Sept. 25, 1956 W. OTTO 2,764,027

THERMAL FUSE

Filed April 19, 1954

3 Sheets-Sheet 1

Fig. 1

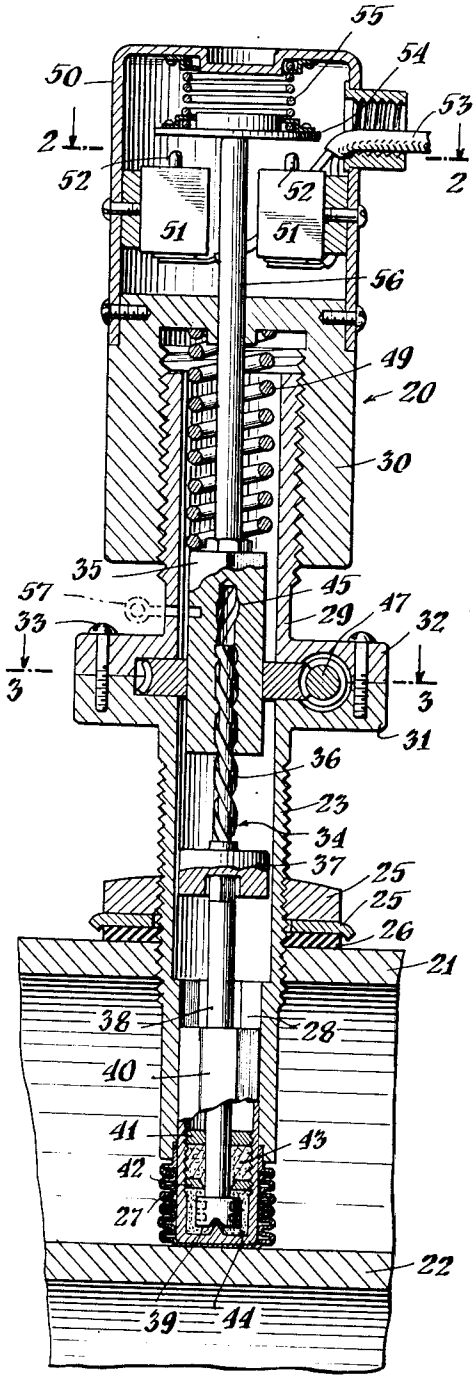


Fig. 2

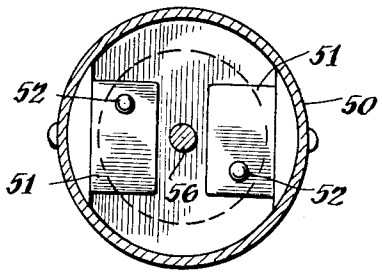


Fig. 3

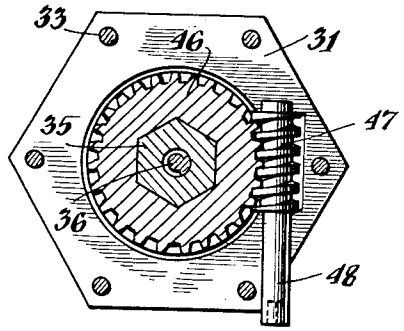
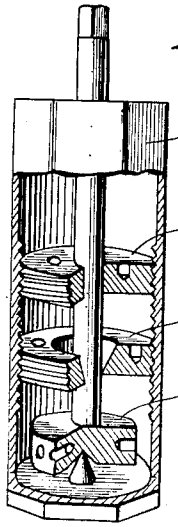


Fig. 4



INVENTOR

Walter Otto

BY

Kane, Dalsimer and Kane

ATTORNEYS

Sept. 25, 1956 W. OTTO 2,764,027

THERMAL FUSE

Filed April 19, 1954 3 Sheets-Sheet 2

Fig. 6

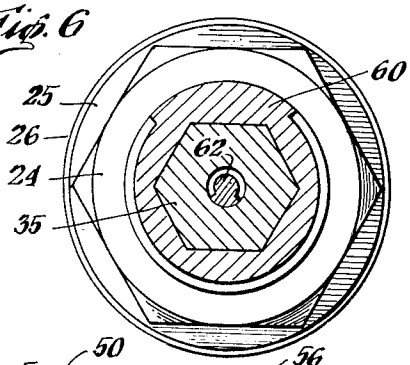


Fig. 5

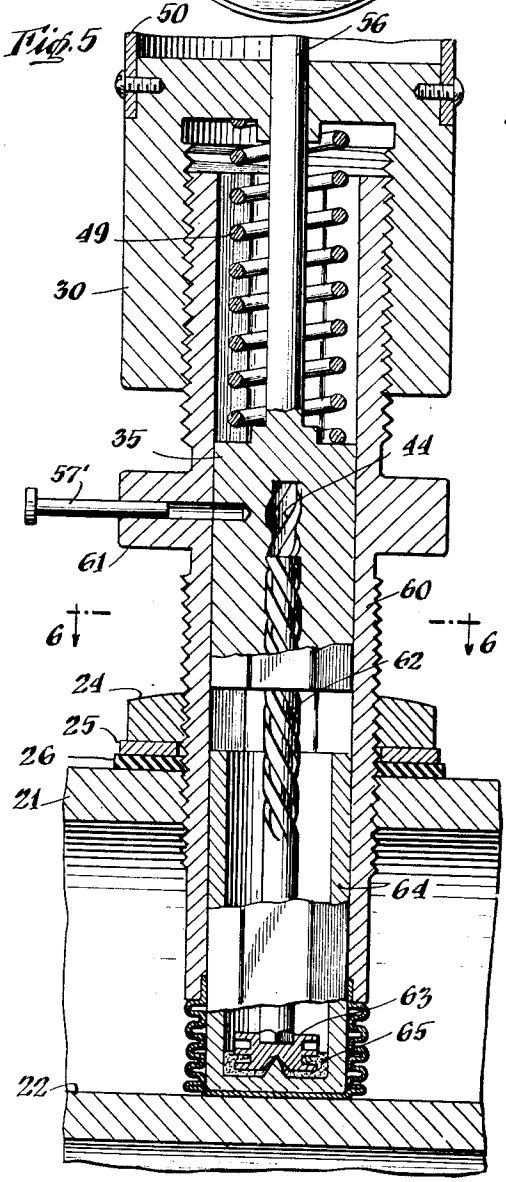


Fig. 7

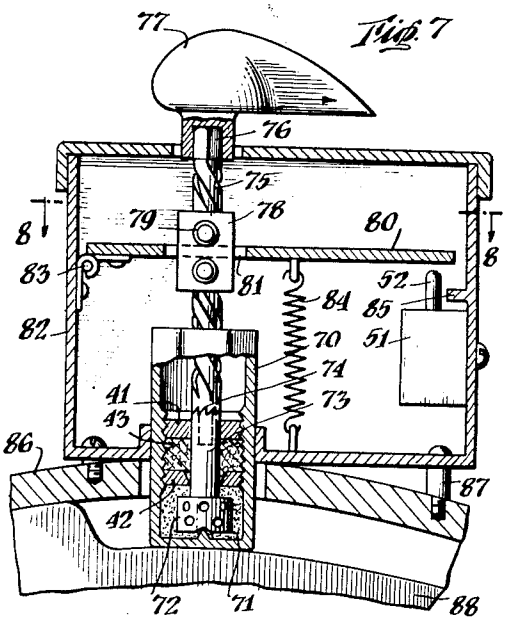


Fig. 8

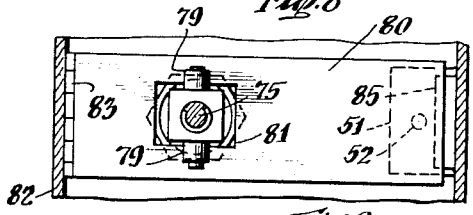


Fig. 9

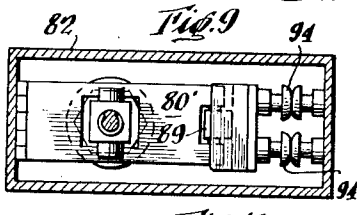
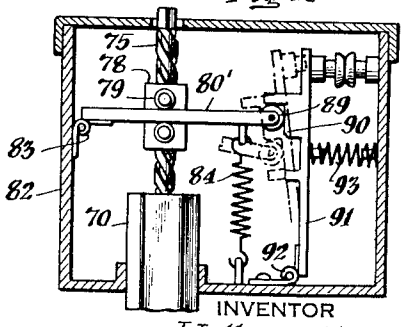


Fig. 10



INVENTOR

Walter Otto

BY

Kane, Dalsimer and Kane

ATTORNEYS

Sept. 25, 1956 W. OTTO 2,764,027

THERMAL FUSE

Filed April 19, 1954 3 Sheets-Sheet 3

Fig. 11

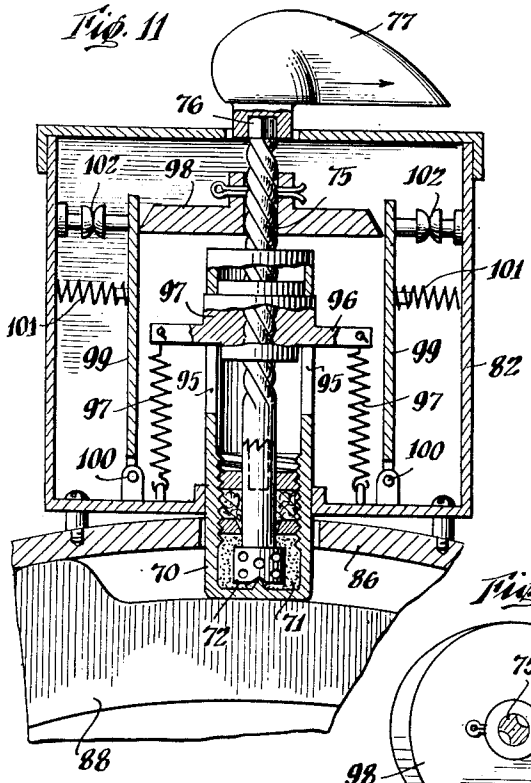


Fig. 12

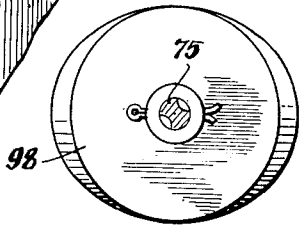


Fig. 13

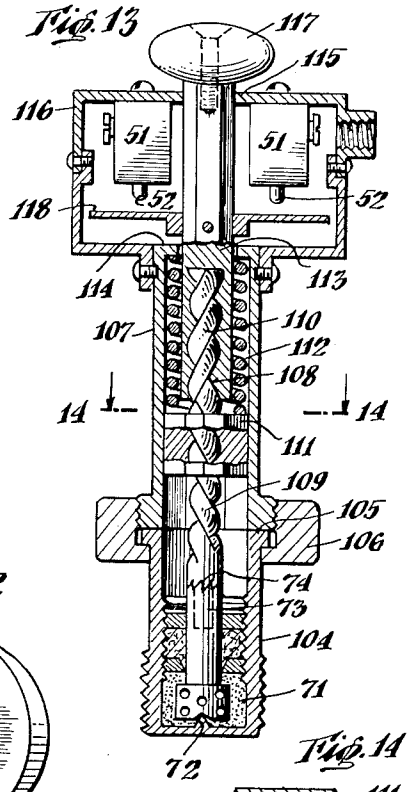


Fig. 14

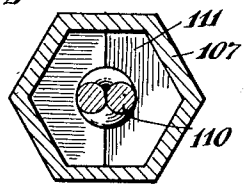
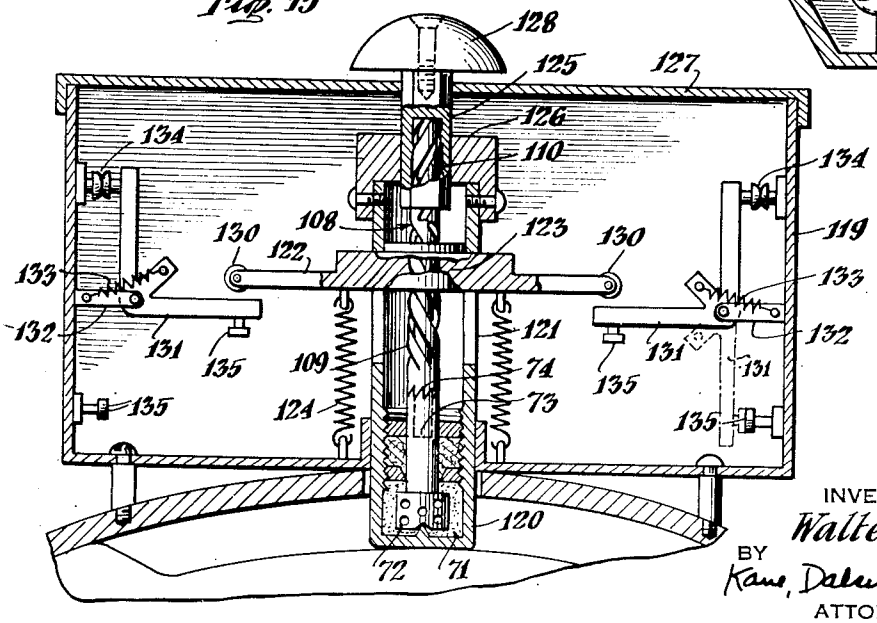


Fig. 15



INVENTOR
Walter Otto
BY
Kane, Dalsimer and Kane
ATTORNEYS

United States Patent Office 2,764,027 Patented Sept. 25, 1956

2,764,027

THERMAL FUSE

Walter Otto, Forest Hills, N. Y.

Application April 19, 1954, Serial No. 423,999
18 Claims. (Cl. 74—2)

This invention relates to an improved thermal fuse or safety device used in connection with apparatus for indicating the overheating thereof, or for controlling the operation of the apparatus, or of other apparatus or signalling devices when the apparatus is heated to a predetermined temperature.

It is an object of the present invention to provide an improved thermal fuse of the above type which is of simplified compact design; which may be provided with self-contained electrical low amperage or high amperage multiple switch devices; which is relatively invulnerable to physical damage; which is relatively simple to reset after the device has been operated; which is relatively foolproof and tamper-proof and provides a high degree of "fail safeness"; and which will give satisfactory service over a long period of time with a minimum amount of wear.

The present invention embodies certain improvements and modifications over the thermal fuses shown in my pending patent applications Serial No. 367,864, filed July 13, 1953, and Serial No. 402,617, filed January 7, 1954. The thermal fuses shown in my prior applications embody actuating members which may shift or reciprocate in a longitudinal direction and are normally urged in one longitudinal direction under spring action but are held under normal operating conditions in a predetermined position by means of a fusible connection. When a predetermined temperature is reached, the fusible connection releases so that the spring can cause the actuating member to reciprocate and cause the operation of a switch or other signalling or control mechanism, such as a valve.

My present invention contemplates the provision of actuating mechanism consisting of a rotatably shiftable member and a longitudinally shiftable member or force applying means for applying force to the member to cause it to rotate. A fusible connection normally restrains the rotatably shiftable member from rotating but when a predetermined temperature is reached the fusible connection is released and the longitudinally shiftable member or force applying means causes it to rotate whereupon the actuating mechanism causes a switch or other control device or signal to operate.

In the accompanying drawings—

Fig. 1 is a longitudinal sectional view of one form of thermal fuse embodying my invention;

Fig. 2 is a cross-sectional view in the direction of the arrows on the line 2—2 of Fig. 1;

Fig. 3 is a cross-sectional view in the direction of the arrows on the line 3—3 of Fig. 1;

Fig. 4 is an elevational view partially in section of the fuse case used in the fuse shown in Fig. 1;

Fig. 5 is a longitudinal sectional view of a modified form of thermal fuse embodying my invention;

Fig. 6 is a cross-sectional view in the direction of the arrows on the line 6—6 of Fig. 5;

Fig. 7 is a longitudinal sectional view of a further modified type of fuse embodying my invention having a simplified reset mechanism which serves also as an indicator to show whether the fuse has operated;

Fig. 8 is a sectional view in the direction of the arrows on the line 8—8 of Fig. 7;

Fig. 9 is a view similar to Fig. 8 showing the same fuse with a modified type of switch suitable for high amperage and high voltage;

Fig. 10 is a partially elevational, partially sectional view of the switch arrangement shown in Fig. 9 indicating the switch in closed position in full lines and in open position in dotted lines;

Fig. 11 is a longitudinal sectional view of a further modified thermal fuse having the same simplified reset mechanism shown in Fig. 8 but using a cam for operating the switches;

Fig. 12 is a detailed view showing the cam disk used in the thermal fuse of Fig. 11 in plan and showing the supporting thread rod in section.

Fig. 13 is a longitudinal sectional view of a still further modified form of thermal fuse embodying my invention;

Fig. 14 is a cross-sectional view in the direction of the arrows on the line 14—14 of Fig. 13; and

Fig. 15 is a longitudinal sectional view of another modified form of thermal fuse.

Referring to the form of apparatus shown in the first four figures of my drawings, I have illustrated a thermal fuse 20 embodying my invention as applied to a steam boiler although it should be understood that my invention may be used for controlling many different types of apparatus such as motors, bearings or the like. The fuse assembly in Fig. 1 is shown as inserted through the outer shell or casing 21 of the boiler and engaging the inner boiler wall 22.

The fuse assembly is provided with a suitable supporting structure such as a metallic casing 23 having an externally threaded portion which is threaded to the outer casing 21 of the boiler and is held firmly in place by lock nut 24, cup washer 25 and gasket 26. The lower part of casing 23 is not provided with an integral closure but is provided with a bellows-type of corrugated cap 27 which may be suitably secured in place as by brazing or soldering. The corrugated cap 27 is made of a good heat conducting material such as metal as, for instance, copper. While the exterior of the casing shell is cylindrical the interior of the lower portion is non-circular as, for instance, hexagonal as shown at 28 in Fig. 1. This prevents the fuse case 40 from rotating therein as will be later seen.

The casing is formed in two separate longitudinal coextensive parts connected together at their ends. The upper part 29 of the casing is provided with a threaded portion which is connected to the compression cap 30 for compressing the spring inside the casing as will be later seen. The adjacent ends of the respective casing sections are provided with hexagonal flanges 31 and 32 which are suitably secured together as by means of screws 33.

The actuating mechanism is disposed inside the casing and consists of a first shiftable member shown generally at 34 and which is supported in the casing for rotary shift movement and a second shiftable member, in the form of an actuating piston or slide 35, which is longitudinally shiftable to cause the rotation of the member 34.

In the form of device shown in Figs. 1 to 4, the rotatably shiftable member is made in several parts. Thus, it consists of the elongated rod, shaft or screw 36 having one or more screw threads of relatively steep pitch formed on the outer surface thereof. At its lower end the threaded rod or shaft 36 is connected to the coupler 37 having a non-circular opening formed in the center of the lower surface thereof engaging the similarly shaped upper end of rod or shaft 38 which, in turn, has the fuse disk 39 connected to its lower end. The fuse disk 39 has apertures formed therein as shown, or has an irregular surface so that the fusible material 44 in which it is embedded will firmly engage or grip the disk and prevent rotation thereof. The lower end of rod 38 and also fuse disk 39 are disposed inside the fuse case 40 which has a cylindrical inner surface but a non-circular outer surface as, for in-

stance, hexagonal so as to fit the interior 28 of the lower portion of the casing and as a result it may shift longitudinally with respect to the lower portion of the casing but may not rotate. The casing is threaded on its inner surface as shown for a short distance above the lower end thereof so as to accommodate the threaded packing disks 41 and 42 which hold the heat resistant packing 43 in place, thereby providing a gland to prevent the escape of the fusible connection material 44 disposed inside the lower portion of the casing surrounding the fuse disk 39.

The fusible connection is preferably formed of a metal which will melt at the desired predetermined temperature. Thus, tin or alloys of tin, or lead may be employed where it is desired to have the connection melt or fuse at a low temperature. Lead or alloys of tin and antimony should be used where it is desired to have the connection melt or fuse at a medium temperature and silver solder may be employed where it is desired to have the connection melt or fuse at a higher temperature. It should be understood, however, that thermoplastic materials may be employed for forming the fusible connection instead of metal solder.

As previously indicated the fuse disk 39 has apertures therein or irregularities in the surface thereof so as to provide a strong connection with the fusible material and prevent relative rotation. Similarly, the inner surface of the fuse case 40 surrounding the fusible connection is knurled or roughened to prevent slippage of the fusible material before it has melted. The bottom wall of the fuse case along with the bellows-type cap 27 provide a heat exchange portion for engaging the apparatus being controlled. Inside the casing the bottom wall is provided with a centrally disposed conical projection engaging a similarly shaped recess in disk 39 and serving as a bearing point for the rotation of the disk.

Returning now to the operating mechanism, as previously pointed out the operating slide 35 causes screw threaded rod 36 to rotate when the slide is shifted vertically with respect thereto. Since rod 36 is coupled to rod 38 which, in turn, is connected to fuse disk 39 and since the fuse disk is embedded in the solidified fusible material 44 the entire assembly is normally retained or held against rotation unless the fusible material has melted to free the fuse disk.

Slide 35 has an opening or bore 45 entering from the lower end thereof and the bore is threaded to mate with the threads of rod 36. It is this threaded engagement that causes the relative rotation of the parts when the slide is reciprocated. The bore 45 does not extend completely through the slide but terminates short of the upper end thereof to thereby limit the downward movement of the slide. The slide is so formed that it is normally held against rotation and for this purpose it is preferably noncylindrical in shape, for example, it may be hexagonal in shape as shown. The slide extends through a similar hexagonal opening in worm gear 46 so that it may reciprocate vertically with respect to the worm gear but cannot rotate with respect thereto. The worm gear is mounted in recesses formed in the mating faces of the flanges 31 and 32 and is free to rotate with respect thereto. However, it is normally held or restrained from rotation by the worm 47 mounted on the end of shaft 48 in recesses provided in the flanges 31 and 32. The shaft 48 has a socket formed in the end thereof to recess a key whereby it may be rotated.

Normally, the interengagement between the worm gear 46 and worm 47 prevents operating slide 35 from rotating. However, when it is desired to reset the mechanism after it has been operated a key may be inserted in shaft 48 so as to rotate the worm which, in turn, causes rotation of gear 46. This rotation is transmitted to the slide 35 so that it may be fed upwardly on the threaded rod 36 and returned to its normal position.

Suitable force applying or energy storing means such as helical spring 49 are provided to normally urge the slide 35 inwardly. The helical spring extends between the end of slide 35 and compression cap 30 and the compression cap is adjusted so that the spring is under partial compression and will exert the desired force on the slide.

Beyond the compression cap, I provide a switchcase 50 having suitable control devices as, for instance, the low amperage, pin operated, type of switches 51 mounted therein. Switches of this type are well known and are operated by pressing the pins 52 inwardly. Switches 51 are connected by leads 53 to suitable signalling apparatus or to relays for controlling the operation of the apparatus, or for controlling other circuits. Mounted immediately above the switches is an operating plate 54 having spring 55 mounted thereabove under partial compression so that in the absence of restraint, plate 54 is forced inwardly into engagement with pins 52, to cause the operation of the switches. Under normal conditions, however, the operating plate 54 is restrained or held in elevated position out of engagement with the switch pins 52 by means of rod 56 connected to the upper ends of slide 35 and extending longitudinally through the center of spring 49 into engagement with the plate 54. The length of the rod is such that when the parts are in their indicated positions the switch operating plate 54 is held out of engagement with the switch operating pins.

In using my improved thermal fuse or safety device it is first assembled in the manner shown in Figs. 1 to 4. The worm gear 47 is rotated so as to shift slide 35 to the indicated position and safety pin 57 is then inserted through an aperture in the casing into an aperture in the slide so as to prevent the force of spring 49 from being transmitted downwardly through the assembly and thereby causing distortion or damage to the corrugated cap 37. Spring compression cap 30 is then adjusted so as to cause spring 49 to apply the desired force against operating slide 35.

The safety fuse may be applied to a steam boiler or other apparatus in the manner shown and when thus installed safety pin 57 is removed. This causes the spring to press the assembly inwardly so that the bellows-type cap 27 and fuse case 40 engage the heat exchange wall 22 insuring good thermal contact therewith. While the temperature of the boiler is below the fusing point of the fusible connection 44 the rotatable assembly 34 will be restrained from rotating and operating slide 35 will be restrained from shifting longitudinally (as previously explained, it is restrained from rotating by worm gear 48 and worm 47).

When the temperature of the wall 22 rises to a level to cause the fusible connection 44 to fuse, the rotatable assembly will be released and will be free to rotate with the result that slide 35 will be shifted downwardly by spring 49 bringing rod 56 with it and as a result pins 52 will be pressed inwardly by plate 54 to operate the switches 51. The switches in turn may be connected to operate suitable warning signals or they may be connected to relays which, in turn, shut off the boiler or cause the operation of other apparatus. The downward movement of the slide is terminated by the upper end of the bore 45.

When the condition which caused the overheating of the apparatus has been corrected, it will cool off sufficiently so that the fusible connection 44 will again solidify and restrain the fuse disk 39 and the rest of the rotatable assembly from rotating. The worm can then be rotated to rotate worm gear 46 and slide 35 and thereby feed the slide upwardly on the threaded rod 36 and return it to its normal operating position. If an attempt is made to reset the mechanism before the apparatus has sufficiently cooled, the fusible connection 44 will still remain in molten condition with the result that the entire assembly 34 and disk 39 will rotate when worm 47 is operated and, accordingly, the slide 35 cannot be shifted or returned to position. This provides an additional safety feature preventing the premature operation of the apparatus.

It will thus be seen that my improved safety fuse is of improved design and compact construction and can be readily reset after it has been thermally operated. It should also be noted that if any of the parts of the operating mechanism should fail in normal operation, the apparatus is "fail safe" since spring **49** will shift slide **35** downwardly causing the operation of switches **51** which, in turn, will operate the signalling apparatus, control mechanism, etc.

In Figs. 5 and 6 I show a modified form of thermal fuse which does not have a separate reset mechanism. This form of apparatus may be provided with a supporting structure in the form of a unitary tubular casing **60** having a central non-circular flange **61** of hexagonal shape for accommodating a wrench in applying the fuse to a boiler or other apparatus. The lower portion of the casing may be threaded as shown so that it can be attached to the outer wall **21** of a boiler with the heat exchange end in engagement with the inner wall **22**. A lock nut **24**, washer **25**, and gasket **26** is preferably applied as in the first form of my invention to hold the fuse firmly and tightly in place.

The upper end of the casing is likewise threaded and receives the spring compression cap **30** to which the switch casing **50** is connected as in the first form of my invention. The exterior of the casing, with the exception of the flange **61**, is cylindrical in shape but the interior is non-cylindrical preferably hexagonal as shown so that the operating slide **35** and fuse case **64** cannot rotate with respect thereto.

The actuating mechanism in this form of my invention comprises the rotatably shiftable rod **62** having one or more threads of relatively steep pitch formed on the outer surface thereof and formed with a non-circular lower end in engagement with a similar non-circular opening in fuse disk **63**. The fuse disk **63** is similar to fuse disk **39** in the first form of my invention having apertures or serrations in the surface thereof and having an indentation formed centrally of the lower surface thereof serving as a bearing point in engagement with a conical projection formed centrally of the fuse case wall. Fuse case **64** has the same external contour as the inside of casing **60** so that it cannot rotate with respect thereto. The lower part of the fuse case has a small quantity of fusible material of the type indicated above, forming a fusible connection **65** between the fuse disk **63** and the casing. The inner surface of the fuse case at the point of connection is preferably serrated or roughened to prevent relative rotation of the fuse material and the case before the connection has melted.

An operating slide **35** similar to the operating slide in the first form of my invention is provided to cause rotation of threaded rod **62** when the slide is reciprocated due to the coaction between the screw threads on the rod and the screw threads formed in the bore **44**. Spring **49** surrounding the rod **56** and extending between slide **34** and the upper end of compression cap **30** serves to normally urge the slide inwardly. A safety pin **57'** similar in function to safety pin **57** is likewise provided.

The thermal fuse shown in Figs. 5 and 6 may be used in the same manner as my first form of fuse. Under normal conditions the fusible connection **65** restrains the fuse disk **63** and screw threaded rod **62** against rotation with the result that slide **35** cannot reciprocate under the action of spring **49**. When the predetermined temperature is reached and the fusible connection melts, the rod **62** is released for rotation with the result that slide **35** shifts inwardly under the action of spring **49** causing the operation of the switches or other control devices. In resetting this form of thermal fuse, it is removed from the boiler and disassembled so that slide **35** can again be shifted back to its proper position.

Referring now to Figs. 7 and 8, I have shown a further modified form of thermal fuse in which the rotatably shiftable member of the actuating mechanism extends for substantially the entire length of the apparatus. In this case the supporting structure takes the form of a relatively short tubular fuse case **70** closed at the bottom and open at the top and having a cylindrical inner surface and a non-cylindrical, such as hexagonal, outer surface. The fuse case is supported by the lower wall of casing **82** and may shift longitudinally with respect thereto but may not rotate. The closed lower end of the fuse case serves as the heat exchange portion for engaging the apparatus to be controlled and the fusible connection **71** is disposed immediately inside thereof. Projecting inwardly from the closed lower end is a tapered or conical projection similar to that provided in the other forms of the invention serving as a bearing point for the fuse disk **72**. The inside of the casing is threaded as shown to receive the washers **41** and **42**, which hold the heat resistant packing **43** in place.

The rotatable member is formed in two parts. The lower part **73** is connected to the fuse disk **72** and has ratchet-like teeth **74** at its upper end engaging with similar teeth formed on the lower end of the part **75** on which screw threads of relatively steep pitch are formed. The upper end of part **75** is preferably non-circular in shape as shown at **76** and has the combined handle and pointer **77** secured thereto so that it will rotate with the part **75**.

The second shiftable member, which shifts in a longitudinal direction with respect to the first shiftable member, is in the form of slide **78** which has a threaded opening therein in engagement with the threads on the rod **75** so that reciprocal movement of the slide **78** causes rotation of the rod **75** and rotation of the rod **75** causes longitudinal movement of slide **78**. Rotatable bearings **79** project laterally from the slide and engage with the switch operating plate **80** on the two sides of aperture **81** through which the slide **78** and rod **75** project. The switch operating plate **80** is hinged to the casing **82** at one side wall as indicated at **83** and a spring **84** is connected between the lower wall of the casing and the plate **80** so as to normally pull it downwardly. When spring **84** shifts plate **80** downwardly, it moves slide **78** with it causing rod **75** to rotate in a clockwise direction. The ratchet teeth **74** are so arranged as shown that when the rod **75** rotates in a clockwise direction it likewise causes rod **73** to rotate in a clockwise direction. On the other hand, the arrangement is such that rod **75** can be rotated in a counterclockwise direction and the ratchet teeth will slide over each other due to the yielding action permitted by spring **84**.

The normal "set" position of the parts are shown in Fig. 7 with the operating plate **80** arranged in horizontal position. When the fusible connection **71** is solidified the parts will be restrained in this position. Under those circumstances, the handle **77** will point as shown to a suitable marking on the cover of casing **82** indicating normal operating conditions. When the apparatus overheats and the fusible connection melts spring **84** pulls the operating plate **80** downwardly causing rotation of rod **75** and over handle **77** with the result that the handle will then point to a marking on the cover of casing **82** indicating overheating or abnormal operating conditions. At the same time, switch operating plate **80** engages the pin **52** of pin-type switch **51** mounted on the side wall of the casing to cause the operation thereof. A suitable stop **85** is provided on the side wall of the casing to limit the downward movement of the plate **80**.

The resetting of the apparatus is very simple since it is only necessary to rotate handle **77** in a counter-clockwise direction until it points to the proper marking indicating normal operating conditions. The rotation of handle **77** in a counter-clockwise direction will cause slide **78** and switch operating plate **80** to shift upwardly to the horizontal position indicated in Fig. 7. If the apparatus remains overheated at the time of resetting, the parts will again revert to the switch operating position since the fusible connection **71** will be molten and will not restrain the rotatable parts **73** and **75**. If, on the other hand, the

apparatus has cooled sufficiently for the fusible connection to solidify the rod 75 may rotate in a counter-clockwise direction with respect to rod 73, due to the ratchet teeth 74 and the yielding action of spring 84.

While the fuse shown in Figs. 7 and 8 may be used to control various types of apparatus, it is particularly applicable to electric motors and I have shown it applied to such a motor having a casing 86 to which the fuse casing 82 is attached in suitable fashion as by screws 87. The supporting structure of the fuse 70 projects through the motor casing 86 with the heat exchange inner end portion in engagement with the motor stator 88. The pin type of switch 51 may be connected to warning signals to indicate overheating or to relays for controlling the motor circuit or for controlling other apparatus.

In Figs. 9 and 10, I have shown a thermal fuse similar to that shown in Figs. 7, and 8 with the exception that it serves to operate a high amperage switch, rather than the low amperage microswitch 51. The supporting structure, including the casing 70, and the actuating mechanism, including the rotating rod portions, slide 78, bearing 79, etc., remain the same. The switch operating plate 80' is somewhat shorter in length than the switch operating plate 80 and is provided with a roller 89 at its outer free end which engages with a cam surface 90 formed on the lever 91 which is pivoted at its lower end 92 to the base of the casing 82. The conformation of the cam surface 90 is such that when switch operating plate 80' is in horizontal position the lever 91 is substantially vertical. When the thermal fuse is operated by overheating and the switch operating plate is shifted downwardly by spring 84 to the position shown in dotted lines in Fig. 10, the cam surface permits lever 91 to pivot inwardly under the action of helical spring 93, which is under partial compression, to the position shown in dotted lines in Fig. 10. The contact points 94 of the switch mechanism are arranged so that they are in engagement when the thermal fuse is in its "set" position and lever 91 is vertical. The contacts are open when the fuse has operated and the lever is in the position shown in dotted lines. To insure good contact when the fuse has been "set," one or both contacts in each pair should be spring mounted or lever 91 should be made of resilient material and should be stressed when in closed position.

In Figs. 11 and 12, I have shown another modification of the thermal fuse shown in Figs. 7 and 8 incorporated in a similar box or casing 82. In this form the fuse case 70 is somewhat longer than the case 70 and has slots 95 formed on diametrically opposite sides thereof to accommodate the laterally projecting arms 96 on the operating slide 97. The operating slide 97 has threaded engagement with the threaded rod 75 so that longitudinal shifting of the slide causes rotation of the rod and rotation of the rod, in turn, causes longitudinal shifting of the slide. Springs 97 which are stressed in tension normally serve to pull the slide downwardly which would result in clockwise rotation of rod 75 and handle 77.

As in the form of my invention shown in Figs. 7 and 8 the rotation of the rod and the shifting of the slide are prevented under normal operating conditions by means of the fusible connection 71 between the fuse disk 72 and case 70. Upon overheating and melting of the fusible connection the spring shifts the slide downwardly causing clockwise rotation of the rod and handle. The slots 95 serve to limit the movement in both directions between normal position and released position.

In this form of my invention the rod 75 carries a cam disk 98 which engages levers 99 pivotally mounted at their lower ends on the switch case as shown at 100. The levers are pressed inwardly (away from the casing wall) by partially compressed springs 101. The cam is so arranged that when the thermal fuse is in its normal or set condition it serves to retain the levers 99 in vertical position holding the contacts 102 in closed position. When the thermal fuse is released on overheating and rod 75 rotates one-quarter turn under the force exerted by the slide and springs the cam permits springs 101 to move the levers 99 inwardly breaking the contacts. One of the contacts 102 in each set is preferably spring mounted so as to insure good engagement when the switch is closed.

A thermal fuse of the type shown in Figs. 11 and 12 may be used to directly control the circuit of the apparatus to which it is applied. As in the forms shown in Figs. 7 through 10, it may be readily reset by merely turning handle 77 in a counter-clockwise direction.

Referring to the form of apparatus shown in Figs. 13 and 14, the thermal fuse comprises a fuse case 104 which may be externally threaded at its lower end to facilitate its attachment to a bearing or other form of apparatus to be controlled thereby. The upper end of the fuse case is provided with a flange 105 whereby it may be attached as by a coupling nut 106 to the externally threaded lower end of a casing portion 107. The fuse disk 72 is connected to the lower end of the rotatable rod 73 having a ratchet 74 at its upper end engageable with a ratchet formed at the lower end of the rotatable rod 108. The rod 108 is formed with upper and lower screw threads arranged in reverse relationship. Thus, the lower threaded portion is formed with a left-hand thread 109 and the upper portion is formed with a right-hand thread 110. The lower threaded part engages with the internally threaded slide 111 which is of split construction, being formed of two separate parts as shown in Fig. 14 which are assembled around the lower screw threads and brazed, soldered or otherwise secured together.

The slide 111 has a non-circular shape as, for instance, hexagonal and engages with a similarly shaped interior portion of casing 107 whereby it can slide longitudinally of the casing but cannot rotate with respect thereto. Shifting of the slide with respect to the lower threaded portion 109 of rod 108 causes rotation thereof. Thus, when the slide is shifted downwardly it causes the rod to rotate in a clockwise direction. Due to the arrangement of the ratchet teeth 74 the parts are restrained against movement in a clockwise direction when the fusible connection 71 is solidified. A helical spring 112, extending between the flanged upper end of casing 107 and the slide 111, normally urges the slide downwardly but the slide and rod 108 are restrained against movement by the solidified fusible connection 71. When the fusible connection melts the spring presses the slide downwardly causing the clockwise rotation of rod 108.

In engagement with the upper threaded portion 110 of rod 108, I provide another slide 113 which due to the right-hand configuration of the screw 110 will be shifted upwardly when rod 108 rotates in a clockwise direction. The slide 113 has a non-circular exterior configuration as, for instance, hexagonal and passes through a similarly shaped opening provided by flange 114 and by the top portion 115 of which casing 116 so as to be restrained against rotation while at the same time permitting longitudinal shift movement. At its upper end slide 113 is provided with a suitable handle 117.

Inside the switch casing a switch operating bar 118 is secured to slide 113 so as to shift therewith. When the thermal fuse is released by overheating, switch operating bar 118 shifts upwardly and engages and operates the pins 52 of pin-type micro-switch 51.

When the thermal fuse of Figs. 13 and 14 is in its normal set condition, it appears as shown in Fig. 13. Upon overheating the fusible connection 71 melts and under action of spring 112 slide 111 is shifted downwardly rotating rod 108 in a clockwise direction, with the result that slide 113 is shifted upwardly causing switches 51 to operate and also causing handle 117 to project upwardly giving a visual signal showing overheating or a dangerous condition. The micro-switches may be connected to other signalling apparatus or to relays for controlling motors, bearings, or other apparatus to which the fuse is applied. When the overheated

condition has been corrected and the fusible connection 71 has again solidified, the fuse can be reset by simply pressing handle 117 inwardly rotating rod 108 in a counter-clockwise direction so as to shift slide 111 back to its normal set position. The ratchet teeth 74 together with spring 112 permit the rod 108 to rotate in a counter-clockwise direction with regard to rod 73. However, the teeth prevent such relative movement of rod 108 in a clockwise direction when the fusible connection 71 is in solidified condition. If an attempt is made to reset the thermal fuse before the fusible connection has solidified, it will immediately return to its released position thus preventing premature operation of the apparatus being controlled.

In the form of apparatus shown in Fig. 15, I have provided a casing 119 through which the fuse case 120 projects into contact with the apparatus to which it is applied. The actuating mechanism in this form of apparatus is somewhat similar to that shown in Figs. 13 and 14. Thus, the fusible connection 71 inside the lower end of the fuse case restrains the fuse disk 72 against rotation and the fuse disk is mounted at the lower end of rod 73 having ratchet teeth 74 at its upper end in engagement with similar ratchet teeth formed on the lower end of rod 108 formed with a left-hand screw thread section 109 at its lower end and a right-hand screw thread section 110 at its upper end. The casing 120 is formed with diametrically opposite slots 121 which accommodate the laterally projecting arms 122 formed on slide 123 which has threaded engagement with the lower thread section 109 of rod 108. Springs 124 normally serve to pull the slide downwardly which, in turn, would result in rotation of rod 110 in a clockwise direction. The slots 121 serve to provide upper and lower limits to the movement of slide 123.

As in the form of my invention shown in Figs. 13 and 14 the device shown in Fig. 15 is provided with an additional slide shown at 125 which engages the screw threads 110 at the upper end of rod 108 so that when rod 108 rotates in a clockwise direction the slide 125 is shifted upwardly. The slide 125 is of non-circular cross-section exterior shape as, for instance, hexagonal and passes through a similarly shaped cap 126 formed on the top of casing 120 so that it may shift longitudinally with respect thereto but may not rotate. It also projects through an opening in the cover 127 of casing 119 and is provided with a suitable handle 128 at the upper end thereof.

The normal preset or initial position of the thermal fuse is shown in Fig. 15. When the apparatus is overheated it causes the fusible connection 71 to melt. Springs 124 will cause slide 123 to shift downwardly rotating rods 73 and 108 in a clockwise direction with the result that slide 125 shifts outwardly and handle or head 128 will project beyond the cover of casing 119. This gives visible indication of overheating or of an undesirable condition which needs correcting. Simultaneously, arms 122 and slide 123 move downwardly and the rollers 130 at the ends of the arms engage the arms 131 on snap action or toggle switch pivotally mounted on the brackets 132 as shown and normally held in elevated position shown in Fig. 15 by springs 133 so that contacts 134 are in engagement with each other. However, when the arms 122 engage the snap action switch arms and shift them past dead-center the springs serve to shift the switches downwardly so that the contacts 135 engage each other. In this form of apparatus the contacts 134 may serve to control the circuit of the motor or other apparatus to which the thermal fuse is applied. The contacts 135 may serve to control signalling apparatus or they may serve to control other apparatus such as cooling apparatus which is brought into play when the motor is overheated. When the apparatus has cooled sufficiently for the fusible connection 71 to solidify, the handle 128 may again be depressed causing rotation of rod 108 in a counter-clockwise direction with the result that slide 123 is again returned to its normal preset position as shown in Fig. 15 engaging the upper flight of the snap action switch arms so as to return them to the position shown in full lines in Fig. 15.

From the foregoing description of the several embodiments of my invention, it will be seen that I have provided an improved thermal fuse comprising actuating mechanism having a first rotatably shiftable member and a second longitudinally shiftable member interengageable with each other so that the shifting of one causes a corresponding shifting of the other and also having a fusible connection arranged in heat exchange relationship with the apparatus to be controlled for restraining the members from movement. A suitable control device such as a switch is positioned to be operated by the actuating mechanism when the fusible connection is released.

It will be appreciated that the apparatus is of relatively compact design, and may be provided with self-contained electrical low amperage or high amperage multiple switches. It is also relatively simple to reset and is relatively tamper-proof and foolproof and gives satisfactory service over a long period of time with a minimum amount of wear.

Modifications may be made in the illustrated embodiments of my invention without departing from the invention as set forth in the accompanying claims.

I claim:

1. A thermal fuse operating in response to the increase in temperature of apparatus of the type having a casing and a heated wall which are relatively shiftable under thermal expansion and contraction, said fuse comprising: a support cooperable to be fixedly mounted on the casing of the apparatus; thermally response means carried by said support and shiftable relative thereto and cooperable to thermally engage the wall of the apparatus, said thermally responsive means including actuating mechanism disposed in a normal inactivated position under normal operating temperatures and being shiftable to an activated position when a predetermined elevated temperature is reached; and a single force applying assembly including a spring operatively connected to said actuating mechanism to bias the thermally responsive means into engagement with the wall of the apparatus and to shift the actuating mechanism into activated position when said predetermined elevated temperature is reached.

2. A thermal fuse operating in response to the increase in temperature of apparatus of the type having a casing and a heated wall which are relatively shiftable under thermal expansion and contraction, said fuse comprising: a supporting structure having mounting means for fixedly mounting the fuse on the casing of said apparatus and provided with an inner end cooperable to project towards the wall of the apparatus; a fusible connection carried by said support at the inner end thereof and having limited fixed movement inwardly and outwardly from the inner end of the support and cooperable to be disposed in heat exchange engagement with the wall of the apparatus, said fusible connection including a fusible mass which is sold at normal operating temperatures but which fuses when subjected to predetermined elevated temperatures; actuating mechanism mounted in said support and having limited fixed movement relative thereto, said actuating mechanism including a movable member shiftable between a normal inactivated position and an activated position and also having means operatively connected with said fusible connection so as to retain the movable member in normal inactivated position while said fusible mass is in solid condition; and a single force applying assembly including a spring in operative relation with the actuating mechanism for biasing the fusible connection into heat exchange engagement with the wall of the apparatus and for also causing the movable member to shift to activated position when the fusible mass melts.

3. A thermal fuse as set forth in claim 2 in which said movable member is rotatably shiftable and a second movable member which is longitudinally shiftable and which has threaded engagement with the first movable member is also provided and the force applying assembly is operatively connected to said second member.

4. A thermal fuse or safety device operating in response to the increase to a predetermined level of the temperature of apparatus to which it is applied comprising: a supporting structure presenting a heat exchange portion cooperable to be disposed in heat exchange relationship to said apparatus; actuating mechanism including a first shiftable member supported by said supporting structure for rotary shift movement, a second shiftable member carried by said supporting structure for longitudinal shift movement, one of said shiftable members having a screw thread of relatively steep pitch and the other of said members having thread engaging means in engagement therewith whereby longitudinal shift movement of said second shiftable member causes rotary shift movement of said first shiftable member and vice versa, and spring means in operative relation to one of said members to urge said members to shift relatively to each other in one direction to a predetermined position; a control device having means in operative relationship to said actuating mechanism so that the actuating mechanism causes the operation thereof when said shiftable members are shifted to said predetermined position; and fusible means disposed adjacent said heat exchange portion and connecting one of said shiftable members to the supporting structure to restrain shift movement thereof and to hold said shiftable members in an initial position spaced from said predetermined position at normal temperatures but which fuses at a predetermined temperature to release said shiftable members whereby said spring means causes said shiftable members to shift to said predetermined position to operate said control device.

5. A thermal fuse or safety device as set forth in claim 4 in which the spring means is cooperative to urge said heat exchange portion into engagement with the apparatus to which the fuse is applied.

6. A thermal fuse or safety device as set forth in claim 4 in which the control device includes means in operative relationship with the first shiftable member to cause its operation upon the rotary shifting of said first shiftable member to different relative positions.

7. A thermal fuse or safety device as set forth in claim 4 in which the control device includes means in operative relationship with the second shiftable member to cause its operation upon the longitudinal shifting of said second shiftable member to different relative positions.

8. A thermal fuse or safety device as set forth in claim 4 in which the control device includes an electrical switch which is caused to open and close by the shifting of said actuating mechanism to different relative positions.

9. A thermal fuse or safety device as set forth in claim 4 in which the control device includes an electrical switch which is caused to operate by the rotary shifting of said first shiftable member to different relative positions.

10. A thermal fuse or safety device as set forth in claim 4 in which the control device includes an electrical switch which is caused to open and close by the longitudinal shifting of said second shiftable member to different relative positions.

11. A thermal fuse or safety device as set forth in claim 4 in which a visual indicator is provided in operative relationship with the actuating mechanism so as to indicate relative positions of said shiftable members.

12. A thermal fuse or safety device as set forth in claim 4 in which a visual indicator is provided in operative relationship with the first shiftable member so as to be shifted by the rotary shifting thereof and thereby indicate its relative position.

13. A thermal fuse or safety device as set forth in claim 4 in which the control device includes a snap action switch and the actuating mechanism has means in operative relationship to said switch to cause it to snap to open and closed positions as the shiftable members shift between initial and predetermined positions.

14. A thermal fuse or safety device as set forth in claim 4 provided with reset mechanism for returning said shiftable members from said predetermined position to their initial position after the fusible means has solidified.

15. A thermal fuse or safety device operating in response to the increase to a predetermined level of the temperature of apparatus to which it is applied comprising: a supporting structure presenting a heat exchange portion cooperable to be disposed in heat exchange relationship to said apparatus; actuating mechanism including a first shiftable member supported by said supporting structure for rotary shift movement, a second shiftable member carried by said supporting structure for longitudinal shift movement, one of said shiftable members having a screw thread of relatively steep pitch and the other of said members having thread engaging means in engagement therewith whereby longitudinal shift movement of said second shiftable member causes rotary shift movement of said first shiftable member and vice versa, and spring means in operative relation to one of said members to urge said members to shift relatively to each other in one direction to a predetermined position; a control device having means in operative relationship to said actuating mecehanism so that the actuating mechanism causes the operation thereof when said shiftable members are shifted to said predetermined position; fusible means disposed adjacent said heat exchange portion and connecting one end of said first shiftable member to the supporting structure to restrain shift movement of said members and to hold them in an initial position spaced from said predetermined position at normal temperatures but which fuses at a predetermined temperature to release said shiftable members whereby said spring means causes said shiftable members to shift to said predetermined position to operate said control device; and reset mechanism for returning said shiftable members from said predetermined position to their initial position after the fusible member has again solidified.

16. A thermal fuse or safety device as set forth in claim 15 in which the reset mechanism includes a worm gear embracing the second shiftable member so that said second shiftable member may shift longitudinally but is restrained from rotary shift movement with respect thereto and also a worm in engagement with the worm gear and having means for rotating the same.

17. A thermal fuse or safety device as set forth in claim 15 in which the first shiftable member is formed of two rod sections in actual alignment and in end to end engagement with each other and having a ratchet type of connection at their adjacent ends, one of the rod sections being engaged with the fusible means and the other section being in engagement with the slide.

18. A thermal fuse or safety device as set forth in claim 15 in which the first shiftable member is formed of two rod sections in actual alignment and in end to end engagement with each other and having a ratchet type of connection at their adjacent ends, one of the rod sections being engaged with the fusible means and the other section being in engagement with the slide, and the reset mechanism being in the form of a handle having operative connection to the second mentioned rod section so that the said rod section may be rotated thereby.

References Cited in the file of this patent

UNITED STATES PATENTS

1,015,084	Rowe	Jan. 16, 1912
1,748,330	Corey	Feb. 25, 1930
2,150,858	Eggleston	Mar. 14, 1939
2,307,356	Kirk	Jan. 5, 1943