United States Patent [19]

Plasko

[11] **3,917,327**

[45] **Nov. 4, 1975**

[54] **THERMALLY ACTUATED DEVICE AND DOOR LATCH MEANS UTILIZING THE SAME OR THE LIKE**

[75] Inventor: **Emil Robert Plasko,** Washington Township, Ohio

[73] Assignee: **Micro Devices Corp.,** Dayton, Ohio

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[21] Appl. No.: **440,159**

[52] **U.S. Cl.** **292/1;** 292/201

[51] **Int. Cl.²** **E05C 19/16**

[58] **Field of Search** ..... 292/201, 216, DIG. 66

[56] **References Cited**

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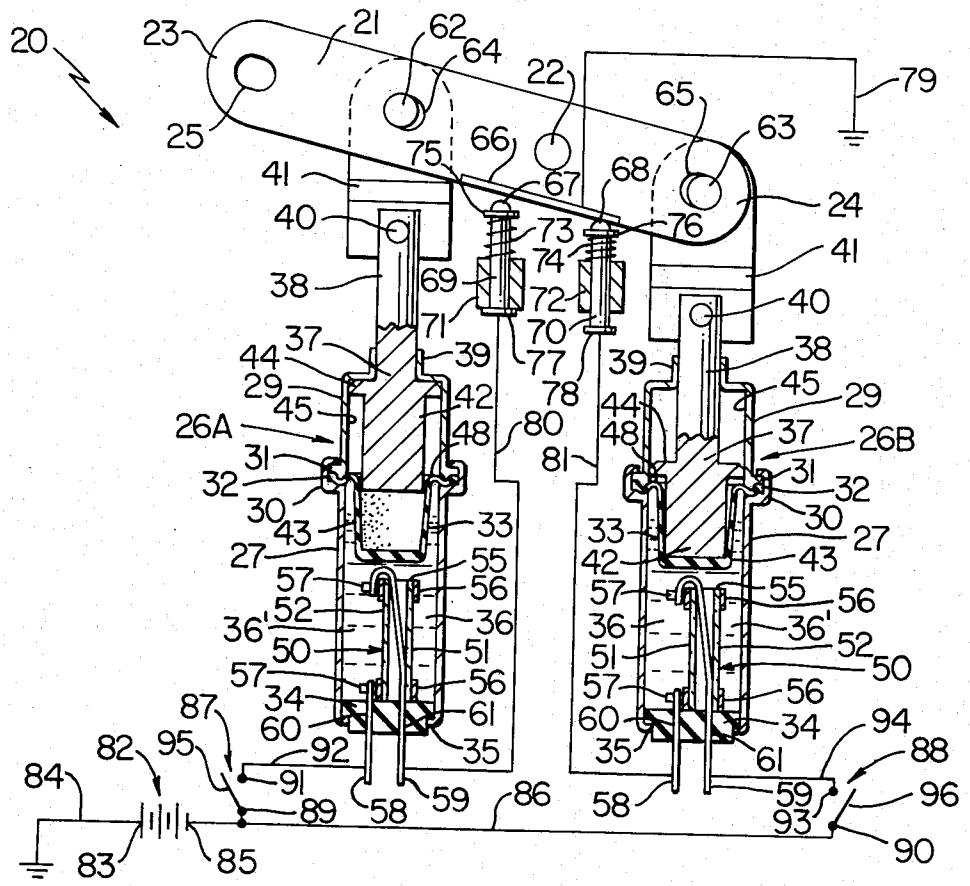
Primary Examiner—Richard E. Moore

Attorney, Agent, or Firm—Candor, Candor & Tassone

[57] **ABSTRACT**

A thermally actuated device having a housing provided with a chamber having a thermally responsive medium therein and being defined in part by a motion-transmitting member movable relative to the housing in response to expansion or contraction of the thermally responsive medium that is adapted to be heated by an electrical heater disposed in the chamber, the heater comprising a cylindrical member of electrical insulating material having a conductive coating on the surface thereof that provides substantially a uniform thermal flux to the thermally responsive medium throughout substantially the entire surface area of the heater. Two such actuators are utilized with a door latch member so that when one of the devices is thermally actuated, the same moves the latch member to a locking position thereof and when the other device is thermally actuated, the same moves the latch member to an unlocking position thereof.

15 Claims, 12 Drawing Figures



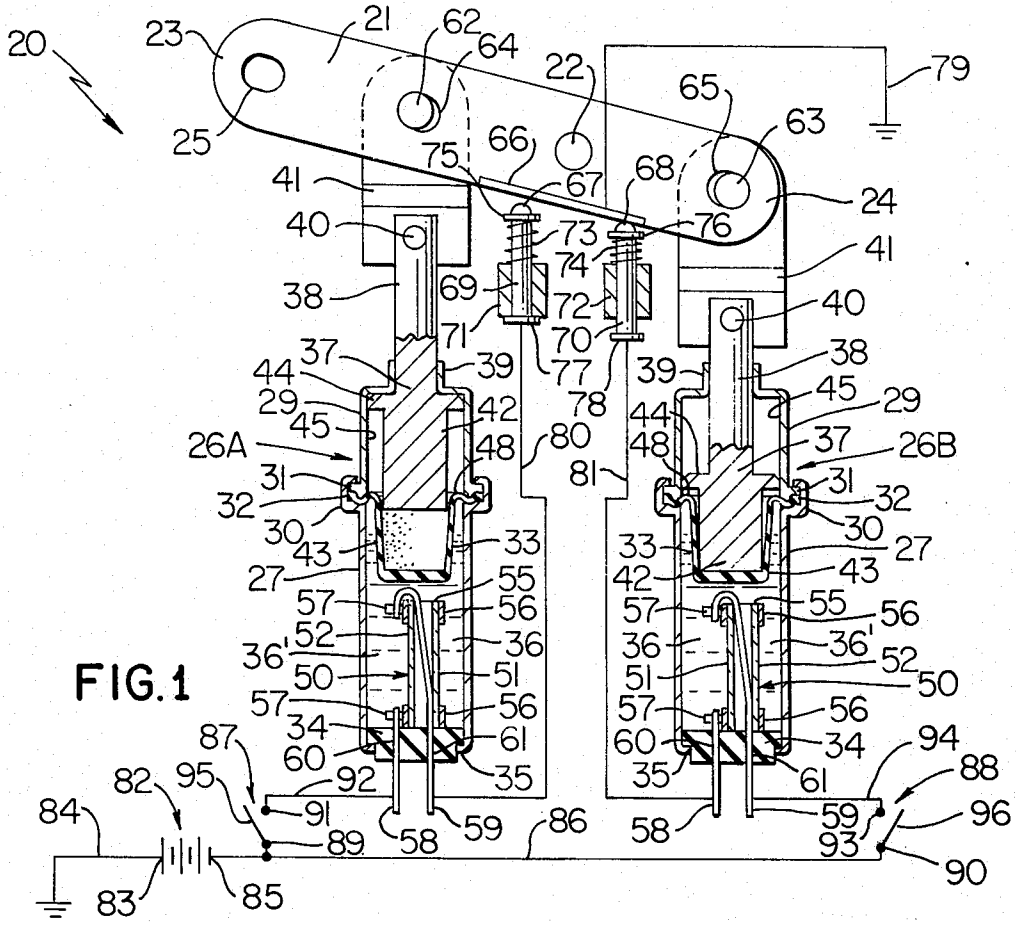

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FIG. 1

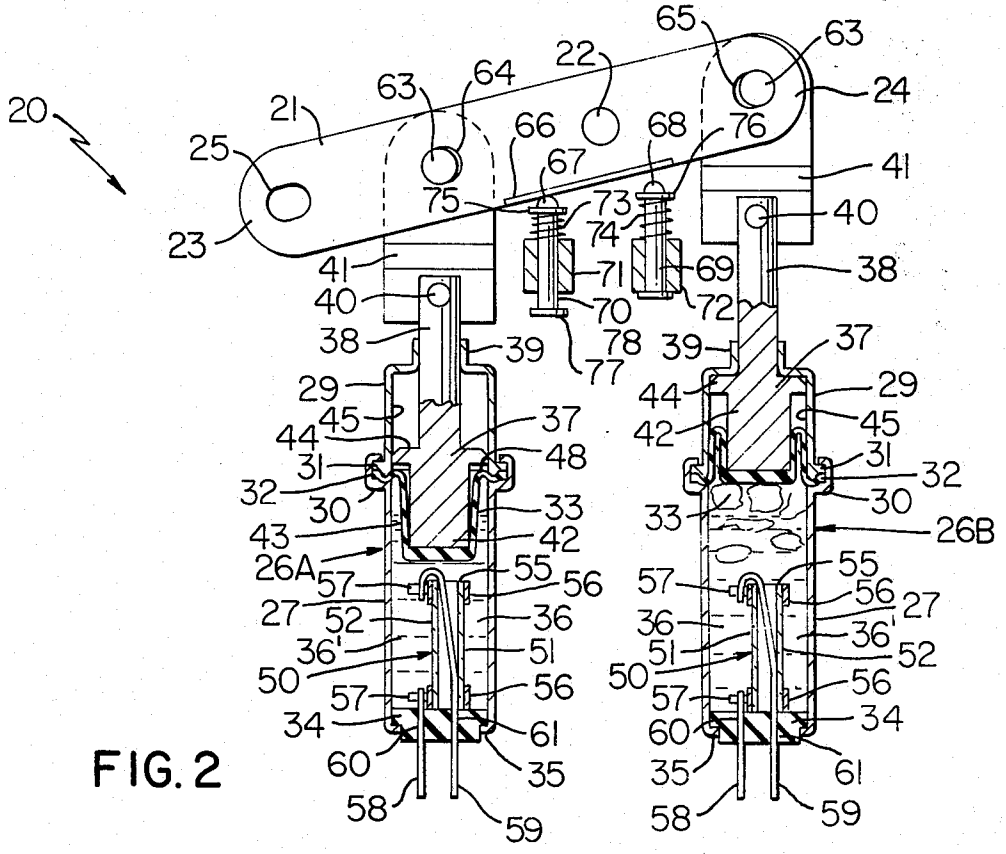

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FIG. 2

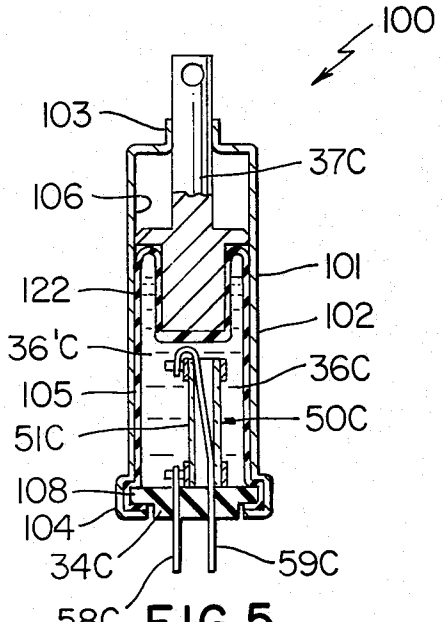


FIG. 5

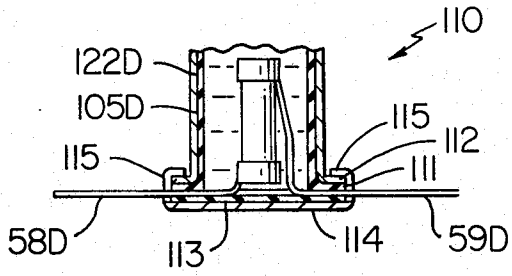


FIG. 6

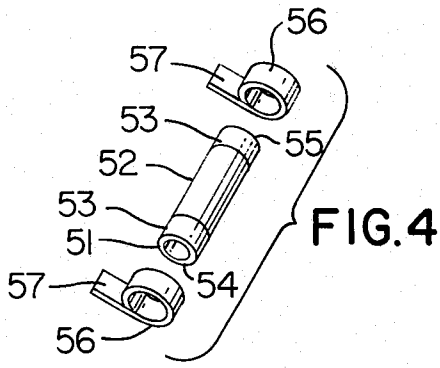


FIG. 4

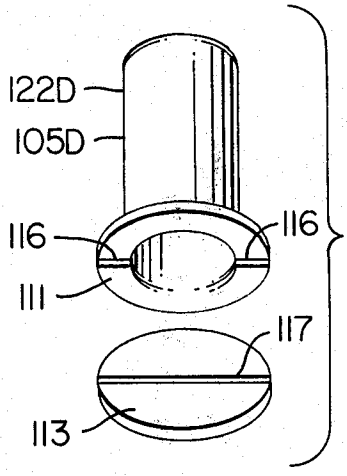


FIG. 7

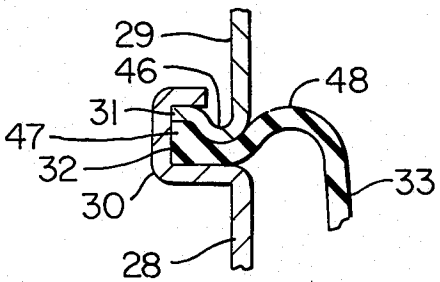


FIG. 3

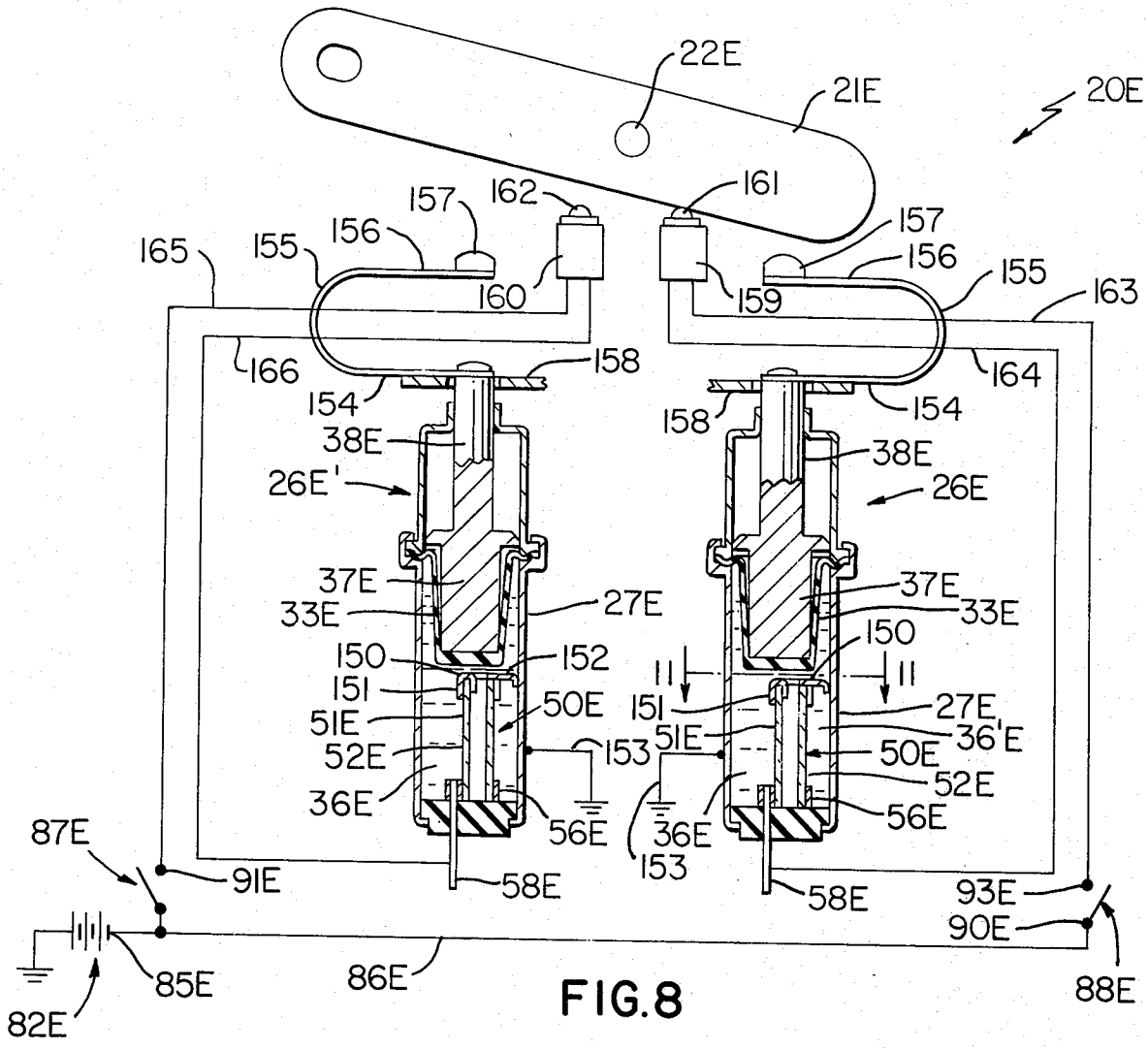


FIG.8

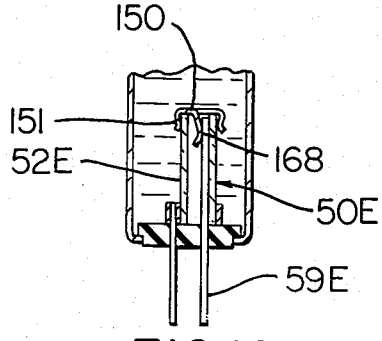


FIG.12

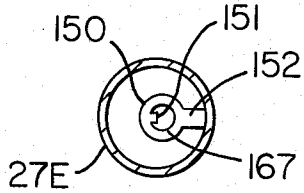


FIG.11

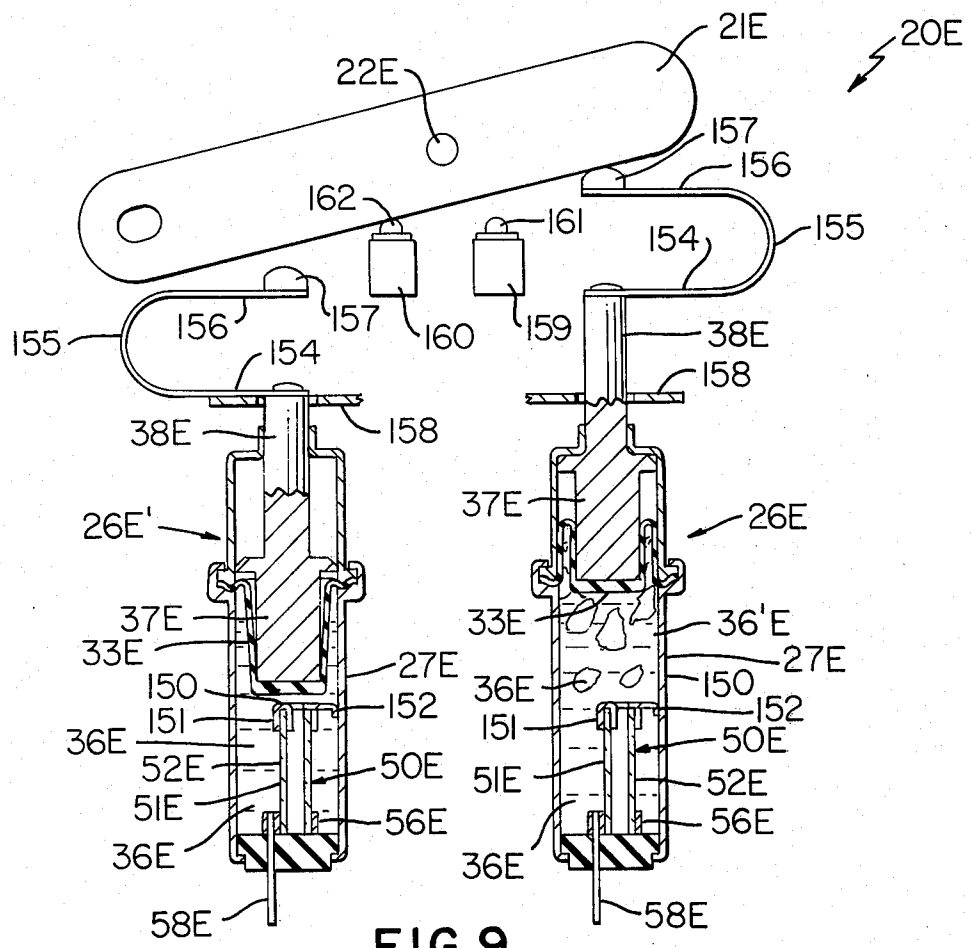

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FIG. 9

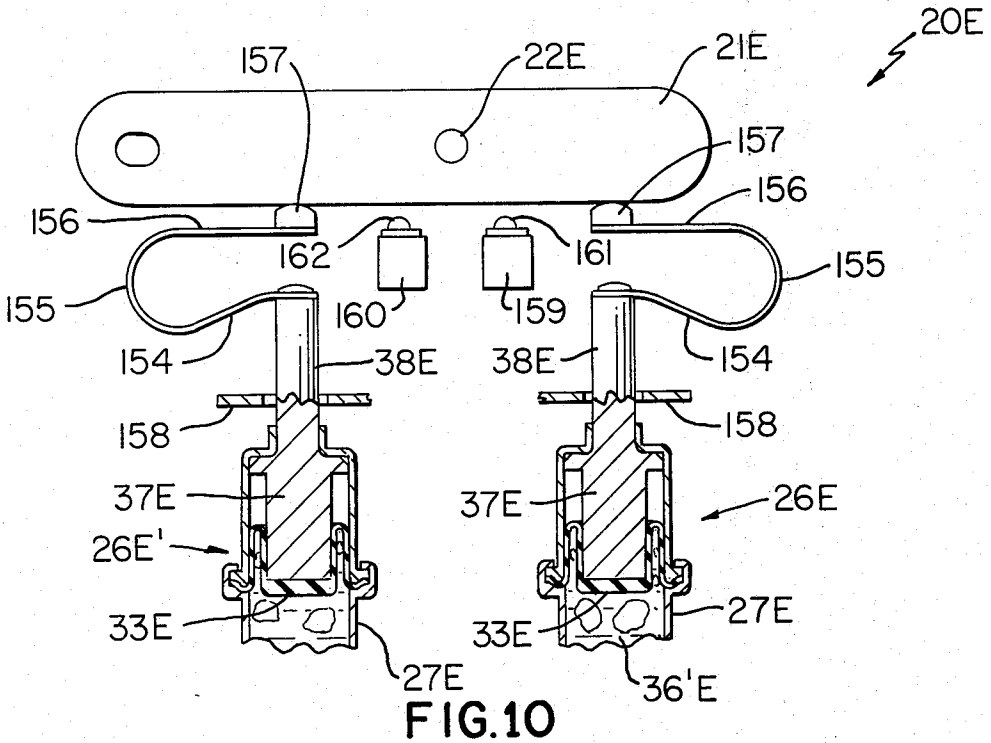

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FIG. 10

THERMALLY ACTUATED DEVICE AND DOOR LATCH MEANS UTILIZING THE SAME OR THE LIKE

This invention relates to an improved thermally actuated device as well as to an improved door latch arrangement utilizing such thermally actuated devices or the like.

It is well known that a thermally actuated device can be provided wherein the same comprises a housing means having a chamber therein filled with a thermally responsive medium, such as Freon, and bein defined in part by a motion-transmitting member movable relative to the housing means in response to expansion or contraction of the thermally responsive medium that is adapted to be heated by an electrical heater disposed in the chamber. For example, see the patent to Harris, U.S. Pat. No. 3,609,635, and the patent to Stropkay, U.S. Pat. No. 3,664,698 which disclose such thermally actuated devices.

It is a feature of this invention to provide an improved thermally actuated device of the above type.

It is another feature of this invention to provide an improved door latching mechanism utilizing such thermally actuated devices or the like.

In particular, one embodiment of this invention provides an improved heater means for such a thermally actuated device or the like, the heater means providing substantially a uniform thermal flux to the thermally responsive medium in the thermally actuated device throughout substantially the entire surface area of the heater means whereby it is believed that no hot spots will be created by the heater means of this invention that might cause a deterioration or break-down of the thermally responsive medium as well as a breakdown of the heater means itself. Such a heater can comprise a tubular cylindrical member of electrical insulating material having a conductive coating on the exterior surface thereof that provide an electrical resistance heater when electrical current passes through the same.

Another embodiment of this invention provides electrical insulating material substantially completely bordering the chamber of the thermally actuated device to effectively electrically insulate the electrical heater from the housing means of the device.

For example, the motion-transmitting member of the thermally actuated device can comprise a flexible diaphragm of the rolling type and be formed of electrical insulating material, the flexible diaphragm closing off a tubular housing member between the opposed ends thereof and having a tubular portion extending along the inside surface of the tubular member to one end thereof. A closure member of electrically insulating material closes off that one end of the tubular member and cooperates with the tubular portion of the diaphragm to seal the closure member to that one end of the tubular member whereby the chamber is substantially completely defined by the diaphragm and the closure member.

Such thermally actuated devices of this invention or other thermally actuated devices can be utilized to form an improved door latch means of this invention, such as a remote control door latch means for a vehicle access door or the like wherein the conventional door locking mechanism thereof comprises a manually operated plunger which when pushed downwardly locks the door and when pulled upwardly unlocks the door.

One embodiment of this invention provides a movable latch member for cooperating with the plunger of the conventional door locking mechanism and a pair of thermally actuated devices respectively and operatively associated with the latch member. One of the thermally actuated devices when thermally actuated causes movement of the latch member to its plunger locking position and the other of the thermally actuated devices when thermally actuated causes movement of the latch member to its plunger unlocking position.

Accordingly, it is an object of this invention to provide an improved thermally actuated device having one or more of the novel features set forth above or hereinafter shown or described.

Another object of this invention is to provide an improved remote controlled door latching arrangment for a vehicle or the like, the latching arrangement having one or more of the novel features set forth above or hereinafter shown or described.

Other objects, uses and advantages of this invention are apparent from a reading of this description, which proceeds with reference to the accompanying drawings forming a part thereof and wherein:

FIG. 1 is a cross-sectional view schematically illustrating the improved door latching arrangement of this invention, with the improved thermally actuated devices of this invention illustrated being in cross section and with the latch means being in the unlocked position thereof.

FIG. 2 is a view similar to FIG. 1 and illustrates the door latching arrangement in the locking position thereof.

FIG. 3 is an enlarged, fragmentary, cross-sectional view illustrating a joint structure of one of the thermally actuated devices of FIG. 1 in combination with the rolling diaphragm thereof.

FIG. 4 is an exploded, perspective view of the improved heater means for the thermally actuated devices of FIG. 1.

FIG. 5 is a view similar to FIG. 1 and illustrates another embodiment of the thermally actuated device of this invention.

FIG. 6 is a fragmentary view similar to FIG. 5 and illustrates another embodiment of the thermally actuated device of this invention.

FIG. 7 is an exploded, perspective view of certain parts of the device of FIG. 6.

FIG. 8 is a view similar to FIG. 1 and illustrates another embodiment of the improved door latching arrangement of this invention with the improved thermally actuated devices of this invention illustrated in cross section and with the latch member being in the unlocked position thereof.

FIG. 9 is a view similar to FIG. 1 and illustrates one of the thermally actuated devices moving the door latching member to its door locking position.

FIG. 10 is a fragmentary view similar to FIG. 9 and illustrates an attempt to move the door latching member form its latching position to its unlocking position while the latching thermally actuated device is still in the actuated condition thereof.

FIG. 11 is a fragmentary cross-sectional view taken on line 11—11 of FIG. 8 and illustrates one lead means for the electrical heater means of the thermally actuated devices of the latching arrangement of FIG. 8.

FIG. 12 is a fragmentary cross-sectional view of another embodiment of the thermally actuated devices of this invention.

While the various features of this invention are hereinafter described and illustrated as being particularly adapted to provide thermally actuated devices for operating a door latch means for a vehicle or the like, it is to be understood that the various features of this invention can be utilized singly or in any combination thereof to provide thermally actuated devices for other uses as desired.

Therefore, this invention is not to be limited to only the embodiments illustrated in the drawings, because the drawings are merely utilized to illustrate one of the wide variety of uses of this invention.

Referring now to FIGS. **1** and **2**, one embodiment of the improved door latch arrangment of this invention is generally indicated by the reference numeral **20** and comprises a latch member **21** pivotally mounted by a pivot member **22** intermediate its opposed ends **23** and **24** to a door structure (not shown) with the end **23** having an elongated slot **25** therein for interconnecting the end **23** of the lever **21** to a suitable and conventional up and down vertically moved and normally manually operated vehicle door latch plunger member (not shown) so that when the lever **21** is pivoted in a clockwise directioin to the position illustrated in FIG. **1** in a manner hereinafter described, such door latch plunger is moved to its up position and thus to its door unlocking position and when the lever **21** has the end **23** thereof pivoted downwardly in the manner illustrated in FIG. **2**, such door latch plunger member is moved vertically downwardly and thus to its door locking position. The elongated slot **25** in the lever **21** permits such arcuate motion of the end **23** of the lever while causing substantially straight line vertical motion of a cylindrical pin (not shown) passing through the slot **25** and being fixed to the door latch plunger.

The door latch or member **21** is moved between its operating positions by a pair of thermally actuated devices of this invention that are respectively and generally indicated by the reference numerals **26A** and **26B** with the parts thereof being identical and therefore being indicated by like reference numerals so that the description of one actuator **26A** or **26B** also applies for the other actuator **26B** or **26A.**

Each thermally actuated device **26A** and **26B** comprises a housing means **27** formed of two metallic tubular members **28** and **29** having adjacent ends **30** and **31** crimped or rolled together to secure the same together and to hold an outer peripheral bead or portion **32** of a flexible rolling diaphragm **33** of rubber or other suitable flexible and electrically insulating material therebetween which cooperates with the tubular member **28** and an electrically insulating end closure **34** at the lower end **35** of the tubular housing member **28** to define a chamber **36** therein.

A piston member **37** has a part thereof disposed in the upper tubular member **29** with a piston rod portion **38** thereof passing out through a reduced tubular end **39** of the tubular housing member **29** to be interconnected by a pin means **40** to a lever actuator or bracket **41** for the latch lever **21** in a manner hereinafter described. A reduced lower end **42** of the piston member **37** is adapted to be received in a cup forming portion **43** of the rolling diaphragm **33** when the same is in its natural position as illustrated in FIG. **1**, the piston member **37** having a large annular guiding portion **44** between the portions **42** and **38** thereof for sliding against the inside peripheral surface **45** of the tubular member **29** as the piston member **37** moves upwardly and downwardly in the manner illustrated in FIGS. **1** and **2.**

The chambers **36** of the thermally actuated devices **26A** and **26B** are adapted to have a thermally responsive medium **36'** disposed therein for expanding and contracting in rerlation to the temperature thereof and thereby causing the diaphragms **33** to roll upwardly or downwardly relative to the housing means **27** in a manner well known in the art. For example, each chamber **36** can be partially or completely filled with liquid Freon which when heated, as described in the aforementioned U.S. Patents, will rapidly vaporize and thereby expand in the chamber **36** to drive the rolling diaphragm **33** upwardly in the manner illustrated by the actuator **26B** in FIG. **2** to drive the piston member **37** thereof upwardly therewith for transmitting motion to the lever **21** in a manner hereinafter described.

In order to insure that the rolling diaphragm **33,** as it rolls between the positions illustrated in FIGS. **1** and **2** for the actuator **26B,** will have many cycles and thereby be long lasting, the housing members **28** and **29** can be so formed in the manner illustrated in FIG. **3** adjacent the ends **30** and **31** thereof that the end **31** provides an arcuate annular portion **46** to trap an annular bead **47** of the rolling diaphragm **33** between the ends **31** and **30** of the members **29** and **28** and permit the rolling diaphragm **33** to have a preformed annular fold **48** adjacent to the piston portion **42** when the diaphragm **33** is in its relaxed position illustrated in FIG. **3.** Thus, the diaphragm **33** will begin to roll with the fold **48** up along the peripheral surface **45** of the housing member **29** in the manner illustrated by the diaphragm **33** of the actuator **26B** in FIG. **2.** Also the cup shape of the portion **43** of the diaphragm has the side wall thereof normally at an angle relative to the piston portion **42** but once pressure is developed in the respective chamber **36,** the side wall of the cup portion **43** is deformed against the piston portion **42** in the manner illustrated by the actuated device **26B** of FIG. **2.**

An improved electrical heater maens of this invention for the thermally responsive medium **36'** for each actuator **26A** and **26B** is generally indicated by the reference numeral **50** and comprises a cylindrical tubular member **51** of electrically insulating material, such as a glass tube formed of a glass material having a relatively low coefficient of theremal expansion and a relatively high coefficient of heat conductivity, such as pyrex provided with a conductive coating **52** on the outer peripheral cylindrical surface thereof throughout the entire length of the tubular member **51,** the conductive coating **52** being formed of any suitable material which will cause the same to act as a heater means when an electrical current is passed therethrough. For example, such coating can comprise a tin oxide coating.

In order to enhance electrical connection to the conductive coating **52,** bands **53** of silver paint can be provided at the opposed ends **55** and **54** of the tubular member **51** on top of the coating **52** so that when electrical connection is made respectively to the bands **53,** electrical current is adapted to flow from one band **53** through the coating **52** to the other band **53** and such flow of current through the coating **52** causes the coating **52** to heat up and provide a sufficient temperature to not only vaporize the thermally responsive liquid **36'** adjacent the same, but also to be conducted by the tube **51** to the interior surface thereof to vaporize the liquid **36'** adjacent the same and thereby cause the rolling diaphragm **33** to be rolled upwardly in the mananer illus-

trated by the device **26B** in FIG. **2** by the thus expending medium **36'** in the chamber **36.** It is believed that when freon is used for the medium **36'** , the same will vaporize adjacent the inside and outside surfaces of the heater **50** in a second or so after the heater **50** is energized and since a uniform surface of the conductive coating **52** and the inside surface of the tube **51** is provided to the medium **36'** , it is believed that the energized heater **50** will not have "hot spots" and will thereby provide a uniform thermal flux to the medium **36'** through substantially the entire length of the coating **52** and tube **51** to not only not tend to breakdown the freon **36'** , but also to not tend to breakdown the heater **50** itself.

For example, it is believed that when a conventional coiled wire electric heater is utilized in the chamber **36** for heating the medium **36'** in the manner previously described, "hot spots" are created by such coiled wire heater because of the nonuniformity of the coiled wire heater and it is believed that such "hot spots" not only tend to break down the freon **36'** because of the excessive heat being created by such "hot spots" , but also such "hot spots" tend to break down the coiled wire heater itself whereby should the same subsequently break through the deterioration thereof, the broken coiled wire heater has a tendency to spring apart and, thus, against the housing means to cause an adverse short circuiting situation.

However, as previously stated, it is believed that the tubular heater means **50** of this invention will not have such adverse "hot spots" and thereby will not tend to break down the freron **36'** or cause a deterioration of itself.

A pair of metal bands **56** are looped in such a manner that the same can be telescoped onto the conductive bands **53** of the tubular member **51** in a press fit manner to provide good electrical contact therebetween so that outwardly extending or projecting ends **57** of the bands **56** can be utilized for lead attaching purposes for each heater means **50.**

For example, a pair of wire leads **58** and **59** can be respectively inserted through suitable openings **60** and **61** in the electrical insulating end closure **34** of the respective actuator **26A** or **26B** with the lead **59** being soldered or otherwise electrically interconnected to the projection **57** of the lower conductive band **56** of the heater means **50** while the other lead **59** is adapted to project through the interior of the tubular member **51** and out of the upper end **55** thereof to be soldered or otherwise attached to the projection **57** of the upper conductive band **56** in the manner illustrated in FIG. **1.** With the leads **58** and **59** being appropriately secured and sealed in the openings **60** and **61** of the end closure **54,** it can be seen that the leads **58** and **59** not only secure the tubular member **51** thereto, but also the leads **58** and **59** provide electrical connection to the opposed ends **54** and **55** of the conductive coating **52.**

As previously stated, it is believed that when electrical current is applied to the conductive coating **52** in a manner hereinafter described, the conductive coating **52** will present a uniform thermal flux to the thermally responsive medium **36'** adjacent thereto throughout substantially the entire surface area of the coating **52** so that no "hot spots" will occur and the medium **36'** will thereby be uniformally heated and vaporized adjacent the inside and outside surfaces of the heater **50** for the purpose previously described whereby it is believed that the heater **50** will not tend to break down the thermally responsive medium **36'** as might be the case when "hot spots" occur in heater means of conventional form.

The devices **26A** and **26B** previously described respectively have their bracket members **41** provided with pivot pins **62** and **63** that project through elongated openings or slots **64** and **65** in the lever **21** respectively formed on opposite sides of the pivot pin **22** in the manner illustrated in FIGS. **1** and **2** to operate the lever in a manner hereinafter described.

The lever **21** has a conductive flange **66** disposed adjacent a pair of spring biased contact members **67** and **68** respectively carried on conductive rods **69** and **70** disposed for axial movement in tubular insulating members **71** and **72** fixed to the vehicle door or the like and being urged upwardly by compression springs **73** and **74** respectively disposed between the insulating sleeves **71** and **72** and enlarged parts **75** and **76** of the contact members **67** and **68** until enlarged ends **77** and **78** of the rods **69** and **70** engage against the lower ends of the insulating sleeves **71** and **72** to limit further upward movement thereof.

The conductive flange **66** of the lever **22** can be interconnected to ground by an electrical lead **79** as illustrated in FIG. **1.**

The rod **69** of the contact member **67** is interconnected by the lead **80** to the lead **59** of the thermally actuated device **26A** while the rod **70** of the contact member **68** is interconnected by the lead **81** to the lead **58** of the device **26B.**

The electrical power soure or battery for the vehicle containing the door latching arrangement **20** of this invention is generally indicated by the reference numeral **82** and has one side **83** interconnected to ground by a lead **84** and the other side **85** thereof interconnected to a power source lead **86** for the door latching arrangement **20.** Normally open "unlock" and "lock" switches, that are generally indicated by the reference numeral **87** and **88** in FIG. **1,** have one side or contact **89** and **90** thereof interconnected to the power source lead **86** while the other side or contact **91** of the switch **87** is interconnected by a lead **92** to the lead **58** of the device **26A** and the other side or contact **93** of the switch **88** is interconnected by a lead **94** to the lead **59** of the device **26B.** The switches **87** and **88** respectively have movable switch blade means **95** and **96** for bridging the contact points **89, 91** and **90, 93** thereof for respectively closing the switches **87** and **88,** but automatically return to the open position thereof when manually released.

The operation of the door latching arrangement **20** of this invention will not be described.

Assuming that the door latching arrangement **20** is in the position illustrated in FIG. **1** wherein the end **23** of the lever **21** is in the up position thereof so that the manually operated plunger of the vehicle door latching mechanism is in its up and thus unlocked position and it is desired to move the same to its door locking position, the operator merely closes the lock switch **88** whereby the switch blade **96** bridges the contacts **90** and **93** and thus permits electrical current to flow from the power source lead **86** and lead **59** of the device **26B** through the conductive coating **52** of the heater means **50,** lead **58,** lead **81** and contact **68** to ground through the conductive flange **66** and lead **79** of the lever **21** so that the electrical heater **50** for the device **26B** is energized to cause the freon **36'** therein adjacent the heater **50** to vaporize almost instantaneously and thereby ex-

pand and drive the rolling diaphragm 33 upwardly in the manner illustrated in FIG. 2 whereby the lever 21 pivots in a counterclockwise direction on the pilot pin 22 thereof so that the end 23 of the lever moves to the door lock position as illustrated in FIG. 2.

As the lever 21 is pivoting in a counterclockwise direction about the pivot pin 22 from the position illustrated in FIG. 1 to the position illustrated in FIG. 2, it can be seen that the flange 66 of the lever 21 eventually pivots away from the contact 68 as the end 78 of the rod 70 thereof bottoms out against the conductive sleeve 72 to thereby break the flow of current through the heater 50 of the actuator 26B whereby the device 26B cannot be actuated by the switch 88 when the lever 21 is in the door locking position of FIG. 2. Also, this feature of terminating current flow to the heater 50 before the stroke of the actuated device 26B is completed eliminates the need for circuit breakers for the system 20. Thus, the switch 88 is only operable for moving the lever 21 to its door locking position of FIG. 2. Likewise, when the lever 21 is in its door unlcoked position of FIG. 1, the device 26A cannot be actuated by the door unlock switch 87 since the contact button 67 is away from the conductive flange 66 of the level 21 whereby no current can flow through the heater 50 of the device 26A unless the lever 21 is in its door locked position as FIG. 2.

Thus, when it is desired to unlock the door from the door locked position of FIG. 2 to the door unlocked condition of FIG. 1, the unlock switch 87 is moved to its closed position to thereby permit electrical current to flow through the electrical heater 50 of the device 26a since the contact member 67 is in engagement with the conductive flange 66 of the lever 21, whereby the heater 50 of the device 26A is energized and thereby vaporizes the freon 36' adjacent the same to cause the rolling diaphragm 33 of the device 26A to move upwardly and therby drive the piston member 37 thereof upwardly to pivot the lever 21 in a clockwise direction about the pivot pin 22 from the position illustrated in FIG. 2 to the position illustrated in FIG. 1. Thus, the door lock plunger is moved to its unlocked position and as the lever 21 is moving to the unlocked position illustrated in FIG. 1, the conductive flange 66 of the lever 21 moves out of contact with the contact 67 to break the electrical circuit to the heater means 50 of the device 26A so that the device 26A cannot be again acutated until the lever 21 is in its door locked position of FIG. 2.

Since the door latching member 21 is held in the unlocked position of FIG. 1 or the locked position of FIG. 2 by the conventional detent means of the door latching mechanism, and since the pistons 37 of the devices 26A and 26B are directly interconnected to the latch member 21, stops need not be provided to prevent the piston members 37 from bearing against the diaphragms 33 when the diaphragms 33 are in their down and at rest positions as illustrated in FIG. 1 so that such piston members 37 will not unduly stress such diaphragms 33 in their relaxed or deactuated condition.

Also, should an attempt be made to actuate the device 26A while the actuator 26B still has its medium 36' in an actuated or expanded condition thereof, such as illustrated in FIG. 2, even though once the heater means 50 has been deenergized and the heat sink effect of the surrounding mechanism will almost simultaneously cause the medium 36' to cool in a second or so to permit the actuated diaphragm 33 to move down to its at rest position, suitable overrun springs could be provided between the piston parts 38 of the piston members 37 and their associated bracket means 41 to take up such dual actuation forces as will be apparent in connection with the description of the embodiment of the system of FIGS. 8–11 that will be hereinafter described.

Therefore, it can be seen that the door lock arrangement 20 of this invention permits the door latch member 21 to be remotely controlled by the devices 26A and 26B between its locked position of FIG. 2 and its unlocked position of FIG. 1 by utilizing the relatively small theremally actuated devices 26A and 26B in the manner previously described.

However, it is to be understood that the devices 26A and 26B can be utilized for other motion transmitting purposes than the door latching arrangement 20 previously described.

Another thermally actuated device of this invention is generally indicated by the reference numeral 100 in FIG. 5 and parts thereof similar to the devices 26A and 26B previously described are indicated by like reference numerals followed by the reference letter "C".

As illustrated in FIG. 5, the device 100 includes the piston member 37C and heater means 50C previously described but has a different housing means 101 and rolling diaphragm 122 now to be described.

The housing means 101 comprises a one piece tubular member 102 having opposed ends 103 and 104 and the rolling diaphragm 122 has a tubular portion 105 extending down along the internal peripheral surface 106 of the housing member 102 from the fold 107 thereof to be crimped by the end 104 of the housing member 102 around an annular flange 108 of the end closure member 34C of the heater means 50C whereby not only does the tubular portion 105 of the rolling diaphragm 122 fluid seal the housing member 102 to the end closure 34C, but also the tubular portion 105 of the rolling diaphragm 122 together with the end closure 34C completely borders the chamber 36C for the thermally responsive medium 36'C with electrically insulating material except for the leads 58C and 59C so that the lead 59C could be disposed externally to the tubular member 51C as the same would be completely insulated from the casing 102 by the rolling diaphragm 122 and no short circuiting would take place therebetween.

For example, another thermally actuated device of this invention is generally indicated by the reference numeral 110 in FIGS. 6 and 7 and parts thereof similar to the device 100 are indicated by like reference numerals followed by the letter "D".

As illustrated in FIG. 6, the actuator 110 is provided with the tubular portion 105D of the rolling diaphragm 122D extending down along the internal peripheral surface 106D of the one piece tubular housing member 102D in the same manner as provided for the actuator 100 except that the tubular portion 105D of the rolling diaphragm 122D terminates in an outwardly directed annular flange 111 and the lower end of the tubular housing member 102D likewise terminates in an outwardly directed annular flange 112 complimentary thereto. A disc-like end closure member 113 of electrically insulating material cooperates with the flange 111 of the rolling diaphragm 122D to sandwich the leads 58D and 59D therebetween so that the leads 58D and 59D can project outwardly therefrom for lead attachment purposes while being compressed between the flange 111 of the rolling diaphragm 122D and the end

closure **113** by a clip member **114** disposed against the end closure **113** and having bent over fingers or annular flange **115** gripping against the flange **112** of the housing member **102C** in the manner illustrated in FIG. **6.** The flange **115** can have suitable openings passing therethrough through which the leads **58D** and **59D** can project or the flange **115** can comprise a plurality of fingers between which the leads **58D** and **59D** can project.

If desired, the annular flange **111** of the rolling diaphragm **122D** and the end closure **113** can have suitable grooves **116** and **117** formed therein in the manner illustrated in FIG. **7** to facilitate the assembly of the leads **58D** and **59D** therebetween if the material for the flange **111** and end closure **113** is not sufficiently resilient to completely capture the leads **58D** and **59D** therebetween when the clip **114** secures the same together.

While the door latching arrangement **20** previously described is of the two lead type and has the pistons **37** of the thermally actuated devices **26A** and **26B** directly interconnected to the latch member **21,** it is to be understood that the door latching system of this invention could be so constructed and arranged that a one wire or one lead electrical circuit could be provided which would be more compatible for an automobile door latching system and/or the door latching arrangement could be such that the pistons of the thermally actuated devices could merely provide a pushing function on the door latch member without being directly interconnected thereto.

For example, such a door latching system of this invention is generally indicated by the reference numeral **20E** in FIGS. **8–10** and parts thereof similar to the system **20** previously described are indicated by like reference numerals followed by the reference letter "E".

As illustrated in FIG. **8,** the system **20E** includes two like thermally actuated devices **26E** and **26E'** with the devices **26E** and **26E'** being identical in structure and thereby having the same reference numeral and letter for like parts thereof.

Each actuator **26E** and **26E'** has the terminal **58E** interconnected to the conductive coating **52E** of the heater means **50E** by conductive clip means **56E** previously described. However, the upper end of the conductive coating **52E** of each heater **50** is interconnected to the conductive housing means **27E** by a conductive cap **150** disposed on the upper end of the tubular member **51E** and held thereto by spring fingers **151** of the cap member **150** illustrated in FIGS. **8** and **11,** the cap member **150** having a large resilient finger **152** thereof extending outwardly therefrom and bearing against the insdie surface of the housing means **27E** to electrically interconnnect the conductive coating **52E** to the housing means **27E.** In this manner, the housing means **27E** is interconnected to ground through the frame structure of the automobile in a conventional manner as the frame structure of the automobile is normally considered as ground for the electrcial system for the automobile, such ground circuit being schematically illustrated by the ground leads **153** in FIG. **8.**

The projecting portion **38E** of each piston **37E** of the devices **26E** and **26E'** is interconnected to one leg **154** of a U-shaped overrun spring member **155** having the other leg **156** thereof provided with a bumper means **157** for bumping aagainst the latch member **21E** to cause the same to pivot about its pivot point **22E** for door locking and unlocking means in a manner hereinafter described.

Because the pistons **37E** of the actuators **26E** and **26E'** are not directly interconnected to the door latch member **21E,** the same normally are disposed in their down position as illustrated in FIG. **8** and in order to prevent the weight of such piston member **37E** from unduly stressing the diaphragms **33E** in their relaxed condition, suitable stationary stop means **158** can be carried by the frame structure of the vehicle so that the legs **154** of the overrun springs **155** will bear against the same when the devices **26E** and **26E'** are in their deactuated condition of FIG. **8** so that the stop means **158** will bear the weight of the piston means **37E** and not the diaphragms **33E.**

A pair of electrical switches **159** and **160** are carried by the frame means of the vehicle so as to have the respective plungers **161** and **162** thereof engaged by the latch member **21E** in such a manner that the plunger **161** of the switch **159** is only the closed position thereof when the latch member **21E** is in its door unlatched position of FIG. **8** and only during part of the time that the door latch member **21E** is moving from the door unlatched position of FIG. **8** towards the door latching position of FIG. **9.** Similarly, the plunger **162** of the switch **160** is only moved to its closed position when the latch member **21E** is in its door latched position of FIG. **9** or during part of the travel from the door latched position of FIG. **9** toward the door unlatched position of FIG. **8** for a purpose as will be apparent hereinafter.

The switch **159** when closed by its plunger **161** is adapted to interconnect a lead **163** with a lead **164,** the lead **163** being interconnected to the contact **93E** of the door latching switch **88E** and the lead **164** being interconnected to the terminal **58E** of the device **26E.** Thus, since the contact **90E** of the door latching switch **88E** is interconnected by the lead **86E** to the side **85E** of the vehicle battery **82E,** current is adapted to flow through the conductive coating **52E** of the heater means **50** of the device **26E** only when the switch **88E** is moved to its closed position and the switch **159** is in its closed position whereby the flow of current is from the battery **82E,** lead **86E,** lead **163,** lead **164,** terminal **58E,** conductive coating **52E,** end cap **150** and actuator housing **27E** to ground by the lead **153** for causing the device **26E** to drive the piston **37E** upwardly in the manner previously described by vaporizing the freon **36'E** adjacent the heater **50E** as illustrated in FIG. **9.** Thus, the bumper **157** on the U-shaped spring **155** is adapted to engage against the latch member **21E** and pivot the same in a counterclockwise direction to move the same from the latching position of FIG. **8** to the door unlatching position of FIG. **9.** During such upward movement of the piston **37E,** it can be seen that the latch member **21E** will move away from the plunger **161** of the switch **159** to thereby terminate the flow of current to the heater means **50E** of the actuator **26E** before the full stroke of the piston **37E** is reached whereby once the actuator **26E** has reached the full stroke position of FIG. **9,** the heat sink arrangement of the vehicle framing means sufficiently cools the medium **36'E** in the chamber **36E** to permit the diaphragm **33E** to move back downwardly to its deactuated position of FIG. **8** and the piston **37E** will follow therewith until the leg **154** of the overrun spring **155** engages against the stop **158** as illustrated in FIG. **8.**

With the latch member **21E** now in the door latching position of FIG. **9,** it can be seen that the door latch

member **21E** is now engaging the plunger **162** of the switch **160** to interconnect a lead **165** with a lead **166**, the lead **165** being interconnected to the contact **91E** of the door unlatching switch **87E** and the lead **166** being interconnected to the terminal **58E** of the actuator **26E'**.

Thus, when it is desired to move the latch member **21E** from the door latching position of FIG. **9** back to the door unlatching position of FIG. **8**, the switch **87E** is closed and the heater means **50E** of the device **26E'** is now energized in the manner previously described to drive the piston **37E** thereof upwardly to engage its bumper **157** against the member **21E** and pivot the same in a clockwise direction about the pivot **22E** to move the same from the latched position of FIG. **9** to the door unlatched position of FIG. **8**. During such clockwise movement of the door latch member **21E**, the switch **160** is opened so that the medium **36'E** therein can again be liquidified through the heat sink arrangement of the door frame means in a matter of a second or so after the termination of the operation of the heater **50E** whereby the diaphragm **33E** and piston **37E** of the actuator **26E'** can again return to its relaxed position of FIG. **8** with the overrun spring **155** being held by the stop **158** as illustrated in FIG. **8**.

In those extremely rare cases where a person has caused an actuation of the device **26E** or **26E'** and before the medium **36'E** therein has been reliquified, the person causes the other device **26E'** or **26E** to be actuated so that both devices **26E** and **26E'** are operating against the lever **21E** in a manner to fight against each other, it can be seen that the overrun springs **155** will have the legs **154** and **156** thereof compressed toward each other in the manner illustrated in FIG. **10** to take up such dual expansion of the medium **36'E** of the devices **26E** and **26E'** so that there will be no adverse forces imposed on the devices **26E** and **26E'** that would harm the same. Thus, when the devices **26E** and **26E'** are fighting against each other in the manner illustrated in FIG. **10**, the door latch member **21E** is out of contact with both plungers **161** and **162** of the switches **159** and **160** so that the flow current to the heater means **50E** thereof is terminatted whereby the pistons **37E** will subsequently move to their deactuated positions and the detent means for the door latching means will cause the door latch member **21E** to move to either the latching or unlatching position thereof as the case may be.

Thus, it can be seen that the door latching arrangement **20E** of FIGS. **8–11** provides a one wire or one lead electrical system suitable for automobile use and the same readily permits both devices to be actuated without adverse affect on the door latching system, the devices not being directly interconnected to the door latch member **21E**, but being operatively associated therewith.

In order to insure that the medium **36'E** in the devices **26E** and **26E'** is readily accessible to the interior of the tubular heater means **50E**, the end caps **150** for interconnecting the upper end of the coatings **52E** to the housing means **27E** can have suitable openings provided therein as illustrated by the reference numeral **167** in FIG. **11** with the openings **167** being formed by the formation of the tang means **151** of the cap **150**, if desired.

Further, such caps **150** can be further modified to permit an internal lead to be inteconnected to the upper end of the conductive coating **52E** in the manner illustrated in FIG. **12** wherein the internal lead **59E** is electrically interconnected by a resilient finger **168** of the end cap **150** bearing against the same with the end cap **150** being resiliently secured on the upper end of the tubular heater **50E** by the spring fingers **151** in the manner previously described.

As previously stated, it may be desired to maintain all of the embodiments of the devices **26** of this invention in a substantially vertical position thereof as illustrated in order to insure proper operation thereof because it may be found that the heater means **50** of the devices **26** must remain completely submerged in the medium **36'** during heating thereof to prevent the heater means **50** from getting too hot and perhaps burning out. Also, it may be found that it is desired to have the heater means **50** each supported in a raised relation to the bottoms of the respective devices **26** so that the medium **36'** is free to flow through the centers of the heater means **50** for better heat transfer to the medium **36'** as well as for insuring that the heater means **50** will not become too hot through the improved circulation of the medium **36'** relative thereto.

Therefore, it can be seen that not only have improved thermally actuated devices been provided by this invention over the form of the devices set forth in the aforementioned U.S. patents, but also this invention provides an improved remoted controlled door locking arrangement or the like.

While the forms of the invention now preferred have been described and illustrated as required by the patent statute, it is to be understood that other forms can be utilized and still come within the scope of the appended claims.

What is claimed is:

1. In a thermally actuated device comprising a housing means having a chamber provided with a thermally responsive means and being defined in part by a motion transmitting member movable relative to said housing means in response to expansion or contraction of said thermally responsive means, the improvement of an electrical heater means disposed in said chamber for heating said thermally responsive means when said heater is energized, said heater providing substantially a uniform thermal flux to said thermally responsive means throughout substantially the entire surface area of said heater, said heater comprising a member of electrical insulating material having a conductive coating on the exterior surface thereof that provides an electrical resistance heater means when electrical current passes through the same.

2. In a thermally actuated device comprising a housing means having a chamber provided with a thermally responsive means and being defined in part by a motion transmitting member movable relative to said housing means in response to expansion or contraction of said thermally responsive means, the improvement of an electrical heater means disposed in said chamber for heating said thermally responsive means when said heater is energized, said heater providing substantially a uniform thermal flux to said thermally responsive means throughout substantially the entire surface area of said heater, said heater comprising a cylindrical member of electrical insulating material having a conductive coating on the exterior surface thereof that provides an electrical resistance heater means when electrical current passes through the same.

3. In a thermally actuated device as set forth in claim **2**, said cylindrical member being tubular and having opposed ends with said conductive coating extending

substantially to said ends.

4. In a thermally actuated device as set forth in claim 3, a pair of electrical leads carried by said housing means and respectively being electrically interconnected to said conductive coating at said ends of said cylindrical member.

5. In a thermally actuated device as set forth in calim 4, one of said leads extending through said tubular member from one end thereof to the other end thereof and being electrically interconnected to its respective end of said conductive coating exterior of the respective end of said tubular member.

6. In a thermally actuated device comprising a housing means having a chamber provided with a thermally responsive means and being defined in part by a motion transmitting member movable relative to said housing means in response to expansion or contraction of said thermally responsive means, the improvement of an electrical heater means disposed in said chamber for heating said thermally responsive means when said heater is energized, said heater providing substantially a uniform thermal flux to said thermally responsive means throughout substantially the entire surface area of said heater, said motion transmitting member comprising a flexible diaphragm of the rolling type, said housing means comprising a tubular member having opposed open ends, said diaphragm closing off said tubular member between said ends thereof and having a tubular portion extending along the inside surface of said tubular member to one end thereof, and a closure member closing said one end of said tubular member and cooperating with said tubular portion of said diaphragm to seal said closure member to said one end of said tubular member whereby said chamber is defined by and substantially completely bordered by said diaphragm and said closure member.

7. In a thermally actuated device comprising a housing meanas having a chamber provided with a thermally responsive means and being defined in part by a motion transmitting member movable relative to said housing means in response to expansion or contraction of said thermally responsive means, the improvement of an electrical heater means disposed in said chamber for heating said thermally responsive means when said heater is energized, said heater providing substantially a uniform thermal flux to said thermally responsive means throughout substantially the entire surface area of said heater, said motion transmitting member comprising a flexible diaphragm of the rolling type, said housing means comprising a tubular member having opposed open ends, said diaphragm closing off said tubular member between said ends thereof and having a tubular portion extending along the inside surface of said tubular member to one end thereof, and a closure member closing said one end of said tubular member and cooperating with said tubular portion of said diaphragm to seal said closure member of said one end of said tubular member whereby said chamber is defined by said diaphragm and said closure member, said closure member and said diaphragm being formed of electrically insulating material whereby said chamber is completely bordered by electrically insulating material.

8. In a thermally actuated device as set forth in claim 7, a piston member disposed in said tubular member and having opposed ends, one end of said piston member being engageable with said diaphragm and the other end thereof projecting out of the other end of said tubular member.

9. In a thermally actuated device as set forth in claim 8, said heater comprising a cylindrical member having a longitudinal axis extending generally in the same direction as the longitudinal axis of said tubular member and said piston member.

10. In a thermally actuated device comprising a housing means having a chamber provided with a thermally responsive means and being defined in part by a motion transmitting member movable relative to said housing means in response to expansion or contraction of said thermally responsive means that is adapted to be heated by an electrical heater means that is disposed in said chamber for heating said thermally responsive means when said heater is energized, the improvement wherein said chamber is substantially completely bordered by solid electrically insulating material the majority of which comprises a rolling diaphragm that comprises said motion transmitting member.

11. In a thermally actuated device comprising a housing means having a chamber provided with a thermally responsive means and being defined in part by a motion transmitting member movable relative to said housing means in response to expansion or contraction of said thermally responsive means that is adapted to be heated by an electrical heater means that is disposed in said chamber for heating said thermally responsive means when said heater is energized, the improvement wherein said chamber is substantially completely bordered by electrically insulating material, said motion transmitting member comprising a flexible diaphragm of the rolling type and formed of electrically insulating material, said housing means comprising a tubular member having opposed open ends, said diaphragm closing off said tubular member between said ends thereof and having a tubular portion extending along the inside surface of said tubular member to one end thereof, and a closure member of electrically insulating material closing said one end of said tubular member and cooperating with said tubular portion of said diaphragm to seal said closure member to said one end of said tubular member whereby said chamber is defined by said diaphragm and said closure member and is thereby substantially completely bordered by electrically insulating material.

12. In a thermally actuated device as set forth in claim 11, a piston member disposed in said tubular member and having opposed ends, one end of said piston member being engageable with said diaphragm and the other end thereof projecting out of the other end of said tubular member.

13. In a thermally actuated device as set forth in claim 12, said heater comprising a cylindrical member having a longitudinal axis extending generally in the same direction as the longitudinal axis of tubular member and said piston member.

14. In a thermally actuated device as set forth in claim 11, said heater means having a pair of leads extending between said tubular portion of said diaphragm and said closure member to the exterior of said housing means for lead attachment purposes.

15. In a remote controlled door latching arrangement for a vehicle and the like wherein a latch member is to be moved between a locking position thereof and unlocking position thereof, the improvement comprising a pair of thermally actuated devices respectively and operatively associated with said latch member, one of said devices when thermally actuated causing movement of said latch member to its locking position, the

other of said devices when thermally actuated causing movement of said latch member to its unlocking position, each device comprising a housing means having a chamber provided with a thermally responsive means and being defined in part by a motion transmitting member movable relative to said housing means in response to expansion or contraction of said thermally responsive means that is adapted to be heated by an electrical heater means that is disposed in said chamber for heating said thermally responsive means when said heater is eneragized, said motion transmitting member being operatively associated with said latch member, and an electrical system for said devices, said system having means for permitting only said one device to be thermally actuated by energizing said heater thereof when said latch member is in its unlocking position and said other device to be thermally actuated by energizing said heater thereof when said latch member is in its locking position, said means of said system causing only the energizing of said heater of said one device when said latch member is in its unlocking position and only during part of the movement of said latch member to its locking position and causing only the energizing of said heater of said other device when said latch member is in its locking position and only during part of the movement of said latch member to its unlocking position.

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