lowering of the range is performed by rotating the knob 82 which causes the screw 74 to be threaded inwardly or outwardly against the spring bar 70 and it also rotates simultaneously the cam 80 so as to raise or lower the spring bar 70.

In this arrangement the bellows 34 acts as a very low rate spring and the change in the range is chiefly the result of the change in the position and the tension of the spring bar 70 causing the change in position of the toggle means relative to the movement of the bellows follower 58 and of the bellows 34. By this construction I obtain many advantages not found in prior controls. The switch is simple and has very few parts. None of the parts are complicated and all can be made with few and simple operations. Little assembly work is required. The bellows has a direct connection with the movable contact 30 through the bellows follower 58 so that the force provided by the pressure within the bellows can be exerted directly through the spring contact-carrying member 28 to hold the contact 30 tightly closed, while the spring force of the bellows 34 together with any vacuum which may be present within the bellows may aid the toggle mechanism in pulling the contacts apart. I prefer to charge the bulb 38 and the bellows 34 with a limited charge of sulphur dioxide since that gas is substantially at atmospheric pressure within the normal range of operation in a household refrigerator switch. However, limited charges of other volatile liquids may be used for this and other applications and other types of fluids may be used for operating the bellows. For example, for high temperature applications, such as water coolers, tetrafluorodichloro ethane (F-114) may be used, while methyl chloride may be used for low temperature applications such as ice cream cabinets.

This switch can be readily made with a much lower differential than has been heretofore feasible in household refrigerator controls. In spite of the low differential no difficulty is encountered in obtaining an adequate range adjustment be-

cause of the method of providing a range adjustment, namely by shifting the position of the toggle mechanism. Theoretically, a spring bar, such as the spring bar **70**, should be provided upon both sides of the control with one bar for the outer end of each toggle pin. While slightly better results could be obtained by such a construction I find that the increased complication required by such a construction is not warranted by any possible improvements in results excepting possibly in unusual situations. I find that altogether satisfactory results are obtained by the construction shown.

The control operates to the greater extent below the center line of the toggle links **64** and **66**. In the lower portions of the range adjustment I prefer to allow the toggle pins to go slightly across the dead center, as shown in Fig. 1. For all other positions I prefer to operate altogether upon the lower side of the dead center position, as shown in Fig. 2. In the highest position of the range adjustment, the opening force is so great that the switch with the limited charge provided will not open at room temperatures to provide a shut-off. I make the rate of the spring bar **70** itself sufficiently low so that the resultant toggle components are high enough that the force required to move the bellows follower upwardly from the open circuit position is greatest at the start of the movement so that when the movement starts it will go directly to completion at an accelerating speed so that the contacts **30** and **32** are moved rapidly to closed position. Upon the return movement, the contacts are opened with a similar snap action. In addition, the slot **62** is made sufficiently large so that there is some lost motion between the insulated member **60** and the spring contact-carrying member **28**. When the contacts are in the closed position the bottom of the slot **62** bears heavily upon the spring contact-carrying member **28**. When the bellows follower **58** moves downwardly the top of the slot **62** does not engage the spring contact-carrying member **28** until the bellows follower has begun to move downwardly at an accelerating speed. This provides a very desirable form of snap action which prevents unnecessary arcing and the burning of the contacts. For use with direct current, a "blow out" permanent magnet may be used to snuff out any arc at the contacts.

There is substantially no friction in the switch since the only pivot points are those of the toggle links **64** and **66** which are formed by knife edges. There is substantially no friction between the insulating extension **60** and the spring contact-carrying member **28** and the spring effect of the bellows **34** and the contact-carrying spring member **28** is comparatively low. By this new type of switch construction, I therefore obtain many advantageous features.

While the form of embodiment of the invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A control comprising an actuating means, toggle means connected to the actuating means, a control device operated by one of said means, and adjustment means for varying the movement of the actuating means and the toggle means said adjustment means including means effective in one position to cause the movement of said toggle means to be confined to one side of the dead center position of the toggle means, and effective in another position to cause the limits of movement to extend to opposite sides of the dead center position of the toggle means.

2. A control comprising an actuating means, a toggle means connected to the actuating means for controlling the movement of the actuating means, adjustment means effective in one position for setting the termination of movement of the actuating means in one direction directly adjacent one side of the dead center position of the toggle means and effective in a second position for terminating the movement in the same direction directly adjacent the opposite side of the dead center position of the toggle means, and means for varying the termination of the movement in the opposite direction for varying the differential of the control.

3. A control comprising an actuating means, a switch contact device, positive connecting means providing a positive connection between said means and said device for moving said switch contact device in substantially direct proportion to the movement of the actuating means for applying a positive contact closing force to said device, and toggle means for controlling the movement of one of said means.

4. A control comprising an actuating means, a switch contact device, positive connecting means providing a positive connection between said means and said device for moving said switch contact device in substantially direct proportion to the movement of the actuating means for applying a positive contact closing force to said device, toggle means for controlling the movement of one of said means, and adjustment means for varying the dead center position of the toggle means in the direction of movement of one of the other means.

5. A control comprising actuating means, a control device movable to first and second control positions, positive connecting means positively connecting said actuating means and said control device for moving said control device in substantially direct proportion to the movement of said actuating means, a support means, adjustable means for moving said support means generally parallel to the movement of said connecting means, and toggle means connecting said support means and said connecting means for controlling the movement of the connecting means.

6. A control comprising actuating means, a control device movable to first and second control positions, positive connecting means positively connecting said actuating means and said control device for moving said control device in substantially direct proportion to the movement of said actuating means, a support means, adjustable means for moving said support means generally parallel to the movement of said connecting means, a toggle link linking said connecting means and said support means, said support means incorporating spring means for applying a column load to the toggle link.

7. A control comprising actuating means, a control device movable to first and second control positions, positive connecting means positively connecting said actuating means and said control device for moving said control device in substantially direct proportion to the movement of said actuating means, a support means, adjustable means for moving said support means generally parallel to the movement of said connecting means, a toggle link linking said connecting means and said support means, said support means incorporating spring means for applying

a column load to the toggle link, and means for varying the tension of said spring means.

8. A control comprising actuating means, a control device movable to first and second control positions, positive connecting means positively connecting said actuating means and said control device for moving said control device in substantially direct proportion to the movement of said actuating means, a toggle means having one end pivoted to one of said means, and a spring means pivotally connected to said toggle means.

9. A control comprising actuating means, a control device movable to first and second control positions, positive connecting means positively connecting said actuating means and said control device for moving said control device in substantially direct proportion to the movement of said actuating means, a toggle means having one end pivoted to one of said means, a spring means pivotally connected to said toggle means, and means for adjusting said spring means.

10. A control comprising actuating means, a control device movable to first and second control positions, positive connecting means positively connecting said actuating means and said control device for moving said control device in substantially direct proportion to the movement of said actuating means, a toggle means having one end pivoted to one of said means, and adjustment means for moving the other end of the toggle means.

11. A control comprising actuating means, a switch contact device movable to first and second control positions, positive connecting means positively connecting said actuating means and said switch contact device for moving said switch contact device in substantially direct proportion to the movement of said actuating means and for applying a positive contact closing force to said contact device, a pair of toggle links extending on opposite sides of and each being pivotally connected at one end to one of said means, a spring means for applying a column load to said links.

12. A control comprising actuating means, a control device movable to first and second control positions, positive connecting means positively connecting said actuating means and said control device for moving said control device in substantially direct proportion to the movement of said actuating means, a pair of toggle links extending on opposite sides of and each being pivotally connected at one end to one of said means, a spring means for applying a column load to said links, and adjustment means for moving the other end of one of said toggle links.

13. A control comprising actuating means, a control device movable to first and second control positions, positive connecting means positively connecting said actuating means and said control device for moving said control device in substantially direct proportion to the movement of said actuating means, a pair of toggle links extending on opposite sides of and each being pivotally connected at one end to one of said means, an anchorage for the other end of each of said toggle links, and adjustment means for adjusting one of said anchorages in a direction generally parallel to the movement of said one means.

14. A control comprising an actuating means, a switch contact device, positive connecting means extending directly between the actuating means and the switch contact device for positively providing a movement of the switch contact device substantially in proportion to the movement of the actuating means and for applying a positive contact closing force to said contact device, a toggle means for controlling the movement of one of said means, and an adjustable stop for limiting the movement of said connecting means in one direction.

15. A control comprising an actuating means, a control device operated by said actuating means, a toggle link connected to one of said means, a flat spring bar connected to and exerting a yielding force upon the end of said toggle link for providing a snap action, and adjusting means for moving the spring bar relative to one of said means in a direction transverse to said toggle link for varying the tripping point of said link.

16. A control comprising an actuating means, a control device movable to first and second control positions, a positive two way constant ratio power transmitting connecting means connecting said actuating means and said control device for positively operating said control device to and from both said first and second control positions in movements every part of which is substantially in a constant ratio to the movement of the actuating means, and toggle means having its greatest resistance to movement at the beginning of the movement of the control device from its first and second control positions and providing an acceleration of the movement as the movement progresses for controlling the movement of one of said means, said toggle means including a substantially rigid link and a low rate spring having a small change in force for the amount of deflection caused by the movement of the link.

17. A control comprising a control means movable to first and second control positions, an actuating means operably connected to the control means for moving the control means to and from said positions, toggle means for controlling the movement of one of said means to provide a snap acting movement, said toggle means including a toggle spring, adjustment means for directly adjusting the tension of said toggle spring, and adjustment means for adjusting the dead center position of the toggle means.

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