

Aug. 16, 1966

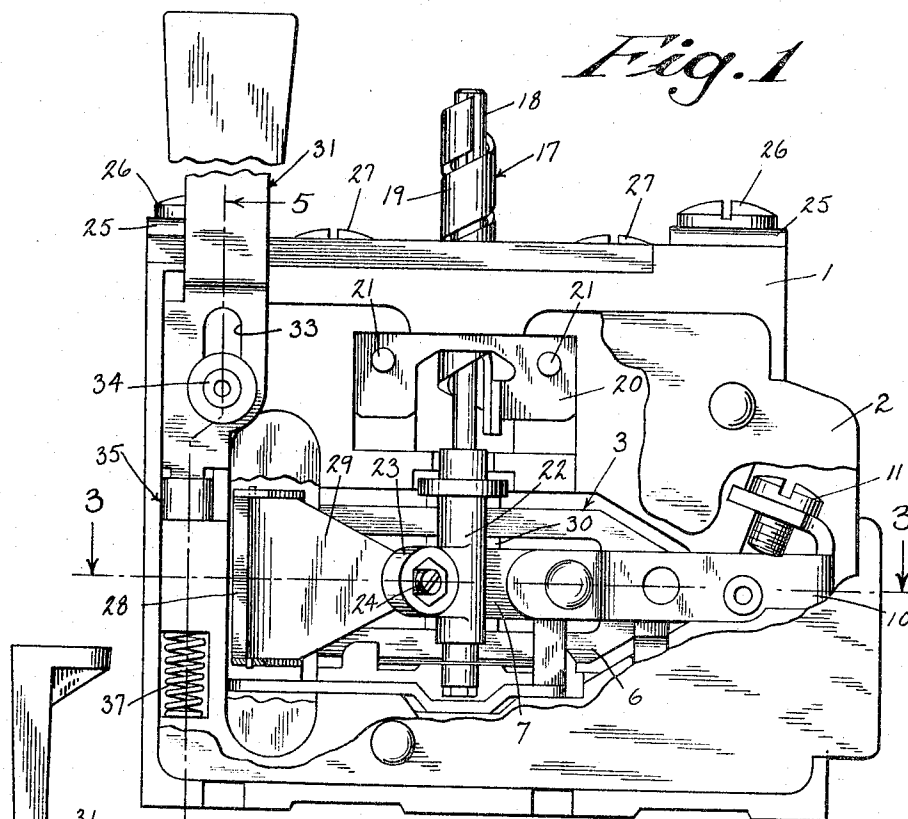
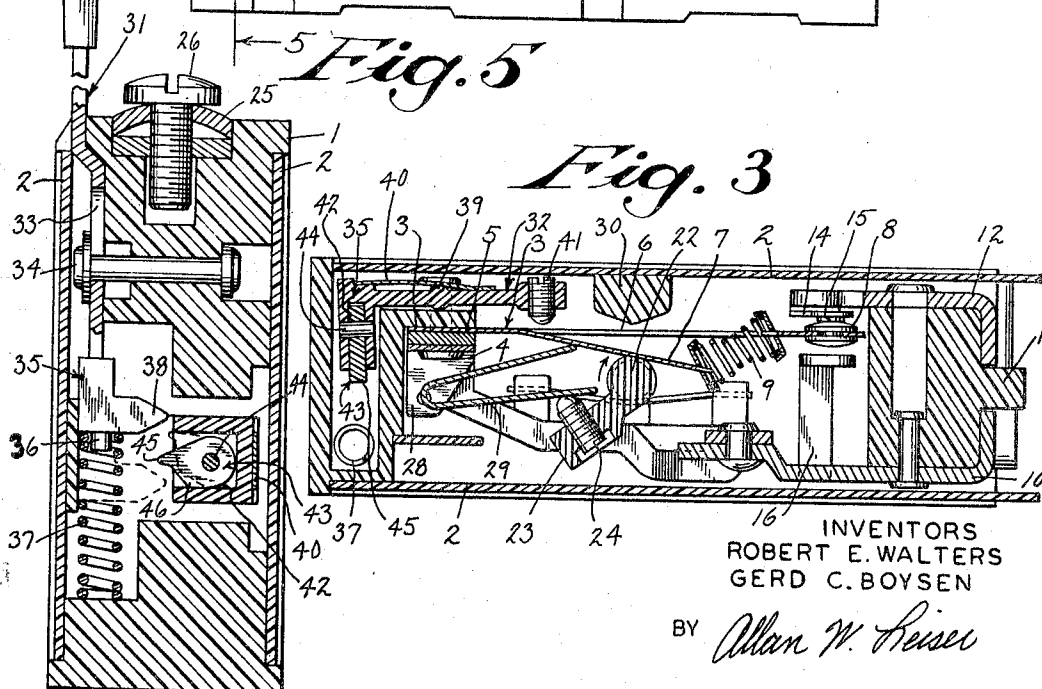
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3,267,236

OVERLOAD RELAY WITH TAMPER PROOF RESET MECHANISM

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Fig. 2

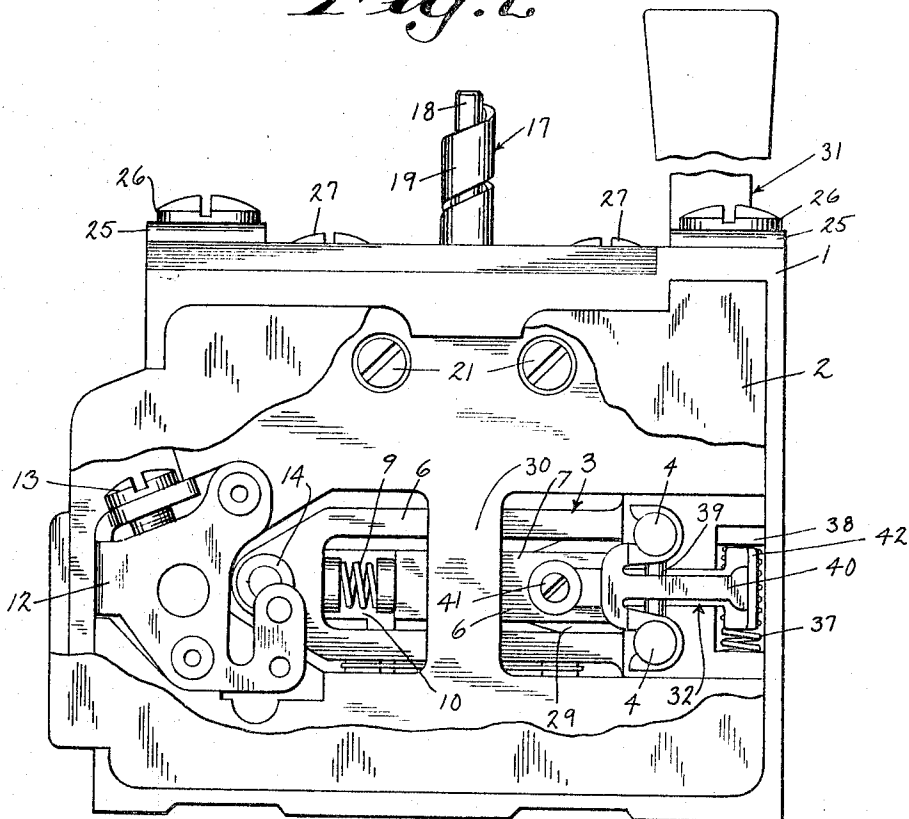
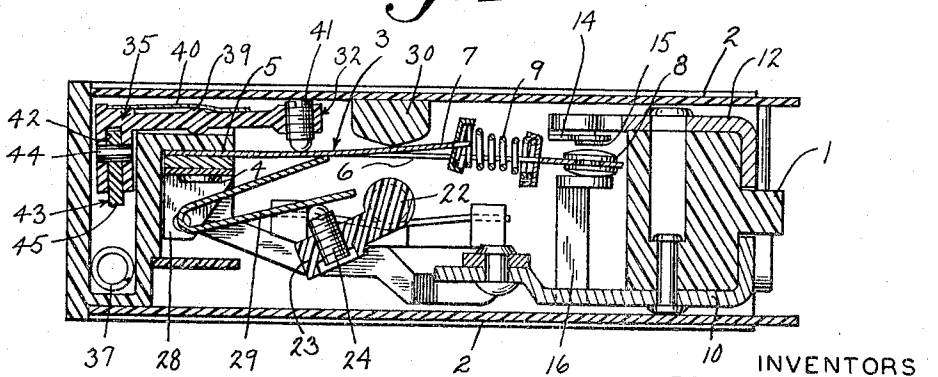


Fig. 4



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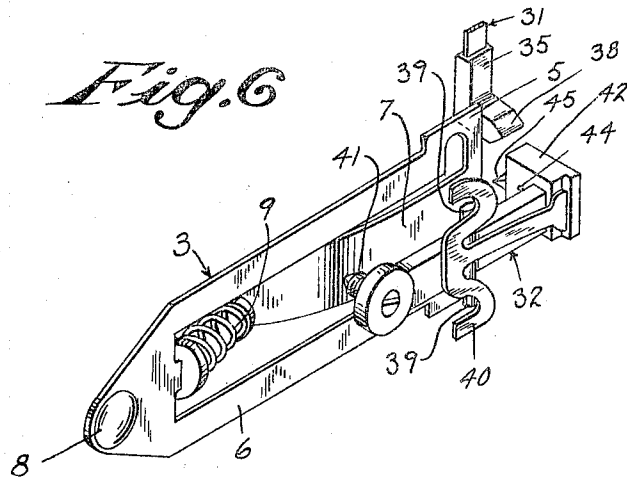
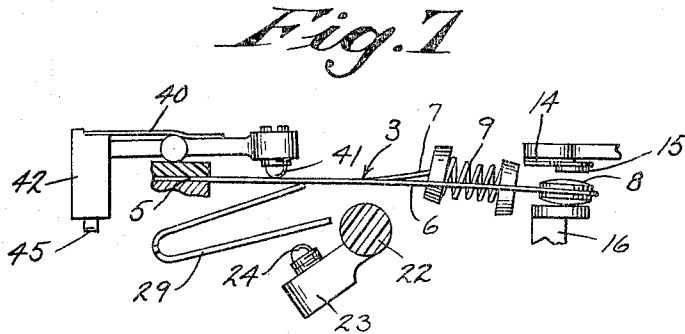
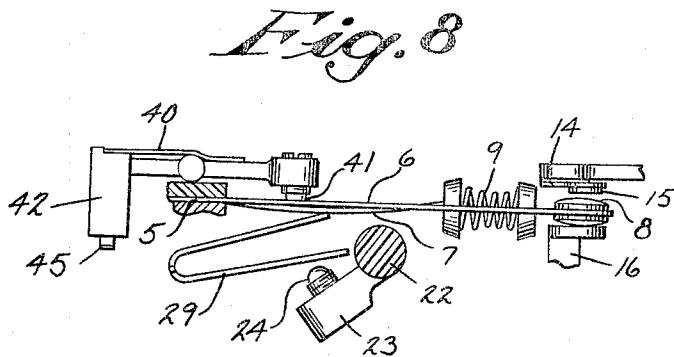
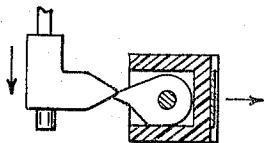
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3,267,236 OVERLOAD RELAY WITH TAMPER PROOF RESET MECHANISM

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This invention relates to overload relays; and it resides more particularly in a tamper-proof relay including switch means movable between open and closed positions, a reset plunger reciprocable between extended and depressed positions, a first cam member mounted on and movable with the plunger, and a second cam member operatively connected to the switch and disposed at an intermediate point in the path of travel of the first cam member with the plunger, movement of the plunger from extended toward depressed position causing the first cam member to move into a camming engagement with the second cam member in which the second cam member is moved away from the first to move the switch toward closed position, the first cam member being adapted to ride over the second to an overtravel position.

This invention is particularly useful in connection with bi-metal relays of the type which incorporate precision or snap action switches. In such relays, there is a bi-metal heat sensing element which, in the presence of excessive heat moves to act on a spring arm of the switch to throw the switch from closed to open position. Such bi-metal relays are of two types so far as resetting is concerned. In some, the snap switch is biased so that as soon as the bi-metal element cools and moves away from the switch the switch returns to closed position automatically. Such automatic resetting action is particularly desirable, for example, for unattended installations where continuous operation of a system is desired. Other relays are intended to have a manual resetting action, and are designed so that a manually operable lever or plunger must be actuated to move the switch back to its closed position.

Heretofore, however, it has been possible to convert manually resettable bi-metal relays to ones having automatic action, intentionally or accidentally, simply by holding the reset plunger in a depressed position. In this way, the reset mechanism is held against the switch and, as soon as the bi-metal element cools and moves away, causes it to close. In the presence of a continuing overload, this can cause repeated surges which can damage or destroy the expensive equipment the relay is designed to protect. In some cases, blocking in of the reset plunger in this manner may prevent tripping altogether with even worse consequences.

It is the general object of this invention to provide a relay in which manipulation of a reset mechanism cannot interfere with normal tripping and resetting operation of the relay.

It is a specific object of the invention to provide a relay in which tamper-proof characteristics are obtained by means of a pair of cam members operatively interposed between a reset plunger and a switch in which one of the cam members is adapted to ride over the other to an overtravel position.

It is another object of the invention to provide such a relay in which there is an overtravel and the cam members have relatively sharp crests so that it is virtually impossible to hold the reset plunger in such a position as to prevent tripping or to cause automatic resetting.

It is a further object of the invention to provide such a relay in which one of the cam members is pivotally mounted to prevent it from blocking a return of the reset plunger.

It is still another object of the invention to provide a

relay with a tamper-proof resetting mechanism which is sturdy and effective while being of minimum size.

It is still another object of the invention to provide a relay incorporating such a reset mechanism in which both the tripping means and resetting means are adjustable for highly accurate calibration of the relay.

It is a still further object of the invention to provide such a relay which has compensating means incorporated therein to compensate or correct for variations in ambient temperature.

It is still another object of the invention to provide a relay which has a snap action, both as to tripping and resetting.

Other objects and advantages will appear from the description to follow. In the description, reference is made to the accompanying drawings, forming a part hereof, in which there is shown by way of illustration and not of limitation a preferred embodiment of the invention.

In the drawings:

FIG. 1 is a front view in elevation with parts broken away showing a preferred embodiment of a relay formed according to this invention.

FIG. 2 is a rear view in elevation with parts broken away of the relay of FIG. 1.

FIG. 3 is a view in cross-section of the relay of FIG. 1 taken in the plane 3—3 shown in FIG. 1, the parts of the relay being shown in an untripped or normal operating position.

FIG. 4 is a view in cross-section similar to FIG. 3 but with the operating elements of the relay being shown in a tripped position.

FIG. 5 is a view in cross-section taken in the plane 5—5 shown in FIG. 1, with alternative positions of cam members being shown in dotted lines.

FIG. 6 is a fragmentary view in perspective showing the resetting mechanism of the relay of FIG. 1.

FIG. 7 is a fragmentary view showing the relay snap action switch in an open position after the bi-metal tripping means has cooled and moved to a withdrawn position.

FIG. 8 is a fragmentary view showing the snap action switch and resetting mechanism in the positions assumed immediately prior to the completion of a resetting action, and

FIG. 9 is a fragmentary view showing the positions of the resetting cam members when the relay elements are in the positions of FIG. 8.

The various operating parts of the relay shown in the drawings are mounted on an insulating case 1 that has thin, flat side covers 2 which are broken away in FIGS. 1 and 2 to reveal the interior structure. The relay has a snap action precision switch that includes a flat, electrically conductive leaf spring 3 shown in perspective in FIG. 6. A pair of rivets 4 mount one end 5 of the leaf spring 3 to the case 1. From the end 5 extend an outer, generally U-shaped contact carrying arm 6 and an inner actuator blade 7. The deflectable, free end of the contact carrying arm 6 mounts a movable contact 8, and a toggle spring 9 is interposed between this free end of the contact carrying arm 6 and the deflectable end of the blade 7. This snap action switch operates in well-known manner, particularly as described in U.S. Patent No. 2,260,964, and other forms of snap action switches can be used in the invention in lieu of the particular precision switch described.

A conductive front terminal 10 of complex configuration extends from the stationary, mounted ends 5 of the leaf spring 3 along the bottom of the case 1, as can be seen most clearly in FIG. 1, and thence outwardly of the case 1 where it is provided with a front terminal screw 11. A rear terminal 12, seen most clearly in FIG. 2, is provided on the side opposite the terminal 10 and has an appropri-

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ate terminal screw 13 for connection, along with the terminal screw 11, into an electrical circuit. The terminal 12 is provided with a resilient, electrically conductive extension 14, seen most clearly in FIGS. 3 and 4, at the end of which is a stationary contact 15 in position to be engaged by the movable contact 8 of the leaf spring 3. When the contact 8 is in engagement with the contact 15 an electrical circuit is completed through the relay from terminal screw 11, the terminal 10, the leaf spring 3, contacts 8 and 15, terminal 12 and terminal screw 13.

A third terminal member 16 is mounted on the case 1 below the terminal 10 and terminates opposite the contact 15 on the other side of the contact 8. In the particular embodiment of the invention shown herein, the terminal 16 is blind and serves primarily as a stop for the contact 8 as will be described. It should be apparent, however, that the terminal 16 could be provided with a terminal screw and a contact engageable with the contact 8 so that it could be connected into an alternative electrical circuit to be energized when the contact 8 is in the tripped position shown in FIG. 4.

A heat sensitive tripping means designated generally by the reference numeral 17 is mounted in and extends through the top of the case 1. It comprises a central shaft 18 and a coiled bi-metal heat sensing element 19 which has its upper end firmly fixed in a slot at the top of the shaft 18. A plate 20 is affixed securely to the bottom end of the coil 19 and is mounted on the case 1 by rivets 21. A trip member 22 is firmly mounted on the shaft 18 near its lower end and has a radially projecting actuating finger 23 provided with a calibrating screw 24.

In the embodiment of the invention shown herein, the bi-metal coil 19 is designed so that it tends to uncoil in the presence of heat causing the shaft 18 and trip member 22 to rotate in a clockwise direction as seen in FIGS. 3 and 4.

A pair of conducting busses 25 are mounted on the top of the case 1 and are provided with terminal screws 26 for connection into a line circuit. A second pair of terminal screws 27 is provided, on the inner ends of the busses 25, and these serve as means to connect a heater (not shown) across the busses 25, which heater surrounds the upwardly extending portion of the bi-metal coil 19 in the usual manner. The heat generated by the heater is of course a measure of the load in the circuit being protected and the heater and the bi-metal coil 19 may be selected to provide for rotation of the trip member 22 at any desired load.

Pivotaly mounted on a U-shaped bracket 28, to be interposed between the trip member 22 and leaf spring 3, is a bileaved compensator 29 of a rigid bi-metal construction which has one of its leaves engageable with the calibrating screw 24 and the other leaf engageable with the spring arm 7. The compensator 29 serves to transmit motion of the trip member 22 to the leaf spring 3. It also, however, serves to correct for ambient temperatures. That is, the bi-metal construction of the compensator 29 is such that in the presence of higher temperatures its leaves tend to fold together. This same temperature causes the trip member 22 to rotate in a clockwise direction as seen in FIGS. 3 and 4, but such rotation is taken up or compensated for by the fact that the leaves of the compensator 29 are closer together so that the same relative additional rotation of the member 22 is necessary in order to actuate the spring 3. Thus, the relay functions as it is designed to do even in the presence of high ambient temperatures. Further accuracy is insured by the calibrating screw 24 which may be extended or retracted to alter tripping characteristics.

A comprehensive analysis of the operation of snap action switches is not necessary here, since such switches are well-known in the art. Suffice it to say for present purposes that the leaf spring 3 is normally in the closed position shown in FIG. 3. That is, the spring arm 7 is normally in an over-center position downwardly as seen in FIG. 3, and the contact arm 6 is in an over-center position upwardly with the toggle spring 9 serving to hold the contact arm 6 and the contact 8 resiliently against the

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stationary contact 15 and in general to hold the switch relatively securely in the position of FIG. 3. The trip member 22 serves as a stop to limit downward motion of the arm 7 while the stationary contact 15 serves as a stop to limit upward motion of the arm 6.

In the event of an overload accompanied by excessive heat, the trip member 22 will rotate in counterclockwise direction as seen in FIG. 3 from a withdrawn position, the position of FIG. 3, to a tripping position, the position of FIG. 4. This causes the screw 24 to move against the compensator 29 which in turn moves against the spring arm 7 forcing it to and over center so that the switch assumes the open position shown in FIG. 4 where the arm 7 is over-center upwardly and the arm 6 is over-center downwardly to move the contact 8 out of engagement with the contact 15. A stop 30 formed in the case 1 serves to limit upward motion of the arm 7 while the stop afforded by the terminal 16 limits downward motion of the arm 6. The switch has a snap action both in the opening action described and in the resetting or closing action referred to hereinafter.

In the embodiment of the invention shown herein, the leaf spring 3 is unbiased so that when it is in the position shown in FIG. 4 and the member 22 then rotates in a counterclockwise direction upon cooling, toward the withdrawn position of FIG. 3, the switch remains in the position of FIG. 4. The positions after cooling but before reset are shown in FIG. 7. A biased snap switch such as those normally used in automatic resetting bi-metal relays, in which the spring blade is normally not in the plane of the contact arm and tends to urge the switch toward closed position, may also be used so long as it is allowed sufficient travel so that the bias is overcome. That is, enough space must be allowed so that the arms 6 and 7 can move further apart and the toggle spring 9 can assume a position more nearly transverse to the plane of the spring 3 so that the force exerted by the spring 9 overcomes the bias or tendency of the switch to return to a closed position. This might be done, for example, by moving the stop 30 and the terminal 16 further from the spring 3. An unbiased switch is, however, more satisfactory simply because it requires less space.

Resetting of the switch, returning it to the closed position shown in FIG. 3, is accomplished by means of a resetting mechanism including a vertically reciprocable plunger designated generally by the reference numeral 31 and a lever member designated generally by the reference numeral 32. The plunger 31 is formed of flat sheet material and is provided with a vertical slot 33. A rivet 34 extends through the slot 33 to mount the plunger 31 on the case 1, allowing it a vertical reciprocating movement between, as seen in FIG. 5, an upper or extended position and a lower or depressed position. The plunger 31 is narrowed at its lower end and a generally L-shaped member 35, which serves as a first cam member, is mounted thereon with a tight friction fit to be movable vertically with the plunger 31. The member 35 moves vertically in a channel formed in the case 1 to further guide the reciprocating movement of the plunger 31. On its bottom surface, the member 35 is provided with a downwardly extending boss 36 which seats the upper end of a compression spring 37, the lower end of which is seated on the case 1, the spring 37 serving to urge the plunger 31 in an upward direction or toward its extended position. A camming leg 38 of the member 35 extends inwardly and has a wedge-like configuration with a relatively sharp crest.

The lever 32 is provided at about its mid point with transversely extending trunnions 39 which are pivotally received in grooves formed in the case 1 to pivotally mount the lever 32. A lyre-shaped spring member 40 holds the lever 32 in place and is itself secured on the case 1 by means of the rivets 4, the spring member 40 serving to urge the lever 32 in a counterclockwise direction as seen in FIGS. 3 and 4. The forward end of the lever 32, the end to the right as seen in FIGS. 3 and 4, is provided with

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a calibrating screw 41 which is engageable with the arm 7 as the lever 32 pivots in a clockwise direction and is adapted to urge the arm 7 downwardly to throw the spring 3 from the open position shown in FIG. 4 to the closed position shown in FIG. 3.

The other, rear end of the lever 32, to the left as seen in FIGS. 3 and 4, is provided with an integral cage 42 that faces and opens outwardly toward the path of movement of the leg 38 with the plunger 31 and within which a second cam member 43 is freely pivotally mounted by means of a transverse pin 44. As can be seen most clearly in FIG. 5, the cam 43 has a generally triangular or wedge-like, outwardly extending camming lobe 45, also with a relatively sharp apex or crest, and is provided with a shoulder 46 which is engageable with the cage 42 to limit its pivotal movement in a downward direction to the position shown in full lines in FIG. 5. In this position, termed herein a camming position, the lobe 45 is directly in the path of travel of the camming leg 38 of the cam member 35. The cam 43 can also, however, pivot in a clockwise direction as seen in FIG. 5 to the position shown in dotted lines where it is in what is termed herein a by-pass position only partially in the path of travel of the leg 38.

The action of the resetting mechanism of the invention can be understood with reference to FIGS. 3 through 5 and 7 through 9. After a tripping action caused by the trip member 22, the switch is in the position shown in FIG. 4. Upon cooling, the member 22 moves away from the compensator 29 and the elements are then in the positions of FIG. 8, with the arm 7 in an upward position against the calibrating screw 41. The plunger 31 and lever 32 will normally be in the positions shown in FIG. 5. That is, the spring 37 holds the plunger 31 in its extended position so that the leg 38 is above the cam 43. The spring 40 holds the lever 32 in a retracted position, with the cage 42 and cam 43 near the plunger 31. The cam 43 will normally be held by gravity in the position shown in full lines in FIG. 5, its camming position in which the lobe 45 is in the path of the leg 38. When the plunger 31 is then moved to its depressed position, shown in dotted lines in FIG. 5, the elements will move first to the positions of FIGS. 8 and 9. That is, the leg 38 will cammingly engage the lobe 45 thus pivoting the lever 32 in a clockwise direction as seen in FIGS. 3 and 4 toward an actuating position. This pushes the screw 41 against the arm 7 thus moving the arm 7 downwardly to the position of FIG. 8 where a very slight additional movement will throw it over-center and thus throw the switch to the closed position of FIG. 3. Thus, the cam 43 is operatively connected to the spring 3 through the lever 32 to cause the switch to close when cammingly engaged by the leg 38.

The leg 38 and cam 43 and the remaining elements of the relay are so designed so that the lever 32 is only pivoted far enough to effect a throwing action just prior to a point where the cam 38 rides over the lobe 45. This is illustrated in FIG. 9 where it can be seen that just before the arm 7 goes over-center the crests of the cam members 38 and 45 are almost at the same level. After the throwing action, the leg 38 moves to a position of overtravel corresponding to a fully depressed position of the plunger 31 so that it is in the dotted line position shown in FIG. 5. When the leg 38 is below the cam 43, the spring 40 causes the lever 32 to return to its normal or retracted position.

When manual pressure is removed from the plunger 31, the spring 37 tends to move it upwardly and the leg 38 then engages the underside of the lobe 45 causing the cam 43 to pivot to the dotted line position shown in FIG. 5, termed a bypass position, where the lobe 45 is only partially in the path of travel of the leg 38 and the leg 38 is allowed to ride over it without substantial pivotal movement of the lever 32. The fact that the lobe 45 remains partially in the path of travel of the leg 38 insures, in the event that gravity does not cause the cam 43 to move to the full line position in FIG. 5, that the lobe 45 will be

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caught by the arm 38 in a downward movement to be moved to the full line position where it can have the required camming action.

The pivotability of the cam 43 to a by-pass position also prevents blocking if the relay trips while the plunger 31 is depressed. If this should occur, the leg 38 would be below the cam 43 and the arm 6 would hold the lever 32 in a retracted position to hold the lobe 45 directly over the leg 38. If the cam 43 could not pivot, it would then be necessary to forcibly pull the plunger 31 upwardly to move the leg 38 past the cam 43 preparatory to resetting. With the pivotable cam 43, however, the spring 37 alone can push the plunger 31 upwardly with no substantial movement of the lever 32 against the arm 6.

The generally wedge shaped, relatively sharply crested configuration of the cam leg 38 and lobe 45, and the fact that a throwing action occurs only when the cam 38 is just about to over-ride the lobe 45 makes it virtually impossible to hold the lever 32 in a blocking position where it would prevent the switch from moving to the open position of FIG. 4 or cause it to return automatically to closed position. This is also insured by the fact that the cam leg 38 is capable of an overtravel since it would be necessary to hold the leg 38 in a precise position at an intermediate point in its path of travel in order to have a blocking engagement. The resetting action actually occurs at a precise line in the path of movement of the parts rather than over a large area.

If a resetting action should be attempted while the trip member 22 is still in a tripping position, which would occur in the case of a continuing overload, the switch will be prevented by it from moving to closed position. The design of the spring 3 is such that the contact 8 does not engage the contact 15 until the end of a closing action. Thus, if the arm 7 is prevented by the member 22 from going over-center, the contact 8 will not meet the contact 15, thus preventing even a momentary contact which might cause damage in the event of a continuing overload.

When the switch is in the closed position shown in FIG. 3, the arm 7 is relatively far removed from the screw 41 so that actuation of the lever 32 by the plunger 31 has no effect on the spring 3.

Although a preferred embodiment of the invention has been shown and described herein, it will be obvious that a number of variations could be made without departure from the invention. By way of example only, the cam leg 38 could be pivotally mounted rather than the cam 43 to allow return of the plunger 31. For this reason, it is not intended that the invention be limited except insofar as such limitations appear in the following claims.

We claim:

1. In an overload relay, the combination comprising: switch means movable between open and closed positions; a reset plunger reciprocable between extended and depressed positions; a first cam member mounted on and movable with the plunger and having a camming lobe with a relatively sharp crest; and a second cam member operatively connected to the switch and having a camming lobe with a relatively sharp crest that is disposed at an intermediate point in the path of travel of the first cam member with the plunger, movement of the plunger from extended toward depressed position causing the first cam member to move into a camming engagement with the second cam member in which the second cam member is moved away from the first to move the switch toward closed position, the first cam member being adapted to ride over the second cam member to an overtravel position, closing of the switch occurring immediately prior to the point where the first cam member over-rides the second, there being means mounting at least one of the cam members so that upon a return of the first cam member from its overtravel position the first cam member can ride over the second cam member without actuating the switch means.

2. In an overload relay, the combination comprising: switch means movable between open and closed positions; a reset plunger reciprocable between extended and depressed positions; a first cam member mounted on and movable with the plunger that has a camming lobe with a relatively sharp crest; and a second cam member operatively connected to the switch and having a camming lobe with a relatively sharp crest that is disposed at an intermediate point in the path of travel of the first cam member with the plunger, movement of the plunger from extended toward depressed position causing the first cam member to move into a camming engagement with the second cam member in which the second cam member is moved away from the first to move the switch toward closed position, the first cam member being adapted to ride over the second cam member to an overtravel position, closing of the switch occurring immediately prior to the point where the first cam member over-rides the second, at least one of the cam members being pivotally mounted so that upon a return of the first cam member from its overtravel position the pivotally mounted cam member can be pivoted by the other cam member to a by-pass position only partially in the path of travel of the other cam member.

3. In an overload relay, the combination comprising: a switch means movable between open and closed positions; a reset plunger reciprocable between extended and depressed positions; bias means to urge the reset plunger toward its extended position; a first cam member mounted on and movable with the plunger, said first cam member being wedge shaped in configuration and having a relatively sharp crest; an actuating lever pivotally mounted intermediate its ends having one of its ends engageable with the switch means to move the same toward closed position; and a second cam member pivotally mounted at the other end of the actuating lever, said second cam member having a generally triangular camming lobe with a relatively sharp crest, which lobe is disposed in the path of travel of the first cam member with the plunger, movement of the plunger toward its depressed position causing the first cam member to move into a camming engagement with the second cam member in which the second cam member is moved away from the first to pivot the actuating lever and move the switch toward closed position, the first cam member being adapted to ride over the second to an overtravel position, closing of the switch occurring immediately prior to the point where the first cam member over-rides the second, said second cam member being pivotally mounted so that upon the return of the first cam member from the overtravel position the second cam member is adapted to be pivoted by the first cam member to a by-pass position where its camming lobe is only partially in the path of travel of the first cam member so that the first cam member can ride over the second cam member without substantial movement of the lever.

4. In an overload relay having a switch movable between open and closed positions, the combination with said switch of a reset mechanism comprising: a reset plunger reciprocable between extended and depressed positions; a first cam member mounted on and movable with the plunger that has a wedge shaped camming surface having a relatively sharp crest; an actuating arm that is pivotally mounted intermediate its ends and has one end adapted to engage the switch to move the switch toward closed position, the other end of said arm being provided with an open ended cage disposed adjacent to and facing the path of travel of the first cam member with the reset plunger; and a second cam member pivotally mounted in the cage and having a generally triangular camming lobe having a relatively sharp crest projecting outwardly from the cage into the path of travel of the first cam member, said second cam member being provided with stops engageable with the cage so that it is pivotable in an upward direction to a point where the

camming lobe is only partially in the path of movement of the first cam member and is pivotable in a downward direction to a point where the camming lobe is at an intermediate point directly in the path of travel of the first cam member.

5. In an overload relay, the combination comprising: a snap switch having a spring arm that is movable to throw the switch between open and closed positions; a bi-metal element disposed on one side of the switch having an actuating arm that is movable toward and away from the spring arm of the switch in response to heat conditions; a bi-leaved compensator interposed between the actuating arm and the spring arm with one of its leaves in engagement with the spring arm and the other of its leaves in engagement with the actuating arm, the leaves of said compensator being adapted to move closer together upon an increase in heat; an actuating lever pivotally mounted intermediate its ends on the side of the switch opposite from the bi-metal element, said lever having a forward end adapted to engage the spring arm to cause the switch to be thrown to closed position and a rear end having an integrally formed open ended cage; a reset plunger reciprocable between extended and depressed positions; a first cam member mounted on and movable with the reset plunger that passes by the open end of the cage, said cam member being of a generally wedge shaped configuration with a relatively sharp crest; and a second cam member pivotally mounted in said cage with a camming lobe projecting outwardly thereof that is generally triangular with a relatively sharp crest, said second cam member being provided with stops engageable with the cage to limit its pivotal movement between an upper by-pass position where the camming lobe is only partially in the path of travel of the first camming member and a lower camming position in which the camming lobe is at an intermediate point directly in the path of travel of the first camming member.

6. An overload relay according to claim 2, including an actuating lever pivotally mounted intermediate its ends that has one of its ends engageable with the switch means to move the switch means to closed position, the second cam member being mounted on the other end of the actuating lever.

7. In an overload relay, the combination comprising: switch means movable between open and closed positions; a bi-metal element engageable with the switch means that is operable to move the switch means to open position; an actuating lever pivotally mounted intermediate its ends, one end of the actuating lever being engageable with the switch means to cause it to be moved to closed position; a reset plunger reciprocable between extended and depressed positions; a first cam member mounted on and movable with the plunger that has a camming lobe with a relatively sharp crest; and a second cam member mounted on the other end of the actuating lever and having a camming lobe with a relatively sharp crest disposed at an intermediate point in the path of travel of the first cam member with the plunger, movement of the plunger from extended toward depressed position causing the first cam member to move into a camming engagement with the second cam member in which the second cam member is moved away from the first to move the actuating lever and cause the switch means to be moved to closed position, the first cam member being adapted to ride over the second cam member to an overtravel position, closing of the switch means occurring immediately prior to the point where the first cam member over-rides the second, at least one of the cam members being pivotally mounted so that upon a return of the first cam member from its overtravel position the pivotally mounted cam member can be pivoted by the other cam member to a by-pass position only partially in the path of travel of the other cam member.

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