

March 9, 1937.

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2,072,932

METHOD OF AND APPARATUS FOR CONTROLLING ELECTRIC CIRCUITS

Filed March 28, 1934

Fig. 1.

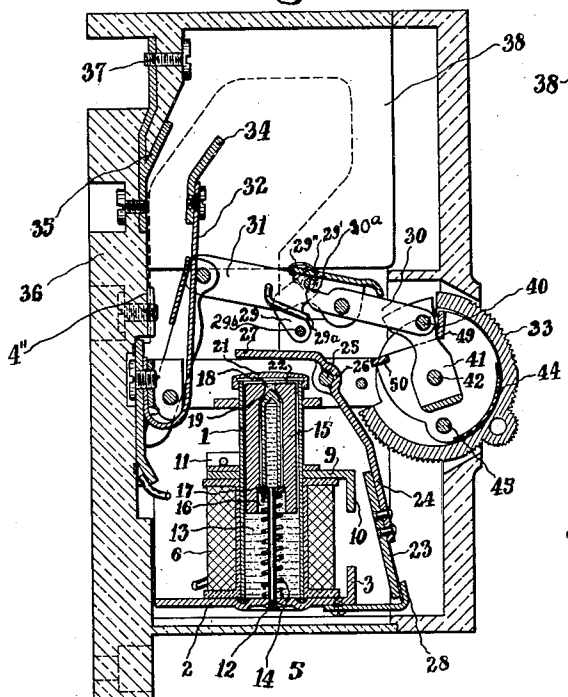


Fig. 2.

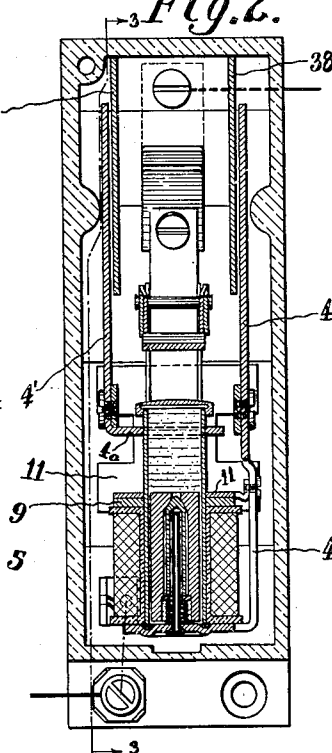


Fig. 3.

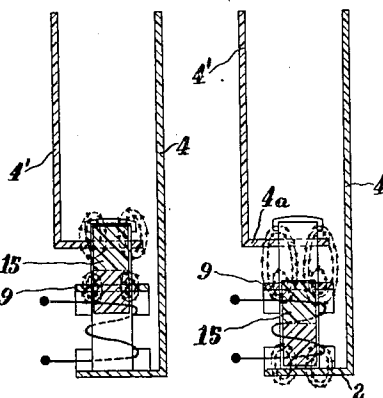
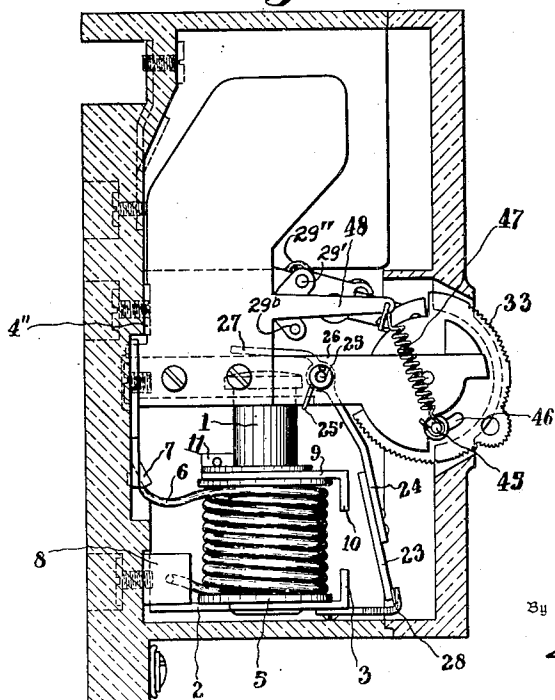


Fig. 4. Fig. 5.

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UNITED STATES PATENT OFFICE

2,072,932

METHOD OF AND APPARATUS FOR CONTROLLING ELECTRIC CIRCUITS

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Application March 28, 1934, Serial No. 717,759

5 Claims. (Cl. 200—109)

My invention is a method of and apparatus for varying the action of an electro-magnet upon an armature for actuating a switch controlling the circuit energizing the electro-magnet or other device.

My invention involves the regulation of the magnetic effect resulting from the flow of current through an electro-magnet by the movement in the magnetic field of a member or bridge which varies the reluctance of the magnetic circuit of the electro-magnet or varies the width of an air gap or gaps in such magnetic circuit. Such member is magnetically permeable and is moved relatively to the magnetic field preferably by the magnetic attraction thereof under control of retarding mechanism. The retarding mechanism preferably consists of a fluid container in which the member is housed and moves against the retarding action of fluid passing from one portion to another portion of the container upon the movement of the member. The member is preferably a core normally biased to its position more remote from the magnetic field, and, in moving to such remote position, the retarding action of the fluid thereon is minimized by by-passing the fluid, preferably through a valved passage in the member.

The movement of the core member to its position more remote from the magnetic field increases the reluctance of the magnetic circuit of the electro-magnet so that a momentary flow of current through the electro-magnet in excess of, but within say ten times, the rated capacity of the device, creates insufficient magnetic flux to operate the switch-controlling armature until such member is moved into the magnetic circuit to decrease the reluctance thereof. The movable member is, however, of such permeability that when it is positioned across the air gap between the pole pieces of the electro-magnet the magnetic flux or number of lines of magnetic force resulting from the flow of a given current through the electro-magnet is so increased that the switch-operating armature is actuated upon the flow of current slightly in excess (say 125%) of the rated capacity of the device. The electro-magnet is so designed that with the maximum reluctance of its magnetic circuit there will be sufficient magnetic flux to attract the armature when the current is so excessive that even a momentary flow thereof is dangerous, say in excess of ten times the rated capacity of the device.

Consequently with my improvements, the switch is permitted to remain closed when current is flowing within the rated capacity of the

device, or when the overload is not excessive nor of long duration, as for instance during the period required to heat the filaments of a lamp or to start a motor. But if a slight overload, say 125%, is of considerable duration, the reluctance of the magnetic circuit of the electro-magnet is so decreased and its magnetic flux is so increased by the interposition of the permeable member in the magnetic circuit that the armature is attracted and opens the switch. If the overload is sufficiently great, a magnetic flux is created by the electro-magnet, despite the reluctance of its magnetic circuit, sufficient to attract the armature and open the switch.

By my improvements there may be provided a circuit protecting device which imposes very little resistance to the flow of current through the circuit and is in no danger of being fused as a result of the high resistance to heavy short circuits incident to the use of thermal control devices. Moreover, my improved device operates at rated capacity regardless of atmospheric temperature, is noiseless in operation, is applicable to either alternating current or direct current circuits, and the switch may be reclosed without waiting for the cooling of heated elements.

The parts may be fully enclosed in a housing with or without a magnetic blow-out.

The switch may be opened manually during the flow of rated current without breaking the switch-operating toggle, but preferably the toggle is sprung to secure a quick break of the switch upon the manual operation of the handle. If desired a quick make and a quick break connection may be made between the manual operating handle and the switch lever.

When the magnetic blow-out is used, it may be associated with the reluctance-varying-member and the poles of the electro-magnet so that the polarities of the magnetic blow-out elements are maintained constant so as to blow the arc in a desired direction away from the operating parts regardless of whether the switch is broken manually or as the result of a long continued slight overload or as the result of a heavy overload or short circuit.

The characteristic features and advantages of my improvements will further appear from the following description and the accompanying drawing in illustration thereof.

In the drawing, Fig. 1 is a vertical sectional view of a switch and circuit breaker embodying my improvements; Fig. 2 is a vertical sectional view on the line 2—2 of Fig. 1; Fig. 3 is a vertical sectional view on the line 3—3 of Fig. 2; Fig. 4 is

a diagrammatic illustration of the magnetization of the magnetic blow-out plates in one position of the reluctance-varying-member; and Fig. 5 is a diagrammatic illustration of the magnetization of the magnetic blow-out plates in another position of the reluctance-varying-member.

In the embodiment of my invention illustrated in the drawing, a cylindrical brass tube 1 is brazed or soldered to a magnetically permeable metal sheet 2 terminating in an upturned end flange forming a pole piece 3 and also having an upturned side flange 4 forming a part of a magnetic blow out.

An insulating spool 5 is sleeved on the tube 1 and has wound thereon an electro-magnetic coil 6 having one of its ends connected with a switch terminal 7 and the other of its ends connected with a load terminal 8. A magnetically permeable apertured plate 9, having a down-turned lip forming a pole piece 10 complementary to the pole piece 3, is sleeved on the tube 1 and is fixed in position and supported by a bracket 11.

A brass pin 12 is fixed to the plate 2 and projects upwardly within the tube 1, which contains a liquid 13, such as oil. A spring 14 is coiled around the pin 12 and supports and normally biases upwardly a magnetically permeable soft iron core 15 containing a longitudinal passage 16, in which is seated a guide ring 17 adapted to slide loosely on the pin 12. The upper end of the passage 16 terminates in a port 18 having a conoidal seat and controlled by a conoidal valve 19 whose downward limit of movement away from the seat may be limited by the ring 17 or by a suitable pin. The top of the tube 1 is sealed by a cap 21 and washer 22.

The magnetically permeable plates 2 and 9 and the coil 6 form an electro-magnet having pole pieces 3 and 10 and whose magnetic circuit has great reluctivity due to the air gap and non-magnetic material between the plates 2 and 9 when the core 15 is in its upper position. When, however, the core 15 is moved downwardly the reluctance of the magnetic circuit of the electro-magnet is decreased as the gap between the magnetic elements thereof is decreased. Consequently, when the core 15 is in its lower-most position there is a substantially continuous metallic magnetic path for the lines of magnetic force and the magnetic flux and attractive power of the magnet is greatly increased.

A magnetically permeable armature 23 is mounted adjacent to the pole pieces 3 and 10 on the non-magnetic arm 24 of a bell-crank lever fulcrumed on the pin 25 journaled in the bracket arms 26. The opposite arm 27 of the bell crank lever tends to counter-balance the armature 23 and, in conjunction with the spring 25', swing the armature outwardly away from the pole pieces 3 and 10 and into engagement with the non-magnetic stop 28. The core 15 works in an aperture in magnetic top end piece 9 and is adapted to contact with the lower magnetic end piece 2. Therefore, when core 15 is in its lowest position the reluctance of magnet 6 is a minimum and the flux a maximum, and the armature 23 is attracted to perform the operations hereinafter described.

When the armature 23 is attracted by the pole pieces 3 and 10 and rocks the lever arms 24 and 27, the latter engages a pin 29b connecting the lower ends of the ears 29 which depend from and are fixed to the half round bar 29' journaled in the toggle link 31. The spring 29'' normally biases the ears 29 and bar 29' so that the half round surface of the latter is engaged by the nose

30a of the link 30 to hold the links 30 and 31 in a substantially straight line. But when the pin 29b at the bottom of the ears 29 is struck by the lever 27 the bar 29' is rocked so that the nose 30a passes the flat surface of the bar 29' to permit the breaking of the toggle joint. The link 31 is connected with a spring switch blade 32 and the link 30 is connected with an operating handle 33 to permit the manual operation of the switch. The terminal 34 of the switch blade 32 is movable into engagement with a terminal 35 fixed to the back of the casing 36 and having a terminal screw 37 for the attachment of a line conductor.

Any arc which tends to form across the gap between the switch terminals 34 and 35 upon the operation of the switch may be extinguished by a magnetic blow-out composed of the magnetic plate 4 bent up from the pole piece 2 and a magnetic plate 4' which has an apertured flange 4a sleeved over the tube 1 at a considerable distance above the pole piece 9 and above the center of the iron core 15 when the latter is in its upper position. Core 15, when in uppermost position, spans the gap between the lower end 4a of the blow-out plate 4' and the upper end of the winding 6 so that the flux from the winding is transmitted with full effect to the upper end of the plate 4'. The lower end of plate 4, however, goes direct to the lower end of the winding 6 and receives flux directly therefrom. The upper ends of the poles 4 and 4' therefore are at opposite polarity and the magnetic flux generated by a sudden rush of current such as that created by a short circuit, is available to extinguish the arc between the contacts 34 and 35 lying intermediate plates 4' and 4. However, after the core 15 begins to move away from the plate section 4a due to the magnetic action of the winding 6, it is important that the polarity of the plate 4' remain the same. This effect is accomplished by my arrangement because, when the core 15 separates from the plate portion 4a, if the core 15 has a north polarity at its upper end, the plate portion 4a adjacent thereto will have a south polarity, being on the opposite side of an air gap from the core. The upper end of plate 4' will have a polarity opposite to that of its lower end 4a, it being the universal rule that magnets have opposite polarities at their opposite ends, so that the polarity of the plate 4' remains the same as when the core 15 is in substantial contact with the plate 4a, assuming that the upper end of core 15 has a north polarity in both situations. The blow-out plate 4 has no cause for changing its polarity having a portion always extending across the lower end of the winding 6. The blow-out plates may have lugs 4'' secured to the insulating casing 36. Incombustible flash guards 38 may depend from the top of the casing between the cheeks of the magnetic blow out.

As illustrated in Fig. 4, when the core 15 is in its upper position the upper portion thereof of N. polarity imparts to the blow-out plate 4' an N. polarity while the plate 4 has an opposite or S. polarity, and should the switch be opened as a result of a short circuit a resultant arc is blown out upward away from the solenoid and operating parts. As illustrated in Fig. 5, when the core 15 is in its lower position its upper portion of N. polarity imparts to the upper end of blow-out plate 4' an N. polarity because of the opposite polarities of the ends of plate 4' and the S. polarity of the lower portion of the core augments the lines of magnetic force in the plate 4 of S. polarity. Hence, when the switch is opened

by a slight overload of long duration any arc formed is blown upward and away from the solenoid and operating parts.

To minimize the danger of arcing, the switch plate may, if desired, be given a quick make and a quick break action by connecting the toggle link 30 with a pivot 40 mounted in the yoke 41 journaled on the pivot 42 to which the handle housing 33 is fixed. The sheet metal casing 44 is journaled on the pivot 42 and provided with the pins 45 projecting through elongated slots 46 in the housing 33. The pins 45 are connected through the springs 47 with arms 48 projecting from the plates 4 and 4'. The casing 44 is provided with the cross members 49 and 50 adapted to engage the yoke 41.

The outer end of the link 30 has a nose 30a adapted to cooperate with the flattened rotatable pintle 29' of the toggle 29 which is normally biased by the spring 29'' against the stop 29a.

When the housing 33 is moved counter-clockwise from the position shown in Fig. 1 to close the switch, the pin 29b is brought down close to the upper arm 27 of the bell-lever and the parts 29, 29' and 30 brought into such position that the rotation of the bell-crank lever on its pivot 25 throws its arm 27 against pin 29b, thereby first rotating ears 29 against spring 29'' so as to withdraw 29' from engagement with the extension or nose 30a and then, by its further movement and pressure on bar 29b to carry ears 29 and the connected parts 30 and 31 upwardly to break the toggle at the pivot between parts 30 and 31.

When the handle housing 33 is turned upward from its position shown in Figs. 1 and 3, the ends of the elongated arcuate slots 46 engage and move the pins 45 and the bar 49 moves the yoke 41 to push the toggle and switch toward closing position. When the springs 47 are moved past the center of the pin 42 they contract and snap the pins 45 to the opposite ends of the slots 46, thereby giving the yoke 41 a quick movement completing the closing of the switch.

In opening the switch, the toggle links 41, 30 and 31 are left in the switch closing position during the initial portion of the movement of the housing 33. But when the springs 47 pass the pin 42, they contract and snap the bar 50 against the link 41, thereby breaking the toggle and releasing the switch.

Having described my invention, I claim:

1. In a circuit breaker of the type having a biased switch blade controlled by a toggle, a toggle tripping mechanism including a container formed partly of non-magnetic material and partly of magnetic material having a portion forming a pole piece, an armature in said container and movable into contact with the magnetic material portion of said container, means for retarding the movement of said armature toward said magnetic material portion of said container, means forming a second pole piece spaced from said first pole piece, a coil wound on said container between the magnetic portion thereof and said means, the passage of current through said coil creating a magnetic flux tending to draw said armature into contact with the magnetic material of said container and thereby decrease the reluctance of the magnetic circuit, and a second armature attracted to said pole pieces to trip said toggle when said first armature contacts with the magnetic portion of said container.

2. In a circuit breaker of the type having a biased switch blade controlled by a toggle, a toggle tripping mechanism including a tube of non-magnetic material, closures sealing the ends of said tubes, one of said end closures being formed of magnetically permeable material forming a pole piece, a magnetically permeable member sleeved on said tube and forming a pole piece spaced from said first named pole piece, a toggle-operating armature movable into engagement with said pole pieces, a magnetically permeable core forming an armature movable in said tube into contact with said magnetically permeable end closure thereof, a coil wound on said tube for the passage of current creating a magnetic flux between said pole pieces, means for normally biasing said core away from said magnetically permeable end closure and away from the field of the magnetic flux, said core being slowly movable by a slight increase in said magnetic flux into contact with said magnetically permeable closure to decrease the reluctance of the magnetic circuit sufficiently to cause the attraction of the said second armature by said pole pieces, and said second armature being attracted by said pole pieces by a greater increase in magnetic flux while said core is spaced from said magnetically permeable end closure.

3. In a circular breaker as set forth in claim 1, a spring normally biasing the first armature away from the magnetic portion of said container, and an armature in said container containing a recess for the reception of said spring when compressed by the movement of said armature into contact with the magnetic material portion of said container.

4. In a circuit breaker as set forth in claim 1, pole pieces extending axially of said core, and a lever supporting the second armature and fulcrumed on an axis extending transversely to the axis of said core.

5. In a circuit breaker of the type having a biased switch blade engaged with a contact by a toggle, a toggle tripping and arc blow-out mechanism including a container formed partly of non-magnetic material and partly of magnetic material having portions forming a plurality of pole pieces, an armature in said container and movable into contact with the magnetic material portion of said container, means for retarding the movement of said armature toward said magnetic material portion of said container, means forming a plurality of pole pieces complementary to and spaced from the pair of pole pieces first named, one of said first named pole pieces and one of said second named pole pieces lying adjacent to the point of engagement of said switch blade with said contact, a second armature complementary to the other pole pieces of said first and second named pairs of pole pieces, a coil wound on said container between the magnetic portion thereof and said means, the passage of current through said coil creating a magnetic field tending to draw said first-named armature into contact with the magnetic material of said container and thereby decrease the reluctance of the magnetic circuit to cause the attraction of said second armature to break said toggle and open said switch and augment the magnetic flux adjacent said switch blade and contact to extinguish any arc formed by the separation thereof.

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