July 21, 1970 R. H. THORNER 3,521,211

SWITCH AND DELAY MECHANISM

Filed Aug. 22, 1968 2 Sheets-Sheet 1

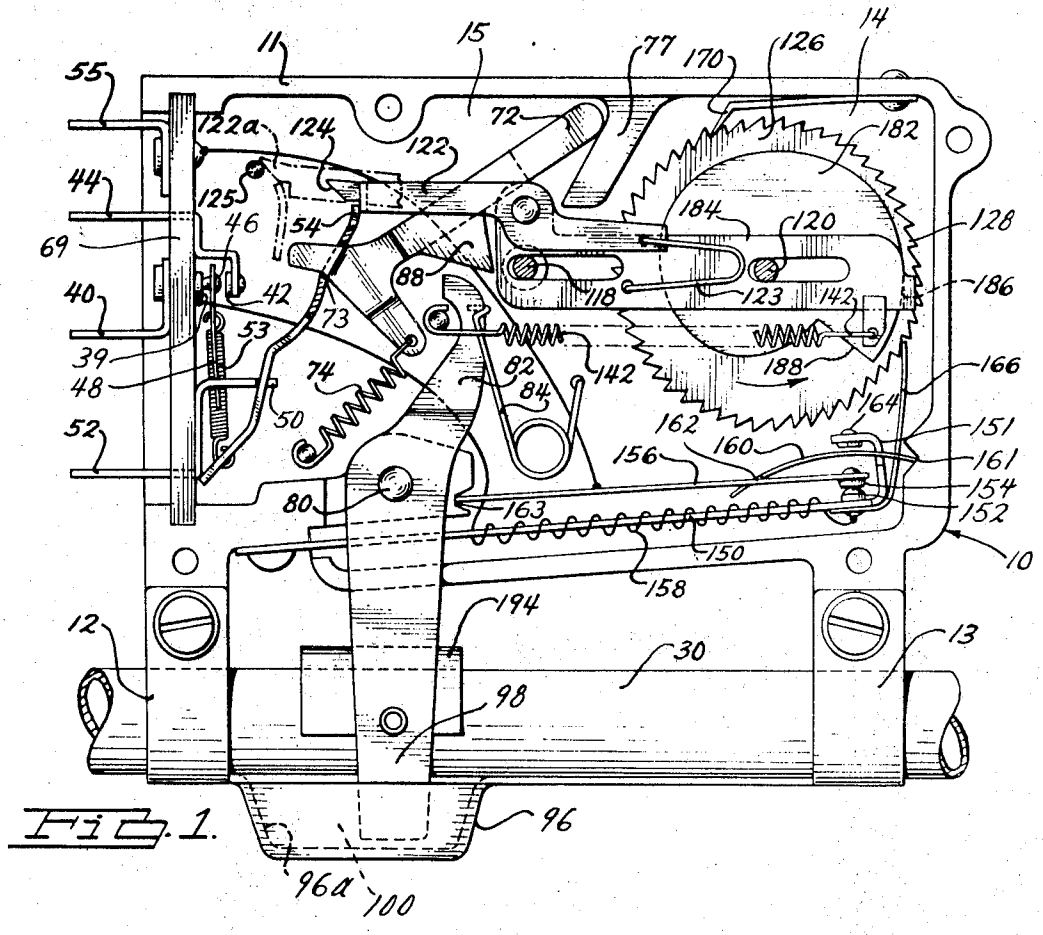


Fig. 1.

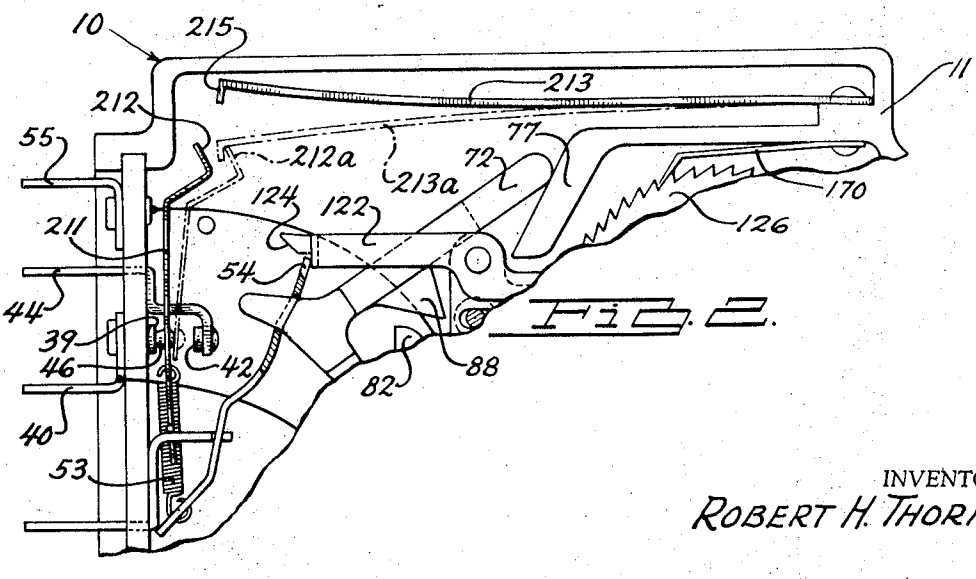


Fig. 2.

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July 21, 1970 R. H. THORNER 3,521,211

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Filed Aug. 22, 1968 2 Sheets-Sheet 2

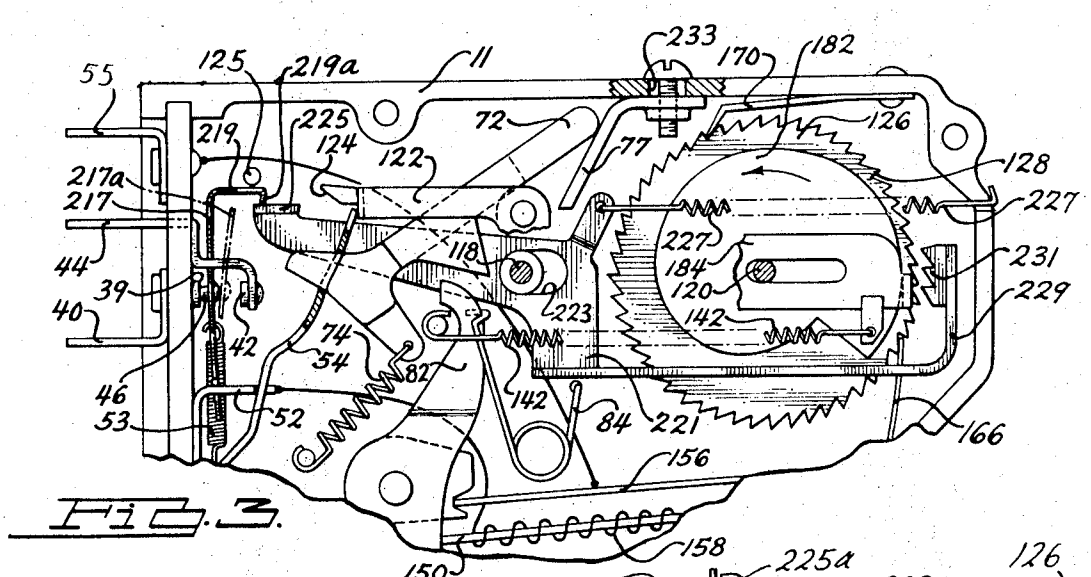


FIG. 3.

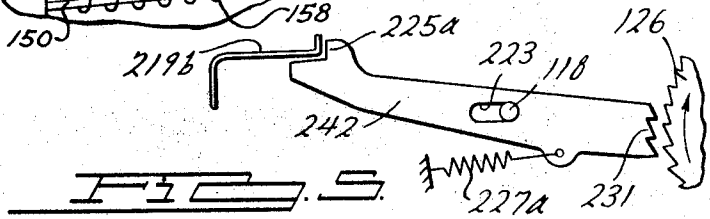


FIG. 5.

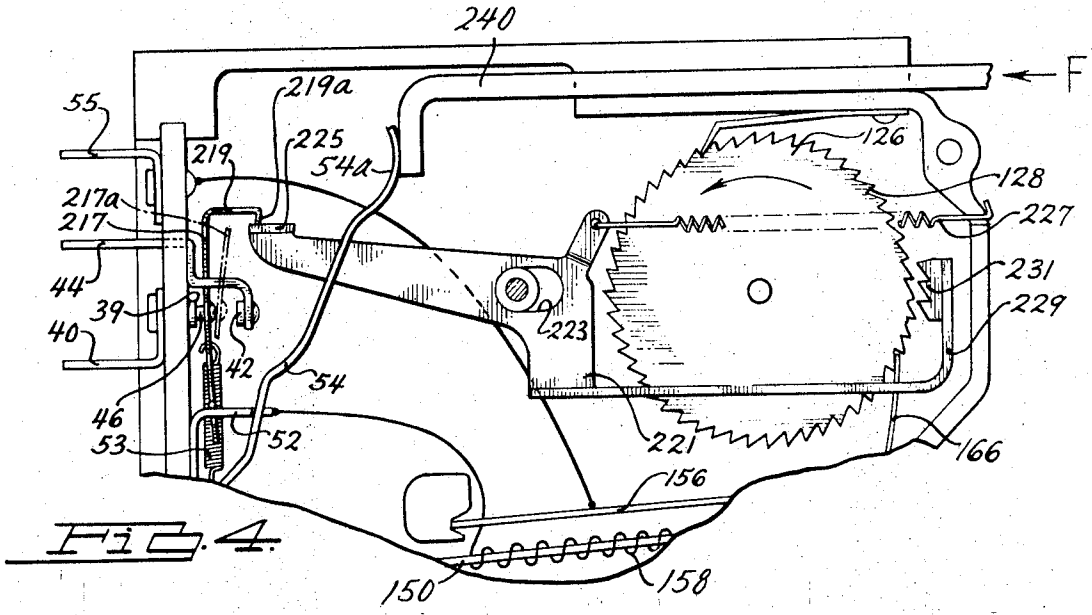


FIG. 4.

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SWITCH AND DELAY MECHANISM

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Continuation-in-part of application Ser. No. 544,960, Apr. 25, 1966, now Patent No. 3,399,541, dated Sept. 3, 1968. This application Aug. 22, 1968, Ser. No. 754,605

Int. Cl. H01h *37/02, 37/52, 37/62*

U.S. Cl. 337—301 19 Claims

ABSTRACT OF THE DISCLOSURE

An electric switch delay mechanism is provided and a novel switch mechanism is adapted to be operated by the delay mechanism. A delay mechanism includes a latch or clutch member adapted to engage and hold the switch blade of a snap-action switch between its total travel to delay the initial or final action of the switch until released as a function of time or temperature, for example. The novel switch includes a unique switch blade to cooperate with the delay mechanism to provide the same action in a single switch as normally provided in two switches.

This application is a continuation-in-part of my application, Ser. No. 544,960 filed Apr. 25, 1966 for "Control Device for Refrigeration System," now Pat. No. 3,399,541.

The present invention relates to a switch mechanism and a mechanism for delaying the action of one of the movable elements of a snap-action switch as a function of time, temperature, or any other control function.

At the present time, mechanisms which can delay the action of a switch for an extended time (such as 4 minutes or more) are very expensive. Also, the present low cost switch delay mechanisms are usually limited to short time-intervals and are limited in their application since they can only delay the "on" or "off" positions of a switch. Frequently it is desired to operate switch means in three positions in which two of the positions conduct current with the third position not conducting current. In this instnace, when snap-action switches are used, two switches are usually required.

One of the objects of the present invention is to provide an improved delay mechanism of very simple construction to enable low cost manufacture, and in which relatively long time-delays are possible.

Another object of the present invention is to provide an improved delay mechanism of the character specified in the preceding paragraph, and which includes a simple thermal timer mechanism enabling improved reliability and low-cost manufacture.

A further object of the present invention is to provide an improved switch mechanism, per se, or in combination with the delay mechanism specified in the preceding paragraphs which, in a single switch provides the action of a plurality of switches.

Further objects and advantages of the present invention will be apparent from the following description, taken in connection with the appended drawings, in which:

FIG. 1 is an elevational view of the control device for illustrating an application of the present invention;

FIG. 2 is a fragmentary elevational view of a modified form of the illustrated control device showing a temperature-sensitive form of the present invention;

FIG. 3 is a fragmentary elevational view of a modified form of the illustrated control device showing a time-sensitive form of the present invention;

FIG. 4 is a fragmentary elevational view of a modified

form of the invention for use in any kind of control device responsive to any kind of controlled condition;

FIG. 5 is an elevational view of the main elements to modify the form of the invention shown in FIG. 4 to provide a reverse action;

It is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

Referring to FIGS. 1, 2 and 3, which are the same as FIGS. 6, 12 and 13, respectviely, of the parent application, Ser. No. 544,960, the present invention will first be illustrated as part of a defrost control for refrigeration machines. The defrost control device, per se, is not the subject of the present invention, since it was completely described and claimed in the parent application.

Referring to FIG. 1, the entire defroster control is shown encased in a housing **11**, and includes a pair of legs or supports **12** and **13** adapted to be secured to the refrigerator at any suitable position on the frost-forming surface. The defroster control may be considered to comprise two components; one component comprises an initiating mechanism or means **14**; and the second component comprises a termination mechanism **15** which controls the duration (or termination) of the defrosting action as shown in FIG. 1.

Temporarily referring to FIG. 1, to be discussed in detail hereinafter, the termination mechanism **15** comprises switching means including an electric switch having a fixed abutment or contact **39** connected to a terminal **40**, and an opposed fixed abutment or contact **42** connected to a terminal **44**. A movable switching contact **46** is carried by a switch blade or arm **48** swingable about a knife-edge connection in a support **50** which is connected to a stationary terminal **52**. A strong extension spring **53** is connected at one end to the contact arm **48** and at its other end to switch actuator means including an actuator arm **54** which has knife-edge connection with support **50**. The switch is shown in its normal position without the defrosting system in operation, and in this position terminal **52** is electrically connected to terminal **40** through contact **46** resting on contact **39** by the force of spring **53**. When arm **54** is moved to the left, as viewed in FIG. 1, by means to be described, spring **53** is moved over-center to the right, as viewed in FIG. 1, so that contact **46** snaps against contact **42** to electrically disconnect terminal **52** from terminal **40** and connect to terminal **44**. In this position, however, the spring **53** maintains a relatively large force urging the arm **54** back to the original position shown in the drawings since the position of the spring is always at the left of the fulcrum of the arm **54**. When arm **54** is moved back to its original position shown, the contact **46** is also snapped back to its original position as shown in FIG. 1. Another terminal **55** is provided for reasons to be discussed hereinafter.

The action of the refrigerator and defroster control is as follows: When the refrigerator thermostat switch (not shown) is closed, with the defroster control switch in the position shown in FIG. 1, the compressor lowers the freezer temperature in a normal manner until shut off by the thermostat. However, when the defroster control causes arm **54** to move to the left in a manner to be described, the refrigerator compressor is turned off and the defrost heater is energized until all the frost melts and is evaporated, all in a manner well known in the art. At this time the air circulation fan is turned off when contact **46** leaves contact **39**. Afer all the frost is melted, the

defroster control causes arm **54** and contact **46** to return to the position shown in FIG. 1, by means to be described, which restores normal refrigeration and starts the circulation fan.

Now referring to FIG. **1**, the means to control the termination of the defrosting action will first be explained. In the component **15**, the mechanism is encased in the housing **11** of any suitable material such as molded plastic. A wall of the housing is formed by the electrical insulating base **69** for the switch, which base is inserted in slots molded in the housing and retained by the housing cover which is shown removed in FIG. 1. In component **15**, the arm **54** carries a detent member **72** hinged thereto by a knife-edge **73** at one end to permit angular movements of the detent in relation to arm **54**. A light extension spring **74** is suitably secured at one end to the housing **11** (or to a post secured thereto) and at its other end to a portion of detent **72** urging the detent downwardly into engagement with a cam or guide member **77**.

A shaft **80**, which may be a molded portion of the plastic housing **11**, is provided to support a latch member or arm **82** for angular movements with respect to the shaft. A very light torsion spring **84** is suitably supported by a cylindrical projection of molded housing **11** to abut latch member **82** and to urge same in a counterclockwise direction into the free position shown in FIG. 1 into abutment with stop means to be discussed. Detent **72** includes a catch portion **88** disposed to engage latch member **82** in a manner to be described.

A small vessel **96**, as shown in FIG. 1, is suitably secured to a portion of the evaporator tube **30** such that the vessel is at least partly below the tubing. The vessel, which is filled with a freezable liquid such as water, may be made of any suitable material. The vessel is mounted to enable a sensing member **98**, which comprises a portion of latch member **82**, to extend inside an ice chamber **100** formed by the vessel. Whenever the water in vessel **100** is frozen, the sensor portion **98** is embedded and "locked" in the ice to prevent clockwise rotation of the arm **82**.

The operation of the termination mechanism above described is as follows. Referring to FIG. 1, assume that chamber **100** of vessel **96** is completely filled with water or other freezable liquid which is frozen in normal refrigerator operation. After frost forms on the evaporator **30** to an undesirable amount, the arm **54** is automatically moved temporarily to the left by means to be described. This action causes contact **46** to move against contact **42** which inactivates the compressor and circulation fan but energizes the defrost heater adjacent the evaporator for melting and disposing of the frost. At this time the ice or frozen liquid in vessel **96** is also subjected to heat somewhat by radiation but primarily by conduction from the defrost heater. Also, movement of the switch arm to its leftward position carries detent **72** leftward until spring **74** causes catch portion **88** to engage latch arm **82**. The leftward actuating force on arm **54** is simultaneously removed, as will be described. Then the force of spring **53** tends to return arm **54** into the position shown with a force that easily overpowers the force of spring **84**. Such forces are transmitted through detent **72** which now abuts latch arm **82** at catch portion **88** tending to impart clockwise angular movement to arm **82**. However, such angular movements are prevented by the sensor **98** now abutting against the ice or frozen liquid in vessel **96** which tends to be compressed between the sensor **98** and the inside wall **96***a* of the vessel. Thus, the ice acts as an ice or frozen-liquid "link" which grows smaller *gradually* as the ice or frozen-liquid progressively melts since contact with the melting ice is maintained by spring **53**. As arm **54** with its detent member **72** *gradually* moves rightwardly when the ice in vessel **96** melts, the end of the detent member rides on cam **77** which *gradually* raises the detent member in opposition to spring **74**. After a predetermined travel of arm **54** and detent **72** which is calibrated to occur when *all* the frost is melted, the catch portion **88** disengages from latch arm **82**. This instantly causes two simultaneous actions as follows: The first action is that spring **84** instantly returns latch member **82** counterclockwise into the angular position shown in FIG. 1; accordingly the sensor **98** is moved through the path of melted ice and away from the remaining ice and restored to its original position shown. The second simultaneous action is that the high force of spring **53** causes arm **54** and detent **72** to snap into the positions shown in FIG. 1, which also moves the contact **46** into the position shown against contact **39**. This terminating action de-energizes the defrost heater and starts the compressor and air circulation fan so that refrigerator operation is again normal. The compressor is again controlled only by the refrigerator thermostat, and the ice in the vessel **96** soon freezes so that the defrosting cycle can be repeated as above described.

Means are provided to produce the small input power force or energy required to operate the initiation mechanism. In the form of the defrost control illustrated in FIG. 1, such input-power means comprises a heat-sensitive element which alternately is heated and cooled under control of a switch operated by the element itself to alternate the application of the heat energy. Referring to FIG. 1, the thermal element illustrated therein comprises a bimetal leaf or strip cantilever member **150** suitably secured at one end to housing **11**. The bimetal includes a U-shaped end portion **151**. An electric-switch contact **152** is carried by the bimetal to alternately engage another contact **154** carried by a knife-edge arm or blade **156** disposed for arcuate movements within the U-portion **151**. The contact **152** is insulated from the bimetal by suitable non-conducting material wherein the bimetal is electrically inert. An electric heating element or heater **158** is shown connected between terminals **40** and **55** and is controlled by contacts **152** and **154**. The heating element **158** is either wound around bimetal **150** or otherwise mounted adjacent thereto. A bowed U-shaped leaf member **160** has one end projecting through an aperture at an intersecting point **162** in blade **156** and the other end in a V-slot **161** molded in housing **11** to urge the knife end of blade **156** against another V-slot **163** in housing **11**. The force of leaf member **160** causes blade **156** to snap either up or down as the intersecting point **162** passes above or below, respectively, a straight line between the two V-slots in housing **11**. In this manner, contacts **152** and **154** are snapped apart or together as shown. When the bimetal **150** is heated after about one to two minutes, for example, it moves upwardly enough to snap contact **154** away from contact **152** against a plastic stop **164** secured to U-portion **151**, thereby de-energizing the heater **158**. The bimetal now cools and warps downwardly for about one or two minutes until contact **154** passes the mid-position of intersection point **162** to snap the contacts together and re-energize heater **158**. In this manner, the heating and cooling cycle is continuous while the compresser is in operation as illustrated in FIG. 1, to be discussed further.

This particular "flasher-type" self-controlling switch has utility, per se, especially when provided as a part of a bimetal timer in the present invention. This unique construction enables design-selection of the time for the heating portion of the cycle and also the time for the cooling portion of the total time-cycle. This is accomplished by (1) varying the distance between contact **152** and the stop **164** and (2) the initial angular position of bimetal **150** in relation to the line between the two V-slots **161** and **163**. An increase in the distance between contact **152** and stop **154** increases the time of the overall cycle, and conversely. If the bimetal is initially positioned so that contact **152** is closer to the line between slots **161** and **163** than stop **164**, the heating time tends to be less than the cooling time, and conversely. This general principle is modified somewhat by other factors such as the rate of heating of the various elements compared to

the rate of cooling thereof, but this unique construction enables some design control separately of the heating and cooling periods.

A ratchet arm, such as leaf element **166**, is secured to bimetal **150** and is insulated by suitable means to be electrically inert. The ratchet-arm and bimetal together comprise the movable actuating means. The ratchet arm engages the teeth **128** of wheel **126** so that each downward movement of bimetal **150** moves wheel **126** one tooth-length in a counterclockwise direction; reverse movements are prevented by a pawl **170**. With 60 teeth in wheel **126**, for example, and a total bimetal time cycle of 3 minutes, the wheel will rotate one turn in 180 minutes or three hours. Hence, in this example, the defroster control "fires" once every three hours of compressor operation.

Means for storing energy in spring **142** comprises a cam **182** which is connected to or is a part of the ratchet wheel **126** for rotation therewith when bimetal **150** reciprocates upon heating and cooling thereof, all as described above. An actuator power element **184** includes a cam follower tab **186** which projects over the cam surface for moving actuator **184** rightwardly upon rotation of wheel **126** counterclockwise. When the energy is stored in spring **142**, a step **188** of cam **182** passes by tab **186** to release actuator **184** which initiates the defrosting action.

The open vessel **96** is mounted adjacent coil **30** in the flow path of melted frost. The latch member **82** includes the sensing portion **98** projecting within the vessel to abut ice between it and the left wall **96***a* of the vessel during the defrosting periods. A semi-cylindrical starter member **194** is loosely connected to sensor **98** with universal movement for enabling the starter to slide on tube **30**. When the refrigerator is first placed in service with no water in vessel **96**, the starter **194** is restrained by resistance of frost on tube **30**. The melted frost gradually fills vessel **96** in subsequent defrost cycles, and the vessel is maintained full in this manner thereafter. A more complete discussion of this form of ice sensor is presented in my Pat. No. 3,350,894.

FIGS. 2 and 3 disclose modifications of the prior form of the invention, which modifications include novel means for delaying the compressor (and/or fan) operation after termination of the defroster cycle. In the form shown in FIG. 2, the switch blade **211** differs from blade **48** because of extension **212** which extends to the side of terminal-piece **44**. The contact **42** is spaced further from contact **39** than in the prior form of the invention to provide increased travel, such as 50–75% more, for example. A bimetal restrainer or latch member **213** is suitably secured to housing **11**, as by riveting, and includes a catch portion **215** disposed to restrain extension **212** in the following manner: the bimetal **213** is shown in the cold position during normal refrigeration when the temperature surrounding the defroster control might be —15 degrees F., for example. When the latch **122** is caused to actuate arm **54**, contact **46** snaps from contact **39** to contact **42** to start the defrost heater and stop the compressor and circulation fan. When all the frost has melted, the ambient temperature is about 65 degrees F. This high temperature causes the bimetal **213** to warp downwardly (FIG. 2) to the position **213***a*, shown dotted. When the defrosting cycle is terminated, the detent **72** and arm **54** are released from latch member **82** so that blade **211** snaps to the left to the position **212***a*. However, the catch portion **215** of bimetal **213** holds and detains the blade extension **212** in a position to maintain contact **46** part-way between contacts **39** and **42**. At this time, the defrost heater is off, and the compressor is not started. When the ambient temperature cools to about 25–30° F., for example, bimetal **213** warps upwardly enough to release the end of extension **212**, and contact **46** then snaps to contact **39** to start the compressor and fan. The catch **215** can be made of plastic and secured to the bimetal to make it inert electrically. A delay mechanism is desired by some refrigerator manufacturers to enable the referigerant to cool down before starting the compressor.

The modification shown in FIG. 3 provides a delay of the switch action in the same manner as in FIG. 2, except the delay is based on time instead of temperature. In FIG. 3, a switch blade **217** includes an extension **219** with a catch portion **219***a* arranged so that the extension is behind terminal portion **44**. A restrainer or clutch member **221** includes a slot **223** cooperating with the boss of shaft **118** to provide a hinge for enabling slight angular and longitudinal movements of the restrainer **221**. The restrainer includes a latch portion **225** adapted to cooperate with extension **219**. A spring **227** has one end connected to the housing and provides a very light force (such as one-half ounce) to urge restrainer **221** in both a rightward movement and a slight clockwise movement. Spring **227** is always overpowered by spring **53** which provides a force acting on extension **219** of about 6 ounces, for example. The restrainer includes a clutch or lock-portion **229** including teeth **231** disposed to engage the teeth **128** of wheel **126**. The heater element **158** must be connected to terminal **52** so that the wheel **126** rotates at all times in the modification of FIG. 3.

In operation, when arm **54** is moved to the left to initiate the defrost action, contact **46** snaps to contact **42** which is spaced further from contact **39** as in the form of FIG. 2, thereby energizing the defrost heater. At this time the blade extension catch **219***a* passes over the end of latch portion **225**. When detent **72** is released from latch member **82** at the end of the defrost cycle, the switch blade **217** snaps to the left when arm **54** snaps to the right. This action causes blade extension **219** to abut latch portion **225** and move restrainer member **221** to the left, as viewed in FIG. 3. This movement is terminated when the teeth **231** engage the teeth **128** of wheel **126**; at this time the contact **46** is held in a position between contacts **39** and **42** so that the defrost heater, the compressor and the fan are all off. As the wheel **126** is rotated the restrainer is revolved counterclockwise about shaft **118**. After about 6 to 10 minutes of such angular rotation, extension **219** is released from latch portion **225** so that the contact **46** snaps to contact **39** to start the compressor and fan. In this manner, the desired delay of refrigeration is provided as a function of time.

In the delay mechanism of FIG. 2, the heater **158** can be connected to terminal **40** as shown, because the wheel **126** can be stopped during the defrost cycle since the delay is a function of temperature. Hence, in the delay mechanism of FIG. 2, the timer mechanism can operate either only during compressor operation or all the time.

It is important to appreciate that, while the particular switch mechanism disclosed in FIGS. 2 and 3 has great utility, other switch arrangements can be operated by the temperature or time responsive means disclosed in FIGS. 2 and 3, respectively. For example, it is possible to provide two separate switch blades with separate sets of contacts having normal travel; the delay mechanism then can hold one of the switch blades from complete movement whereas both switches must be closed to start the compressor. However the switch disclosed herein is simpler and smaller. Also, in all forms of the invention, the switch has been illustrated with the switch actuator **54** only stable in one position. The inventive concepts disclosed herein apply equally well to switches in which the switch actuator is stable in two positions.

FIG. 4 illustrates the mechanism disclosed in FIG. 3 applied to any type of mechanism in which any signal operates a switch, and the action of the switch is delayed in either of its two operating directions. In the example shown in FIG. 4, an actuator **240** is operated to the left, as viewed in FIG. 4 by any signal force F,

so that the arm extension **54***a* causes contact **42** and extension catch **219***a* to move to the right, and operate in the same manner as described in FIG. 3. The force F could be produced, for example, by a temperature or pressure-responsive bellows or diaphragm, or by manual means, or as a position stop for a traveling element of any machine, etc. Then, when the signal force F is removed, the switch-blade is delayed by catch **219***a* a predetermined period of time in the manner described in reference to FIG. 3. Also, when force F is removed, the switch arm **54** and actuator are returned to the positions shown in FIG. 4 by the force of spring **53**; but the switch-blade does not return to its initial position shown until released by the catch **219***a* after the time-delay period. In FIG. 4, the heater **158** is connected across the line terminals as shown, so that the bimetal operates wheel **126** continuously.

Referring to FIG. 5, a modified construction is illustrated to provide an action reverse from the action of the form of the invention shown in FIG. 4.

In FIG. 5, a clutch member **242** takes a different form than the clutch member **221** in FIG. 4. The extension catch **219***b* of the switch blade **217** cooperates with a latch portion **225***a* to provide the desired action. The pin **118** supports the member **242** in slot **223** to enable rightward and leftward movement of the member to engage or disengage, respectively, with the teeth **128** of the ratchet wheel **126**. The ratchet wheel in FIG. 5 is caused to revolve in a clockwise direction by the bimetal **150** (in a manner shown in FIG. 1 of the parent application) in order to provide a counterclockwise movement of the clutch member when engaged with the ratchet member in opposition to spring **227***a* which also pulls the member in a leftward direction. In operation, when the actuator **240** and arm **54** are moved to the left, as viewed in FIG. 4, the catch **219***b* abuts the latch portion **225***a* as shown wherein the spring **53** moves the clutch member **242** to the right into engagement with the teeth of the ratchet member **126**. This action stops the contact **46** in a position between the fixed contacts **39** and **42**. At the same time, the ratchet wheel rotation causes the latch portion **225***a* to move downwardly, as viewed in FIG. 5, for a predetermined period of (delay) time until it clears the end of the catch **219***b*. At this time (at the end of the delay period), two separate actions occur: The first action is that the contact **46** snaps into abutment with contact **42**. In the second action the spring **227***a* returns the latch member to the position shown in FIG. 5 out of engagement with the ratchet wheel **126**. When the actuator and switch arm again return to the position shown (in FIG. 4), the switch blade snaps back to the position shown, so that the rotary effect of spring **227***a* causes the latch portion **225***a* to return to the position shown in FIG. 5, so that the cycle can be repeated.

In all forms of the present invention, if desired, any other motor timer such as a more expensive electric motor timer with gear reduction may be used in place of the bimetal timer shown herein. In this event, the clutch members **221** or **242** would engage any gear of the gear train to provide a wide range of time delays. Adjustment of the time delay in all forms of the invention may be provided by a rheostat in series with the bimetal heater **158**.

What I claim is:

1. In a mechanism including a snap-action device, the combination comprising; two fixed abutments, control means including a member reciprocally movable in a predetermined path of travel between said two abutments, actuator means operatively connected to said control means and including means operable to cause said member to snap from one of said abutments to the second of said abutments, and delay means cooperating with said movable member and operable independently of said actuator means to hold and detain said member temporarily in a position between said two abutments.

2. In a mechanism includling a snap-action switch mounted in a housing, the combination of; two fixed abutments mounted on said housing, at least one of said abutments comprising a fixed contact, switching means including a switching contact adapted to abut said fixed contact and reciprocally movable in a predetermined path of travel between said two abutments, switch actuator means operatively connected to said switching means and including spring means operable to cause said switching contact to snap from one of said abutments to the second of said abutments, and delay means cooperating with said movable switching means and including means to hold and detain said movable contact temporarily in a position between said two abutments.

3. In a mechanism including a snap-action switch mounted in a housing, the combination of; two fixed abutments mounted on said housing, at least one of said abutments comprising a fixed contact, switching means including a switching contact adapted to abut said fixed contact and reciprocally movable in a predetermined path of travel between said two abutments, switch actuator means operatively associated with said switching means and including means operable to cause said switching contact to snap from one of said abutments to the second of said abutments, and delay means cooperating with said movable switching means and automatically operable independently of said actuator means to hold and detain said movable contact temporarily in a position between said two abutments.

4. In a mechanism including a snap-action electric switch, the combination comprising; two fixed contacts, switching means including a switching contact adapted to abut said fixed contacts and reciprocally movable in a predetermined path of travel between said two fixed contacts, switch actuator means operatively connected to said switching means and including snap-action means operable to cause said switching contact to snap from a first of said fixed contacts to the second of said fixed contacts, said snap-action means including a spring having a portion thereof operatively connected to said switching means at all times, said spring having another portion thereof operatively connected to said actuator means in a manner to cause said snap-action upon a predetermined movement of said actuator means, delay means operatively connected periodically to said movable switching means and including means to hold and detain said movable contact temporarily in a position between said two fixed contacts, and said delay means including means to automatically cause a release of said switching means for enabling said movable contact to snap instantly to one of said fixed contacts.

5. In a control mechanism for delaying operation of a device in an electric circuit having a source of electric energy, the combination comprising; a housing, switch means in said circuit and mounted in said housing and including a swingable member to control operation of said device, said swingable member including hinge means at one end thereof cooperating with a fixed portion of said mechanism to provide arcuate movements of the free end of said member, initiating means operatively associated with said switch means to affect operation of said device, said switch means including fixed contact means mounted on said housing, said swingable member at substantially said free end thereof including movable contact means cooperating with said fixed contact means and controlled by said initiating means to regulate said operation of said device in a normal total travel of said movable contact means, and delay means operable independently of said initiating means to hold said swingable member and its said movable contact means in a position between the extremes of said total travel to cause one type of operation of said device, said holding means including means to automatically release said mov-

able contact means to return to one extreme of travel for causing another type of operation of said device.

6. The combination of means defined in claim 4, in which said means included in said delay means for holding said movable contact means detains same for a predetermined period of time, and said release-causing means included in said delay means operates to cause said reelase of said switching means at the termination of said predetermined time period.

7. The combination of means defined in claim 6, and motor-operated timer means cooperating with said delay means to determine said time period, and said delay means being operable independently of said actuator means, and said delay means including clutch means to engage a portion of said timer means for operation thereby to cause initiation of said time period, and said clutch means including means automatically to effect disengagement of said clutch means from said timer means portion as a result of said release of said switching means to cause said termination of said time period.

8. The combination of means defined in claim 6, and motor-operated timer means cooperating with said delay means to determine said time period, said timer means including a slowly rotating member operated by said motor and having a clutchable portion on substantially the perimeter of said rotating member, and said delay means including clutch means to cooperate with said timer means, said clutch means including a gripping portion adapted to be moved into engagement with said clutchable portion to initiate said time period and to move out of said engagement with said clutchable portion for terminating said time period.

9. The combination of means defined in claim 6, and motor-operated timer means cooperating with said delay means to determine said time period, and an electric circuit, and said motor-operated timer means including rotary means and also including movable timer actuating means periodically operated to cause rotation of said rotary means, said timer means including a bimetal element adapted to cause said movements of said movable timer actuating means, electric heating means connected in said electric circuit and mounted near said element to provide electric energy for intermittent heating of said bimetal element for causing reciprocating movements thereof to effect said periodic operation of said movable timer actuating means, switch means in said circuit operated by said bimetal element for controlling said electric heating means to provide said intermittent heating and cooling thereof for effecting said reciprocating movements of said element, and said delay means including clutch means to engage said rotary means for operation thereby to cause initiation of said time period and automatically to disengage from said rotary means to cause said termination of said time period.

10. The combination of means defined in claim 6, and force-producing means operatively associated with said actuator means and including motor-operated timer means to cause said operation of said switch actuator means, and said delay means including clutch means to engage a portion of said timer means for operation thereby to cause initiation of said time period and automatically to disengage from said timer means portion upon said releasing action of said switching means to cause said termination of said time period.

11. In a mechanism including a snap-action electric switch, the combination of; two fixed contacts, switching means including a switching contact adapted to abut said fixed contacts and reciprocally movable in a predetermined path of travel between said two fixed contacts, switch actuator means operatively connected to said switching means and including snap-action means operable to cause said switching contact to snap from a first of said fixed contacts to the second of said fixed contacts, thermally-operated delay means cooperating with said movable switching means and including means to hold and detain said movable contact temporarily in a position between said two fixed contacts, and said delay means including temperature-sensitive means to cause a release of said switching means for enabling said movable contact to snap instantly to one of said fixed contacts.

12. The combination of means defined in claim 11, and said temperature-sensitive means including a bimetal element responsive to ambient temperature changes, said bimetal element including a latch portion comprising said holding means, said latch portion being adapted to engage said movable switching means when said bimetal element warps in one direction as a result of said ambient temperature attaining one predetermined value, and said latch portion being moved out of said engagement with said movable switching means when said bimetal element warps in a direction reverse from said first-named direction as a result of said ambient temperature attaining a second predetermined value.

13. In a mechanism including a snap-action electric switch mounted in a housing, the combination of; two fixed contacts mounted on said housing, switching means including a switching contact adapted to abut said fixed contacts and reciprocally movable in a predetermined path of travel between said two fixed contacts, switch actuator means always operatively connected to said switching means and including snap-action means operable to cause said switching contact to snap from a first of said fixed contacts to the second of said fixed contacts, delay means cooperating with said movable switching means and including means to hold and detain said movable contact temporarily in a position between said two fixed contacts, and said delay means including means to automatically cause a release of said switching means for enabling said movable contact to snap instantly to one of said fixed contacts, and force-producing means operatively associated with said switch actuator means to cause operation thereof.

14. The combination of means defined in claim 4, and force-producing means operatively associated with said switch actuator means to cause operation thereof, said force-producing means including motor-operated timer means to cause operation of said actuator means after periodic time intervals.

15. The combination of means defined in claim 6, and said switch actuator means including a spring acting on said switching means with a predetermined force, and motor-operated timer means cooperating with said delay means to determine said time period, said timer means including a slowly rotating member operated by said motor and having a plurality of teeth on at least a portion of substantially the perimeter of said rotating member, and said delay means including a clutch element disposed to cooperate with said timer means, said clutch element including a portion having a plurality of teeth adapted to be moved into engagement with said member-teeth as a result of said force of said switch spring upon completion of said first-named operative connection to initiate said time period, said clutch element including means to cause said release of said switch means after a predetermined travel of said rotating member, and second spring means acting on said clutch element with a force less than said first named spring force and urging said clutch element out of said engagement when said release is effected.

16. The combination of means defined in claim 6, and motor-operated timer means cooperating with said delay means to determine said time period, and an electric circuit, and said motor-operated timer means including rotary means and also including movable timer-actuating means periodically operated to cause rotation of said rotary means, said timer-actuating means including electric switch means in said circuit, said switch means including a pair of contacts for intermittently opening and closing said circuit, a bimetal element secured at one end to a fixed portion of said machine and

its free end movable in an arcuate reciprocating path as said bimetal element warps upon heating and cooling thereof, an electric heater in said circuit for said bimetal element and controlled by said switch means, a swingable element supported substantially parallel to said bimetal element and having one end hingedly connected to a fixed part of said mechanism and its free end disposed for generally reciprocating arcuate movements from one position to another position, a first of said two elements including a generally U-shaped portion near its said free end for movements therewith, the second of said two elements having its free end disposed within said U-shaped portion, said second element near said free end carrying one of said contacts, said first element at one side of said U-shaped portion carrying the other said contact to cooperate with said one contact to comprise said switch means, a leaf-spring having one end in a hinged connection with a fixed portion of said machine and its other end connected to said swingable element at a position to cause said swingable element to snap from one of said positions thereof to said other position for opening said contacts after said bimetal element is warmed by said heater, and to snap back to said one position upon cooling of said bimetal element to close said contacts and again energize said heater to repeat the cycle, continuously.

17. The combination of means defined in claim **6**, and motor-operated timer means cooperating with said delay means to determine said time period, and power means adapted to be operatively connected to said switch actuating means for periodic operation thereof after a predetermined time interval, said power means being movable in one direction in relation to said switch actuator means while disconnected therefrom, energy-storing spring means acting on said power means and adapted to be charged with energy by said movement of said power means in said one direction, said timer means including means operatively associated with said power means to cause said energy-storing movements thereof, latch means operatively connected to said power means and said switch actuating means and operatively disconnected therefrom during said charging movement of said power means, said latch means including means adapted to operatively connect said switch actuating means and said power means before said charging movement thereof is completed, release means operated after a predetermined travel of said power means corresponding to said predetermined time interval to release same for enabling the stored energy of said spring means to cause said power means to move in a direction opposite from said first named direction for operating said switch actuating means, and means operatively associated with said latch means for causing same to operatively disconnect said power means and said switch actuating means after same has been actuated for enabling independent action of said switch actuating means until the cycle is repeated.

18. The combination of elements defined in claim **14**, and said motor operated timer means including rotary means, and said force-producing means including power means operatively connected to said timer means for actuation thereby to store energy in a slow charging movement thereof, said timer means and said power means including means cooperating to release periodically said stored energy for causing said operation of said switch actuator means, and a source of electric energy in a circuit associated with said mechanism, a heat-responsive bimetal power element operatively associated with said timer means to cause slow rotation of said rotary means, electric heating means mounted near said bimetal element and connected in said electric circuit for heating said element and causing reciprocating movements thereof to provide a small input power force, switch means in said circuit operated automatically by said element in a continuous repetitive cycle to reduce the energy from said heating means after said element in one position thereof has been heated and to increase the energy from said heating means after said element in a second position thereof has cooled for producing said reciprocating movements and said input force, said bimetal element including means providing a snap-action thereof to delay each movement of said element from one of said positions to the other said position for establishing a predetermined period of time for said cycle, and said rotary means including means for counting the number of said time-cycles to cause slowly said charging movement of said power means and for causing operation of said energy release means after a predetermined number of time cycles corresponding to said time interval, said counting means including ratchet means having a predetermined number of ratchet teeth, ratchet-actuating means operated as a result of said reciprocating movements of said bimetal element and adapted to move said ratchet means at least a portion of its total travel upon one said cycle of said bimetal element to cause said slow charging movement of said power means.

19. A switch delay mechanism including a snap-action device mounted in a housing, the combination comprising; a pair of terminals mounted on said housing each having a fixed contact, a contact arm having a contact mounted thereon, said contact arm being pivotally supported on said housing for reciprocal movement between said fixed contacts, actuator means pivotally supported on said housing, means operatively connecting said contact arm and said actuator means, said connecting means being operable to cause said arm contact to snap from one to the other of said fixed contacts, and delay means cooperating with said contact arm and operable independently of said actuator means to hold and detain said contact arm temporarily in a position between said two fixed contacts.

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337—341