

[54] **ELECTRICAL SWITCH MEANS FOR EFFECTING SEQUENTIAL OPERATION**

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[51] Int. Cl. **H01h 21/02, H01h 21/40, H01h 61/01**

[58] Field of Search. **337/41, 42, 112, 102, 337, 337/338, 340, 341, 354, 363, 364, 375, 43, 44; 200/67 D**

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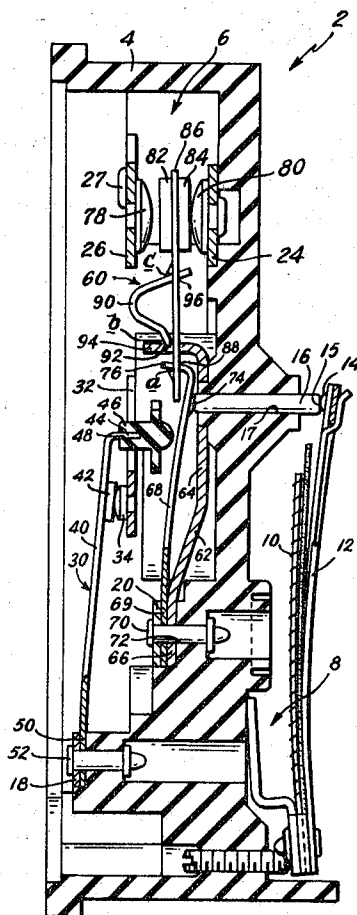
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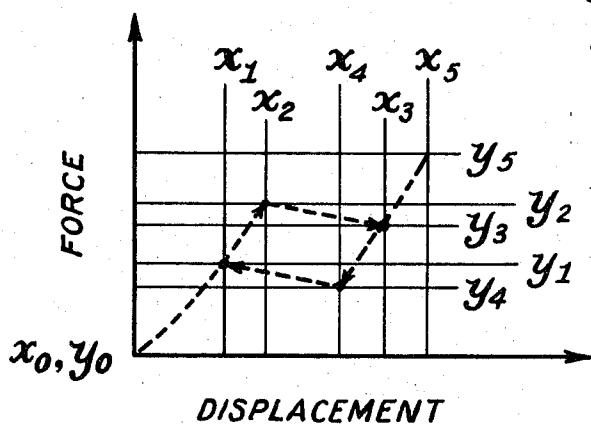
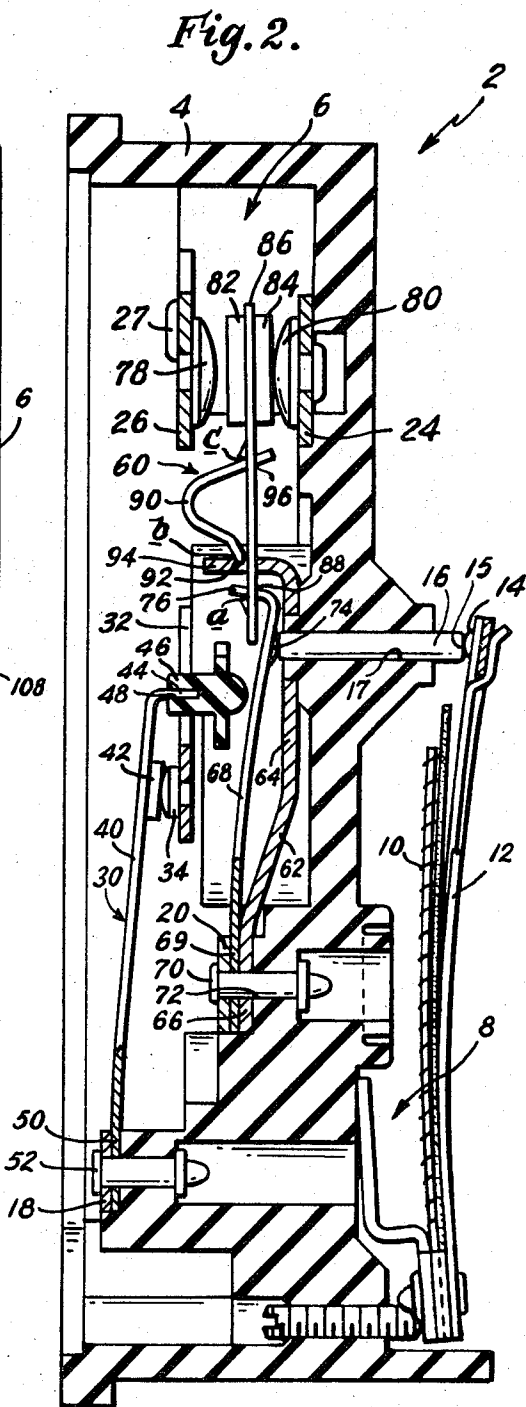
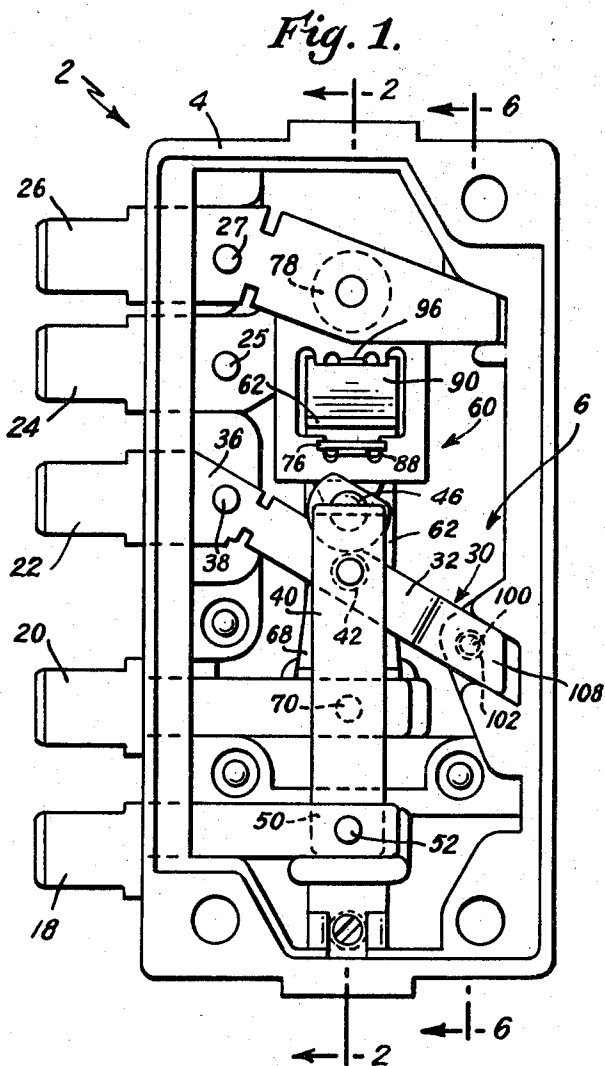
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ABSTRACT

A creep action switch structure auxiliary to and operating in planned sequence with a snap acting switch is shown. In the embodiment shown, the main switch is part of a time delay relay in which the auxiliary switch provides a shorter heat or cool time relative to the main switch and also provides a means of reducing the total time delay on heating or cooling for multiple relay use.

8 Claims, 7 Drawing Figures





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Fig. 4.

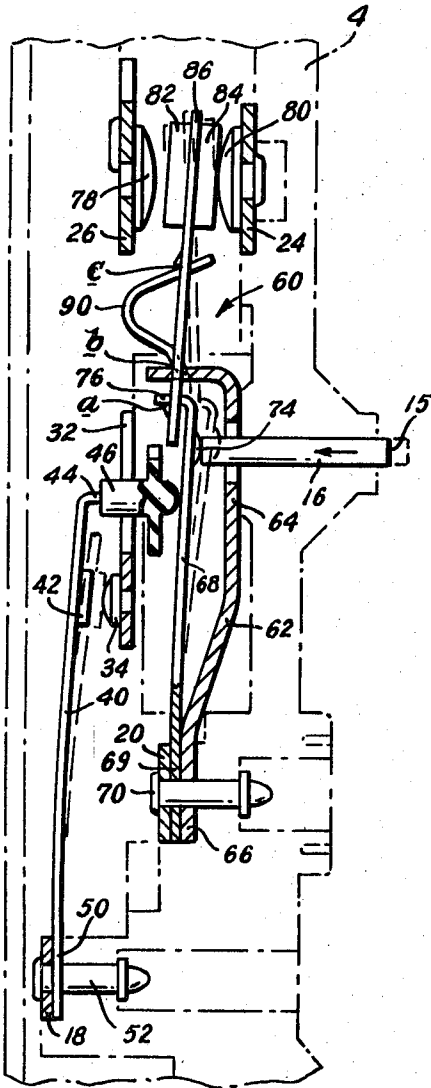
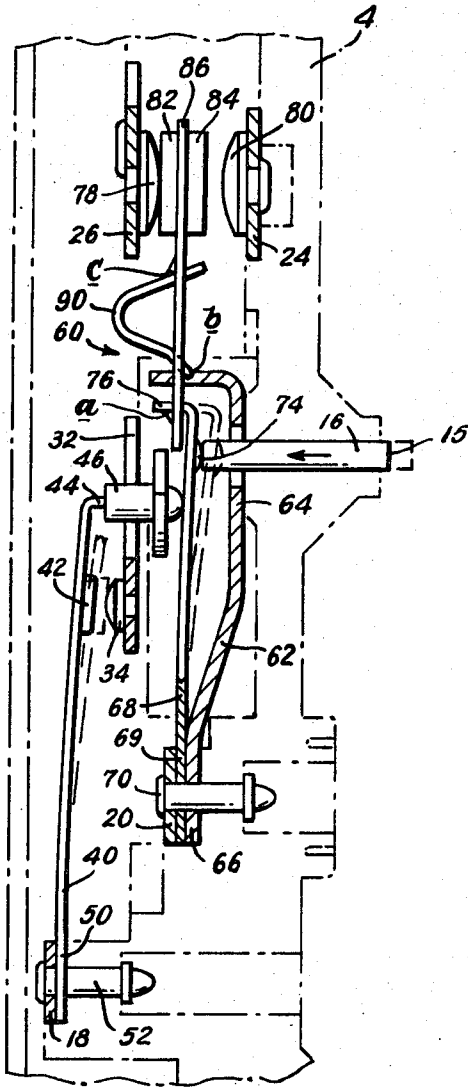


Fig. 5.



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Fig. 6.

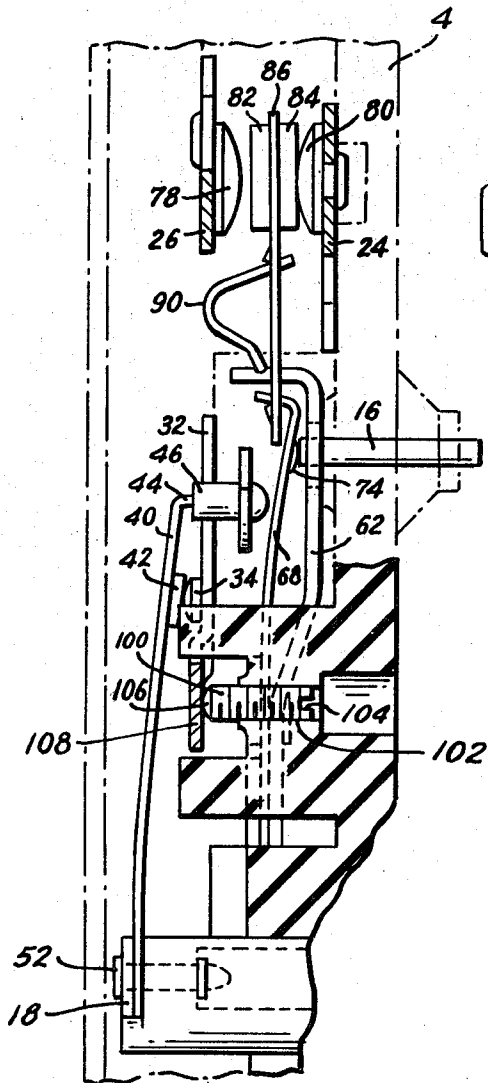
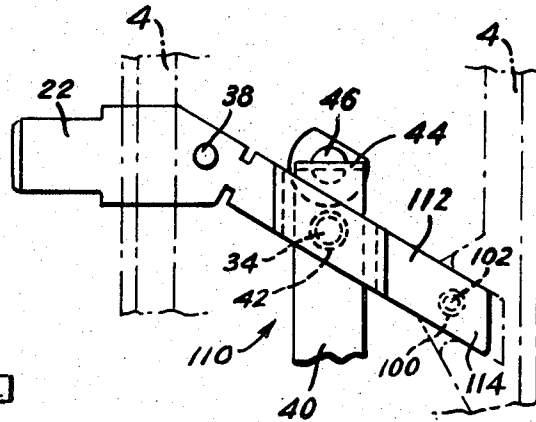


Fig. 7.



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ELECTRICAL SWITCH MEANS FOR EFFECTING SEQUENTIAL OPERATION

This invention relates to the combination of an auxiliary switch with a main switch or relay, and more particularly, to a creep acting switch structure as an addition to a snap acting switch. Among the several objects of the invention is the provision of a reliable yet inexpensive switch which is mounted in operative relation to a main switch and one which is caused to be operated by the main switch. Another object is the provision of a creep acting switch employed with an electrical snap acting switch of the overcenter type which is capable of external actuation. Yet another object is the provision of such an auxiliary switch as an addition to a time delay relay structure. A further object is the provision of planned switching sequence upon actuating a main snap acting switch. Another object is the provision of an auxiliary switch will decrease the heat or cool operating time in relation to the operating time of a main snap acting switch of a time delay relay. Still another object of the invention is the provision of a switch useful in applications for sequencing the turning on of a fan motor relative to the starting of a motor-compressor for air conditioners which otherwise for low voltage room thermostat control circuit normally requires the use of two separate relays. Another object is the provision of a switch for decreasing the cool or turn off time of multiple electric heating elements such as those used in space heaters where more than one relay is used in tandem sequence instead of using relatively complex and expensive combination thermal-magnetic relays of prior art systems.

Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the elements and combination of elements, features of construction, arrangement of parts and planned sequence of operation which will be exemplified in the structures hereinafter described, and the scope of the application which will be indicated in the following claims.

In the accompanying drawings, in which several of various possible embodiments of the invention are illustrated, the structure is shown in relation to a snap acting switch of the type described in Canadian Pat. No. 785,393 issued May 14, 1968, and assigned to the assignee of the instant invention, and additionally in relation to a time delay relay of the type described in U.S. Pat. No. 3,205,327 issued Sept. 7, 1965, also assigned to the assignee of the instant invention.

FIG. 1 is a top plan view shown with the top cover removed of a normally closed auxiliary switch according to the present invention installed in operative relation with a snap acting main switch and as part of a thermal time delay relay. The relay is shown with a thermal actuator heater in the energized condition, the auxiliary switch being open when the heater is in the cool deenergized condition.

FIG. 2 is an enlarged sectional view taken on line 2—2 of FIG. 1 shown with covers removed from both top and bottom sides of the assembly.

FIG. 3 is a graphical representation illustrating the approximate relationship of force and displacement of the motion transfer pin which forms a part of the means of external actuation of the snap acting main switch shown in FIG. 2.

FIG. 4 is an enlarged fragmentary elevation view similar to FIG. 2 showing a combination of auxiliary switch and snap acting main switch in an intermediate position of operation where the contacts of the auxiliary switch are in an open position and a first set of contacts of the main switch are in engagement.

FIG. 5 is an enlarged fragmentary elevation view similar to FIG. 2 showing the contacts of the auxiliary switch in open position and a second set of contacts of the main switch in engagement and with the first set of contacts out of engagement.

FIG. 6 is an enlarged fragmentary elevation view taken on line 6—6 of FIG. 1 showing a means for adjusting the physical location and operation of the auxiliary switch in relation to the snap acting main switch.

FIG. 7 is an enlarged fragmentary top plan view similar to FIG. 1 showing an auxiliary switch similar to that shown in FIG. 2 modified to be normally open or closed when the thermal actuator heater is in the deenergized condition.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

Dimensions of certain of the parts as shown in the drawings have been exaggerated or modified for the purposes of clarity of illustration.

Referring now to the drawings, particularly FIG. 2, there is shown an embodiment of the present invention in the form of a thermal time delay relay generally indicated by numeral 2 comprising a housing 4 which may be made of conventional electrically insulative molded phenolic and is provided with a cavity on one side generally indicated by numeral 6 and is adapted on the other side, generally indicated by numeral 8, for mounting controlling thermal actuator heating means comprising heater 10 and bimetal actuator 12. Covers which would normally be used to enclose cavity 6 and to shield heater 10 and bimetal actuator 12 are omitted for purposes of clarity. Bimetal actuator 12 has a dimple 14 at its distal end to facilitate transmission of force to motion transfer pin 16 slidably mounted in bore 17 of housing 4 for sliding motion in opposite directions. Electrically conductive terminals 18, 20, 22, 24 and 26, whose function will be described later, are mounted in housing 4 of relay 2 and are provided to permit electrical connection to external circuits. Terminals are not shown for connection to the ends of heater 10 for clarity in the drawings; however, they can be installed at any convenient location in housing 4 or one of these may be connected to one of the above-mentioned terminals, if desired.

With further reference to FIGS. 1 and 2, there is shown an auxiliary switch made in accordance with the present invention generally indicated by numeral 30 and installed in housing 4 within cavity 6 of thermal time delay relay 2. Auxiliary switch 30 comprises a relatively stiff stationary electrically conductive member 32 which has mounted thereon a stationary electrical contact 34. In addition, stationary member 32 is cantilever mounted at end 36 to housing 4 such as by rivet 38 and is located so that its distal end is in overlying engagement with adjustment screw 100 (also shown in FIG. 6) used to adjust the physical location of contact 34.

A cantilever mounted electrically conductive flexible, movable arm 40 with a movable electrical contact

42 mounted thereon is biased so that movable contact 42 is closed in electrically conductive relation with stationary contact 34. A tap 44 extends from the distal end of movable arm 40 for solidly connecting therewith insulator member 46 such as by press fit into mating bore 48 provided in insulator member 46. End 50 of movable arm 40 together with terminal 18 are attached to housing 4 of relay 2 by conventional means such as rivet 52. Auxiliary switch 30 is shown in a creep acting construction; i.e., when force is applied to insulator member 46 so as to move it to the left as shown in FIG. 2, movable arm 40 is flexed and movable contact 42 separates from stationary contact 34 in a linear relation to the force or movement opening the circuit. Switch 30 is shown biased normally closed in its at rest position; however, switch 30 is open when heater 10 of relay 2 is deenergized and bimetal actuator is cool. Although auxiliary switch 30 is shown to be creep acting, it should be noted that it is within the purview of the invention to employ a snap acting mechanism for the auxiliary switch.

Again referring to FIG. 2, a snap acting main switch means is generally shown by numeral 60 built within cavity 6 in housing 4 in combination with auxiliary switch 30. Main switch 60 includes electrically conductive support member 62 referenced by seat portion 64 of housing 4 and attached thereto at end 66 and return spring 68 cantilever mounted to housing 4 at end 69. Support member 62, return spring 68 and terminal 20 are attached to housing 4 by conventional means such as electrically conductive rivet 70 inserted through aperture 72 of housing 4. Return spring 68 has a dimpled portion 74 which facilitates contact with transfer pin 16 for transmitting force and movement from bimetal actuator 12 through actuator dimple 14 between the solid and dotted lines shown for return spring 68 in FIG. 5 and for biasing transfer pin 16 towards the position shown in FIG. 2 and in dotted lines in FIGS. 4 and 5. Electrically conductive terminal 24, on which is attached by conventional means, such as by welding, stationary electrical contact 80, is fastened to housing 4 by suitable means such as rivet 25. Arranged generally opposite contact 80 is another stationary contact 78 mounted on electrically conductive terminal 26 which is attached to housing 4 by suitable means such as rivet 27.

Located intermediate contacts 78 and 80 and movable into and out of engagement with contacts 78 and 80 are a pair of electrical contacts 82 and 84 respectively which are mounted on an electrically conductive hinge plate 86. The free end 76 of return spring 68 extends through an aperture 88 at one end of hinge plate 86 and by means of mating slots, shoulders and tab struck from return spring 68 and hinge plate 86 provide a floating hinge or joint *a* for a hinged connection between return spring 68 and hinge plate 86.

Snap acting main switch 60 also includes a spring member 90 formed of electrically conductive material and flexed in U shaped form as best seen in FIGS. 2, 4 and 5. One end of spring 90 fits in a slot 92 at free end 94 of support 62 to form a hinged joint *b*. End 94 of support 62 extends through aperture 88 in hinge plate 86. The other end of U shaped spring member 90 is hingedly connected to hinge plate 86 at a location indicated by numeral 96 by means of mating slots and

tabs formed in spring member 90 and hinge plate 86 forming hinged joint *c*.

The electrical path through main switch 60 is from either terminal 26 and contact 78 or terminal 24 and contact 80 to either of contacts 82 and 84 respectively to hinge plate 86 and thence to rivet 70 and terminal 20 by a dual path of which one path is from hinge plate 86 to return spring 68 through hinged joint *a* and the other path is from hinge plate 86 at hinged joint *c* to spring 90 continuing through support 62 at hinged joint *b* to rivet 70.

Main switch 60 in the embodiments shown in the drawings and as used in the instant invention is in a monostable form. Switch 60 is shown in its at rest position with the heater 10 in energized condition in FIG. 2 (dotted lines in FIGS. 4 and 5) with contacts 80 and 84 in engagement and return spring 68 bearing against transfer pin 16 at dimple 74 to bias it in the position shown. The characteristic of switch 60 is for hinge plate 86 carrying contacts 82 and 84 to be moved quickly by U spring 90, i.e., snap, between contacts 78 and 80 whenever hinge *a* approaches a position where it lies on an imaginary line intersecting joint *b* and joint *c* as shown in solid lines in FIGS. 4 and 5 and this is the trigger or snap acting point of the mechanism. Actuation of switch 60 is obtained by applying an increasing or decreasing force at end portion or point 15 of transfer pin 16 which moves the transfer pin against dimple 74 of return spring 68 and deflects spring 68 so that joint *a* is moved arcuately towards one side or the other of the imaginary line through joint *b* and joint *c*.

To describe the operation of the combination of auxiliary switch 30 and main switch 60, it is helpful to analyze the displacement of transfer pin 16 in FIGS. 2, 4, and 5. FIG. 3 shows an approximate curve of force versus displacement at point 15 of transfer pin 16. Starting with low or zero force, point 15 of pin 16 is at the dotted line position of FIG. 5. As the force of point 15 is increased, point 15 moves along a line such as the dotted line shown in FIG. 3 between x_0, y_0 and x_1, y_1 , in a creep action. As the force is further increased, point 15 continues to creep along a line such as the dotted line shown to coordinates x_2, y_2 , at which point the trigger or snap action point is reached, the force levels at return spring 68 dimple 74 change, and point 15 quickly moves or snaps to the position shown by coordinates x_3, y_3 , which is to the solid lines of FIG. 5. If the force is further increased, point 15 moves such as along dotted line to x_5, y_5 and the displacement between x_3 and x_5 is called overtravel.

Upon reducing the force at the end of transfer pin 16, point 15 moves such as along dotted line of FIG. 3 in a creep action until coordinates x_4, y_4 are reached at which point the trigger or snap action point is reached, force levels at dimple 74 again change and point 15 moves quickly or snaps to the position given by x_1, y_1 which is to dotted lines of FIG. 5. If the force is further decreased, point 15 moves such as along dotted line towards x_0, y_0 and displacement between x_1 and x_0 is called overtravel.

Continuing with reference to FIG. 3, operating movement of switch 60 is identified as occurring between x_1 and x_3 with x_1, y_1 representing the at rest position of switch 60 and x_3, y_3 the overcentered or operating position. An operating cycle of switch 60

from its at rest position consists in sequence of a creep movement range, snap movement range, return creep movement range and return snap movement range, as defined by the movement of point 15 at the end of transfer pin 16 and excluding overtravel. In a typical switch of the type shown herein, creep movement is 0.004 to 0.005 of an inch.

Operation of auxiliary switch 30 in combination with main switch 60 is described by first referring to FIG. 4 showing the first embodiment of the invention in which dotted lines show both switches in their at rest position and solid lines show an intermediate position. At the at rest point, auxiliary switch contacts 34 and 42 and main switch contacts 80 and 84 are closed. As force is increased on transfer pin 16, point 15 moves through its creep movement range, transfer pin 16 is displaced towards dimple 74, flexing return spring 68 towards insulator member 46 which moves to flex movable arm 40 resulting in separating contact 42 from contact 34. Since this is accomplished within the creep movement range of main switch 60, contacts 80 and 84 are still closed and contacts 78 and 82 are still open while auxiliary switch contacts 34 and 42 have opened as shown by the solid lines in FIG. 4.

Referring now to FIG. 5, as force is increased further on transfer pin 16, return spring 68 is further flexed towards insulator member 46 and the free end 76 of spring 68 continues to move, carrying with it joint *a* until the trigger or snap acting point is reached. At this point, main switch contacts 80 and 84 snap open and contacts 78 and 82 snap closed as shown by the solid lines.

Still referring to FIG. 5, operation in a reverse direction is described when the force at point 15 on transfer pin 16 is decreased. The distance between the solid and dotted lines illustrates the distance of auxiliary switch contact 42 from auxiliary switch contact 34 resulting from the previous movement of point 15 on transfer pin 16 through the sum of the creep movement range and snap movement range. As the force is reduced, point 15 moves first through its return creep movement range and then through its return snap movement range. Auxiliary switch contacts 34 and 42 are separated by a distance which exceeds the return creep movement range and consequently remain open while point 15 traverses through its return creep movement but close during the interval point 15 quickly moves through its return snap movement range and main switch contacts 80 and 84 snap closed and 78 and 82 snap open.

The aforementioned operation requires locating auxiliary switch 30 in housing 4 so that it will be in a particular spatial relation to main switch 60. This can be accomplished in many ways and one method is illustrated in the embodiment shown in FIGS. 1 through 6 through adjusting screw 100. Referring particularly to FIG. 6, adjustment screw 100 is threaded through tapped hole 102 in housing 4 and contains a slotted head 104 accessible through side 8 which is on the opposite side of housing 4 from cavity 6 in which auxiliary switch 30 and main switch 60 are installed. End 106 of screw 100 bears against stationary member 32 so that free end 108 can be moved arcuately around end 36 where member 32 is cantilever mounted to housing 4. Movable arm 40 in its at rest position is biased so that

contact 42 bears against contact 34 which is attached to member 32. Additionally insulator member 46 is solidly connected to arm 40 at tab 44. By turning adjustment screw 100, the position of contacts 34 and 42 through member 32 and therefore of insulator member 46 is changed with relation to housing 4. Main switch 60 is attached to housing 4 as described previously. Thus the position of return spring 68 is fixed in relation in housing 4. Consequently, the position of insulator member 46 in relation to return spring 68 is varied by turning screw 100. This method of adjustment illustrates one way of setting the combination of auxiliary switch 30 and main switch 60 so that auxiliary switch contacts 34 and 42 close quickly during the interval after main switch 60 has been triggered and contacts 78 and 82 are snapping open and contacts 80 and 84 are snapping closed, as previously described.

A modification of switch 30 is shown in FIG. 7 and generally indicated by numeral 110. Switch 110 is biased normally open in its at rest position which is an opposite configuration to the normally closed configuration of switch 30 of the FIG. 1-6 embodiment. This modification in structure is accomplished by changing the stationary member 32 of switch 30 to a suitable form such as shown by stationary member 112 with a U shaped section ridging over movable arm 40 and mounting stationary electrical contact 34 on the same side of member 112 as housing 4. Movable arm 40 mounts movable contact 42 on the side of arm 40 remote from housing 4. Free end 114 of stationary member 112 is in overlying engagement with adjustment screw 100.

The embodiment heretofore described illustrates achieving of sequencing of auxiliary switch 30 in relation to main switch 60 where auxiliary switch contacts 34 and 42 open in advance of main switch contacts 78 and 82 snapping closed and contacts 80 and 84 snapping open and where auxiliary switch contacts 34 and 42 close quickly after the triggering point of main switch 60 has been reached and during the interval contacts 78 and 82 snap open and contacts 80 and 84 snap closed.

Other adjustment is possible such as where auxiliary switch 30 contacts 34 and 42 open during the interval after the monostable main switch 60 has been triggered and is snapping to its overcenter position and where auxiliary switch contacts 34 and 42 are sequenced to close before main switch 60 is triggered to return to its at rest position.

Still other modes of operation are obtained where the normally open auxiliary switch 110 is substituted for the normally closed switch 30 in the embodiment shown in FIG. 2 resulting in what will be called a normally open combination. This normally open combination provides the opposite of the two modes of operation previously described. With the position of auxiliary switch 110 of FIG. 7 adjusted by screw 100 so that contacts 34 and 42 open after triggering main switch 60 due to energization of heater 10 and during the interval contacts 78 and 82 are snapping open and contacts 80 and 84 are snapping closed, auxiliary switch contacts 34 and 42 close in advance of triggering main switch 60 due to deenergization of heater 10 and prior to contacts 78 and 82 snapping closed and contacts 80 and 84 snapping open.

With the same normally open combination embodiment, and with auxiliary switch 110 adjusted by screw 100 so that contacts 34 and 42 close after triggering main switch 60 and during the interval contacts 78 and 82 are snapping closed and contacts 80 and 84 are snapping open, auxiliary switch contacts 34 and 42 open in advance of triggering main switch 60 and prior to contacts 78 and 82 snapping open and contacts 80 and 84 snapping closed.

It will be seen that the combination of auxiliary switch 30 or 110 and main switch 60 built into an assembly as described above permits the use of an external actuating means. As seen in FIGS. 1 and 2, the combination of auxiliary switch 30 and main switch 60 cooperate with bimetal thermal actuator 12 and are controlled by electric heater 10 to provide a thermal time delay relay.

Referring to FIGS. 1 and 2, bimetal actuator 12 is controlled by electric heater 10 so that dimple 14 of actuator blade 12 moves away from heater 10 as shown in FIG. 2 followed by transfer pin 16 which is biased by return spring 68 when heater 10 is energized and toward spring 68 when heater 10 is deenergized. FIG. 2 shows the assembly with heater 10 energized placing bimetal actuator 12 and transfer pin 16 at an extreme position away from spring 68 so that the combination of auxiliary switch 30 and main switch 60 is in its at rest position.

When heater 10 is deenergized, bimetal actuator 12 through dimple 14 exerts an increasing force on transfer pin 16 moving pin 16 in a direction towards return spring 68 until auxiliary switch 30 opens followed by monostable main switch 60 snapping to its overcenter position. When heater 10 is energized, transfer pin 16 moves in a direction away from return spring 68 permitting main switch 60 to snap to its at rest position and auxiliary switch 30 is adjusted by screw 100 to close during this snapping interval.

The various modes of operation previously described for auxiliary switch 30 or 110 in combination with main switch 60 can be obtained in thermal time delay relay 2.

To illustrate one mode, refer to FIG. 2 showing an arrangement containing auxiliary switch 30 and main switch 60 in their at rest position resulting when heater 10 is energized and dimple 14 of actuator 12 is at an extreme position away from return spring 68. In addition auxiliary switch 30 has been adjusted so that contacts 34 and 42 close at the extreme point of the return snap movement range described in relation to FIG. 3 for the interval of switch 60 snapping to its at rest position. With a typical timing for this type of relay of 20 seconds heat and 85 seconds cool and with this adjustment, auxiliary switch contacts 34 and 42 close quickly 20 seconds following energizing of heater 10 during the interval contacts 78 and 82 open and contacts 80 and 84 close. When heater 10 is deenergized, auxiliary switch 30 contacts 34 and 42 separate slowly after approximately 60 seconds cool time which is obtained from the four to five thousandths inch creep movement range before main switch 60 snaps to its overcenter position in approximately 85 seconds total cool time, opening contacts 80 and 84 and closing contacts 78 and 82.

Use of this timing sequence is illustrated in controlling electric heater elements. It is common practice to limit the maximum electric heater element current in an individual circuit so that large heater assemblies may consist of numerous heater elements each controlled by a separate relay. Further, it is desirable to turn on the plurality of heater elements in sequence to prevent a large momentary increase in current and turn off the elements in sequence as quickly as possible after the relay is deenergized. Thermal time delay relays of the instant invention provide this performance.

To illustrate, assume an installation consisting of a number of electric heating elements and the same number of thermal time delay relays with auxiliary switches where each element is connected to a source of power through contacts 80 and 84 of the main switch and the heater 10 of each relay is connected to its source of power through auxiliary switch contacts 34 and 42 of the preceding relay and the heater of the first relay is connected through a control switch for the installation. System turn on and turn off times can be expressed mathematically as follows:

n = No. of electric heating elements;

n = No. of thermal time delay relays with auxiliary switches;

th = time delay on heat (energizing of heater) for auxiliary and main switch to snap to its at rest position;

tc = time delay on cool (deenergizing of heater) for main switch to snap to overcenter position;

ta = time delay on cool for auxiliary switch to open;

(1) — system turn on time = $th_1 + th_2 + th_3 + \dots th_n$

(2) — system turn off time = $[tc_1 + tc_2 + tc_3 + \dots tc_n] - [(tc_1 - ta_1) + (tc_2 - ta_2) + (tc_3 - ta_3) + \dots (tc_{n-1} - ta_{n-1})]$. Sequencing of turn on is accomplished by the usual tandem connection of the relays.

Sequencing of turn off is also accomplished in the same manner. However, the instant invention shortens the system turn off time by the difference in time between turn off of the main and auxiliary switches for each relay except the last used in the system. Assume a system of four heating elements and four relays with typical timing for each relay of 20 second heat — 85 seconds cool on main switch and 20 seconds heat — 60 seconds cool on auxiliary switch. Total system turn on time is 80 seconds. Total system turn off time is 265 seconds. Without the instant invention, total system turn off time would have been 340 seconds. The decrease of 75 seconds in turn off for the system minimizes overshoot in the controlled temperature. Of further significance is the time for the system to reach one half of total heater power since at this level the heat provided is in the range of expected system heat loss for much of the operating time. At this point, turn off time is decreased to 120 seconds which represents a 30 percent decrease over the turn off time of 170 seconds without the instant invention. This avoids the use of more sophisticated and expensive relays such as quick or instantaneous combination thermal-magnetic types.

Another mode of operation of the instant invention is described by assuming a thermal time delay relay illustrated in FIG. 2 except with the auxiliary switch 1 ad-

justed for opening of contacts 34 and 42 at the extreme of the motion differential of main switch 60 when it snaps to its overcenter position on cool time of heater 10 and bimetal actuator 12. With this adjustment upon energizing of heater 10, auxiliary switch contacts 34 and 42 will close slowly prior to main switch 60 snapping to its at rest position by the four or five thousandths inch of return creep movement range. To illustrate this mode, assume an installation of a thermal time delay relay with a typical timing of 20 seconds heat — 85 seconds cool on main switch and 15 seconds heat — 85 seconds cool on auxiliary switch with the main switch controlling the compressor motor and the auxiliary switch controlling the fan motor of an air conditioner. When the system control energizes the relay heater, the auxiliary switch closes after approximately 15 seconds, turning on the fan motor and the main switch closes after approximately 20 seconds, turning on the compressor motor. Upon deenergizing the relay heater, both the fan motor and compressor motor are turned off in approximately 85 seconds. This mode of operation reduces the total current load placed on the power supply at one time and is important where restrictions exist on the maximum allowable starting current of equipment. The instant invention accomplishes this for a low voltage system control circuit with one relay whereas in prior art system two conventional relays would be needed.

As many changes could be made on the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense, and it is also intended that the appended claims shall cover all such equivalent variations as come within the true spirit and scope of the invention.

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.

I claim:

1. Electrical sequencing apparatus comprising a housing,

a first switch mounted in the housing including:
a first stationary contact;
a first movable contact;

means to cause the first movable contact to move into and out of engagement with the first stationary contact, the means including a member movable in a first direction with creep action for a first interval, with snap action for a second interval and movable in a second return direction with creep action for a third interval, and with snap action for a fourth interval;

a second switch mounted in the housing including:

a second stationary contact mounted on a relatively stiff elongated member, the member cantilever mounted in the housing, and means are provided in the housing to bias the free end of the elongated member into desired adjusted position;

a second movable contact movable into and out of engagement with the second stationary contact; a creep acting movable contact arm on which the second movable contact is mounted, and motion transfer means for transferring motion from the first switch to the second switch to cause the movable contact arm to move and the second movable contact to move into and out of engagement with the second stationary contact; the second stationary contact positioned in the housing so that the first direction creep action of the movable member of the first switch is transferred to the movable contact arm of the second switch to cause creep opening of the second switch and in the return direction the snap action of the movable member of the first switch is transferred to the movable contact arm of the second switch to cause snap action closing of the second switch.

2. Apparatus according to claim 1 in which a tab is provided on the free end of the movable contact arm and the motion transfer means is fixedly mounted on the tab and adapted to engage the first switch.

3. Electrical sequencing apparatus comprising a housing,

a first switch mounted in the housing including:
a first stationary contact;
a first movable contact;

means to cause the first movable contact to move into and out of engagement with the first stationary contact, the means including a member movable in a first direction with creep action for a first interval, with snap action for a second interval and movable in a second return direction with creep action for a third interval, and with snap action for a fourth interval;

a second switch mounted in the housing including:

a second stationary contact mounted on a relatively stiff elongated member, the member cantilever mounted in the housing, and means are provided in the housing to bias the free end of the elongated member into desired adjusted position;

a second movable contact movable into and out of engagement with the second stationary contact; a creep acting movable contact arm on which the second movable contact is mounted, and motion transfer means for transferring motion from the first switch to the second switch to cause the movable contact arm to move and the second movable contact to move into and out of engagement with the second stationary contact; the second stationary contact positioned in the housing so that the first direction creep action of the movable member of the first switch is transferred to the movable contact arm of the second switch to cause creep closing of the second switch and in the return direction the snap action of the movable member of the first switch is transferred to the movable contact arm of the second switch to cause snap action opening of the second switch.

4. Apparatus according to claim 3 in which a tab is provided on the free end of the movable contact arm and the motion transfer means is fixedly mounted on the tab and adapted to engage the first switch.

5. Electrical sequencing apparatus comprising a housing,
 a first switch mounted in the housing including:
 a first stationary contact;
 a first movable contact;
 means to cause the first movable contact to move into and out of engagement with the first stationary contact, the means including a member movable in a first direction with creep action for a first interval, with snap action for a second interval and movable in a second return direction with creep action for a third interval, and with snap action for a fourth interval;
 a second switch mounted in the housing including:
 a second stationary contact mounted on a relatively stiff elongated member, the member cantilever mounted in the housing, and means are provided in the housing to bias the free end of the elongated member into desired adjusted position;
 a second movable contact movable into and out of engagement with the second stationary contact;
 a creep acting movable contact arm on which the second movable contact is mounted, and motion transfer means for transferring motion from the first switch to the second switch to cause the movable contact arm to move and the second movable contact to move into and out of engagement with the second stationary contact;
 the second stationary contact positioned in the housing so that the first direction snap action of the movable member of the first switch is transferred to the movable contact arm of the second switch to cause snap action opening of the second switch and in the return direction the creep action of the movable member of the first switch is transferred to the movable contact arm of the second switch to cause creep closing of the second switch.

6. Apparatus according to claim 5 in which a tab is provided on the free end of the movable contact arm and the motion transfer means is fixedly mounted on the tab and adapted to engage the first switch.

7. Electrical sequencing apparatus comprising a housing,
 a first switch mounted in the housing including:
 a first stationary contact;
 a first movable contact;
 means to cause the first movable contact to move into and out of engagement with the first stationary contact, the means including a member movable in a first direction with creep action for a first interval, with snap action for a second interval and movable in a second return direction with creep action for a third interval, and with snap action for a fourth interval;
 a second switch mounted in the housing including:
 a second stationary contact mounted on a relatively stiff elongated member, the member cantilever mounted in the housing, and means are provided in the housing to bias the free end of the elongated member into desired adjusted position;
 a second movable contact movable into and out of engagement with the second stationary contact;
 a creep acting movable contact arm on which the second movable contact is mounted, and motion transfer means for transferring motion from the first switch to the second switch to cause the movable contact arm to move and the second movable contact to move into and out of engagement with the second stationary contact;
 the second stationary contact positioned in the housing so that the first direction snap action of the movable member of the first switch is transferred to the movable contact arm of the second switch to cause snap action closing of the second switch and in the return direction the creep action of the movable member of the first switch is transferred to the movable contact arm of the second switch to cause creep opening of the second switch.

8. Apparatus according to claim 7 in which a tab is provided on the free end of the movable contact arm and the motion transfer means is fixedly mounted on the tab and adapted to engage the first switch.

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