July 2, 1963 R. E. WALTERS 3,096,415

RELAY

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Fig. 1

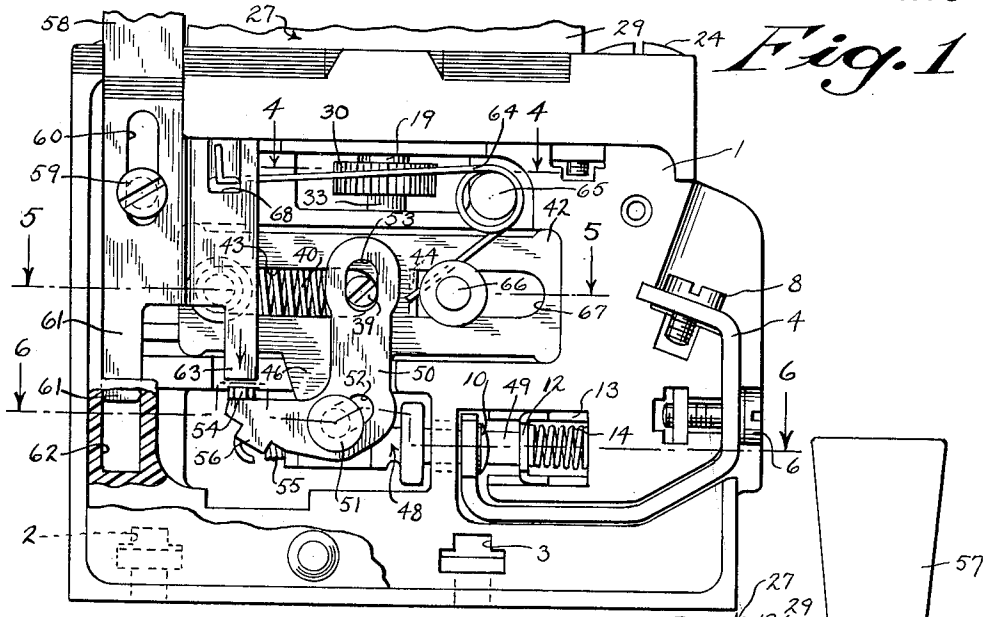
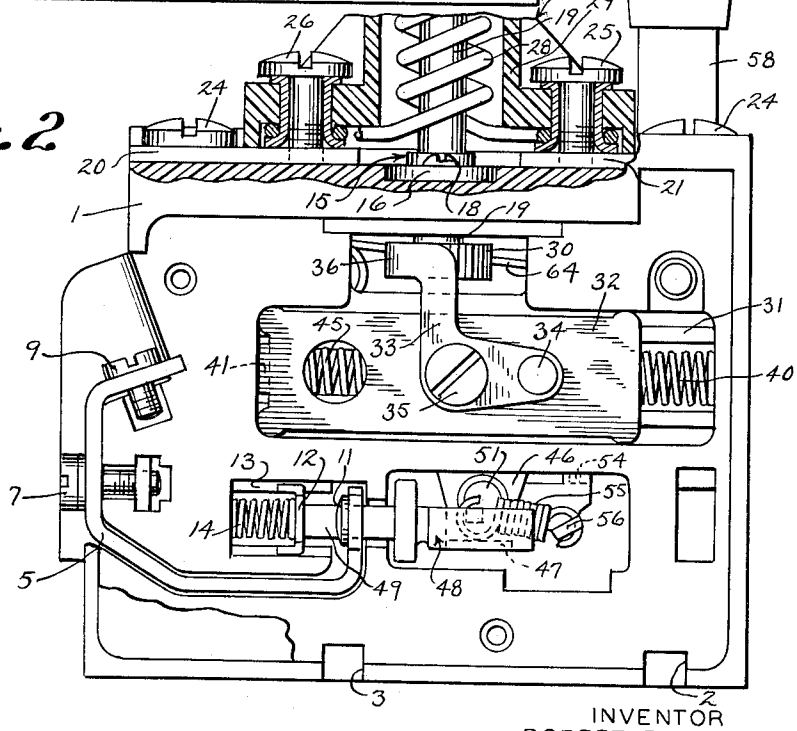


Fig. 2



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Fig. 3

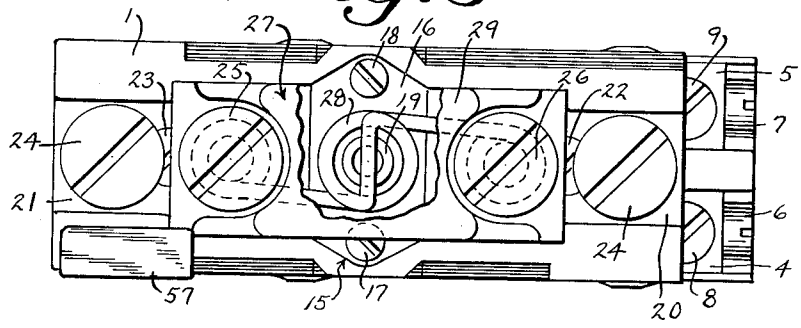


Fig. 4

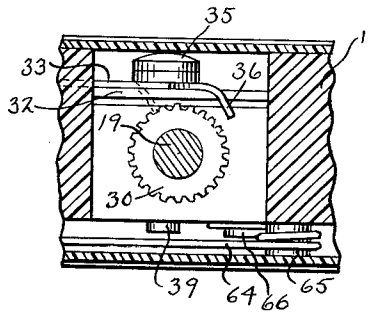


Fig. 5

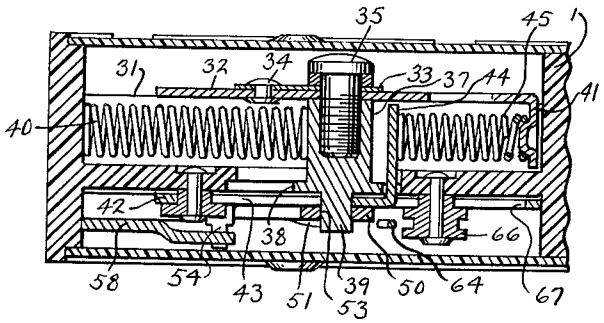
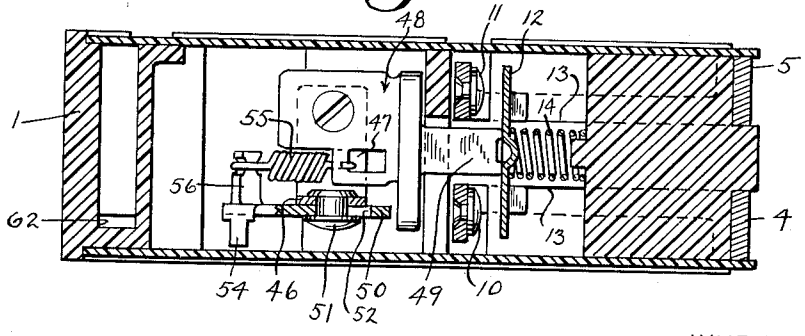


Fig. 6



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Fig. 7

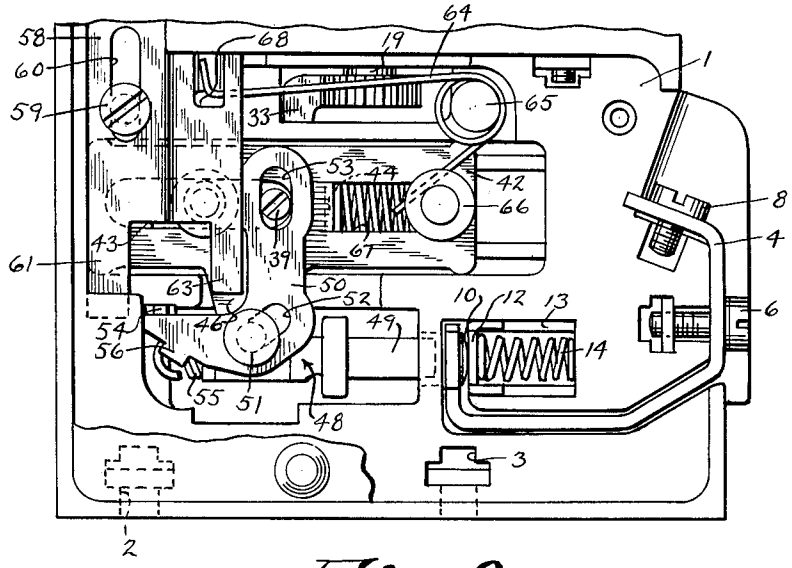
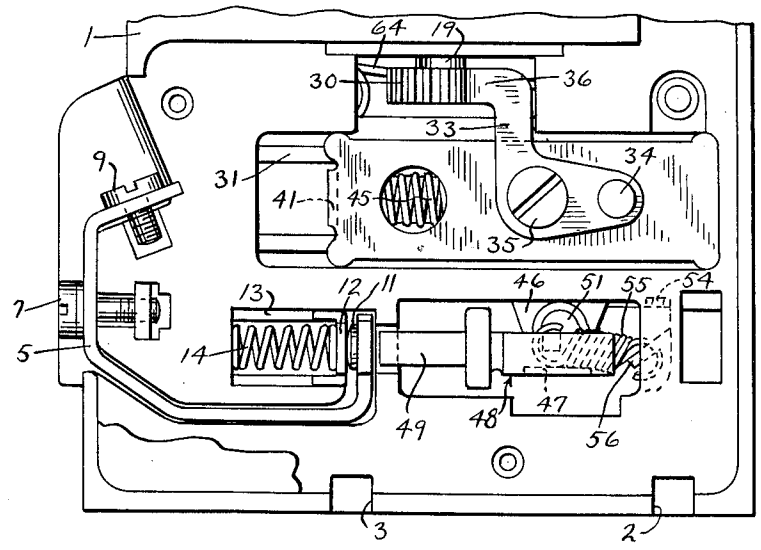


Fig. 8



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Fig. 9

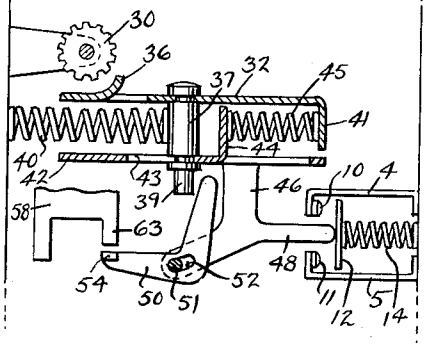


Fig. 12

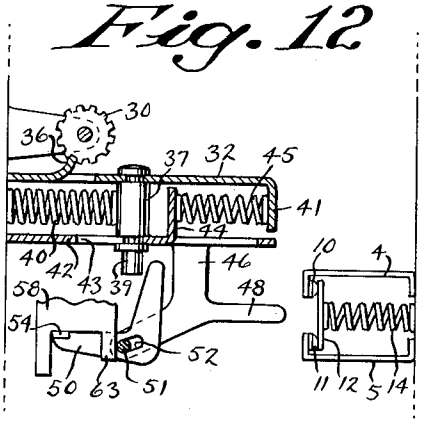


Fig. 10

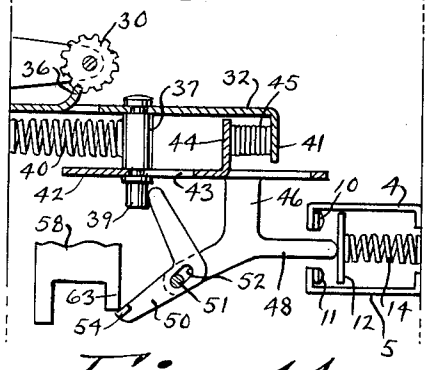


Fig. 13

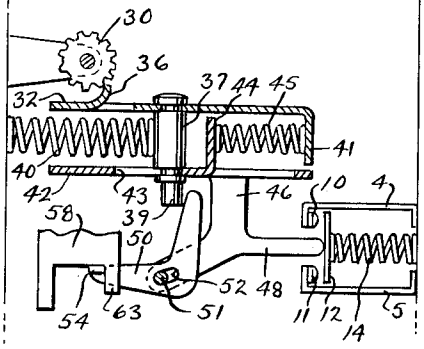


Fig. 11

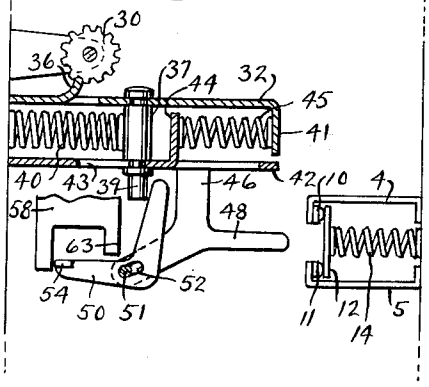
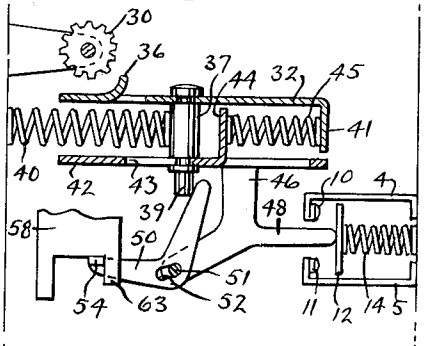


Fig. 14



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Fig. 15

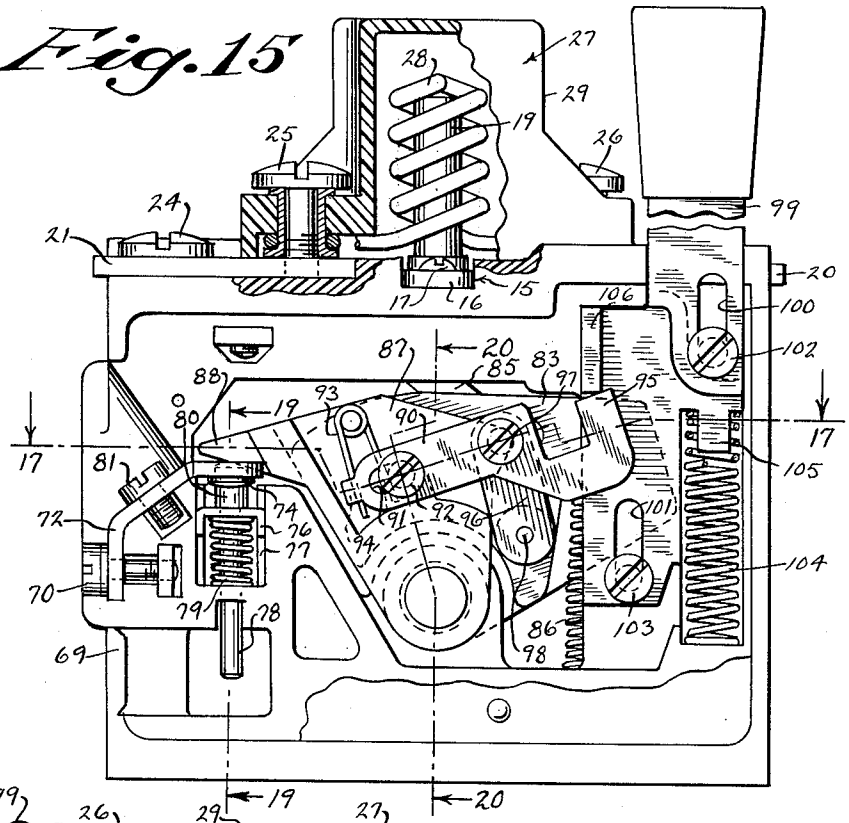
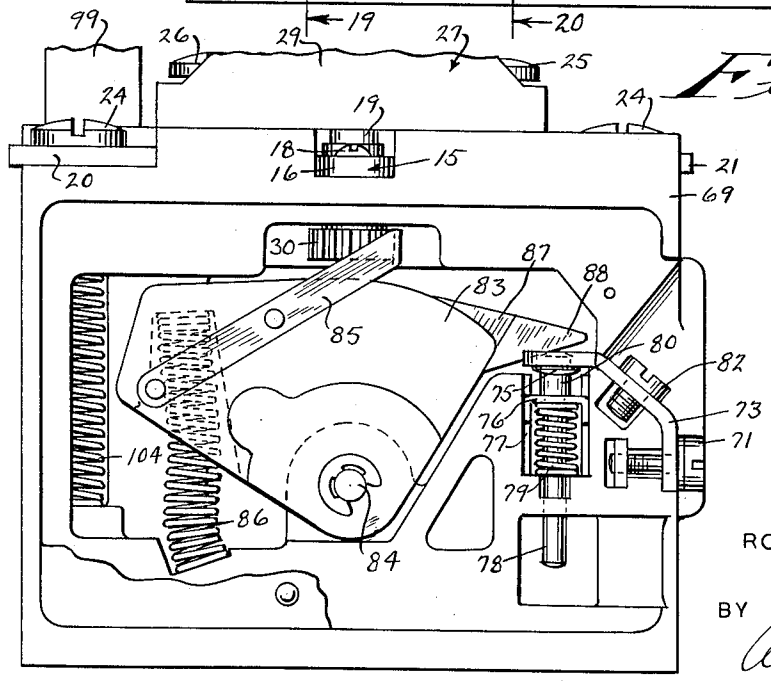


Fig. 16



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Fig. 17

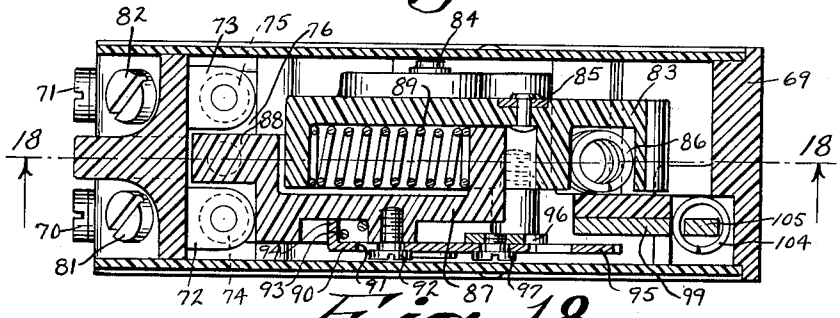


Fig. 18

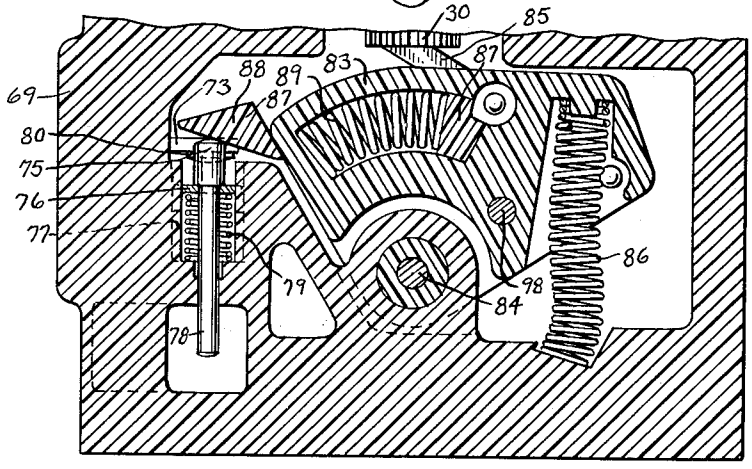


Fig. 19

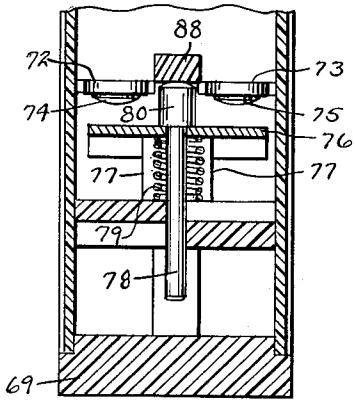
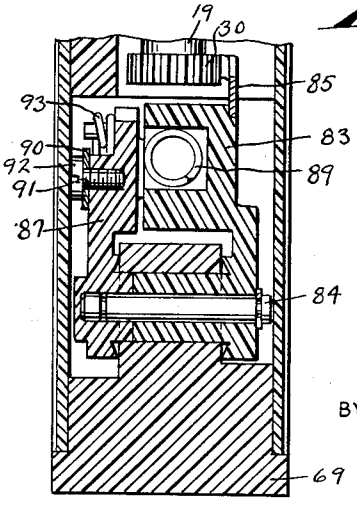


Fig. 20



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Fig. 21

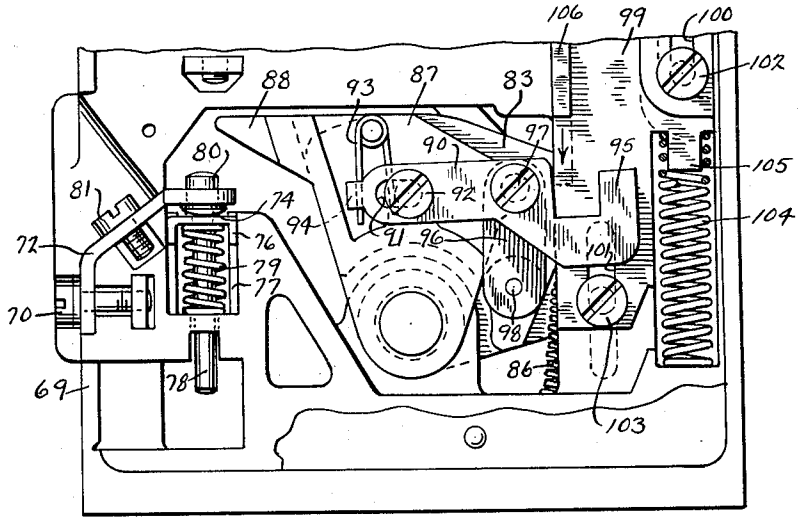
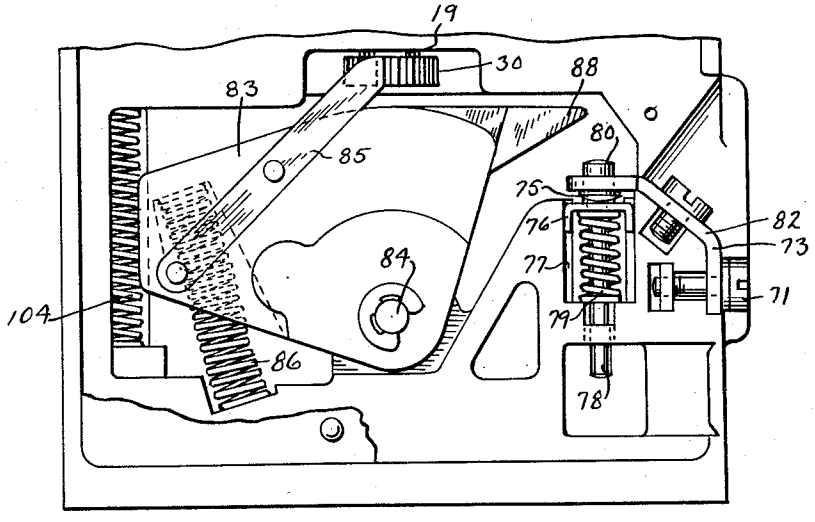


Fig. 22



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Fig. 23

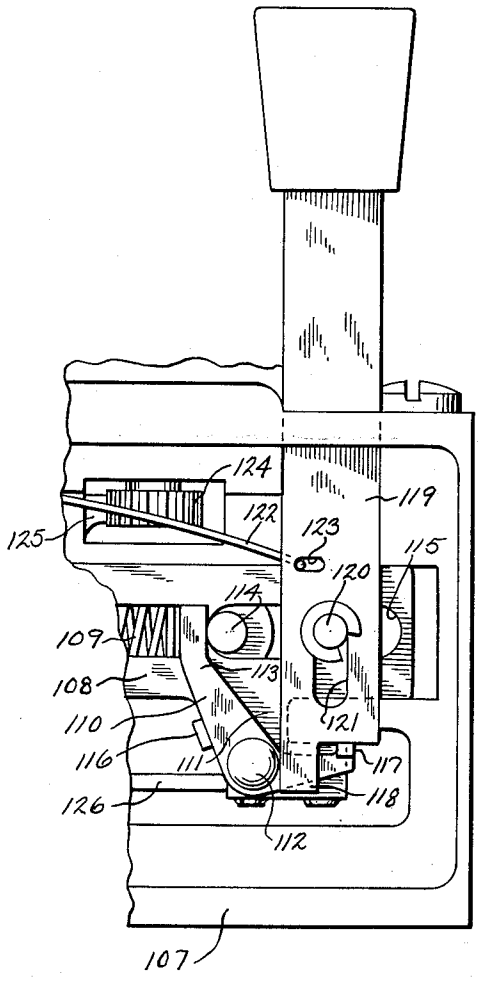


Fig. 24

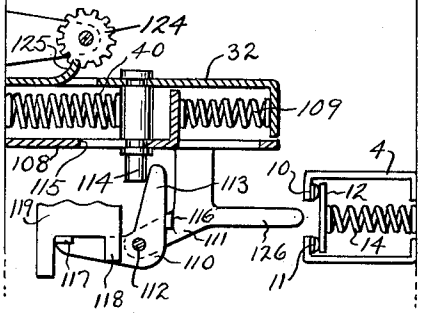


Fig. 25

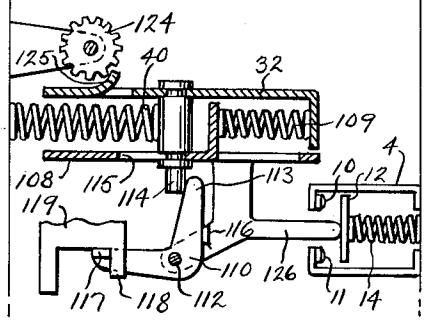
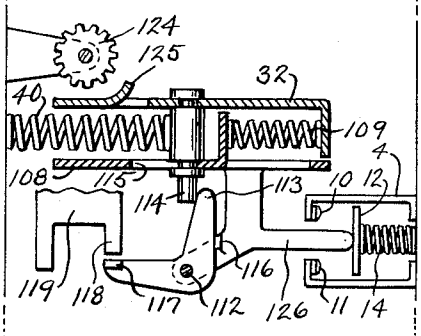


Fig. 26



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United States Patent Office 3,096,415 Patented July 2, 1963

3,096,415

RELAY

Robert E. Walters, Bayside, Wis., assignor to Allen-Bradley Company, Milwaukee, Wis., a corporation of Wisconsin

Filed May 27, 1960, Ser. No. 32,250
15 Claims. (Cl. 200—124)

The invention relates to protective relays and it more particularly resides in a relay having an actuator, adapted for operating an electrical contact or the like, which is moved in an actuating direction by a trip member upon a release of such member, there being provided a cocking mechanism, including a reset lever, that retains the actuator in its actuated position as the trip member is cocked and then permits a return of the actuator from its actuated position, the cocking mechanism being arranged so that upon the actuator being returned from its actuated position such actuator will be free to respond to the trip member regardless of the reset lever position.

A common use for protective relays is in motor control circuits having electro-magnetic line contactors. In such use the thermal element of a relay is responsive to motor load current and the relay contacts are disposed in a control circuit for the magnetic actuator of the line contactor, whereby an overload current causes a relay operation that in turn acts to open the line contactor of the motor control circuit. The present invention is particularly adapted for such use, however, relays of this invention will also be found useful in other devices employing both primary and auxiliary circuits, or in any other relay application.

It has long been considered desirable for protective relays and other protective devices such as circuit breakers to provide a trip-free action in which the contact actuator may not be restrained from opening the contacts when tripping conditions occur. In circuit breakers with manual operating levers that have both "on" and "off" positions the trip-free feature is commonly incorporated. In protective relays, such as those of this invention, where the manual reset lever does not include an "off" position for opening the contacts, but is intended only to reclose the contacts after an automatic opening, the inclusion of trip-free operation is not as readily accomplished. Also, tamper-free properties, wherein the reset lever may not act on the contact actuator and contacts unless and until tripping conditions and a subsequent tripping action have occurred, have not been commonly incorporated in commercial protective relays.

Trip-free action is important to insure against damage of expensive equipment in the presence of a continuing overload. Previous protective relays, however, have sometimes provided for a direct closing action by the reset lever upon the electrical contacts. In such constructions a machine operator can depress and hold the reset element to maintain the contacts in closed position. If this is done after a tripping action and in the presence of a continuing overload substantial damage to related machinery can readily result. Also, response to an initial overload can be defeated by permanently holding the reset lever in a depressed position.

In the present invention a trip-free operation is had in which the position of the reset lever will not restrain opening of the contacts, and in addition tamper-free properties are provided so that except upon the condition of an overload the contacts will be held in their normal position. An example of the desirability of tamper-free properties is the case where a push button control station at which an operator of a machine positions himself is located remote from the line switch and its associated protective relays. In such an arrangement manipulation of a relay reset lever should not interfere in machine operation, for then unauthorized personnel could stop the machine by simply depressing the reset lever. An important machine operation might be interrupted and costly unwarranted interference with the operation would occur. This has been entirely possible with some previous relays which have provided trip-free properties, i.e., the relay will definitely trip if overload occurs while the machine is running, through the use of a reset mechanism in which movement of the reset lever causes a corresponding opening of the relay contacts. Thus, it has heretofore been possible to accidently or intentionally circumvent the protection of starting and stopping switches by manipulation of the reset lever. Previous attempts have been made to incorporate fully tamper-free properties in a trip-free protective relay, but the devices produced have been relatively ineffective.

It is therefore an object of this invention to provide a protective relay wherein manipulation of the reset element will only act upon the switch actuating elements subsequent to occurrence of a tripping action.

It is another object of this invention to provide a protective relay wherein manipulation of the reset element can in no way prevent a tripping action when tripping conditions have occurred.

It is another object of this invention to provide a protective relay wherein, after a tripping action with its attendant movement of an actuator has occurred, such actuator will be held in its actuated position until a reset action has been completed and tripping conditions have been terminated, thereby preventing a return of the actuator in the presence of continuing tripping conditions.

It is a further object of this invention to provide a protective relay wherein the internal cocking apparatus may not be manipulated until and unless tripping conditions have occurred.

It is a further object of this invention to provide a protective relay which may be placed in an exposed location without being subject to tampering or accidental manipulation.

It is a further object of this invention to provide a protective relay readily adaptable to provide either a contact opening or a contact closing action.

It is still another object of this invention to provide a protective relay readily adaptable for response to a variety of stimuli, such as temperature, pressure and magnetic conditions.

It is a still further object of this invention to provide a protective relay which incorporates the above described properties and which operates with a simple, rugged, positive action and which is relatively inexpensive to construct and maintain.

These and other objects and advantages will appear from the description to follow. In the description, reference is made to the accompanying drawings which form a part hereof and in which there are shown by way of illustration and not of limitation specific forms in which this invention may be embodied.

In the drawings:

FIG. 1 is a front view in elevation with parts broken away and in section of a thermally responsive relay embodying the invention, the elements being shown in the positions assumed subsequent to a tripping action,

FIG. 2 is a rear view in elevation with parts broken away and in section of the relay of FIG. 1, the elements being in the positions assumed subsequent to a tripping action,

FIG. 3 is a top view with parts broken away of the relay shown in FIGS. 1 and 2,

FIG. 4 is a fragmentary view in section of the relay taken in the plane 4—4 indicated in FIG. 1,

FIG. 5 is a fragmentary view in section of the relay taken along the plane 5—5 as indicated in FIG. 1,

FIG. 6 is a view in section of the relay taken along the plane 6—6 as indicated in FIG. 1,

FIG. 7 is a front view in elevation similar to FIG. 1, with the elements being shown in the positions assumed prior to a tripping action,

FIG. 8 is a rear view in elevation similar to FIG. 2 with the elements being shown in the positions assumed prior to a tripping action,

FIG. 9 is a schematic representation of the principal operating elements of the relay of FIGS. 1–8, such elements being shown in positions assumed subsequent to a normal tripping action,

FIG. 10 is a schematic representation of the relay with the elements in the positions assumed prior to the final increment of a resetting action,

FIG. 11 is a schematic representation of the relay with the elements shown in the positions assumed upon the completion of a resetting action,

FIG. 12 is a schematic representation of the relay with the elements shown in their reset positions prior to a tripping action, and with the reset lever in depressed position,

FIG. 13 is a schematic representation of the relay with the elements shown in positions assumed during a phase of a tripping action occurring while the reset lever is depressed,

FIG. 14 is a schematic representation of the relay with the elements shown in the positions assumed upon completion of the tripping action occurring while the reset lever is depressed,

FIG. 15 is a front view in elevation with parts broken away of a second embodiment of the invention in which a rotary action is utilized for operation of the relay, the elements being shown in the positions assumed subsequent to a tripping action,

FIG. 16 is a rear view in elevation with parts broken away of the second embodiment with elements thereof in positions assumed subsequent to a tripping action,

FIG. 17 is a view in section of the second embodiment taken in the plane 17—17 as designated in FIG. 15,

FIG. 18 is a view in section of the second embodiment taken in the plane 18—18 as designated in FIG. 17,

FIG. 19 is a fragmentary view in section of the second embodiment taken in the plane 19—19 as designated in FIG. 15,

FIG. 20 is a fragmentary view in section of the second embodiment taken in the plane 20—20 as designated in FIG. 15,

FIG. 21 is a fragmentary front view in elevation with parts broken away of the second embodiment with the elements thereof being shown in the positions assumed prior to a tripping action,

FIG. 22 is a fragmentary rear view in elevation with parts broken away of the second embodiment with the elements thereof in the positions assumed prior to a tripping action,

FIG. 23 is a fragmentary front view in elevation of a relay similar to the relay of FIGS. 1–8 with the elements thereof shown in positions assumed prior to a tripping action, but with the reset lever in a depressed position,

FIG. 24 is a schematic representation of the principal operating elements of the relay of FIG. 23, such elements being in the positions assumed prior to a tripping action with the reset lever in a depressed position,

FIG. 25 is a schematic representation of the relay of FIG. 23 with the elements in positions assumed subsequent to the effective completion of a tripping action occurring while the reset lever is depressed, and

FIG. 26 is a schematic representation of the relay of FIG. 23 with the elements in positions assumed subsequent to the final increment of a tripping action, said positions being assumed after the reset lever has been raised.

Referring now to FIGS. 1 through 8 and the embodiment of the invention shown therein, the numeral 1 designates a molded case of insulating material on which the operating parts of the relay are mounted. Mounting holes 2 and 3 are provided in the case 1 and stationary contact terminals 4 and 5 are secured in place by means of mounting screws 6 and 7. The terminals 4 and 5 are provided with upwardly extending portions which threadedly receive terminal screws 8 and 9 to which control circuit leads may be attached. Terminals 4 and 5 also extend inwardly within the case 1 to present a pair of spaced stationary contacts 10 and 11 which are bridged by a movable contact 12 slidably mounted and guided by a track 13 formed as a part of the case 1. A contact bias spring 14 urges the bridging contact 12 toward a closed position with contacts 10 and 11. Although the embodiments of my invention shown in the drawings utilize normally closed contacts, it is to be understood that other contact arrangements such as normally open contacts, or multiple contacts having both normally open and closed positions may be used, or further modification replacing the contacts with some other structure, such as a valve stem, may be employed without departure from the invention.

Referring more specifically to FIGS. 2 and 3, a solder type thermal responsive unit 15 is mounted upon the top of the case 1. The thermal unit 15 includes a molded base 16 secured in place by screws 17 and 18, and a hollow heat conducting stud 19 extending from above the base to its underside. The stud 19 is restrained from rotation by a crimped connection with the base 16. On opposite sides of the thermal unit 15 are conducting busses 20 and 21 secured atop the case 1 by screws 22 and 23. The outer ends of busses 20, 21 are provided with a pair of terminal screws 24 which serve for connecting the relay into a load circuit, such as one phase of the line leading to a polyphase motor. The inner ends of busses 20, 21 are provided with threaded openings to receive terminal screws 25 and 26. Mounted by terminal screws 25 and 26, and thereby electrically bridging the gap between busses 20, 21, is a heater 27 consisting of a resistance coil 28 and a case 29 that protects the coil 28 from air currents. The coil 28 encircles the stud 19, whereby the heat transfer from the resistance coil 28 to the stud 19 is a measure of load current passing through the busses 20, 21.

The stud 19 extends downwardly within the case 1 and forms a bearing for a rotatable ratchet 30 that is normally restrained from rotation by a film of a heat fusible alloy, such as an eutectic solder, occupying the clearance between the stud 19 and the ratchet 30. Thus, when the heat generated by current flowing through coil 28 is sufficient to heat stud 19 and fuse the alloy, ratchet 30 will be free to rotate, thereby providing an indication of an overload, or excessive current in a load circuit. As in usual practice, the composition and configuration of the coil 28 may be selected to provide for the release of ratchet wheel 30 at any desired current, whereby a range of operation may be had.

Referring now more particularly to FIGS. 2, 4 and 5, case 1 is provided with a shallow, but wide track 31 in which there is slidably mounted a rectangular trip member 32 shaped from thin sheet material. A resilient metal pawl 33 is mounted on the trip member 32 by a rivet 34 and an assembly screw 35, and includes an inwardly turned ear 36, shown more particularly in FIG. 4, that is engageable with the ratchet 30. Also mounted on trip member 32, by means of the screw 35, is a sidewardly projecting pin 37 provided with a rim 38 and a projection 39 at the end remote from the trip member 32. A spring 40 is interposed between the pin 37 and a wall of the case 1 to urge trip member 32 in a direction to the right as seen in FIG. 5, movement to the right being limited by the length of the trip member track 31 and an inwardly turned trip member ear 41. When the trip member 32 is moved by the spring 40, which is to the right in FIG. 5 and to the left in FIG. 2, it is said to be in tripped position. As shown in FIGS. 2 and 4, trip mem-

ber 32 may assume the tripped position only when pawl ear 36 is disengaged from the ratchet 30. When ear 36 is in engagement with ratchet 30, trip member 32 is held against the action of the spring 40 in a position as shown in FIG. 8, which would be to the left in FIG. 5, and this position may be termed a cocked position. Hence, when the fusible alloy, normally restraining ratchet 30 from rotation, fuses in response to excessive heat from the coil 28, ratchet 30 will be free to rotate to release the pawl ear 36 and allow spring 40 to move trip member 32 to tripped position. The ratchet 30 thus functions as a releasable catch and the pawl ear 36 is a latch that is held captive by such catch until a condition for release occurs.

As seen more particularly in FIGS. 1, 5 and 6, track 31 also slidably mounts an actuator 42 that is provided with a longitudinal slot 43 through which the pin projection 39 extends. Actuator 42 is formed of thin sheet material and is provided with an inwardly turned ear 44 spaced from the rim 38 of the pin 37. A compression spring 45 is placed between the trip member ear 41 and the actuator ear 44 to urge the actuator 42 in a direction to the left as seen in FIGS. 1, 5 and 7, and the position to the left is herein termed a retracted position. The spring 45 may, however, act between the actuator 42 and the case 1. Such retracted position is assumed in FIG. 7, while the position to the right as shown in FIGS. 1 and 5 is said to be an actuated position.

Actuator 42 is also provided with a downwardly extending portion 46 which is bent at its lower end to form an inwardly turned platform 47 on which is mounted a rod 48 of complex configuration. The rod 48 has a free end 49 projecting toward the movable contact 12 and upon moving the rod 48 with the actuator 42 into actuated position the free end 49 will strike the contact 12 and carry it to open position, as seen in FIGS. 1, 2 and 6.

As is shown in FIGS. 1 and 7, a cocking lever 50 in the form of a bell crank may be mounted on the actuator portion 46 by a pin 51 passing through a slot 52 near the center of the bell crank. Cocking lever 50 is also provided at its upper end with a second slot 53 which encircles the projection 39 of the trip member pin 37. In addition, cocking lever 50 is provided with a working surface, preferably in the form of an arm 54, which projects outwardly to extend into the vertical path of a reset lever 58. Due to slot 52, cocking lever 50 is capable of some sliding motion along the pin 51, which motion is normally prevented by a spring 55 connected at one end of an inwardly turned ear 56 of the bell crank 50 and connected at its other end to the platform 47 and rod 48. The slot 52 and spring 55 may serve as one possible means to insure a fully trip-free action as will be hereinafter described.

The reset lever 58 is free to move vertically in complementary recesses of case 1 and is held captive by a pin 59 that extends through a slot 60 in the lever 58. Lever 58 is further guided by having a lower projection 61 fit snugly within a slide 62 formed in case 1. The upper end of the reset lever 58 extends above the case 1 to present a manually engageable cap 57, and the lower end of lever 58 has a downwardly extending operating portion, preferably in the form of a finger 63 parallel to and spaced inwardly from the projection 61, so as to present a bifurcated lower end. The finger 63 is positioned to engage the cocking lever arm 54 when the cocking lever 50 is in the position shown in FIG. 1. Otherwise, the finger 63 will slide by arm 54 upon depression of reset lever 58. A grasshopper spring 64, centered on a pin 65 mounted on case 1, has one end anchored against a pin 66 that is mounted on case 1 and passes through a slot 67 of actuator 42. The other end of spring 64 engages in an opening 68 of reset lever 58 to urge the reset lever 58 in an upward direction.

The operation of the embodiment of the invention shown in FIGS. 1 through 8 may now be explained by reference to FIGS. 9 through 14 wherein the elements schematically represented are designated by reference numerals corresponding to the numerals used for like parts in the description of FIGS. 1 through 8.

Referring first to FIG. 11, the elements of the relay are shown in the positions normally assumed prior to a tripping action, or subsequent to the completion of a reset action. That is, pawl ear 36 is in engagement with ratchet 30, thereby holding trip member 32 against spring 40 and in a cocked position. Spring 45 has moved actuator 42 into its retracted position, thereby bringing the forward end of slot 43 into engagement with pin 37 and moving actuator rod 48 out of engagement with bridging contact 12. Hence, spring 14 has moved bridging contact 12 into closed position so that a circuit may be completed through the relay. Also, cocking lever 50, with its working arm 54, has been carried by actuator 42 to a corresponding retracted position where working arm 54 is out of the path of travel, and therefore not engageable by reset finger 63. Thus, the circuit to be protected by the relay is allowed to be normally activated and manipulation of the reset lever may in no way affect the normally closed contact position.

Referring now to FIG. 9, the elements of the relay are shown in the positions normally assumed immediately after a tripping action. Thus, the presence of excessive heat has freed ratchet 30 so that the pawl ear 36 is no longer restrained. Trip member 32 has therefore been moved by spring 40 into its tripped position, and its pin 37 has engaged actuator 42 at the forward end of slot 43 to carry the actuator into its actuated position. The rod 48 has consequently engaged bridging contact 12 to open the same and interrupt the circuit in which the contacts are connected. The movement of the actuator 42 has also carried the cocking lever 50 to a position wherein its working arm 54 is directly beneath the reset finger 63.

With the elements in the tripped position of FIG. 9 resetting can readily be accomplished by depressing reset lever 58 to cause the finger 63, through the arm 54, to rotate the cocking lever 50 counterclockwise as viewed in FIGS. 9–14. In FIG. 10 the elements are shown in the positions assumed upon fully depressing reset finger 63, this being immediately prior to the completion of the reset action. Reset finger 63 has moved downwardly against the working arm 54 to pivot cocking lever 50 about pin 51 whereby the upper leg of cocking lever 50 has forced pin 37, and hence trip member 32, to the left as seen in FIG. 10. This is the cocked position for trip member 32 and the pawl ear 36 has engaged with the ratchet 30, so that the member 32 will remain in cocked position if the ratchet 30 has become fixed by solidification of the solder. A resultant force of the pivot motion of the cocking lever 50 causes the lever 50 to work against the pin 51 so as to hold the actuator 42 in its actuated position during the initial resetting action. The spring 45 is compressed by the motion of trip member 32 relative to the actuator 42 and is thereby prepared to urge the actuator 42 toward retracted position upon release of the reset finger 63. The actuator rod 48 is therefore held in engagement with bridging contact 12 to maintain an open contact position. The circuit in which the relay contacts have been inserted is thus maintained in an interrupted condition throughout the resetting of the trip member, thereby preventing reestablishment of a control circuit which would cause damage to related equipment in the presence of a continuing overload condition.

When the reset finger 63 is released from the position shown in FIG. 10, the parts will assume a position dependent upon the condition of ratchet 30. If an overload still persists and the fusible alloy is in a melt the ratchet 30 will rotate upon release of the reset lever and the parts will resume the positions shown in FIG. 9 in response to the bias of the spring 40. If, however, an overload is no longer presented and the fusible alloy has

cooled, ratchet 30 then being prevented from rotation, pawl ear 36 will be engaged and held so that the parts will assume the positions shown in FIG. 11, wherein spring 45 has returned the actuator to its retracted position, the cocking lever 50 has pivoted to its normal position, and rod 48 has retreated from the bridging contact 12 to have a normally closed condition.

In FIGS. 12–14, the operation of the slot 52 and the spring 55, constituting one possible means of providing for a trip-free action, is shown schematically. In FIG. 12, the operating parts of the relay are shown in the positions of FIG. 11 with the exception that the reset finger 63 has been depressed. This represents a condition that would occur if someone were tampering with the reset lever. If an overload should now occur, the operating parts will move into the positions shown in FIG. 13. In FIG. 13, bridging contact 12 has been partially opened by actuator rod 48, and working arm 54 has come into engagement with the side of the reset finger 63 and the cocking lever 50 is in its normal position relative to actuator 42, that is, the slot 52 in cocking lever 50 is to the right with respect to pivot pin 51, spring 55 normally holding the lever 50 in this position. The position of FIG. 13 is merely transitory and the operating parts move immediately to the position shown in FIG. 14, wherein the contacts are fully opened. The actuator 42 has moved into its full actuated position while the cocking lever 50 has been held back by the engagement against the side of the reset finger 63, the slot 52 in the cocking lever 50 permitting this relative displacement. The apparatus may then be readily reset by raising the reset finger 63 to bring it into engagement with the top side of the working arm 54. It can be seen that the slot 52 and the spring 55 are provided to allow for a complete tripping action while the reset lever is maintained in a depressed position.

The slot 52 and the spring 55 constitute a preferred means to provide for effective tripping of the relay when the reset lever 58 is in a depressed position, and are further described in the copending application of Gerd C. Boysen, Serial Number 32,372, wherein the advantages of such a structure are more fully discussed. It is entirely feasible, however, to provide a fully trip-free relay without incorporating such a structure, and a relay without means comparable to slot 52 and spring 55 is shown in FIGS. 23–26. In FIG. 23, there is shown an insulating case 107 which slidably mounts an actuator 108, comparable to the actuator 42, which is biased toward the right, or toward a retracted position, by a spring 109. A cocking lever 110 is pivotally mounted on a downwardly extending portion 111 of the actuator 108 by a pin 112. The cocking lever 110 is substantially incapable of longitudinal movement relative to the actuator 108. The upper leg 113 of the cocking lever 110 is engageable with a pin 114 extending through a slot 115 in the actuator 108 and which is mounted on a trip member (not shown) comparable to the trip member 32. An ear 116 projecting from the actuator portion 111 serves to limit motion of the cocking lever 110 in a counterclockwise direction. The cocking lever 110 carries a working arm 117 which is engageable with a reset finger 118 which projects downwardly from a reset lever 119. The reset lever 119 is mounted on and vertically reciprocable with respect to the case 107 by means of a pin 120 which passes through a slot 121 in the reset lever 119. A grasshopper spring 122, engaged in an opening 123 in the lever 119 and mounted at its other end on the case 107, serves to urge the reset lever 119 upwardly. A ratchet 124 serves as a releasable catch in the manner hereinabove described in connection with the relay of FIGS. 1–8, and is engageable by a pawl 125 mounted on the trip member (not shown). A rod 126 extends from the actuator 108 and serves to actuate the relay contacts (not shown).

The normal operation of the relay of FIG. 23 is substantially identical to that of the relay of FIGS. 1–8 as described and shown in FIGS. 9–11. The tripping operation of the relay of FIG. 23 when the reset lever 119 has been previously depressed, however, is shown schematically in FIGS. 24–26, wherein the principal operating elements, insofar as possible, bear reference characters corresponding to those in FIG. 23. However, since the trip member, trip member spring, stationary contacts, movable contact, and movable contact spring are not shown in the relay of FIG. 23, and since these elements are, in the relay of FIG. 23, substantially identical to the trip member 32, trip member spring 40, stationary contacts 10 and 11, movable contact 12, and movable contact spring 14 of the relay of FIGS. 1–8, these elements have been assigned reference characters, respectively, corresponding to those assigned their counterparts in the relay of FIGS. 1–8.

Referring first to FIG. 24, the various elements, with the exception of the reset lever 119, are in their normal reset position. That is, the pawl 125 is engaged with the ratchet 124 to hold the trip member 32 in cocked position against the spring 40. Spring 109 has moved the actuator 108 to a retracted position, the right hand edge of the slot 115 being thus brought into contact with the pin 114 and the rod 126 being moved back from the movable contact 12 to allow the spring 14 to move the movable contact 12 to closed position with the stationary contacts 10 and 11. Cocking lever 110, with arm 117, has been moved to a position corresponding to the retracted position of the actuator 108, wherein the arm 117 is not engageable with the finger 118. The reset lever 119 has, however, been depressed wherein the finger 118 is in a position to block movement of the arm 117, and hence the actuator 108, toward actuated position.

In FIG. 25, a tripping condition has occurred. Thus, the alloy has fused to allow the ratchet 124 to rotate to free the pawl 125, thereby allowing the spring 40 to move the trip member 32 toward tripped position, this motion causing pin 114, through its engagement with the right hand edge of slot 115, to move the actuator 108 toward actuated position. The cocking lever 110 is moved with the actuator 108, the motion of both elements being limited by the engagement of the arm 117 with the side of the finger 118, thus causing the travel of the actuator 108 to be abbreviated. The relay of FIG. 23 is designed, however, so that the abbreviated travel of the actuator 108 causes the rod 126 to be moved far enough to engage and move back the movable contact 12 to a point where the circuit between the contacts 10 and 11 is fully opened. In other words, in FIG. 25 the actuator 108 has effectively completed its movement to actuated position and the relay has tripped regardless of the depressed position of the reset lever 119.

In FIG. 26, the elements are shown in the positions assumed after the finger 118 has been lifted from its blocking engagement with the arm 117, these positions corresponding to those assumed subsequent to a normal tripping action without interference by the reset finger 118. In other words, the actuator 108, with its associated elements, has been moved to the normal limit of its travel, this final increment of motion serving to bring the arm 117 to a position under the finger 118 wherein the relay may be reset as in FIGS. 9–11, this motion incidentally serving to cause further opening of the contacts.

In essence, the relay of FIG. 23 is designed with sufficient actuator travel so that the contacts will be fully opened regardless of a blocking engagement between the arm 117 and finger 118, thus making it unnecessary to provide means comparable to the slot 52 and spring 55 of the relay of FIGS. 1–8.

Referring now to FIGS. 15–22, there is shown therein a second embodiment of the invention utilizing a rotary motion. Referring first more particularly to FIGS. 15–20, wherein the operating parts of this embodiment are shown in a tripped position, the numeral 69 designates an

insulating case comparable to case 1. Mounted on the case 69 by screws 70 and 71 are terminals 72 and 73 having stationary contacts 74 and 75. Stationary contacts 74 and 75 are bridged by a movable contact 76 slidably mounted in an opening 77 of case 69 and guided in its movement by a pin 78 slidably received in case 69. Bridging contact 76 is urged towards closed position by a spring 79 disposed about pin 78 and seated at one end against a wall of the case 69. As seen more particularly in FIG. 19, pin 78 passes through bridging contact 76 and is provided with a relatively larger head 80 engageable with the upper surface of bridging contact 76. Thus, a downward force exerted on head 80 will cause an opening movement of the bridging contact 76. Terminals 72 and 73 are provided with terminal screws 81 and 82 thereby providing means for incorporating the device into any desired circuit.

Passing through the top of case 69 is a spindle assembly 15, like that more particularly described in connection with the embodiment of the invention shown in FIGS. 1–8, that mounts a ratchet 30.

Referring now to FIGS. 15 and 16, *a* trip member 83 is pivotally mounted on a pin 84 provided in case 69. Pawl 85 is mounted on trip member 83 and engageable with ratchet 30. Spring 86 seated at one end against case 69 urges trip member 83 in a clockwise, or tripping, direction, as seen in FIG. 16, about pivot pin 84, such motion normally being prevented by the engagement of pawl 85 with ratchet 30.

As seen in FIGS. 15 and 21, a molded actuator 87 of roughly triangular configuration is also mounted on the pivot pin 84 and is provided with a laterally spaced working projection 88 engageable with the trip member 83 and the pin projection 80. As shown more clearly in FIG. 18, a compression spring 89, acting between the trip member 83 and the actuator 87 serves to urge the actuator 87 in a clockwise direction relative to the trip member 83. As in the embodiment of FIGS. 1–8, it will be understood that it is not necessary to have the spring 89 work between the trip member 83 and the actuator 87, it merely being necessary to provide means to urge the actuator in a clockwise direction, such movement resulting in a retracted position.

Referring now to FIGS. 15 and 21, a primary cocking lever 90, formed from sheet metal, is provided with a slot 91 through which it is pivotally mounted by an assembly pin 92 to the actuator 87. A coil spring 93, mounted on the actuator 87 and operating between the pin 92 and an inwardly turned ear 94 of the primary cocking lever 90, serves to normally maintain the pin 92 in engagement with the right hand end of the slot 91 as seen in FIGS. 15 and 21. The primary cocking lever 90 is further provided with a generally U-shaped extension terminating in working arm 95. A secondary cocking lever 96, also of sheet metal construction, is pivotally connected at one end by an assembly screw 97 to the primary cocking lever 90 and at the other end by a pin 98 to the trip member 83.

A stamped sheet metal reset lever 99 is provided with two slots 100 and 101 through which it is slidably mounted by pins 102 and 103 to the case 69, the extent of its vertical motion being limited thereby. A compression spring 104, seated on the case 69 and a projection 105 of the reset lever 99 and operating therebetween, serves to urge the reset lever 99 in an upward direction. A reset finger 106 is mounted on the reset lever 99 and is carried in a vertical direction upon movement thereof.

In the operation of this embodiment of the invention, the operating elements therein normally occupy the positions shown in FIGS. 21 and 22 wherein the trip member 83 is held against the spring 86 by the engagement of the pawl 85 with the ratchet 30, this being known as a cocked position. The spring 89 has moved the actuator 87 in a clockwise direction as seen in FIG. 21 to a retracted position thereby holding the actuator working projection 88 away from the pin projection 80. Thus, the bridging contact spring 79 has ben freed to move the bridging contact 76 into engagement with the stationary contacts 74 and 75 thereby completing a circuit therebetween. In addition, the primary cocking lever 90 and the working arm 95 are in the positions shown in FIG. 21 wherein the working arm 95 is not engageable by the reset finger 106.

Referring now to FIGS. 15–20, when an overload has occurred sufficient to fuse the alloy and release the ratchet 30, thereby releasing the pawl 85, the spring 86 causes the trip member 83 to rotate in a clockwise direction, as seen in FIG. 16, about the pivot pin 84 to a tripped position. In this motion the trip member 83 engages the actuator working projection 88 causing the actuator 87 to rotate in a counterclockwise direction as seen in FIG. 15 to an actuated position. As the actuator 87 is carried in its movement to actuated position, the working projection 88 comes into engagement with the pin projection 80 and forces it downwardly thereby causing the bridging contact 76 to be moved against the spring 79 and open the circuit between the contacts 74 and 75. The working arm 95, with the primary cocking lever 90 and the secondary cocking lever 96, is carried in a counterclockwise direction as seen in FIG. 15 by the movement of the actuator 87 to a position wherein it is engageable by the reset finger 106. When the reset lever 99 is then moved downwardly, the reset finger 106 engages the working arm 95 thereby causing the primary cocking lever 90 to pivot in a clockwise direction, as seen in FIG. 15, about the pin 92. The frictional engagement of the finger 106 with the working arm 95, operating through the primary cocking lever 90 against the pin 92 causes the actuator 87 to be held in actuated position, while the force exerted on the pin 97, operating through the secondary cocking lever 96 on the pin 98, operates to pivot the trip member 83 in a counterclockwise direction as seen in FIGS. 16 and 22, thereby returning the pawl 85 to an engageable position relative to the ratchet 30. The spring 89 is compressed by the relative motion between the actuator 87 and the trip member 83. When the reset lever 99 is then released, the elements will assume positions dependent on the condition of the ratchet 30. If the fusible alloy has cooled, indicating that the overload is no longer present, the trip member 83 will be held in cocked position by the pawl 85, and the spring 89 will return the actuator 87 to a retracted position thereby releasing the bridging contact 76 to be moved to its closed position. Simultaneously, the working arm 95 will be carried to a position wherein it may not be engaged by the reset finger 106. If, however, the ratchet wheel 30 remains rotatable, the elements will again assume the positions of FIGS. 15–20.

If the reset finger 106 should have been previously moved into a working position by depression of the reset lever 99, a tripping action will cause the inner edge of the working arm 95 to engage the finger 106, thus somewhat shortening the path of movement of the primary cocking lever 90. However, the yielding mounting of the primary cocking lever 90 on the actuator 87, due to the slot 91 and the spring 93, permits the actuator 87 to complete its movement to actuated position regardless of the blocking engagement. It may again be seen, however, that the necessity for the yielding mounting may be avoided by providing an effective range of movement for the actuator 87 whereby blocking of the cocking means could shorten the travel of the actuator but wherein such a shortened travel would still serve to effectively open the contacts.

Although the drawings of this embodiment of the invention show the use of primary and secondary cocking levers, it will be readily seen that minor positional changes would permit the use of a single cocking lever engageable with the trip member 83 at a point intermediate its ends.

It will also be readily understood that the laterally extending cocking lever working abutment and reset

finger configuration of the first embodiment herein and spaced reset arm and reset finger configuration of the second embodiment herein are interchangeable. A relay containing this invention may also be easily designed to react to electrical conditions other than overloads as in those cases where it is desired to initiate some action upon detection of a lack of current flow, or could be further designed to react to chemical or mechanical conditions rather than electrical conditions. In addition, it is not necessary that such a relay employ a contact actuating member, and a valve stem or other type of actuator may be provided. In essence it is necessary only that such a relay be provided with a device capable of detecting the presence of predetermined tripping conditions and an actuator, the actuation of which will produce a desired result.

The relay of this invention has a trip-free action wherein the contacts will open upon occurrence of a tripping action regardless of reset lever position. In addition, manipulation of the reset lever will not influence contact position when the contacts are closed and there is no tripping condition. The reset lever therefore has the principal function of resetting and cocking the mechanism only after tripping has taken place. Another feature is that during resetting the contacts are held open until the reset lever is released. Then, if an overload condition has persisted the contacts will remain open, or be immediately reopened, when the reset lever is released so as to allow the tripping member to function. The invention presents a trip-free relay in the broadest sense and makes possible the most advantageous overload relay protection.

While there have been three embodiments of a trip-free and tamper-free relay of improved construction shown and described herein, it is to be understood that this invention is not to be limited to any particular form or arrangement of parts except insofar as such limitations are included in the following claims.

I claim:

1. In a relay the combination comprising: an actuator movable between a retracted position and an actuated position; trip means to move said actuator toward actuated position, said trip means being capable of being returned to a cocked position; bias means urging said actuator toward said retracted position; cocking means movable in response to the movement of said actuator and engageable with said trip means and having a working surface thereon; and a reset lever having an operating portion operatively engageable with said working surface only when the cocking means has been moved in response to said actuator to a position corresponding to said actuated position of said actuator, said cocking means being operatively associated with said trip means and actuator such that upon engagement of said working surface by said reset lever said cocking means serves to move said trip means toward said cocked position while holding said actuator in said actuated position.

2. In a relay the combination comprising: a trip member movable between cocked and tripped positions and having a driving portion thereon; means to move said trip member toward tripped position; an actuator movable between a retracted position and an actuated position which is engageable by said driving portion of said trip member to be carried therewith upon said trip member being moved toward its tripped position, said actuator thereby being moved toward its actuated position; bias means urging said actuator toward said retracted position; cocking means have a working surface thereon which is carried by said actuating member and engageable with said trip member; and a reset lever substantially independent of said actuator and trip member and having an operating portion operatively engageable with said working surface only when said working surface has been carried by said actuator to a position corresponding to said actuated position of said actuator.

3. In a relay the combination comprising: a releasable catch, a trip member movable between cocked and tripped positions and having a driving portion thereon; latch means mounted on said trip member and engageable with said catch to hold said trip member in cocked position; bias means to urge said trip member toward tripped position; an actuator movable between retracted and actuated positions and engageable with said driving portion to be carried thereby in the movement of said trip member toward tripped position, said actuator thereby being moved to its actuated position; bias means to urge said actuator toward retracted position; cocking means carried by said actuator and engageable with said trip member and having a working surface thereon, and a movable reset lever having an operating portion engageable with said working surface when the actuator has moved to its actuated position.

4. In a relay the combination comprising: a releasable catch; a trip member having a latch engageable with said catch for holding the trip member in cocked position, said trip member being movable between said cocked position and a tripped position, and having a driving element thereon; bias means urging said trip member toward tripped position; an actuator having a retracted position and an actuated position and engageable by said driving element to be carried with said trip member when moved toward said tripped position and thereby moved to said actuated position; resilient means urging said actuator toward said retracted position; cocking means carried by said actuator and movable in response to the movement of said actuator and engageable with said trip member and having a working surface thereon; and a reset lever having an operating portion adapted to be depressed and to strike said working surface when said working surface has been moved in response to the movement of said actuator to said actuated position, which operating portion upon being depressed to strike said working surface causes the cocking means to return the trip member toward cocked position and retain the actuator in actuated position.

5. In a relay the combination comprising: an actuator movable between actuated and retracted positions; resettable trip means for moving the actuator to said actuated position; a reset lever having an operating portion movable in a line of thrust; and cocking means cooperatively associated with said actuator and trip means which has a surface thereon relatively movable with respect to said line of thrust, which surface is brought into said line of thrust upon said actuator moving to its actuated position; whereby movement of said operating portion in its line of thrust against said surface causes said cocking means to reset said trip means while retaining the actuator in actuated position.

6. In a relay the combination comprising: a trip member movable between cocked and tripped positions having a driving portion thereon; means to move said trip member toward tripped position; an actuator movable between a retracted position and an actuated position which is engageable by said driving portion of said trip member to be carried therewith upon said trip member being moved toward its tripped position, said actuator thereby being moved toward its actuated position; bias means urging said actuator toward said retracted position; cocking lever means carried by said actuating member and engageable with said trip member and having a working arm thereon; and a reset finger having a working stroke in which it is engageable with said working arm when said arm has been carried to a position corresponding to the actuated position of said actuating member, said reset finger being located to allow effective motion of said actuator to actuated position before the reset finger and arm may strike one another, the engagement of said finger against said arm during a working stroke causing said cocking lever means to return said trip member to-

ward cocked position while retaining said actuator in actuated position.

7. In a relay the combination comprising: a trip member movable between cocked and tripped positions; means to move said trip member toward tripped position; an actuator movable between a retracted position and an actuated position which is engageable by said trip member to be carried therewith upon said trip member being moved toward its tripped position, said actuating member thereby being moved toward its actuated position; bias means urging said actuator toward said retracted position; a movable reset finger; and cocking lever means carried by said actuator and engageable with said trip member and having a working arm engageable with said reset finger whereby upon such engagement movement of said reset finger will cause said cocking lever to move said trip member toward cocked position while retaining said actuator in actuated position, said working arm being blockingly engageable with said reset finger at a point in the path of movement of said actuator and cocking lever means toward actuated position after said actuator has effectively completed said movement.

8. In a relay the combination comprising: a trip member movable between cocked and tripped positions having a driving portion thereon; means to move said trip member toward tripped position; an actuator movable between a retracted position and an actuated position which is engageable by said driving portion of said trip member to be carried therewith upon said trip member being moved toward its tripped position, said actuator thereby being moved toward its actuated position; bias means urging said actuating member toward said retracted position; cocking means carried by said actuating member and engageable with said trip member and having a working arm thereon; and a reset finger movable into engagement with said working arm when said arm has been carried to a position corresponding to the actuated position of said actuator, the engagement of said finger against said working arm causing said cocking lever means to move said trip member toward cocked position while retaining said actuator in actuated position, said actuator being freed to move toward its retracted position when said reset finger is disengaged from said working arm.

9. In a relay the combination comprising: a stationary contact; a movable contact; a contact actuator biased toward a retracted position and movable therefrom to a contact actuating position; tripping means adapted to move said actuator toward its actuating position and to be reset; cocking lever means movable with said actuator and having a working arm with a path of travel corresponding to the movement with said actuator; and a reciprocable reset finger depressable to engage said working arm when said working arm is in a position corresponding to the actuating position of said actuator and to by-pass said working arm with a clearance therebetween when said working arm has moved in its path of travel to a position corresponding to the retracted position of said actuator, said reset finger upon engagement with said working arm causing said cocking lever means to reset said tripping means while holding said actuator in said actuating position.

10. In a relay the combination comprising: an actuator biased toward a retracted position and movable therefrom to an actuated position; tripping means adapted to move said actuator toward its actuated position and to be reset; cocking lever means movable with said actuator and having a working arm with a path of travel corresponding to the movement with said actuator; and a reciprocable reset finger depressable to engage said working arm when said working arm is in a position corresponding to the actuated position of said actuator and to by-pass said working surface with a clearance therebetween when said working arm has moved in its path of travel to a position corresponding to the retracted position of said actuator, said clearance being sufficient to allow effectively complete motion of said working arm and actuator to actuated position, said reset finger upon engagement with said working arm causing said cocking lever means to reset said tripping means while holding said actuator in said actuated position.

11. In a relay having a base, a stationary contact, and a movable contact, the combination with: a releasable catch; a trip member pivotally mounted on said base and pivotable between cocked and tripped positions, being biased toward said tripped position, and having latch means thereon engageable with said catch to hold said trip member in cocked position; an actuator pivotally mounted on said base and pivotable between retracted and actuated positions, being biased toward said retracted position, said actuator being engageable by said trip member to be carried therewith upon movement of said trip member toward tripped position said actuator being carried thereby to actuated position, said actuator also being engageable with said movable contact to actuate same; cocking lever means pivotally mounted on and carried by said actuator and having a working arm thereon, said cocking lever means being engageable with said trip member; and a reset finger adapted to be depressed to engage said working arm when said working arm has been carried by said actuator to a position corresponding to the actuated position of said actuator said reset finger upon said engagement causing said cocking lever means to retain said actuator in actuated position while pivoting said trip member toward said cocked position.

12. In a relay having a base, a stationary contact, and a movable contact, the combination with: a releasable catch; a trip member pivotally mounted on said base and pivotable between cocked and tripped positions, being biased toward said tripped position, and having latch means thereon engageable with said catch to hold said trip member in cocked position; an actuator pivotally mounted on said base and pivotable between retracted and actuated positions, being biased toward said retracted position, said actuator being engageable by said trip member to be carried therewith upon movement of said trip member toward tripped position said actuator being carried thereby to actuated position, said actuator also being engageable with said movable contact to actuate same; a primary cocking lever pivotally mounted on and carried by said actuator and having a working arm thereon; a secondary cocking lever pivotally mounted on said primary cocking lever and engageable with said trip member; and a reset finger adapted to be depressed to engage said working arm when said working arm has been carried by said actuator to a position corresponding to the actuated position of said actuator said reset finger upon said engagement causing said primary cocking lever to retain said actuator in actuated position while causing said secondary cocking lever to pivot said trip member toward said cocked position.

13. In a relay having a base, a stationary contact, and a movable contact, the combination with: a releasable catch; a trip member slidably mounted on said base and slidable between cocked and tripped positions, being biased toward said tripped position, and having latch means thereon engageable with said catch to hold said trip member in cocked position; an actuator slidably mounted on said base and slidable between retracted and actuated positions, being biased toward said retracted position, said actuator being engageable by said trip member to be carried therewith upon movement of said trip member toward tripped position said actuator being carried thereby to actuated position, said actuator also being engageable with said movable contact to actuate same; a cocking lever pivotally mounted on and carried by said actuator and having a working arm thereon, said cocking lever being engageable with said trip member; and a reset finger adapted to be depressed to engage said working arm when said working arm has been carried by said ac-

tuator to a position corresponding to the actuated position of said actuator said reset finger upon said engagement causing said cocking lever to retain said actuator in actuated position while sliding said trip member toward said cocked position.

14. In a relay having a tripping mechanism movable from cocked to tripped position and including a trip member and a contact actuator, the combination with: cocking means carried by said tripping mechanism and having a working arm thereon, said working arm having thereby a path of motion from cocked to tripped positions; and a reset finger movable to engage said working arm and thereby actuate said cocking means, said reset finger being operatively engageable with said working arm only at a point in the path of motion of said working arm after said tripping mechanism has effetcively completed its tripping motion, said cocking means upon being actuated serving to move said trip member to a position corresponding to said cocked position of said tripping mechanism while holding said actuator in a position corresponding to said tripped position of said tripping mechanism.

15. In a relay having a trip member movable between tripped and cocked positions and an actuator movable between retracted and actuated positions, said trip member and actuator being operatively associated such that said actuator will be carried to actuated position in response to the movement of said trip member to tripped position, the combination with a cocking lever pivotally mounted on said actuator and having a working arm and a point of engagement with said trip member, said working arm and said point of engagement being spaced apart and remote from the point of said pivotal mounting whereby force exerted on said working arm will cause said cocking lever to retain said actuator in actuated position while moving said trip member toward cocked position; and a reset lever having an operating portion operatively engageable with said working arm only when said actuator has moved to said actuated position.

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