Dec. 18, 1928. 1,695,723

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TIME ELEMENT ELECTRORESPONSIVE DEVICE

Original Filed Sept. 14, 1925

Fig. 1.

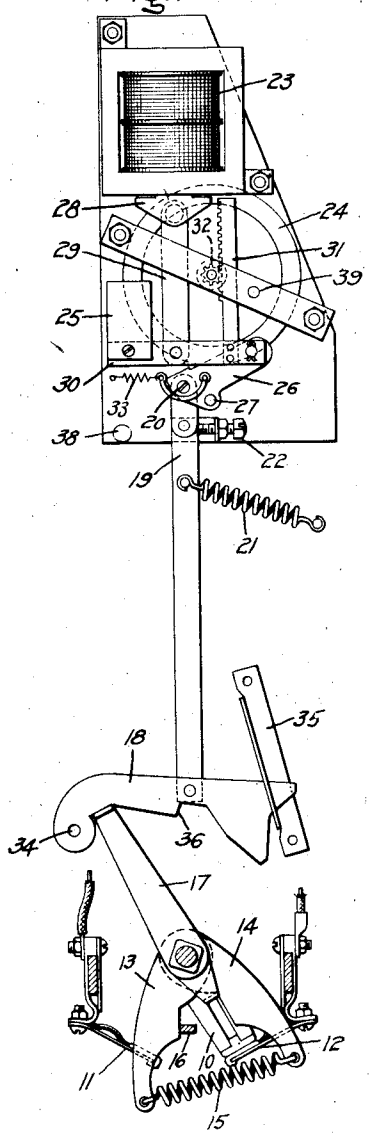
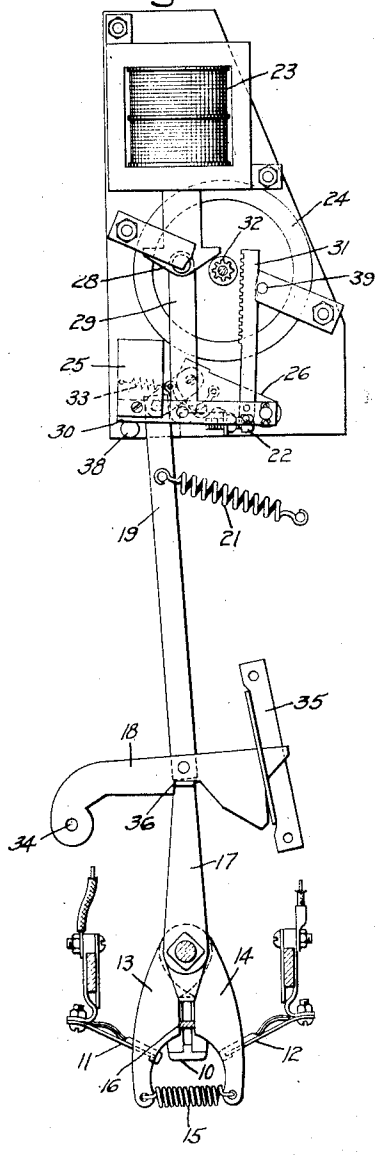


Fig. 2.



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UNITED STATES PATENT OFFICE.

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TIME-ELEMENT ELECTRORESPONSIVE DEVICE.

Application filed September 14, 1925, Serial No. 56,102. Renewed May 4, 1928.

This invention relates to time element electroresponsive devices, particularly those which operate a time interval after a predetermined change in the energization thereof. While not limited thereto, the invention is of particular usefulness in circuit controlling devices that operate to open a controlled circuit a time interval after the occurrence of undervoltage conditions or failure of power.

The invention provides an improved form of time element electroresponsive device of the above character which has the following practical operating advantages:

The device operates substantially instantaneously in one direction and with a time delay in the other direction.

The time element is substantially constant as it depends upon the inertia of a moving body.

The inertia of the moving body is utilized in effecting the operation of a circuit controlling switch or the like after the lapse of a desired time interval.

The operation of the electroresponsive time element controlling mechanism is not seriously affected by dust and dirt.

The electroresponsive controlling mechanism is of relatively small size and, consequently, of small power consumption.

In carrying a preferred embodiment of the invention into effect in an undervoltage circuit protective switch, the switch is biased to the open position and is latched in the closed position. A movable tripping member is biased into tripping engagement with the latch mechanism and is operated to and maintained in an inactive position whenever a voltage responsive electromagnet is energized above a predetermined value.

The return of the movable tripping member into tripping engagement with the latch mechanism upon a reduction in the energization of the electroresponsive means is delayed by means of an inertia flywheel, which is operated through a rack and pinion mechanism. The arrangement of the rack and pinion mechanism is such that the rack automatically is disengaged from the pinion to permit instantaneous operation of the tripping member to the inactive position and is reengaged automatically with the pinion to establish a two-way driving connection that permits the inertia of the flywheel to delay the return movement of the tripping member and also supply energy to the member to assist in tripping the latch mechanism.

A better understanding of the invention may be had from the accompanying drawing in which Fig. 1 shows a preferred embodiment of the invention in a time element undervoltage protective switch for alternating current motors; and Fig. 2 shows the relative positions of the operating parts of the switch mechanism after the time element voltage responsive mechanism operates to open the switch.

In Fig. 1 the pivoted switch member 10 and the cooperating stationary contacts 11 and 12 constitute a well known form of starting switch for alternating current induction motors. The switch member 10 is operated into engagement with the contacts 11 to start the alternating current motor through a suitable voltage reducing compensator. For the sake of clarity, the motor and the compensator are not shown in the drawing. Operation of the switch member 10 into engagement with the contacts 12 establishes full voltage running connections for the motor.

The switch member 10 is biased from each circuit closing position to the off position in which it is shown in Fig. 2 by the double acting biasing mechanism comprising the two pivoted levers 13 and 14. These two levers are interconnected by the tension spring 15 and cooperate with the stationary stop 16 and the arm 17 which is secured to move integrally with the switch member 10. The biasing arrangement is such that when one of the pivoted levers 13 or 14 is engaged by the lower end of the arm 17 upon movement of switch member 10 from the off position, the other lever will engage with the stop 16, thereby setting up a strain in the biasing spring 15 which tends to return the switch member 10 to the off position from either the starting or the running position.

As illustrated in the drawing the latch mechanism for holding switch 10 in the running position is of the form fully described and claimed in my copending patent application, Serial #48,422, filed August 5, 1925, although other suitable forms of latch mechanism may be employed if desired. In

the preferred form shown, the upper end of the arm 17 cooperates with a notched latch 18 to insure that the switch is first operated to the starting position before operation to the running position. The arm 17 and the latch 18 also function to hold the switch 10 in the running position in which it is shown in Fig. 1. As is more fully set forth in my above application a toggle 19 having one end pivoted about the stationary pin 20 and the other end connected to the latch 18 is arranged to prevent movement of the latch 18 out of the path of the arm 17 when the toggle is extended as shown in Fig. 1. The toggle 19 is biased to the extended position by its own weight, although preferably an additional biasing spring 21 is provided in order to render the toggle mechanism proof against accidental tripping by extraneous jars or shocks. The adjustable stop 22 is so positioned that the toggle is maintained on dead center or preferably slightly over center, thus rigidly locking the latch 18 against movement by the arm 17.

In accordance with my present invention, the tripping of the latch mechanism to permit the switch to open in accordance with its bias is effected by the time element undervoltage mechanism comprising the electromagnet 23, fly-wheel 24 and the weight 25, which are interconnected with the operating member 26 carrying the tripping pin 27 in the following manner: The plunger or core 28 of the voltage responsive electromagnet 23 is connected through the link 29 to an intermediate portion of the balancing arm 30 which carries the weight 25 at one end and is pivotally connected to the operating member 26 at the other end. The operating member 26 is pivotally mounted upon the stationary pin 20 and is provided with a tripping pin 27 for collapsing the toggle 19 and thereby permitting the switch 10 to return to the off position in accordance with its bias.

A rack gear 31 is secured to the balancing arm 30 a short distance from the pivotal connection of the arm 30 with the operating member 26. The relative mass of the weight 25 and the rack 31 are so proportioned that the weight tilts the rack into engagement with the pinion 32 which is fixed upon the shaft of the flywheel 24 when the balancing arm 30 is held in the upper position by the electromagnet 23 as indicated in Fig. 1. The biasing spring 33 is connected to the operating member 26 through any well known overcenter arrangement so that the member 26 is biased to rotate in the counter clockwise direction when raised to the inactive position as shown in Fig. 1, and is biased in the opposite direction when moved to the operating position indicated in Fig. 2. If desired, the electromagnet 23 and the flywheel 24 may be mounted upon a suitable base to which the stationary pin 20 and the adjustable stop 22 also are secured in order to form a unitary structure as indicated in the drawing.

With the switch 10 in the off position and the various elements of the undervoltage time element control mechanism in their respective positions shown in Fig. 2, the operation of the arrangement is as follows: When the operating winding of the electromagnet 23 is energized sufficiently to attract the plunger 28, the weight 25 and the balancing arm 30 are lifted. Due to the opposing strain exerted upon the member 26 by the overcenter biasing spring 33, counter clockwise rotation of the operating member 26 about the stationary pin 20 is restrained initially, thereby maintaining the rack 31 in sliding engagement with the stop 39 and out of engagement with the pinion 32 during a quick upward movement of the balancing arm 30. Since the flywheel is maintained disconnected, the upward travel of the plunger 28 and the resulting movement of the operating member 26 to the inactive position occurs substantially instantaneously upon the energization of the electromagnet 23.

As the plunger 28 reaches the attracted position in which it is shown in Fig. 1, the action of the overcenter biasing spring 33 upon the operating member 26 is reversed, and the member 26 together with the weight 25 tilt the balancing arm 30 so as to move the rack 31 into engagement with the pinion 32 as shown in Fig. 1.

With the operating member 26 in the inactive position the switch member 10 may be operated into engagement with stationary contact 11 by means of a suitable operating handle, not shown in the drawing. As the upper end of arm 17 moves to the right along the inclined cam surface of the latch 18, the latch 18 rotates about its pivotal support 34 and slides in the slotted guide 35, thus raising the notch 36 out of the path of the upper end of the arm 17. The toggle 19 readily yields as the latch 18 is raised.

Upon a quick operation of the switch 10 from the starting position, the upper end of arm 17 passes the notch 36 before the latch 18 falls into engagement with the end of the arm 17. The switch 10 then may be operated into the running position in which it engages with the stationary contacts 12. This permits the latch 18 to fall into engagement with the upper end of the arm 17 as shown in Fig. 1. In this position of latch 18, the toggle 19 is fully extended and effectively prevents movement of the latch 18 out of the path of the arm 17 by the strain of the biasing spring 15. Hence, the switch 10 is locked securely in the running position and may be released only by collapsing the toggle 19.

The electroresponsive controlling mechanism operates to collapse the toggle 19 with a time delay action as follows: Upon a reduction in the energization of electromagnet 23 below the value required to maintain the plunger 28 in the attracted position, the plunger together with the weight 25 fall as a unit and drive the flywheel 24 through the rack 31 and the pinion 32. As the flywheel 24 is accelerated slowly, the movement of the operating member 26 from the inactive position into tripping engagement with the toggle 19 is delayed for a time interval depending upon the inertia of the flywheel. After the elapse of the required time interval, the downward movement of the weight 25 and the plunger 28 carries the tripping pin 27 on the operating member 26 into engagement with the toggle 19. When the operating member 26 is decelerated upon the engagement of the tripping pin with the toggle 19, the flywheel operates to drive the member 26 through the two-way driving connection established by the pinion 32 and the rack 31, thereby assisting the weight 25 and the plunger 28 in throwing the toggle 19 over center against the strain of the biasing spring 21. In this way the energy stored in the flywheel 24 becomes effective to assist in collapsing the toggle 19 and insures that the toggle 19 is always collapsed even though the frictional resistance is high or the toggle is over center a considerable amount due to misadjustment of the stop 22.

When the toggle 19 is collapsed, the latch 18 is free to be moved about its pivotal support 34 by the switch biasing spring 15 operating through the arm 17 on the lower cam surface of the latch 18. Consequently the latch 18 is moved quickly out of the path of the arm 17, thereby permitting the switch 10 to operate to the off position in accordance with its bias.

After the toggle 19 is tripped the movement of the operating member 26 is continued until the end of the balancing arm 30 strikes the stationary stop 38. Should the inertia of the flywheel 24 tend to continue movement of the operating member 26, the balancing arm 30 pivots about the stop 38 as an axis and the resulting movement disengages the rack 31 from the pinion 32 as shown in Fig. 2. This interrupts the two-way driving connection between the flywheel 24 and the operating member 26 and effectively prevents excessive strains upon the gear teeth of the pinion 32 and the rack 31.

The operation of the time element undervoltage control mechanism is not seriously effected by accumulation of dirt or dust in the teeth of either the pinion 32 or the rack 31. Due to the pivotal mounting of the balancing arm 30, the rack 31 moves away from the pinion 32 when particles of dirt tend to jam between the teeth of the rack 31 and the pinion 32, thus allowing the dirt particles to fall from the teeth of the rack or the pinion.

Since the kinetic energy accumulated by the flywheel 24 during the retardation of the movement of the operating member 26 to the tripping position is available to complete the tripping operation due to the two-way driving connection between the flywheel and the operating member, the weight 25 and the electromagnet 23 may be of relatively small size. This reduces the consumption of power required to maintain the operating member 26 in the inactive position, which is a feature of considerable practical operating value.

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

1. A time element electroresponsive device comprising a member movable in each of two directions, electroresponsive means for controlling the movement of the member, a movable inertia element, and connections between the inertia element and the member through which the inertia element resists both acceleration and deceleration of the member in one direction and permits unrestrained movement thereof in the other direction.

2. A time element electroresponsive device comprising an electromagnet, a member operable between two positions under the control of the electromagnet, a movable inertia member, and means arranged to operatively connect the inertia element with the member during movement of the member to one position so that the inertia of the element resists both acceleration and deceleration of the member, said means being arranged to interrupt the connection between the inertia element and the member during movement of the member to the other position.

3. A time element electroresponsive device comprising a member movable between two positions, electroresponsive means for controlling the movement of the member, an inertia time delay element, and mechanism for automatically establishing a two-way driving connection between the member and the inertia element during movement of the member in one direction between said positions.

4. A time element electroresponsive device comprising a movable member biased to one position, electroresponsive means for operating the member to another position upon a predetermined energization of the said means, an inertia time delay element, and mechanism for automatically establishing a two-way driving connection between the member and the inertia element during movement of the member in accordance with its bias.

5. A time element electroresponsive device comprising a movable member biased

to one position, electroresponsive means for moving the member to and maintaining the member in another position upon a predetermined energization of the said means, a movable inertia element, and means arranged to operatively connect the inertia element with the member upon a reduction in the energization of the electroresponsive means to permit the inertia of the element to resist both acceleration and deceleration of the member during the return thereof to said biased position.

6. A time element electroresponsive device comprising an electromagnet, a member under the control of the electromagnet and operable to a predetermined position for effecting operation of the device responsively to a predetermined variation in the energization of the electromagnet, a movable inertia element, and mechanism controlled by the electromagnet for establishing a driving connection between the member and the inertia element to permit the inertia of the element to both retard the movement of the member to its operating position and supply energy to the member to operate the device.

7. In a time element electroresponsive device, the combination of a movable member, electroresponsive means for controlling the movement of the member, a rotatable inertia element, and mechanism controlled by the said means for establishing a two-way driving connection between the movable member and the rotatable inertia element during a predetermined movement of the member.

8. In a time element electroresponsive device, the combination of a movable member, electroresponsive means for controlling the movement of the member in each direction, a rotatable inertia element, and means including a rack and pinion for interconnecting the member and the rotatable element to permit the inertia of the rotatable element to resist both acceleration and deceleration of the member in one direction, said means being arranged to disconnect the inertia element upon movement of the member in the other direction.

9. In a time element electroresponsive device, the combination of a member biased to one position, electroresponsive means for operating the member to another position upon a predetermined energization of the said means, a rotatable inertia element, and a rack and pinion mechanism arranged to establish a two-way driving connection between the movable member and the rotatable inertia element during movement of the member in accordance with its bias.

10. A time element circuit controlling device comprising a switch, electroresponsive means having a movable member for causing operation of the switch upon a predetermined variation in the energization of said means, a movable inertia element, and mechanism controlled by said electroresponsive means for establishing connections between the movable member and the inertia element to permit the inertia of the element to delay movement of the member to operate the switch and to supply energy to operate the switch.

11. The combination of a switch biased to open position, latch mechanism for holding the switch in the closed position, electroresponsive means for controlling said latch mechanism to release the switch, and inertia time element means arranged to be operatively connected with the electroresponsive means to both delay the operation of said means to release the switch and supply energy to effect the release of the switch.

12. A time element undervoltage protective device comprising a switch biased to open position, latch mechanism for holding the switch in the closed position, an electromagnet energized in accordance with the voltage of the circuit controlled by the switch, a member under the control of the electromagnet and biased into tripping engagement with the latch mechanism, a movable inertia member, and mechanism controlled by the electromagnet for establishing a two-way driving connection between the member and the inertia element upon a predetermined reduction in the energization of the electromagnet to permit the inertia of the element to both retard the movement of the member into tripping engagement with the latch mechanism and supply energy to the member during the tripping of the latch mechanism.

In witness whereof, I have hereunto set my hand this 11th day of September, 1925.

GEORGE R. TOWNSEND.