

March 1, 1966

H. L. RANDOLPH ETAL

3,238,335

THERMAL TIME DELAY ELECTRIC SWITCH MEANS HAVING
SELECTIVELY ADJUSTABLE ON AND OFF TIMES

Filed June 5, 1962

4 Sheets-Sheet 1

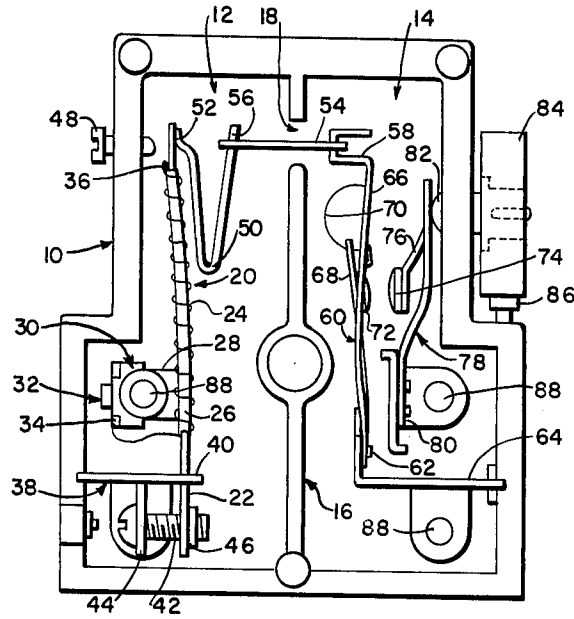


FIG. 1.

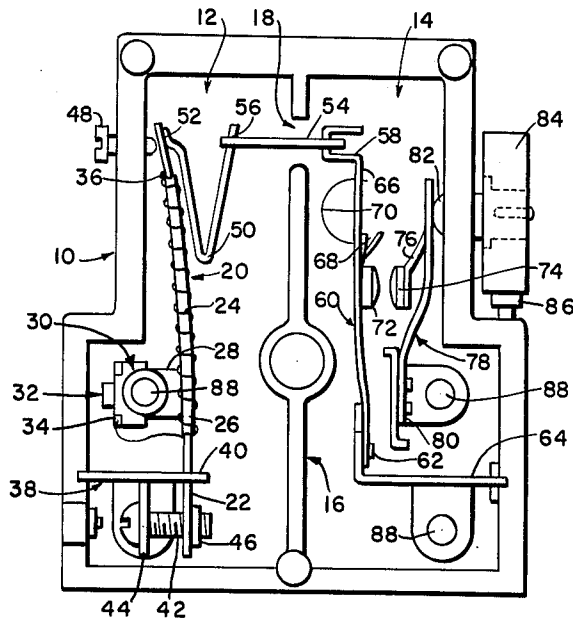


FIG. 2.

INVENTOR

Hollis L. Randolph &
George L. Thayer, Jr.

BY

Herbert M. Birch

ATTORNEY

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4 Sheets-Sheet 2

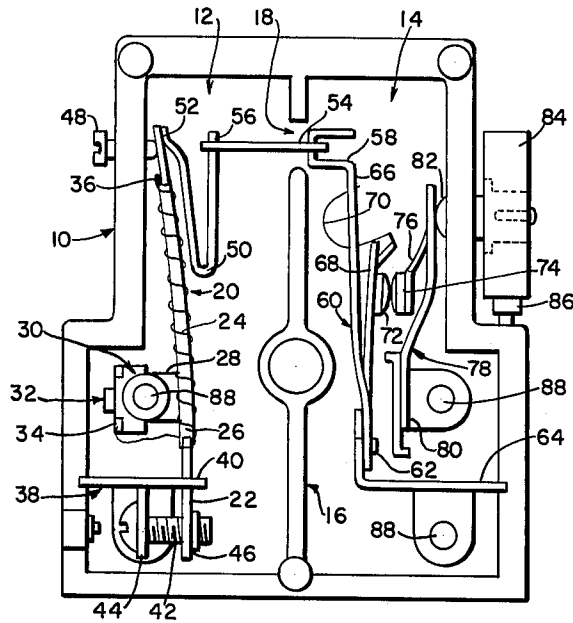


FIG. 3.

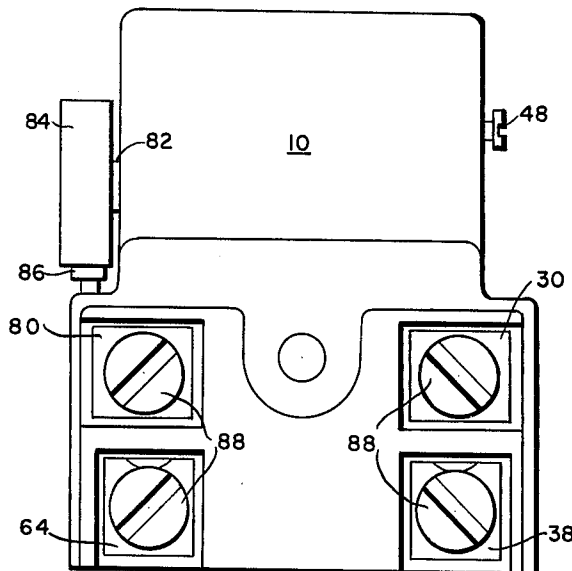


FIG. 4.

INVENTOR

Hollis L. Randolph &
George L. Thayer, Jr.

BY

Herbert M. Birch

ATTORNEY

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4 Sheets-Sheet 3

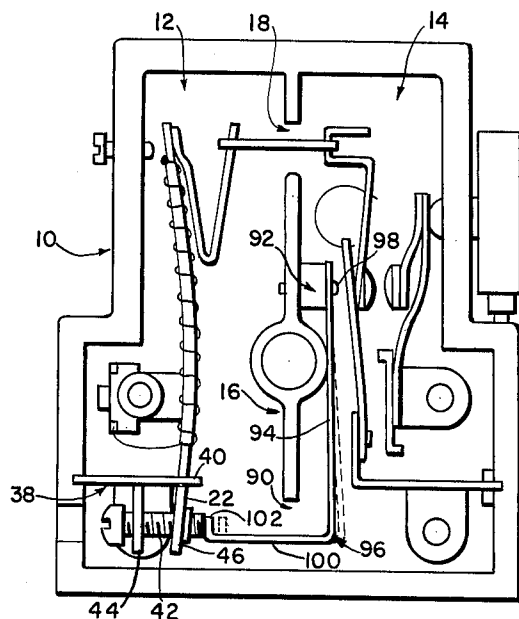


FIG. 5.

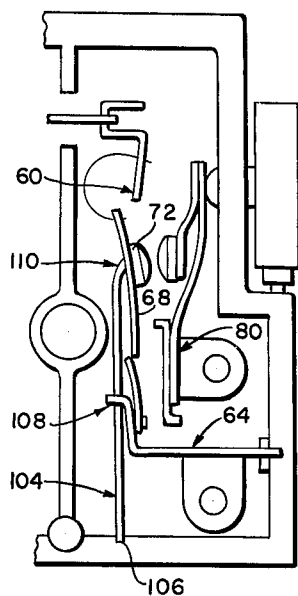


FIG. 6.

INVENTOR

Hollis L. Randolph &
George L. Thayer, Jr.

BY

Herbert M. Birch

ATTORNEY

March 1, 1966

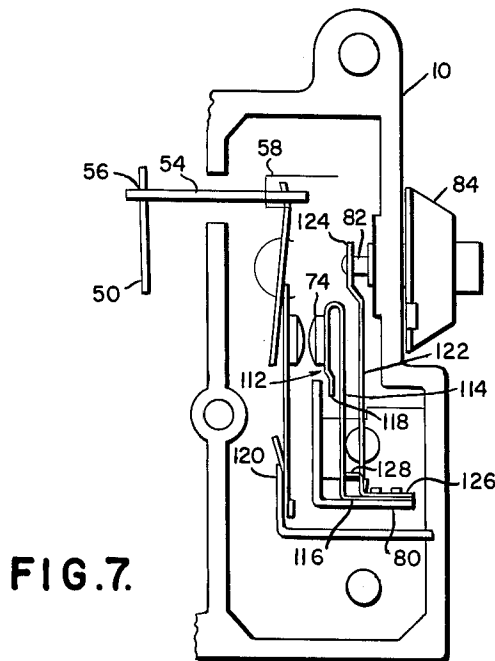
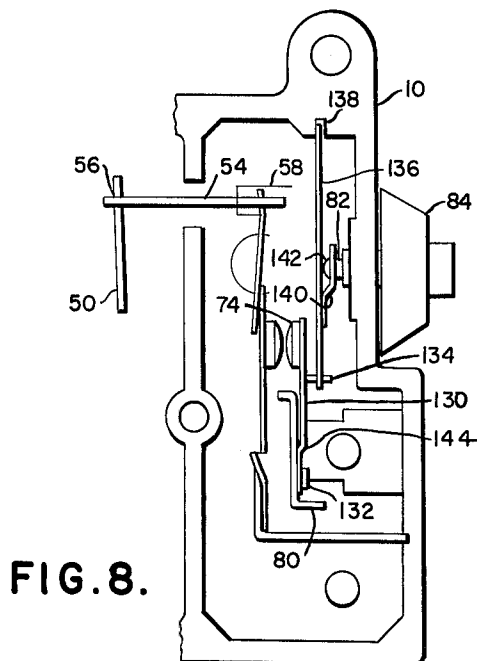
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4 Sheets-Sheet 4



INVENTOR
Hollis L. Randolph &
George L. Thayer, Jr.

BY

Herbert M. Birch

ATTORNEY

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**THERMAL TIME DELAY ELECTRIC SWITCH
MEANS HAVING SELECTIVELY ADJUSTABLE
ON AND OFF TIMES**

Hollis L. Randolph, Lakewood, and George Leo Thayer, Jr., Santa Ana, Calif., assignors to Robertshaw Controls Company, Richmond, Va., a corporation of Delaware
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46 Claims. (Cl. 200—122)

This invention relates to electric switches and more particularly to thermally operated time delay switches having bimetallic operating elements therein, wherein predetermined time lags in the ON and OFF functions of the switch, subsequent to the initiation of each of the said functions, may be selectively provided.

Switches of the type generic to the present invention are used, for example, in conjunction with gas-fired forced air heating systems wherein a single switch unit is required to turn on a fan motor after a suitable delay subsequent to ignition of the gas burner and subsequently then turn off the fan motor after a suitable delay subsequent to the extinguishment of the gas burner.

It is an object of this invention to provide a thermal time delay electric switch wherein predetermined delays in both the ON and OFF functions thereof may be selectively provided.

Another object of this invention is to provide a thermal time delay electric switch wherein predetermined delays in both the ON and OFF functions thereof may be selectively provided and further, wherein the entire switch is contained in a single, small, economical package.

Still another object of this invention is to provide a thermal time delay electric switch having novel voltage compensation means therein, whereby time delay variations caused by variations in voltage are minimized.

Yet another object of this invention is to provide a thermal time delay electric switch including ambient temperature compensating means for preventing ambient temperature changes from causing variations in the predetermined ON and OFF function time delays of the said switch.

These and other objects of the present invention will become more apparent with reference to the following specification and drawings which relate to several preferred embodiments of the invention.

In the drawings:

FIGURE 1 is a complete schematic of one embodiment of the switch mechanism of the present invention;

FIGURE 2 is a schematic of the switch means of FIGURE 1 in a different operating position;

FIGURE 3 is a schematic showing the switch means of FIGURES 1 and 2 in still another operating position;

FIGURE 4 is a rear view of the casing containing the switch means;

FIGURE 5 is a complete schematic of another embodiment of the switch mechanism of the invention;

FIGURE 6 is a partial schematic illustrating another embodiment of the switch mechanism of the invention;

FIGURE 7 is a partial schematic illustrating still another embodiment of the switch mechanism of the invention; and

FIGURE 8 is a partial schematic illustrating yet another embodiment of the switch mechanism of the invention.

Referring in detail to the drawings, and more particularly to FIGURES 1, 2 and 3, the thermal time delay switch of the present invention is shown as being housed in a casing 10 of insulating material having two inner compartments 12 and 14 therein which comprise, respectively, an actuator cavity and a switch cavity, separated by an internal partition 16.

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The internal partition has a through-port 18 therein connecting the actuator and switch cavities 12 and 14, respectively, for a purpose which will presently become apparent.

The thermal actuator means is located in the actuator cavity 12 and includes a main motive element 20 comprising an elongated bimetal element 22 having a heater coil 24 wound thereon. A fiberglass sleeve 26 or other suitable insulating means is placed around the bimetal element 22 beneath the heater coil 24.

Intermediate the ends of the main bimetal 22 and mounted in a T-slot 28 in the wall of the casing 10 is a heater terminal 30 held in place by a plurality of bent tabs 32. The heater terminal 30 includes a conductive tab 34 which is bent over one end of the heater coil 24 to thereby provide one of the connections to the said heater coil. The other end of the heater coil is connected directly to the upper end of the main bimetal element 22 as indicated at 36.

Mounted inside the wall of the casing 10 and extending at right angles thereto, is a conductive terminal bracket 38 which intersects and engages the main bimetal 22 at substantially right angles at a point below the insulating sleeve 26. Thus, a circuit through the heater coil and main bimetal 22 may be completed via the two terminals 30 and 38. The end of the bracket 38 which engages the main bimetal 22 and the said bimetal 22 are respectively bifurcated and notched as generally indicated at 40, to form a fulcrum or pivot for the main bimetal intermediate the ends thereof.

Means for biasing the main bimetal 22 about the fulcrum 40 is provided in the form of an adjustment screw 42, supported in a fixed tab or bushing 44 dependent from the terminal bracket 38, and threadably engaging an internally threaded eyelet 46 in the main bimetal 22 at a point immediately adjacent the lower end thereof.

In addition to the biasing screw 42 adjacent the lower end of the main bimetal 22, an adjustable limit stop in the form of a calibration screw 48 is threaded through the outer casing 10 at a point adjacent the upper tip of the main bimetal 22.

The remainder of the motive means for the switch actuator comprises a second or compensating bimetal element 50 which has a substantially inverted U-shape having a tendency to close its arms in response to an increase in the temperature thereof.

One leg of the U-shaped bimetal 50 is brazed or otherwise integrally affixed to the upper end of the main bimetal 22, as indicated at 52, whereby the said U-shaped or second bimetal 50 is suspended in an upright position from the top of the said main bimetal 22.

The switch actuating means in the actuator cavity 12 is connected to the switch means in the switch cavity 14 via a transfer link 54 extending from a connection at the upper tip 56 of the free arm of the U-shaped bimetal 50, through the through-port 18 in the internal partition 16, to a connection with the hook-shaped upper end 58 of the main spring assembly 60 of the switch mechanism now to be described.

The main spring assembly 60 is riveted or otherwise affixed at its lower end 62 to a conductive terminal bracket 64 mounted inside the wall of the casing 10 within the switch cavity 14. Although not specifically shown in front elevation, the main spring assembly comprises a main bifurcated spring portion 66 having an integral flexible tongue 68 between the bifurcations which cooperates with a rolling spring 70 to produce a snap action of the said tongue 68. A contact button 72 is provided on tongue 70. The self bias of the main spring acts in the direction from the inner partition 16 to the outer wall of the casing 10.

A stationary switch contact 74 is mounted on one arm 76 of an inverted Y-shaped upper portion of an adjustable contact spring 78, which, in turn, is riveted at its lower end to a fixed terminal bracket 80 mounted in the wall of the casing 10. The self bias of the contact spring 78 is toward the wall of the casing 10 and abuts an adjustable stop means in the form of a calibrated screw 82 threadably mounted in the said wall of the casing 10. A suitable dial 84 on the exterior end of the calibrated screw 82 cooperates with a spring-biased click adjustment means 8 mounted on the exterior of the casing 10.

By referring to FIGURE 4, the relative position of the external connections for the heater contact terminals 30 and 38 and the switch contact terminals 64 and 80 may readily be seen. A plurality of terminal screws 88 are provided, one for each of the said terminals.

Ambient temperature compensation

Referring first to FIGURE 5, one preferred embodiment for providing ambient temperature compensation, by a compensating action on the main mobile element 20 of the thermal actuating means of the present invention, will now be described.

Basically, the switch and actuator means shown in FIGURE 5 are identical with those shown and described with respect to FIGURES 1, 2 and 3 and like parts are designated by like numerals.

An additional through-port 90 is first provided in the internal partition 16 at a position directly opposite the bias adjusting screw 42 on the main bimetal actuator 22. Also, mounted adjacent the first through-port 18, in the switch cavity 14, is a mounting block 92 on which is provided a flat mounting surface substantially parallel to the partition 16 for mountably receiving the end of the shank 94 of an L-shaped compensating bimetal element 96. The mounting means may be a rivet 98 or any other suitable fastener.

The shank portion 94 extends from the mounting block 92, substantially parallel with the partition 16, to the second through-port 90. The short shank or arm 100 of the L-shaped bimetal 96 extends through the second through-port 90 and into the actuator cavity 12, into juxtaposition with the end of the bias adjusting screw 42 which extends through the threaded eyelet 46 in the main bimetal 22. A foot means 102 is provided on the end of the short shank 100 which is generally conformed to properly receive the tip of the said bias adjusting screw 42. As shown by the dotted line position in FIGURE 5, the L-shaped compensating bimetal 96 is designed to displace to the left in response to an increase in ambient temperature.

Referring now to FIGURE 6, another embodiment is shown for providing ambient temperature compensation by acting on the switch mechanism.

An elongated bimetal compensating element 104 is disposed substantially vertically, as shown, from an anchored position in a slot 106 in the lower wall of the casing 10 to a retaining slotted type fulcrum generally shown at 108 on the main switch terminal bracket 64 and thence coextensively with the flexible contact mounting tongue 68 of the main spring assembly 60. The upper tip of the compensating bimetal 104 comprises a limit-stop 110 located directly behind the moving switch contact 72 on the tongue 68.

The limit-stop 110 on the bimetal compensating element 104 is adapted to be deflected to the left in response to an increase in ambient temperature and to the right in response to a decrease in ambient temperature.

Referring now to FIGURE 7, another switch biasing ambient temperature compensating means is shown which acts to reposition the fixed contact 74 of the switch structure.

The fixed contact 74 is mounted intermediate the ends of a return-bend portion 112 on the upper end of a vertically disposed, elongated, compensating bimetallic leaf

spring 114. The foot 116 of the leaf spring 114 is L-shaped and riveted or otherwise fastened flush with horizontal portion of the contact terminal bracket 80. The lower tip 118 of the return-bend portion 112 is located directly adjacent the upper tip 120 of a vertically extending portion of the terminal bracket 80, whereby movement of the fixed contact to the left, as shown, will be limited. The bimetal spring 114 is adapted to deflect to the left in response to an increase in ambient temperature.

The initial operating point of the bimetal spring 114 and the fixed contact 74 is selectively adjustable via the calibrated screw 82 by means of a second leaf spring 122. The second spring 122 extends from a conformed screw engaging tab 124 at its upper tip, which engages the tip of the calibrated screw 82, substantially parallel and coextensive with the bimetal spring 114 to an L-shaped foot portion 126 which is riveted to the terminal bracket 80 in juxtaposition with the foot 116 of the bimetal spring 114. A small horizontally extending push-tab 128, integral with the second spring 122 a short distance above the horizontal portion of the terminal bracket 80, engages the lower portion of the bimetal spring 114 whereby movement of the second spring 122 via the calibrated screw is transmitted to the fixed contact 74 via the said bimetal spring 114.

In the above-described embodiment of FIGURE 7, the compensating bimetal spring 114 is a current carrying portion of the switch mechanism. In higher current load situations where this feature would become undesirable, the embodiment of FIGURE 8, now to be described, will obviate the difficulty.

The fixed contact 74 is mounted on the upper end of an elongated contact supporting leaf spring 130 riveted or otherwise affixed at 132 to the vertical portion of the terminal bracket 80.

A forked horizontally extending tab 134, integral with the leaf spring 130 immediately below and behind the contact 74, is adapted to engage the lower tip of a vertically extending bimetal leaf spring 136. The upper tip of the bimetal spring 136 is fixedly engaged in a slot 138 in the inner wall of the casing 10. A forked portion 140 intermediate the ends of the bimetal spring 136 is provided with a conformed tab 142 for receivably engaging the tip of the calibrated screw 82.

The bimetal spring 136 is adapted to deflect to the left in response to a rise in ambient temperature and the contact supporting leaf spring 130 is accordingly offset slightly at 144 from the vertical portion of the terminal bracket 80 to allow a limited compensating movement of the contact 74 in the same direction.

Operation

The operation of the thermal actuating means and the switch means without additional thermal compensation means will now be described with reference to FIGURES 1, 2 and 3.

In FIGURE 1, the unenergized position of the main motive element 20 and the compensating U-shape bimetal 50 of the thermal actuating means and the main spring assembly 60 of the switch means is shown, which corresponds to the open position of the switch contacts 72 and 74.

The primary control feature provided by the invention is in the selectively adjustable delays in both the closing time and the opening time of the switch contacts 72 and 74 in response to energization and de-energization, respectively, of the heating coil 24 on the main bimetal 22. The time delay provided by the invention prior to the closing of the contacts 72 and 74 and subsequent to the energization of the heating coil 24 will hereinafter be referred to as the "ON" time. The time delay provided by the invention subsequent to the de-energization of the heating coil 24 and prior to the opening of the contacts 72 and 74 will hereinafter be referred to as the "OFF" time.

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Referring now to FIGURE 1, the switch contacts 72 and 74 are in an open condition. While the main spring assembly 60 of the switch means is biased to deflect left, or counter-clockwise, as shown, to thereby cause the main contact spring 68 and its moving contact 72 to snap toward the fixed contact 74 under the motivation of the rolling spring 70, the main bimetal 22 and compensating bimetal 50, of the thermal actuating means, acting through the transfer link 54, oppose the main spring assembly 60 with an overriding bias to maintain the switch contacts 72 and 74 in an open condition.

When the heater coil 26 is energized to initiate the "ON" time delay, the main bimetal 22 is deflected to the left by the heating action and finally abuts the adjustable limit stop 48 as shown in FIGURE 2. The heating action continues, causing the temperature in the actuator cavity 12 to rise and also causing heat to be conducted from the main bimetal 22 to the compensating bimetal 50, consequently producing a closing up of the U-shaped compensating bimetal 50 as shown in FIGURE 3.

The opposing bias of the main bimetal 22 and compensating bimetal 50, acting through the transfer link 54, is thus gradually relaxed and the main spring 60 of the switch means is permitted to deflect counterclockwise until the critical overcenter position is reached at which the moving contact 72 will be snapped into closed position with the fixed contact 74 (FIGURE 3).

To cause the switch contacts 72 and 74 to break, the heater coil 26 is de-energized. This causes a gradual cooling of the main bimetal 22 and the compensating bimetal 50, thereby permitting the self bias of the said bimetals to override the self bias of the main spring assembly 60, via the transfer link 54, by deflecting the entire linkage system to the right. Upon sufficient cooling and displacement, the critical or overcenter position of the switch is reached and the moving contact 72 on the contact spring 68 is snapped to open position by the action of the rolling spring 70.

Since the heating of the compensating or U-shaped motivating bimetal 50 is primarily by conduction through the main bimetal 22 rather than radiation as in the case of the main motivating bimetal 22, the heating and action of the compensating bimetal 50 are caused to lag that of the main bimetal 22. The main bimetal 22 is primarily heated by radiation from the surrounding heater 24 and, as a result, is very sensitive to voltage fluctuations in the power supply (not shown) for the heating coil 26. By combining the two types of heating with the inherent lag in the heat transfer from the main bimetal 22 to the compensating bimetal 50, voltage fluctuations tend to be averaged out in the thermal lag between the main bimetal 22 on the compensating bimetal 50.

In the embodiment of FIGURES 1, 2 and 3, the "ON" time may be adjusted by either the limit stop 48 which governs the limit of the initial movement of the actuating means, namely, the deflection of the main bimetal 22. The main bimetal 22 is first allowed to deflect into abutment with the limit stop 48 without causing closure of contacts 72 and 74 and then, after a suitable subsequent delay, the limit stop is further adjusted to permit the switch contacts 72 and 74 to close.

An adjustment for both the "ON" and "OFF" times of the invention is provided by the biasing screw 42 at the lower end of the main bimetal 22. By varying the initial position of the lower tip of the main bimetal 22 about the fulcrum 40 thereof, the effect of moving the said lower tip in one direction is to increase the "ON" and decreasing the "OFF" time and conversely in the other direction.

An additional control which affects only the "OFF" time is provided by the calibrated contact stop screw 82. By adjusting the gap between the contacts 72 and 74, the action of the overcenter switch mechanism is changed as to the position at which the critical or overcenter point thereof is reached. For example, if the fixed contact 74 is caused to move toward the moving contact 72 by the

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calibrated stop screw 82, less movement of the main spring 60 to the right is required to cause the contacts 72 and 74 to snap to open position. Thus, movement of the fixed contact 74 to the left caused a decrease in "OFF" time and movement of the said contact to the right caused an increase therein.

Referring now to FIGURE 5, the ambient temperature compensating L-shaped bimetal 96 acts to simultaneously adjust both the "ON" and "OFF" times in response to ambient temperature variation. Since the short leg 100 of the L-shaped bimetal 96 deflects to the left in response to ambient temperature increases, it causes the foot 102 thereon to move the biasing screw 42 and the lower tip of the main bimetal 22 to the left, or clockwise, about the fulcrum 40. The ambient temperature rise, however, causes a greater initial deflection of the main bimetal 22 and the compensating bimetal 50 in a counterclockwise direction about the same fulcrum 40. Thus, with proper mutual calibration between the various bimetal elements, the two above-enumerated effects can be made equal and opposite making the invention stable over a wide ambient temperature range as to both "ON" and "OFF" times.

In the embodiment of FIGURE 6, the bimetal compensating element 104 deflects to the left in response to a rise in ambient temperature and thus causes the stop 110 to move to the left. Since the main spring 60 and the contact carrying spring 68 thereon abutting the stop 110 are biased to the left, the contact spring 68 is constrained to follow the stop 110 and thus vary the critical or overcenter point of the switch means in a manner opposing the effect of the ambient temperature rise. A drop in ambient temperature produces a corresponding corrective deflection of the stop 110 and the contact spring 68 to the right. Both of these corrective movements apply only to the "ON" time, preventing the lengthening of it under cooler conditions and the shortening of it under warmer conditions.

Referring now to FIGURE 7, where the contacts 72 and 74 are shown in open position, the calibrated dial or knob 84 is adjusted for a desired "OFF" time causing the screw 82 to deflect the spring 122 to the left or right as desired. Movement of the spring 122 is transferred to the ambient temperature compensating bimetal contact spring 114 by means of the integral tab 128 on the spring 122. This causes the fixed contact 74 to assume a new position with respect to the moving contact 72.

For example, if the ambient temperature rises, the main spring assembly 60 is permitted to deflect to the left, as hereinbefore described, which tends to lengthen the "OFF" time of the invention since a longer cooling time is required to bring the thermal actuator linkage and the main spring assembly 60 back to the critical or overcenter switch position. Since, however, the compensating bimetal contact spring is also adapted to deflect to the left with an increase in the ambient temperature, the overcenter point of the switch is shifted left requiring less movement of the main spring assembly 60 to the right to reach the overcenter position, thus cancelling the effect of the ambient temperature rise and maintaining the "OFF" time constant as set by the knob 84.

Referring now to FIGURE 8, the initial "OFF" time setting is made via the calibrated dial or knob 84 causing the stop screw 82 to selectively position the ambient temperature compensating bimetal 136 via the forked connection 140 and contact tab 142 thereon and thereby transfer the motion of the bimetal 136 to the contact spring 130 and the fixed contact 74 thereon through the integral tab 134 on the said contact spring 130.

While in this embodiment the operation is substantially identical to that of FIGURE 7, there is no flow of current through the ambient temperature compensating bimetal 136 since it is effectively isolated from the current path of the fixed contact 74.

As can be seen from the foregoing specification and drawings, this invention provides a positive acting, versa-

tile time delay switch for the performance of control functions requiring "ON" and "OFF" time delays, as hereinbefore defined, wherein the said time delays are selectively and individually adjustable and are made effectively non-sensitive to ambient temperature variations and voltage fluctuations.

It is to be understood, that the embodiments shown and described herein are for the purpose of example only and are not intended to limit the scope of the appended claims.

What is claimed is:

1. A thermal time delay switch for providing selectively adjustable ON and OFF times including a thermally biased actuating means, a switch means controlled thereby and a hollow casing for housing said actuating means and said switch means, said casing having at least two side walls; said thermally biased actuating means including a main motive element comprising a main elongated bimetal substantially coextensive with and adjacent one of said side walls and a heater means in heat exchanging relationship with said main bimetal, fulcrum means for said main bimetal adjacent one end thereof, means for adjustably positioning and fixing said one end of said main bimetal about said fulcrum, the other end of said main bimetal being free to move in response to thermal bias derived from said heater means, a curvilinear compensating bimetal, in heat exchanging relationship with said heater means, fixed at one end to said free end of said main bimetal, and a transfer link connected at one end to the other end of said compensating bimetal and at its other end to said switch means; and said switch means including a main spring assembly, coextensive with a portion of said other side wall, having a fixed end and a free end and connected with said other end of said transfer link at said free end, a moving contact means actuated by said main spring assembly and a fixed contact means cooperating with said moving contact means, said main spring assembly of said switch means and said main and compensating bimetal of said actuating means being self-biased so as to act in opposition through said transfer link.

2. The invention defined in claim 1, wherein, in the said actuating means, the said heat exchanging relationship between said heater and said main bimetal is primarily one of radiation and the said heat exchanging relationship between said heater and said compensating bimetal is primarily one of conduction through the said main bimetal, thereby producing a thermal lag between said main bimetal and said compensating bimetal.

3. The invention defined in claim 1, wherein, in the said actuating means, said heater means comprises an electrically energized heating element encompassing a substantial central portion of said main bimetal.

4. The invention defined in claim 1, wherein, in the said actuating means, said heater means comprises an electrically energized heating element encompassing a substantial central portion of said main bimetal and further wherein, in the said actuating means, the said heat exchanging relationship between said heater and said main bimetal is primarily one of radiation and the said heat exchanging relationship between said heater and said compensating bimetal is primarily one of conduction through the said main bimetal, thereby producing a thermal lag between said main bimetal and said compensating bimetal.

5. The invention defined in claim 1, wherein, in the said actuating means, the said means for adjustably positioning and fixing one end of said main bimetal about said fulcrum comprises a bushing fixed to said housing adjacent one side of said fulcrum, an adjusting screw slidably supported in said bushing, and threaded eyelet integral with said one end of said main bimetal for threadably receiving said adjusting screw, whereby turning of said screw provides a means for selectively moving said

one end of said main bimetal towards and away from said fixed bushing and about said fulcrum to selectively vary the self-bias of said main bimetal, thereby providing an adjustment for selectively varying the ON and OFF time delays of said switch.

6. The invention defined in claim 1, wherein said thermally biased actuating means further includes stop means for selectively adjusting the ON time delay, said stop means comprising a calibrated screw extending through said one side wall of said casing adjacent the free end of said main bimetal, whereby the throw of said main bimetal, as effected by the energization of said heater, toward said one side wall is selectively adjustable, said ON time delay being inversely proportional to said throw.

7. The invention defined in claim 1, wherein, in said switch means, said moving contact means comprises a snap acting mechanism and first contact integral with said main spring assembly, said fixed contact means comprises an elongated spring means, adjacent and substantially coextensive with said main spring assembly, fixed at one end and having a second contact mounted adjacent its free end, and wherein said switch means further includes stop means for selectively adjusting the OFF time delay, said stop means comprising a calibrated screw extending through said other side wall of said casing into engagement with said free end of said elongated spring means, whereby said second contact may be selectively positioned with respect to said first contact to selectively control the position of the overcenter point of said snap acting mechanism.

8. The invention defined in claim 1, wherein said thermally biased actuating means further includes stop means for selectively adjusting the ON time delay, said stop means comprising a calibrated screw extending through said one side wall of said casing adjacent the free end of said main bimetal, whereby the throw of said main bimetal, as effected by the energization of said heater, toward said one side wall is selectively adjustable, said ON time delay being inversely proportional to said throw; and wherein, in said switch means, said moving contact means comprises a snap acting mechanism and first contact integral with said main spring assembly, said fixed contact means comprises an elongated spring means, adjacent and substantially coextensive with said main spring assembly, fixed at one end and having a second contact mounted adjacent its free end, and wherein said switch means further includes stop means for selectively adjusting the OFF time delay, said stop means comprising a calibrated screw extending through said other side wall of said casing into engagement with said free end of said elongated spring means, whereby said second contact may be selectively positioned with respect to said first contact to selectively control the position of the overcenter point of said snap acting mechanism.

9. The invention defined in claim 1, wherein said thermally biased actuating means further includes means for selectively determining the throw of the free end of said main bimetal in response to the energization of said heater and wherein, in said switch means, said moving contact means includes a snap-acting mechanism and said switch means further includes means for selectively positioning the overcenter point of said snap-acting mechanism.

10. A thermal time delay switch for providing selectively adjustable ON and OFF times including a thermally biased actuating means, a switch means controlled thereby and a hollow casing for housing said actuating means and said switch means, said casing having at least two side walls; said thermally biased actuating means including a main motive element comprising a main elongated bimetal substantially coextensive with and adjacent one of said side walls and a heater means in heat exchanging relationship with said main bimetal, said main bimetal having one end fixed and the other end of said

main bimetal being free to move in response to thermal bias derived from said heater means, a curvilinear compensating bimetal, in heat exchanging relationship with said heater means, fixed at one end to said free end of said main bimetal, and a transfer link connected at one end to the other end of said compensating bimetal and at its other end to said switch means; and said switch means including a main spring assembly, coextensive with a portion of said other side wall, having a fixed end and a free end and connected with said other end of said transfer link at said free end, a moving contact means actuated by said main spring assembly and a fixed contact means cooperating with said moving contact means, said main spring assembly of said switch means and said main and compensating bimetal of said actuating means being self-biased so as to act in opposition through said transfer link.

11. The invention defined in claim 10, wherein, in the said actuating means, the said heat exchanging relationship between said heater and said main bimetal is primarily one of radiation and the said heat exchanging relationship between said heater and said compensating bimetal is primarily one of conduction through the said main bimetal, thereby producing a thermal lag between said main bimetal and said compensating bimetal.

12. The invention defined in claim 10, wherein, in the said actuating means, said heater means comprising an electrically energized heating element encompassing a substantial central portion of said main bimetal.

13. The invention defined in claim 10, wherein, in the said actuating means, said heater means comprises an electrically energized heating element encompassing a substantial central portion of said main bimetal and further wherein, in the said actuating means, the said heat exchanging relationship between said heater and said main bimetal is primarily one of radiation and the said heat exchanging relationship between said heater and said compensating bimetal is primarily one of conduction through the said main bimetal, thereby producing a thermal lag between said main bimetal and said compensating bimetal.

14. The invention defined in claim 10, wherein said thermally biased actuating means further includes stop means for selectively adjusting the ON time delay, said stop means comprising a calibrated screw extending through said one side wall of said casing adjacent the free end of said main bimetal, whereby the throw of said main bimetal, as effected by the energization of said heater, toward said one side wall is selectively adjustable, said ON time delay being inversely proportional to said throw.

15. The invention defined in claim 10, wherein, in said switch means, said moving contact means comprises a snap acting mechanism and first contact integral with said main spring assembly, said fixed contact means comprises an elongated spring means, adjacent and substantially coextensive with said main spring assembly, fixed at one end and having a second contact mounted adjacent its free end, and wherein said switch means further includes stop means for selectively adjusting the OFF time delay, said stop means comprising a calibrated screw extending through said other side wall of said casing into engagement with said free end of said elongated spring means, whereby said second contact may be selectively positioned with respect to said first contact to selectively control the position of the over-center point of said snap acting mechanism.

16. The invention defined in claim 10, wherein said thermally biased actuating means further includes stop means for selectively adjusting the ON time delay, said stop means comprising a calibrated screw extending through said one side wall of said casing adjacent the free end of said main bimetal, whereby the throw of said main bimetal, as effected by the energization of said heater, toward said one side wall is selectively adjustable, said

ON time delay being inversely proportional to said throw; and wherein, in said switch means, said moving contact means comprises a snap acting mechanism and first contact integral with said main spring assembly, said fixed contact means comprises an elongated spring means, adjacent and substantially coextensive with said main spring assembly, fixed at one end and having a second contact mounted adjacent its free end, and wherein said switch means further includes stop means of selectively adjusting the OFF time delay, said stop means comprising a calibrated screw extending through said other side wall of said casing into engagement with said end of said elongated spring means, whereby said second contact may be selectively positioned with respect to said first contact to selectively control the position of the over-center point of said snap acting mechanism.

17. The invention defined in claim 10, wherein said thermally biased actuating means further includes means for selectively determining the throw of the free end of said main bimetal in response to the energization of said heater and wherein, in said switch means, said moving contact means includes a snap-acting mechanism and said switch means further includes means for selectively positioning the over-center point of said snap-acting mechanism.

18. The invention defined in claim 10, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflection to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature.

19. The invention defined in claim 10, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflection to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature; and wherein said ambient temperature compensating means comprises thermally distortable means fixed at one point and extending into abutment with said moving contact means on said main spring assembly of said switch means, said distortable means acting to reposition said moving contact means in response to ambient temperature variations, whereby the bias placed on said switch means by said ambient temperature variation is effectively opposed.

20. The invention defined in claim 10, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflection to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature; wherein, in said switch means, said moving contact means comprises a snap acting means and a contact integral with said main spring assembly and wherein, said ambient temperature compensating means comprises a thermally distortable means fixed at one point and extending into abutment with said snap acting means adjacent said contact, said distortable means acting to reposition said moving contact means in response to ambient temperature variations whereby the over-center position of said snap-acting means is automatically varied to effectively oppose the bias placed on said switch means by said ambient temperature variations.

21. The invention defined in claim 10, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means

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and responsive to said ambient temperature to impart a deflection to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature; and wherein said ambient temperature compensating means includes a thermally distortable element integral with said fixed contact means, said distortable element comprising a contact spring fixed at one end and carrying a contact at the other end thereof, and acting to vary the position of said contact in said fixed contact means with respect to said moving contact means in response to ambient temperature variations.

22. The invention defined in claim 10, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflection to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature; and wherein said ambient temperature compensating means includes a thermally distortable element integral with said fixed means, said fixed contact means including a contact spring having one fixed end and a contact carried by the free end thereof, said distortable element being fixed at one point and extending into abutment with said contact spring adjacent said contact and acting to vary the position of said contact in said fixed contact means with respect to said moving contact means in response to ambient temperature variations.

23. The invention defined in claim 10, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflection to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature; wherein said ambient temperature compensating means includes a thermally distortable element integral with said fixed contact means, said distortable element comprising a contact spring fixed at one end and carrying a contact at the other end thereof, and acting to vary the position of said contact in said fixed contact means with respect to said moving contact means in response to ambient temperature variations and further wherein said fixed contact means includes stop means for selectively adjusting the OFF time delay, said stop means comprising a second spring, a fixed end adjacent said fixed end of said contact spring, and a free end, and being co-extensive with said contact spring, an integral tab on said second spring adjacent said fixed end extending into abutting juxtaposition with said contact spring, and a calibrated screw extending through said other side wall of said casing into engagement with said free end of said second spring, whereby the position of said contact on said fixed contact means may be selectively varied, via said screw, said second spring, said integral tab and said contact spring, with respect to said moving contact means.

24. The invention defined in claim 10, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflection to the mechanism of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature; wherein said ambient temperature compensating means includes a thermally distortable element integral with said fixed contact means, said fixed contact means including a contact spring having one fixed end and a contact carried by the free end thereof, said distortable element being fixed at one point and extending into abutment with said contact spring adjacent said

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contact and acting to vary the position of said contact in said fixed contact means with respect to said moving contact means in response to ambient temperature variations and further wherein said fixed contact means includes stop means for selectively adjusting the OFF time delay, said stop means comprising an intermediate integral extension on said distortable element and a calibrated screw extending through said other side wall of said casing into engagement with said intermediate extension, whereby the position of said contact on said fixed contact means may be selectively varied, via said screw, said extension, said distortable element and said contact spring, with respect to said moving contact means.

25. The invention defined in claim 1, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflection to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature.

26. The invention defined in claim 1, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflection to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature; and wherein said ambient temperature compensating means comprises a thermally distortable means fixed at one point and extending into abutting relationship with said means for adjustably positioning and fixing said one end of said main bimetal about said fulcrum, said distortable means acting on said last mentioned means to reposition said one end of said main bimetal about said fulcrum so as to effectively oppose any deflection produced in the free end of said main bimetal in response to ambient temperature variations.

27. The invention defined in claim 1, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflection to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature; wherein, in the said actuating means, the said means for adjustable positioning and fixing one end of said main bimetal about said fulcrum comprises a bushing fixed to said housing adjacent one side of said fulcrum, an adjusting screw slidably supported in said bushing, and threaded eyelet integral with said one end of said main bimetal for threadably receiving said adjusting screw, whereby turning of said screw provides a means for selectively moving said one end of said main bimetal towards and away from said fixed bushing and about said fulcrum to selectively vary the self-bias of said main bimetal, thereby providing an adjustment for selectively varying the ON and OFF time delays of said switch; and wherein said ambient temperature compensating means comprises a thermally distortable means fixed at one end and extending into abutment with the end of said adjusting screw adjacent said threaded eyelet, said distortable means acting on said adjusting screw to reposition said one end of said main bimetal about said fulcrum so as to effectively oppose any deflection produced in the free end of said main bimetal in response to ambient temperature variations.

28. The invention defined in claim 1, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflec-

tion to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature; and wherein said ambient temperature compensating means comprises thermally distortable means fixed at one point and extending into abutment with said moving contact means on said main spring assembly of said switch means, said distortable means acting to reposition said moving contact means in response to ambient temperature variations, whereby the bias placed on said switch means by said ambient temperature variation is effectively opposed.

29. The invention defined in claim 1, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflection to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature; wherein, in said switch means, said moving contact means comprises a snap acting means and a contact integral with said main spring assembly and wherein, said ambient temperature compensating means comprises a thermally distortable means fixed at one point and extending into abutment with said snap acting means adjacent said contact, said distortable means acting to reposition said moving contact means in response to ambient temperature variations, whereby the over-center position of said snap-acting means is automatically varied to effectively oppose the bias placed on said switch means by said ambient temperature variations.

30. The invention defined in claim 1, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflection to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature; and wherein said ambient temperature compensating means includes a thermally distortable element integral with said fixed contact means, said distortable element comprising a contact spring fixed at one end and carrying a contact at the other end thereof, and acting to vary the position of said contact in said fixed contact means with respect to said moving contact means in response to ambient temperature variations.

31. The invention defined in claim 1, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflection to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature; and wherein said ambient temperature compensating means includes a thermally distortable element integral with said fixed contact means, said fixed contact means including a contact spring having one fixed end and a contact carried by the free end thereof, said distortable element being fixed at one point and extending into abutment with said contact spring adjacent said contact and acting to vary the position of said contact in said fixed contact means with respect to said moving contact means in response to ambient temperature variations.

32. The invention defined in claim 1, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflection to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in

said ambient temperature; wherein said ambient temperature compensating means includes a thermally distortable element integral with said fixed contact means, said distortable element comprising a contact spring fixed at one end and carrying a contact at the other end thereof, and acting to vary the position of said contact in said fixed contact means with respect to said moving contact means in response to ambient temperature variations and further wherein said fixed contact means includes stop means for selectively adjusting the OFF time delay, said stop means comprising a second spring, a fixed end adjacent said fixed end of said contact spring, and a free end, and being co-extensive with said contact spring, an integral tab on said second spring adjacent said fixed end extending into abutting juxtaposition with said contact spring, and a calibrated screw extending through said other side wall of said casing into engagement with said free end of said second spring, whereby the position of said contact on said fixed contact means may be selectively varied, via said screw, said second spring, said integral tab and said contact spring, with respect to said moving contact means.

33. The invention defined in claim 1, wherein said thermal time delay switch further includes ambient temperature compensating means interconnected with said thermally biased actuating means and said switch means and responsive to said ambient temperature to impart a deflection to the mechanisms of said actuating and switch means which is effectively equal and opposite to the deflection generated therein in response to changes in said ambient temperature; wherein said ambient temperature compensating means includes a thermally distortable element integral with said fixed contact means, said fixed contact means including a contact spring having one fixed end and a contact carried by the free end thereof, said distortable element being fixed at one point and extending into abutment with said contact spring adjacent said contact and acting to vary the position of said contact in said fixed contact means with respect to said moving contact means in response to ambient temperature variations and further wherein said fixed contact means includes stop means for selectively adjusting the OFF time delay, said stop means comprising an intermediate integral extension on said distortable element and a calibrated screw extending through said other side wall of said casing into engagement with said intermediate extension, whereby the position of said contact on said fixed contact means may be selectively varied, via said screw, said extension, said distortable element and said contact spring, with respect to said moving contact means.

34. In a thermal time delay switch, a thermally biased actuating means including a main motive element comprising a main elongated bimetal, and a heater means in heat exchanging relationship with said main bimetal, fulcrum means for said main bimetal adjacent one end thereof, means for adjustably positioning and fixing said one end of said main bimetal about said fulcrum, the other end of said main bimetal being free to move in response to thermal bias derived from said heater means, a curvilinear compensating bimetal, in heat exchanging relationship with said heater means, fixed at one end to said free end of said main bimetal, and an output connection comprising a transfer link connected at one end to the other end of said compensating bimetal.

35. The invention defined in claim 34, wherein, in the said actuating means, the said heat exchanging relationship between said heater and said main bimetal is primarily one of radiation and the said heat exchanging relationship between said heater and said compensating bimetal is primarily one of conduction through the said main bimetal, thereby producing a thermal lag between said main bimetal and said compensating bimetal.

36. The invention defined in claim 34, wherein, in the said actuating means, said heater means comprises an electrically energized heating element encompassing a substantial central portion of said main bimetal.

37. The invention defined in claim 34, wherein, in the said actuating means, said heater means comprises an electrically energized heating element encompassing a substantial central portion of said main bimetal and further wherein, in the said actuating means, the said heat exchanging relationship between said heater and said main bimetal is primarily one of radiation and the said heat exchanging relationship between said heater and said compensating bimetal is primarily one of conduction through the said main bimetal, thereby producing a thermal lag between said main bimetal and said compensating bimetal.

38. The invention defined in claim 34, wherein, in the said actuating means, the said means for adjustably positioning and fixing one end of said main bimetal about said fulcrum comprises a bushing fixed to said housing adjacent one side of said fulcrum, an adjusting screw slidably supported in said bushing, and threaded eyelet integral with said one end of said main bimetal for threadably receiving said adjusting screw, whereby turning of said screw provides a means for selectively moving said one end of said main bimetal towards and away from said fixed bushing and about said fulcrum to selectively vary the self-bias of said main bimetal.

39. In a thermal time delay switch, a thermally biased actuating means including a main motive element comprising a main elongated bimetal, and a heater means in heat exchanging relationship with said main bimetal, fulcrum means for said main bimetal adjacent one end thereof, said one end of said main bimetal being fixed with respect to said fulcrum, the other end of said main bimetal being free to move in response to thermal bias derived from said heater means, a curvilinear compensating bimetal, in heat exchanging relationship with said heater means, fixed at one end to said free end of said main bimetal, and an output connection comprising a transfer link connected at one end to the other end of said compensating bimetal.

40. The invention defined in claim 34, wherein, in the said actuating means, the said heat exchanging relationship between said heater and said main bimetal is primarily one of radiation and the said heat exchanging relationship between said heater and said compensating bimetal is primarily one of conduction through the said main bimetal, thereby producing a thermal lag between said main bimetal and said compensating bimetal.

41. The invention defined in claim 34, wherein, in the said actuating means, said heater means comprises an electrically energized heating element encompassing a substantial central portion of said main bimetal.

42. The invention defined in claim 34, wherein, in the said actuating means, said heater means comprises an electrically energized heating element encompassing a substantial central portion of said main bimetal and further wherein, in the said actuating means, the said heat exchanging relationship between said heater and said main bimetal is primarily one of radiation and the said

heat exchanging relationship between said heater and said compensating bimetal is primarily one of conduction through the said main bimetal, thereby producing a thermal lag between said main bimetal and said compensating bimetal.

43. In a thermal time delay switch, a thermally biased actuating means including a main motive element comprising a main elongated bimetal, and a heater means in heat exchanging relationship with said main bimetal, means for fixing one end of said main bimetal, the other end of said main bimetal being free to move in response to thermal bias derived from said heater means, a curvilinear compensating bimetal, in heat exchanging relationship with said heater means, fixed at one end to said free end of said main bimetal, and an output connection comprising a transfer link connected at one end to the other end of said compensating bimetal.

44. The invention defined in claim 43, wherein, in the said actuating means, the said heat exchanging relationship between said heater and said main bimetal is primarily one of radiation and the said heat exchanging relationship between said heater and said compensating bimetal is primarily one of conduction through the said main bimetal, thereby producing a thermal lag between said main bimetal and said compensating bimetal.

45. The invention defined in claim 43, wherein, in the said actuating means, said heater means comprises an electrically energized heating element encompassing a substantial central portion of said main bimetal.

46. The invention defined in claim 43, wherein, in the said actuating means, said heater means comprises an electrically energized heating element encompassing a substantial central portion of said main bimetal and further wherein, in the said actuating means, the said heat exchanging relationship between said heater and said main bimetal is primarily one of radiation and the said heat exchanging relationship between said heater and said compensating bimetal is primarily one of conduction through the said main bimetal, thereby producing a thermal lag between said main bimetal and said compensating bimetal.

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BERNARD A. GILHEANY, *Primary Examiner*.

ROBERT K. SCHAEFER, *Examiner*.