Aug. 20, 1946. G. H. SYROVY 2,406,265

SHOCK-PROOFING MECHANISM

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Fig. 1.

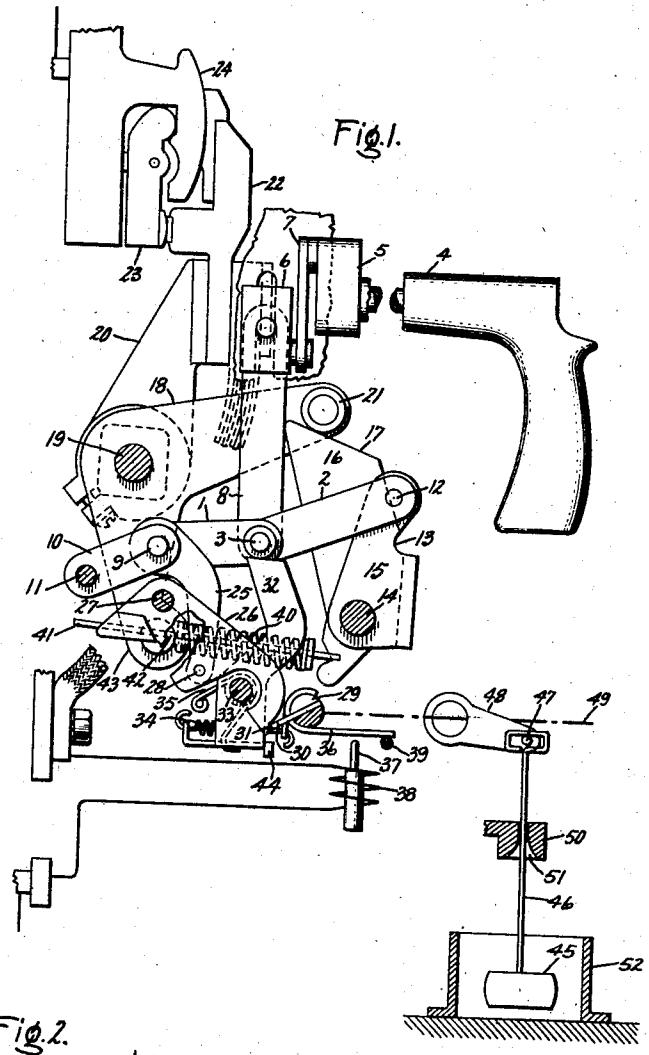
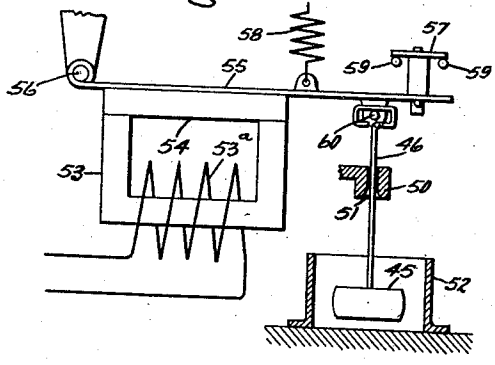


Fig. 2.



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SHOCKPROOFING MECHANISM

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9 Claims. (Cl. 175—336)

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My invention relates to improvements in shock-proofing mechanisms and more particularly to mechanisms for preventing the false operation of devices such as circuit breakers, relays and the like in consequence of shocks without interfering with the intended operation of the devices materially longer than the duration of the shock.

Devices, such as circuit breakers, relays and the like, which are intended to function under abnormal conditions of an electric circuit are liable to operate falsely under shock conditions. On board warcraft, especially in time of battle, such shock-produced false operations could prove extremely crucial by effecting the deenergization of motors and other apparatus so critically needed in operation. In order to prevent such false operations, various arrangements have been proposed and many actually used. Most of these arrangements interfere with or actually prevent the intended fault responsive operation of the devices since they leave the devices indefinitely locked against operation. Other arrangements which do not materially interfere with the intended operation of the devices are either too dependent on the human element or else too complicated to apply to existing circuit breaker and relay structures.

An object of my invention is to provide for devices such as circuit breakers, relays and the like an improved shock-proofing mechanism which prevents false operation of the devices under shock conditions without materially interfering with the intended operation of the devices. Another object of my invention is to provide a shock-proofing mechanism which operates automatically on the occurrence of shock conditions to prevent false operation of the device to which it is applied. A further object of my invention is to provide an automatic shock-proofing mechanism which has a relatively simple structure readily applicable to existing circuit breaker and relay structures. These and other objects of my invention will appear in more detail hereinafter.

In accordance with my invention, I provide for circuit breakers, relays and the like a shock-proofing mechanism which comprises a resiliently pendulously supported weight which is arranged normally readily to partake of the movement of a critical shock-susceptible member of the device but is restrained against such movement during shock conditions in consequence of the deflection of the operating means. Also in accordance with my invention, I provide a shock-proofing mechanism which is readily applicable

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to existing circuit breaker and relay structures.

My invention will be better understood from the folloiwng description when considered in connection with the accompanying sheet of drawings, and its scope will be pointed out in the appended claims.

In the accompanying sheet of drawings, Fig. 1 illustrates a shock-proofing mechanism embodying my invention as applied to a trip-free air circuit breaker, and Fig. 2 illustrates an embodiment of my invention as applied to an electromagnetically actuated device.

In Fig. 1, I have illustrated an embodiment of my invention as applied to an automatic trip-free circuit breaker mechanism such as disclosed in United States Letters Patent 2,152,453, issued March 28, 1939. As shown, this mechanism comprises a main operating toggle consisting of links 1 and 2 pivotally joined at 3. This toggle is arranged to be actuated by a rotatably mounted handle 4, the rotation of which turns a crank 5 to move a reciprocably guided crosshead 6. This is connected to the crank pin of the crank 5 by a link 7 and to the toggle joint pin 3 by a link 8. The toggle link 1 is pivotally connected by a pin 9 to a link 10 mounted on a stationary pivot 11. The toggle link 2 is pivotally connected by a pin 12 to a crank 13, which is rotatable on a fixed shaft 14.

The crank 13 has two rigidly interconnected, parallel arms 15 and 16 through which the shaft 14 extends. The arm 15 is connected to the toggle link 2 and the arm 16 is provided with a cam surface 17. This cam surface is arranged to coact with a contact operating crank 18, which is rigidly connected through a rotatable suitably insulated counter shaft 19 to the movable contact carrying arm 20 of the circuit breaker. When the crank 13 is rotated clockwise by straightening the operating toggle 1—2 in response to elevation of the crosshead 6, the cam face 17 bearing on a roller 21 on the crank 18 rotates the counter shaft 19 counterclockwise to bring the movable contact structure 22 of the circuit breaker into engagement with the stationary contact structure 23, 24.

In order to hold the toggle 1—2 at the pivot 9 in thrust transmitting position relatively to the crank 13, there is associated with the toggle guide link 10 a latching and tripping means comprising a link 25, which is connected to the pin 9 and to a latch 26 mounted on a fixed pivot 27. The link 25 and the latch 26 are so interconnected at 28 as to insure a force reducing connection. Coacting with the latch 26 is a rotatable

tripping shaft 29 to which is secured a detent member 30 adapted to engage the tail 31 of the latch 26.

In the position shown, collapse of the toggle 1—2, that is, counterclockwise rotation of the pivot pin 9 and tripping of the toggle joint 3, is restrained by the latch 26 and the detent 30. Tripping movement, that is, counterclockwise rotation of the tripping shaft 29, effects release of the latch 26 so that it is free to rotate counterclockwise to release the pin 9 and thereby permit collapse of the toggle. In the circuit closed position, the toggle 1—2 is held in an underset position by a prop 32 which is arranged to support the toggle joint 3. This prop is secured to a rotatable shaft 33 and is resiliently connected by a spring 34 to an arm on the tripping shaft 29 so as to facilitate resetting of both the prop and the latching means after a circuit opening operation of the mechanism. The prop 32 is also biased for counterclockwise rotation by suitable means, such as a torsion spring 35.

The tripping shaft 29 is provided with an arm 36 whereby it can be rotated counterclockwise to the releasing position by suitable electroresponsive means, such as the tripping plunger 37 of an electromagnet 38 which may be energized, for example, in response to the current flowing through the circuit breaker, as is well known to the art. Clockwise rotation of the tripping shaft is limited by a stop 39.

The contact operating crank 18 is connected to the crank 13 by means of a compression spring 40, which is guided on a member 41 engaging one end of the crank 13 and having a guided sliding connection at 42 with the downwardly extending arm 43 of the crank 18. In the closed circuit position shown, the spring 40 is under compression so that immediately upon release of the tripping latch, the collapse of the toggle 1—2 is accelerated by the energy stored in the spring whereby to effect rapid movement of the cam surface 17 away from the roller 21. The contact operating crank 18 is also acted upon throughout the opening movement by the spring 40, tending to accelerate the separation of the contacts 22, 23 and 24. During the closing operation when the crank 13 is rotated clockwise, the spring 40 is placed under compression by reason of the comparatively long lever arm 43 of the crank 18 acting in opposition to the spring.

When the toggle 1—2 is released in response to a tripping operation, the pivot pin 9 is free to rotate counterclockwise about pivot 11. This causes a shift of the toggle joint 3 from the end of the prop 32 and permits a free collapse of the toggle. When this occurs, the pivot 9 reverses its movement and drops so that the latch 26 can return to its initial position. During this return movement, the nose 31 of the latch rides over the latch detent 30 and resets to the position illustrated in Fig. 1. The prop 32 is suitably shaped, as illustrated, for permitting free movement of the toggle joint 3 alongside the prop.

The resilient connection 34 between the trip shaft 29 and the prop 32 biases the tripping detent into latching engagement after the latch 26, in dropping, pushes down on and passes by the latch detent 31, the latter snapping into reset position due to the bias of the spring 34. At the same time, the spring 34 and the spring 35 exert a counterclockwise bias on the prop 32 urging it against the side of the link 8 so that, when the links 1 and 2 are raised to toggle position in a subsequent closing operation, the prop 32 is snapped beneath the toggle joint 3 to hold the mechanism in the closed position independently of the actuating handle 4. A stop member 44 is provided for preventing counterclockwise movement of the prop beyond the toggle joint 3.

Since the maintenance of the circuit closing position of the circuit breaker just described is dependent on the engagement of the nose 31 of the latch 26 by the detent 30 on the tripping shaft 29, it will be obvious that something further must be provided to insure this cooperative latching relationship under shock conditions of such a character and intensity as to effect the release of the latch 26. In order to prevent such release, I provide, in accordance with my invention, means for preventing a movable controlling member such as the tripping shaft 29 from changing its position under shock effects. As shown in Fig. 1, this shock-proofing means comprises a weight 45 which is resiliently pendulously supported from the tripping shaft 29 so as to partake of the movement thereof. For this purpose, the weight 45 may be mounted on a resilient member such as a piece of spring wire 46 which obviously is deflectable in any direction. This wire has a transverse loop in which rides a pin 47 mounted in a crank 48 which is suitably secured to the tripping shaft 29 so as to rotate therewith. The longitudinal axis of this tripping shaft 29 is indicated in extension by the dash-dot line 49.

Further in accordance with my invention, I provide means dependent on the deflection of the supporting element 46 in consequence of shock or the like, which causes material movement of the weight 45, for preventing movement of the tripping shaft 29 from its latching position. As shown in Fig. 1, this means comprises a relatively stationary part 50 mounted intermediate the tripping shaft 29 and the weight 45. In accordance with my invention, this stationary part 50 is provided with a hole 51 through which the wire 46 passes. Moreover, the configuration of this hole 51 is such as to permit the wire 46 to move freely lengthwise therein except when the wire is deflected by movement of the weight 45 in consequence of shock and the like. In the arrangement shown in Fig. 1, the hole is generally funnel shaped with the wider end toward the weight 45. In one application of my invention, I have obtained satisfactory operation with a steel wire about 0.040 inch in diameter with the diameter of the opening of the upper part of the hole 51 about 0.042 inch. With such a wire, a weight of about $\frac{1}{4}$ ounce so positioned on the wire as to resonate at from 40 to 50 cycles per second is satisfactory for some applications. The resonance can, of course, be varied by changing the position of the weight on the wire. The size of the wire 46 relatively to the weight 45 is such that the wire is stiff enough not to be deflected by the pitching or tossing of a ship sufficiently to cause a trip locking action.

In order to limit the amplitude of the swing of the weight 45 so as to avoid a permanent set of the wire 46 under voilent shocks and also to prevent the weight from interfering with adjacent parts, I provide suitable means such as a stationary cylindrical member 52, the wall of which surrounds the weight 45 and which has a diameter sufficient to maintain the displacement of the weight 45 within desired bounds.

Assuming the parts positioned as shown in Fig. 1, then as long as there is no shock the wire 46 is straight and free to move up and down in

the hole 51 without material interference with the movement of the tripping shaft 29. Such interference as there is is merely that due to the weight of the additional portions 45, 46, 47 and 48. This, of course, can be readily compensated by adjustment of the spring 34. Consequently, in case of an abnormal circuit condition causing the operation of the tripping plunger 37, the circuit breaker will be opened by the actuation of the tripping shaft 29 just the same as though my shock-proofing mechanism were not present. In other words, no interference with the operation of the circuit breaker appears either under normal or abnormal circuit conditions. If, however, a shock occurs of such magnitude as to tend to release the tripping shaft 29 and thereby open the circuit breaker, the weight 45 will be given an actuating impulse such as to cause vibration of the wire 46 at its resonant frequency. When the wire is set into vibration, it ceases to remain straight and bends more or less into the shape of the configuration of the hole 51 oscillating back and forth like a pendulum. Obviously, as long as the wire is not straight, it cannot be pulled upwardly through the narrow portion of the hole 51 and, consequently, movement of the shaft 29 in the tripping direction, counterclockwise as viewed in Fig. 1, cannot occur. Moreover, since the device is purely automatic, the shock-proofing effect is available without any attention from the operating personnel. If an abnormal circuit condition occurs while the wire 46 is in vibration, the tripping of the circuit breaker will be delayed for the relatively short period of time required for the weight 45 to come practically to a standstill so that the wire 46 is straight long enough to be moved upwardly through the hole 51 into the releasing position of the tripping shaft 29. Ordinarily, this delayed period of tripping, while sufficient to prevent false tripping on shock, is not material to the opening of the circuit breaker under fault conditions.

In Fig. 2, I have shown an embodiment of my invention in an electroresponsive device such as an undervoltage or overcurrent relay. As illustrated, this relay comprises an electromagnet having a stationary magnetic core 53, an energizing winding 53*a*, and an armature 54 secured to a controlling member 55 pivoted at 56. In the specific arrangement shown, the controlling member 55 is arranged to control the movement of a contact 57 in dependence on the energization of the winding 53*a* or, more properly speaking, the resultant of the attractive effect on the armature 54 and the opposing effect of a biasing spring 58. While the controlling member 55 is shown as an actuator for the bridging contact 57 relatively to the cooperating stationary contacts 59, it could, of course, be arranged to trip a circuit breaker or for other purposes, as will be apparent to those skilled in the art.

Inasmuch as a relatively light shock might be sufficient to release the armature 54, particularly if the voltage or current energizing the winding 53*a* happens to be close to the releasing value as determined by the biasing spring 58, a false operation of the relay could readily occur. In order to prevent such false operation, the relay is provided with a shock-proofing mechanism similar to that illustrated in Fig. 1 with the resilient supporting member or wire 46 looped around a pin 60 mounted to move with the controlling member 55. With this arrangement, it will be obvious that, as long as the resilient support 46 is straight, the armature 54 is free to

move in accordance with the purpose for which it was designed to operate. However, in case of shock, the deflection of the supporting wire 46, in consequence of the impulse given to the weight 45, will prevent the movement of the wire through the opening 51 as long as the oscillation of the wire 46 is maintained. As soon as the wire becomes sufficiently straight to move through the opening 51, the armature 54 is free to move in case the abnormal condition for which it is intended to operate is present.

From the foregoing, it will be apparent that shock-proofing mechanisms embodying my invention are purely automatic and that they do not materially interfere with the device in the event of an abnormal circuit condition occurring more or less coincidentally with the shock itself. Furthermore, it will be obvious from the simplicity of the device and its structure that it is readily applicable to existing devices, such as circuit breakers, relays and the like, without material modification in their structure or such space requirements as would make it impractical in application.

While I have shown and described my invention in considerable detail, I do not desire to be limited to the exact arrangements shown, but seek to cover in the appended claims all those modifications that fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A device to be maintained in a predetermined condition, a movable controlling member operative in one position to maintain the device in said predetermined condition but subject to change of position by shock, and means for preventing such change of position comprising a weight, a resiliently pendulous support for said weight deflectable in any direction and arranged to partake of the movement of said member, and means dependent on the deflection of said support in any direction in consequence of shock or the like for preventing movement of said weight in a direction to allow movement of said member from said one position.

2. A device to be maintained in a predetermined condition, a movable controlling member operative in one position to maintain the device in said predetermined condition but subject to change of position by shock, and means for preventing such change of position comprising a weight, a resilient element pendulously supporting said weight to partake of the movement of said member, and stationary means provided with a hole through which said element passes, the configuration of said hole being such as to permit said element to move freely lengthwise therein except when the element is deflected by movement of the weight in consequence of shock and the like.

3. A device to be maintained in a predetermined condition, a movable controlling member operative in one position to maintain the device in said predetermined condition but subject to change of position by shock, and means for preventing such change of position comprising a spring wire mounted to partake of the movement of said member, relatively stationary means provided with a generally funnel shaped hole through which said wire passes, and a weight mounted on said wire beyond the wider end of said hole.

4. An electromagnet comprising an armature and means for preventing the release of said armature from the attracted position in conse-

quence of shock comprising a weight, a resiliently pendulous support for said weight deflectable in any direction and arranged to partake of the movement of said armature, and means dependent on the deflection of said support in any direction in consequence of shock or the like for preventing movement of said weight in a direction to allow movement of said armature from said one position.

5. A circuit breaker tripping mechanism comprising a tripping member, a single resilient element supported from said tripping member and deflectable in any direction, a weight mounted on said resilient element, and means dependent on the deflection of said resilient element in any direction in consequence of shock or the like for preventing a shock actuated tripping operation of said tripping member.

6. A circuit breaker tripping mechanism comprising a tripping shaft rotatable in one direction to effect the tripping of the circuit breaker and means for preventing a shock actuated tripping rotation of said shaft comprising a spring wire supported from said tripping shaft, relatively stationary means provided with a generally funnel shaped hole through which said wire passes, and a weight mounted on said wire beyond the wider end of said hole.

7. A device to be maintained in a predetermined condition, a movable controlling member operative in one position to maintain the device in said predetermined condition but subject to change of position by shock, and means for preventing such change of position comprising a

weight, a resiliently pendulous support for said weight arranged to partake of the movement of said member and to vibrate at a predetermined frequency when subjected to a severe shock, and means dependent on the deflection of said support in consequence of shock or the like for preventing movement of said member from said one position.

8. A device to be maintained in a predetermined condition, a movable controlling member operative in one position to maintain the device in said predetermined condition but subject to change of position by shock, and means for preventing such change of position comprising a weight, a resiliently pendulous support for said weight arranged to partake of the movement of said member and to vibrate at a predetermined frequency when subjected to a severe shock, means dependent on the deflection of said support in consequence of shock or the like for preventing movement of said member from said one position, and means for limiting the amplitude of the vibration of said support.

9. An arrangement for preventing movement of a member subject to change of position by shock, comprising a weight, a single resiliently pendulous support for said weight deflectable in any direction and adapted to be connected to said member, and means dependent on the deflection of said support in any direction in consequence of shock or the like for preventing movement of said weight in a direction to allow movement of the member by shock.

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