Oct. 10, 1933. C. L. HANEL 1,929,552

ELECTRICAL CIRCUIT CONTROLLING DEVICE WITH MINIMUM TIME DELAY ELEMENT

Filed Dec. 7, 1931 2 Sheets-Sheet 1

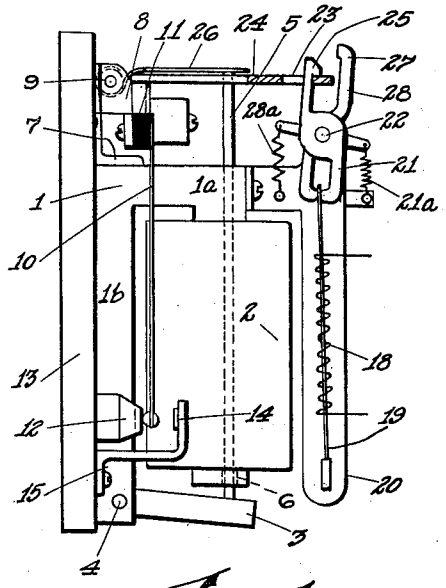


Fig. 1.

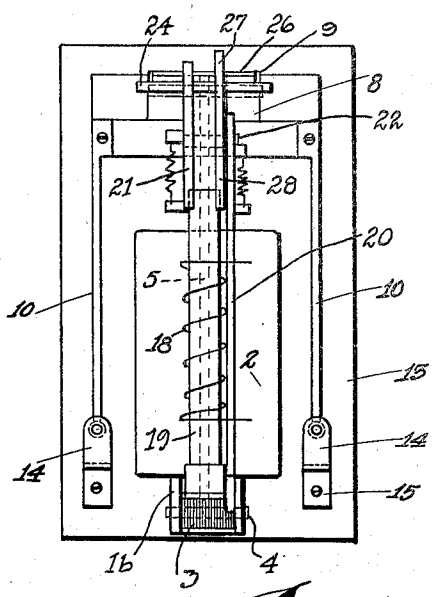


Fig. 2.

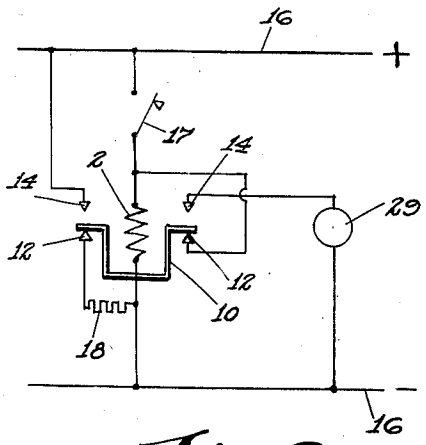


Fig. 6.

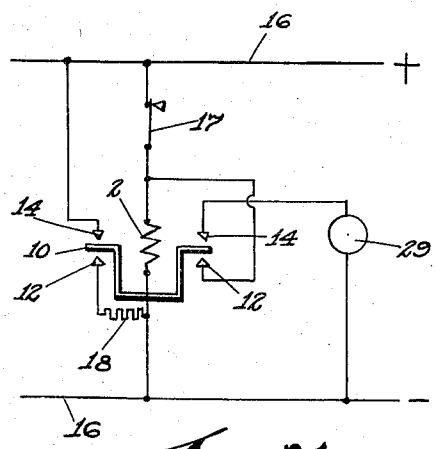


Fig. 7.

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ELECTRICAL CIRCUIT CONTROLLING DEVICE WITH MINIMUM TIME DELAY ELEMENT

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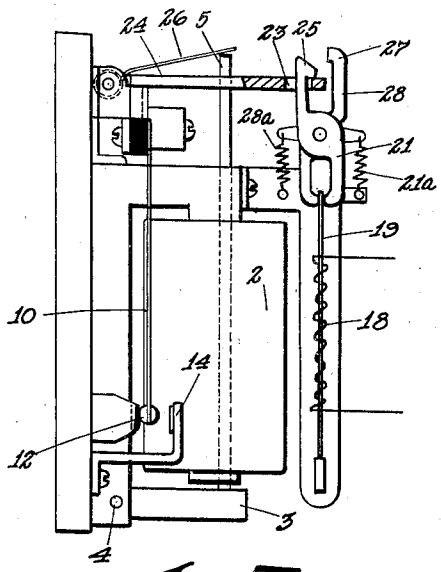


Fig. 3.

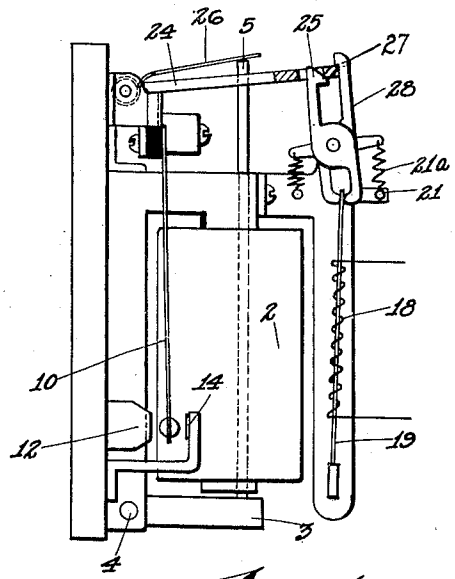


Fig. 4.

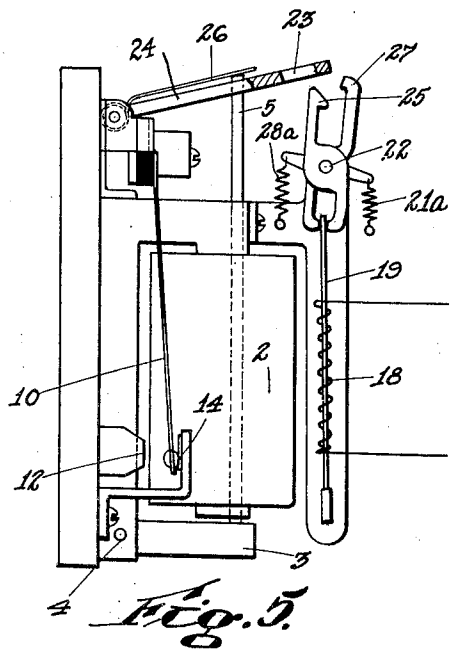


Fig. 5.

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1,929,552

ELECTRICAL CIRCUIT CONTROLLING DEVICE WITH MINIMUM TIME DELAY ELEMENT

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Application December 7, 1931. Serial No. 579,567

13 Claims. (Cl. 175—320)

The present invention relates to electrical circuit controlling devices and has for its object to provide a device of the above indicated character that is adapted to automatically bring about a change in the controlled circuit after the lapse of a predetermined minimum time interval following the energization of the device.

In the control of certain electrical apparatus, it is sometimes absolutely essential that the apparatus shall not be energized until after a minimum time interval has elapsed following the energization of other related apparatus, and the device of the present invention so functions that this minimum time interval will be maintained, even though the device itself is energized at widely varying intervals, as will hereinafter more fully appear from the following description, with reference to the accompanying drawings, in which:—

Fig. 1 is a view in side elevation of the device embodying the invention.

Fig. 2 is a view in front elevation of the device shown in Fig. 1.

Fig. 3 is a view similar to Fig. 1, illustrating the condition of the device at the beginning of its period of energization.

Fig. 4 is a view similar to Fig. 3, illustrating the condition of the device after the lapse of a portion of the minimum time interval.

Fig. 5 is a view similar to Fig. 3, illustrating the operation of the device after the lapse of its minimum time interval.

Figs. 6 and 7 are diagrammatic views showing the circuit connections of the device during its operation.

Like reference characters refer to like parts throughout the drawings.

Referring to the drawings, the device consists of a U-shaped magnetic core 1 having one leg 1*a* thereof surrounded by a winding 2, while the other leg 1*b* supports an armature 3 on a pivot 4. The free end of the armature 3 carries a rod 5 extending upwardly through a slot 6 provided in the core leg 1*a* with the rod 5 extending above the top of the core 1. The upper portion of the core 1 carries a bracket 7 on which is pivotally supported a frame 8 by means of a shaft 9, the frame 8 carrying a pair of downwardly extending contact arms 10, 10 disposed on opposite sides of the coil 2. The arms 10 are connected together across the frame 8 and are insulated therefrom at 11.

With the parts in the position shown in Fig. 1, that is, with the winding 2 deenergized, the arms 10 are in engagement with stationary contacts 12 carried by an insulating base 13 on which the core 1 is mounted, so that a continuous circuit is then maintained between the contacts 12. Movement of the frame 8 about the pivot shaft 9 is adapted to separate the arms 10 from the stationary contacts 12 and swing the arms in the direction of a second pair of stationary contacts 14 carried by terminals 15 mounted on the base 13 and projecting forwardly therefrom. Referring now to Fig. 6, the one terminal of the winding 2 is connected to one of a pair of supply mains 16 energized from a suitable source of electrical energy, while the other terminal is connected to the other main 16 by means of a switch 17. The stationary contacts 12, when engaged by the contact arms 10, are adapted to connect a heating coil 18 in parallel circuit relation with the terminals of the energizing winding 2, so that when the switch 17 is closed the winding 2 and the heating coil 18 will be simultaneously energized. This condition continues while the frame 8 carrying the contact arms 10 remains in the position shown in Fig. 1, and the manner in which the coil 18 is adapted to control movement of the frame 8 will next be described.

Referring again to Fig. 1, the coil 18 is shown as being wrapped around an arm 19 rigidly secured at its lower end to a bracket 20 projecting downwardly from the core 1 in front of the energizing winding 2. The arm 19 is composed of bi-thermal metal so designed that when the arm 19 is at ordinary room temperature it is bent in one direction, whereas when the arm 19 is heated it will bend in the opposite direction, as shown in Fig. 4, owing to the different coefficients of expansion of the metals composing the arm 19. With the arm 19 in an unheated condition, its upper end is yieldingly engaged by the lower end of a lever 21 pivoted at 22 and biased by a spring 21*a* in the direction of the thermal arm 19. The lever 21 extends above pivot 22 through a slot 23 provided in a plate 24 projecting forwardly from the frame 8 and movable therewith, that portion of the lever projecting above the plate 24 providing a shoulder 25 in engagement with one edge of the slot 23. Therefore, with the parts in the position of Fig. 1, the lever 21 prevents the frame 8 from turning about its shaft 9 in a counterclockwise direction.

As previously pointed out, the armature 3 carries a vertically movable rod 5, and the upper end of this rod 5 bears against a resilient member 26 shown extending parallel to the plate 24

in Fig. 1. The resilient member 26 is secured to the frame 8 so that when the armature 3 is attracted by energization of the winding 2, upward flexure of the resilient member 26 by the rod 5 tends to turn the frame 8 with it. However, this tendency towards movement of the frame 8 is prevented by the engagement of the shoulder 25 on the lever 21 with the plate 24, so that the frame 8 is not moved when the armature 3 is first attracted to the core 6, as indicated in Fig. 3. As previously pointed out, when the winding 2 is energized by closure of the switch 17, the heating coil 18 in parallel with winding 2 is also energized through the then closed contact arms 10 and fixed contacts 12, and as the coil 18 heats, this heat is transferred to the bi-thermal arm 19, and the latter slowly straightens and flexes to the right, as shown in Figs. 3 and 4. This has the effect of turning the lever 21 in a counteclockwise direction, so that after the switch 17 has been closed an appreciable time, the shoulder 25 releases the edge of the slot 23 and the plate 24 is free to move upwardly under the urge of the flexed member 26. This movement of the plate 24 and frame 8 separates the contacts 10 from the contacts 12, but before the frame 8 has swung far enough to engage the contact arms 10 with the other stationary contacts 14, the end of the plate 24 engages a shoulder 27 on a lever 28, also mounted on the pivot 22 and biased in the direction of thermal arm 19 by a spring 28*a*. This condition of affairs is shown in Fig. 4, from which it is evident that the frame 8 is maintained in such a position that the arms 10 are substantially midway between the pairs of contacts 12 and 14.

When the plate 24 is released by the lever 21 upon expansion of the bi-thermal arm 19, separation of the contact arms 10 from the stationary contacts 12 immediately deenergizes the heating coil 18, whereupon the bi-thermal element starts to cool off. As the cooling of the arm 19 progresses, it tends to straighten out from the deflected position shown in Fig. 4, so that the upper portion of the arm moves to the left. As previously pointed out, the shoulder 27 of the second lever 28 is at that time holding the plate 24 against upward movement under the tension of the resilient member 26 and, as indicated in Fig. 4, the pull of the spring 28*a* about pivot 22 is such as to maintain the lower end of the lever 28 in engagement with the deflected bi-thermal arm 19. Therefore, as the cooling of the arm 19 causes it to straighten out, the lower leg of the lever 28 is moved to the left, thereby turning the lever in a clockwise direction about its pivot 22. Consequently, as the bi-thermal arm 19 cools off, the shoulder 27 of the lever 28 slowly moves away from the end of the plate 24 until finally the plate 24 is released, as shown in Fig. 5.

Since, as previously pointed out, the plate 24 of the frame 8 is always subjected to the pull of the resilient member 26, while the armature 3 is attracted, the frame 8 is turned further about its pivot shaft 9 immediately upon release of the plate 24. This movement continues until the contact arms 10 engage the second pair of stationary contacts 14, as indicated in Fig. 5. This completes the circuit between the contacts 14, as indicated in the diagrammatic showing of Fig. 6, so as to immediately connect an electrical load indicated at 29 across the supply mains 16 and the load 29 will remain energized so long as the switch 17 remains closed owing to the pressure exerted on the frame by the deflected resilient member 24.

Upon opening the switch 17, thereby deenergizing the winding 2, the armature 3 drops, whereupon the deflected resilient member 26, in straightening out, exerts a downward pressure on the frame 8 which causes the contact arms 10 to separate from the stationary contacts 14 and re-engage the other pair of stationary contacts 12. This turning movement of the frame 8 also causes the plate 24 to resume the position of Fig. 1 and in moving downwardly from its position of Fig. 5, the plate 24 by exerting a camming action on the inclined top of lever 21 turns the lever 21 just enough to permit its shoulder 25 to re-engage the edge of the slot 23. In other words, deenergization of the winding 2 by opening the switch 17 causes all of the parts of the device to resume the position of Fig. 1 in which the bi-thermal arm 19 is flexed to the left, since it is then substantially at room temperature.

In the foregoing description of the functioning of the device, it is obvious that closure of the switch 17 to energize the winding 2 will start a cycle of operations finally resulting in the energization of the electrical load 29 after the expiration of a definite time interval. This time interval is determined by two factors, first, the time required for the bi-thermal arm 19 to be heated enough to cause release of the plate 24 by the lever 21 with resulting deenergization of the heating coil 18, and second, the time required for the subsequent cooling and contraction of the bi-thermal arm 19 to cause a second release of the arm 24 by the lever 28 with resulting energization of the load 29. As previously pointed out, one of the objects of the present invention is to provide a device of this character so functioning that it will be impossible for the electrical load under control to be energized until after the expiration of a minimum time interval under any and all conditions of operation, and the particular functioning of the device with this object in view will now be explained.

Assume that it is an essential condition of the desired operation that the electrical load 29 shall not be energized until after the switch 17 has been closed at least twenty seconds. This being the case, it might be possible to obtain this result by so designing the heating coil 18 that it would take just twenty seconds for the bi-thermal arm 19 to release the plate 24, by turning only the lever 21. But this arrangement would not by any means meet all possible conditions of operation so that the minimum desired interval of twenty seconds would always be obtained. For example, should the switch 17 be closed to start the cycle while the bi-thermal element 19 was still heated from the previous cycle of operation, it is evident that it would take less than twenty seconds to heat the bi-thermal arm 19 to the point where it would release the plate 24.

In the functioning of my improved device, however, there is no possibility of the electrical load 29 being energized within a shorter period than the determined minimum, because of the fact that the heating coil 18 cannot be energized at any time unless it has entirely cooled off, irrespective of whether or not the switch 17 might be closed while the bi-thermal arm 19 still retains some heat from the cycle of operation immediately preceding. The essential condition

of having the bi-thermal arm 19 always substantially at room temperature in the position of Fig. 1 is insured by the fact that the heating of the arm 19 to cause a predetermined expansion after the lapse of a predetermined period merely partly releases the plate 24, while at the same time automatically deenergizing the heating coil 18. Therefore, before the plate 24 can be released to permit movement of the frame carrying the contacts 10, a similar period must necessarily elapse for the cooling of the bi-thermal arm 19. This being so, the time interval of the device is always measured by a complete cycle of heating and cooling of the bi-thermal arm 19.

It is evident that the device is adapted to meet the most extreme conditions of operation such as would be caused by closing the switch 17, opening it after an interval less than the fixed element of the device, before the load 29 is connected, and then closing the switch 17 again. Assuming that the first closing of the switch 17 has been long enough to cause release of the plate 24 by the lever 21, it is obvious that re-closure of the switch 17 cannot reenergize the coil 18 until after the bi-thermal arm 19 has entirely cooled off from its previous heating, since the contacts 12 are only engaged by the contact arms 10 when the bi-thermal arm 19 is substantially at room temperature. Therefore, the device always operates with a minimum of time delay element which remains fixed for any and all conditions of operation.

I claim,

1. A circuit controlling device comprising relatively movable contacts, the position of which is determined by an energizing winding, characterized by the provision of means for permitting engagement of said contacts only after the lapse of a predetermined minimum time interval following the energization of said winding, said minimum time interval being automatically maintained irrespective of successive energizations of said winding through periods less than said minimum interval.

2. In a circuit controlling device, the combination with an energizing winding, a magnetic member freely movable in response to energization of said winding and a movable contact carrying member, of means for imparting the initial movement of said magnetic member to said contact carrying member only after the lapse of a predetermined minimum time interval following the energization of said winding.

3. In a circuit controlling device, the combination with an energizing winding, a magnetic member movable in response to energization of said winding and a movable contact carrying member, of means for imparting the movement of said magnetic member to said contact carrying member only after the lapse of a predetermined minimum time interval following the energization of said winding, said minimum time interval being maintained irrespective of successive energizations of said winding through periods less than said interval.

4. In a circuit controlling device, the combination with an energizing winding, a magnetic member freely movable in response to energization of said winding and a movable contact carrying member, of means for imparting initial movement of said magnetic member in response to energization of said winding to said contact carrying member, only after said winding has been continuously energized throughout a predetermined minimum time interval.

5. In a circuit controlling device, the combination with an energizing winding, a magnetic member freely movable in response to energization of said winding and a movable contact carrying member, of a heat responsive device, and means controlled by said heat responsive device for imparting the initial movement of said magnetic member to said contact carrying member.

6. In a circuit controlling device, the combination with an energizing winding, a magnetic member movable in response to energization of said winding and a movable contact carrying member, of a heat responsive device, and means controlled by both the heating and cooling of said heat responsive device for imparting the movement of said magnetic member to said contact carrying member.

7. In a circuit controlling device, the combination with an energizing winding, a magnetic member movable in response to energization of said winding and a movable contact carrying member, of a heat responsive device, and means controlled by the heating of said heat responsive device for imparting a portion of the movement of said magnetic member to said contact carrying member, the movement of said contact carrying member being completed only upon cooling of said device.

8. In a circuit controlling device, the combination with an energizing winding, a magnetic member freely movable in response to energization of said winding, a movable contact carrying member and a yieldable connection between said magnetic member and said contact carrying member, of a heat responsive device and means controlled by said heat responsive device for preventing the initial movement of said magnetic member in response to energization of said winding from being imparted to said movable contact carrying member until said winding has been continuously energized through a predetermined period.

9. In a circuit controlling device, the combination with an energizing winding, a magnetic member freely movable in response to energization of said winding, a movable contact carrying member and a yieldable connection between said magnetic member and said contact carrying member, of a heat responsive device and means controlled by said heat responsive device for permitting the initial movement of said magnetic member to be imparted to said contact carrying member through said yieldable connection only after said winding has been continuously energized through a predetermined period.

10. In a circuit controlling device, the combination with an energizing winding, a magnetic member freely movable in response to energization of said winding, a movable contact carrying member and a yieldable connection between said magnetic member and said contact carrying member, of a heat responsive device and means controlled by both the heating and cooling of said heat responsive device for permitting initial movement of said magnetic member in response to energization of said winding to be imparted to said contact carrying member through said yieldable connection.

11. In a circuit controlling device, the combination with an energizing winding, a magnetic member freely movable in response to energization of said winding, a movable contact carrying member and a yieldable connection be-

tween said magnetic member and said contact carrying member, of a heat responsive device and means controlled by the heating of said heat responsive device for imparting a portion of the initial movement of said magnetic member in response to energization of said winding to said contact carrying member through said yieldable connection, movement of said contact carrying member being completed only upon the cooling of said heat responsive device.

12. In a circuit controlling device, the combination with an energizing winding, a magnetic member freely movable in response to energization of said winding, a movable contact carrying member and a heat responsive device for controlling a yieldable connection between said magnetic member and said current carrying member, of a source of electrical energy, means for initially connecting said energizing winding and said heat responsive device to said source in parallel circuit relation, and means under control of said heat responsive device for permitting the initial movement of said magnetic member to be imparted to said contact carrying member through said yieldable connection only after said winding has been energized through a predetermined period, such movement of said contact carrying member serving to disconnect said heat responsive device from said source.

13. In a circuit controlling device, the combination with an energizing winding, a magnetic member freely movable in response to energization of said winding, a movable contact carrying member and a heat responsive device for controlling a yieldable connection between said magnetic member and said current carrying member, of a source of electrical energy, means for connecting said winding and said heat responsive device to said source in parallel circuit relation, means controlled by the heating of said heat responsive device for permitting a portion of the initial movement of said magnetic member to be imparted to said contact carrying member, with such movement of the contact carrying member serving to disconnect said heat responsive member from said source, and means controlled by the cooling of said heat responsive member for permitting the contact carrying member to complete its movement under the urge of said yieldable connection.

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