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ELECTRORESPONSIVE OPERATING MECHANISM

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Fig. 1.

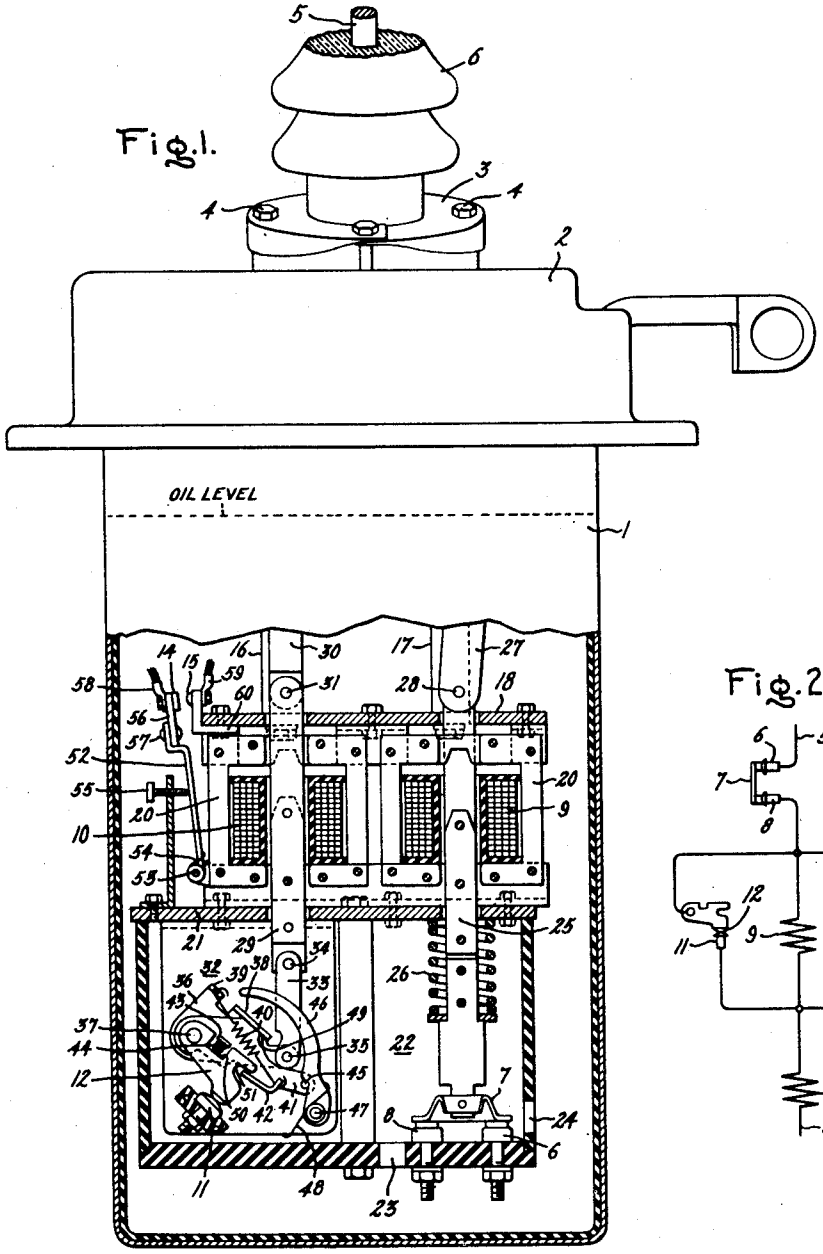

Fig. 2.

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ELECTRORESPONSIVE OPERATING MECHANISM

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7 Claims. (Cl. 317—22)

This invention relates to electro-responsive operating mechanisms and more particularly to an electro-responsive electro-magnetically operated mechanism for controlling an electric circuit interrupter of the reclosing type.

In electric circuit interrupters of the type disclosed in application Serial No. 19,364 filed April 6, 1948, now Patent No. 2,633,514, McCurry et al., assigned to the assignee of this application, satisfactory operation is accomplished when the magnitude of fault or overload current is equal to or greater than the pick-up current. Since opening and closing operations of interrupters of the type disclosed in the above McCurry application are controlled by a timing mechanism, and since proper functioning of the timing mechanism is dependent upon a full operating stroke of the electro-magnetic operating mechanism, improper functioning of the timing mechanism may occur if the contacts are not fully opened during each successive opening operation of the interrupter during persistent fault conditions. Furthermore, operation of the interrupter is likely to be improper when the current to be interrupted is at or near unity power factor and at or near the pick-up current of the electro-responsive means. This is true because the current would be interrupted at the first current zero after the contacts part and since the voltage would be in phase with the current at unity power factor, there would be no voltage to cause the arc drawn between the main contacts to restrike. Hence, at low values of fault or overload current, the contacts would not be accelerated sufficiently in the short time available and hence would not be moved to their fully opened position, which may result in improper operation.

Of course, additional opening force can be achieved by increasing the number of turns utilized in the solenoid which operates the contacts of the interrupter to the open position. If additional turns are added to the operating coil, it is possible that excessive forces will be developed at high fault currents resulting in undue strains being imposed on the timing mechanism and associated parts.

One object of the invention is to provide an improved reclosing circuit interrupter wherein an operating coil having an ample number of turns is used to insure that the mechanism will complete a full opening stroke even though the overload current may be in time phase with the circuit voltage and equal to or slightly in excess of the pick-up value of the interrupter, and wherein means are provided for preventing damage to the mechanism which might occur when the fault or overload current is very large.

Another object of the invention is to provide an electro-responsive operating mechanism wherein one movable member always responds to currents in excess of a predetermined value and wherein another movable member responds to currents in excess of a predetermined value greater than the value of current to which the first movable member responds.

In accordance with the invention, an electro-magnetic device having an operating solenoid and a main movable armature is provided with an auxiliary armature which is responsive to currents through the solenoid coil which are substantially in excess of the currents required to actuate the main movable armature. As applied to an interrupter the auxiliary armature embodied in the invention may be used to insert a current limiting impedance means in circuit with the electroresponsive

means utilized to open the breaker contacts. In this way the operating force developed by the electro-responsive means can be controlled and excessive force on mechanism avoided.

The following description will be better understood when taken in conjunction with the accompanying drawings in which Fig. 1 is a side elevation partially in section of a reclosing circuit breaker embodying the invention, and in which Fig. 2 is a schematic diagram representing the circuit of the device shown in Fig. 1. The scope of the invention will be pointed out in the appended claims.

With reference to Fig. 1, the numeral **1** designates the enclosing tank for the interrupter on the top of which is mounted a cover member **2**. Cover **2** is secured to tank **1** in any suitable manner such as by bolts. A pair of terminal assemblies one behind the other are provided and are secured to cover plate **2**. Each terminal assembly comprises an adapter plate **3** secured to the cover **2** by means of bolts **4**, and a conductor **5** surrounded by insulating bushing **6**. In the schematic diagram of Fig. 2 one terminal is designated by the reference numeral **5** and the other terminal is designated by the reference **5***a*. In Fig. 2 it can be seen that the terminal **5** is connected to fixed contact **6** which in turn cooperates with movable bridging contact **7**. Fixed contact **8** is connected in series with main operating coil **9** and with relay coil **10**. Bridging member **7** is controlled by main coil **9**. Disposed in shunt relationship with respect to the main coil **9** is a fixed contact **11** and movable contact **12**. Contact **12** is controlled by relay coil **10**. The main operating coil **9** is connected in parallel with an impedance means **13** which in turn is connected in series with movable contact **14** and a fixed contact **15**. Contact **14** is controlled in accordance with the invention and is arranged to be closed only in response to a current through relay coil **10** which is substantially in excess of that required to cause contact **12** to open.

As is more fully disclosed in the above mentioned McCurry et al. application, the coils **9** and **10** and parts associated therewith are supported from the cover **2** by means of downwardly extending arms **16** and **17**. Arms **16** and **17** are secured to a metallic plate member **18** to which is bolted laminated frame structure **20** which in turn supports plate member **21** which forms the top wall of the interrupting chamber **22**. Interrupting chamber **22** is provided with expulsion ports **23** and **24**. The assembly as shown in Fig. 1 is immersed in oil to approximately the level indicated. Main operating coil **9** is provided with an armature **25** which is biased downwardly by means of the compressional spring **26**. Bridging contact **7** is secured to the lower extremity of armature **25**. Secured to the upper end of armature **25** is a rod member **27**. Connection between rod **27** and armature **25** is made by means of pin **28**. As is more fully disclosed in the above mentioned McCurry et al. application, rod **27** cooperates with a timing mechanism disposed in the upper part of tank **1** which effectively delays closing operations of bridging member **7**. Movable relay contact **12** is controlled by relay coil **10** through the agency of relay armature **29**. Relay armature **29** is interconnected with the timing mechanism disposed in the upper portion of the tank **1** by means of rod **30** which is connected by pin **31** to armature **29**.

Relay armature **29** causes operation of its movable contact **12** through the agency of the mechanism generally designated at **32**. The mechanism **32** incorporates the link **33** which is pivotally connected as at **34** to the relay armature **29**. The lower end of link **33** is pivoted at **35** to the member **36** which in turn is pivoted to a fixed member **37** secured to the arcing chamber wall or which may be supported in any other suitable manner. It will be observed that the member **36** is constructed with the projection **38** extending along a portion of its upper edge and also that the member **36** is provided with an apertured projection **39** which serves as a means for mounting one end of the tension spring **40**. Also pivotally mounted at **37** is a member **41**. Disposed on the lower surface of the member **41** is an apertured projection **42** to which is attached the other end

of the spring 40. Member 41 is also provided with a projection 43 which engages one end of the compression spring 44. The member 41 is also provided with a projecting pin 45 which engages a curved surface of the curved member 46 which is mounted to a fixed pivot 47 which pivot may be secured to the wall of the arcing chamber. Spring 48 serves to bias the member 46 for rotation in the counterclockwise direction against the pin 45 mounted on the member 41. It will be observed that the surface 49 of the member 41 engages the projection 38 on the member 36. Contact 12 is pivotally mounted at 37 and is provided with a recess 50 into which the projection 43 on the member 41 is movable. The bottom of the recess 50 affords a surface against which the small compression spring 44 is allowed to bear. The contact arm 12 is also constructed with a recess 51 which cooperates with the projection 42 on the member 41.

The operation of the delayed action switch 32 is as follows: Whenever the relay coil 10 is sufficiently energized to impart upward movement to its armature 29 the link 33 is elevated carrying with it the righthand end of the member 36. This motion of member 36 allows the projection 38 on the member 36 to move away from the surface 49 of the member 41, and, as the member 36 is rotated counterclockwise about the pivot 37, the spring 40 is elongated somewhat and a counterclockwise moment is thereby exerted on the member 41. Member 41 is prevented from rotating in a counterclockwise direction, however, for a short time due to the engagement of the pin 45 on member 41 with the curved cam-like surface of the curved member 46. As the arm 33 continues upwardly, the forwardly projecting pin 35 eventually engages the curved member 46 and causes such member to be rotated in the clockwise direction about its fixed pivot 47. This clockwise rotation of the member 46 will cause the pin 45 to ride over the curved cam-like surface of the member 46 due to the pull of tension spring 40 and will permit counterclockwise rotation of the member 41 about the fixed pivot 37. This counterclockwise rotation of member 41 will cause contact arm 12 to be rotated counterclockwise due to the engagement of the projection 42 on the member 41 with the upper edge of the recess 51 on the contact arm 12. In this way the contacts 11 and 12 are separated thereby removing the short circuit from around the main operating coil 9 which thereby causes the fault current to flow through coil 9 and initiates an opening operation of the bridging member 7. Certain opening operations are delayed by the timer by controlling the upward movement of rod 30 and parts associated therewith.

In accordance with the invention, means are provided to prevent damage to the timing mechanism and associated parts when the fault or overload current is extremely severe. In Fig. 1 an armature 52 is shown pivoted at the pin 53 to the frame structure 20 of the relay. Armature 52 is constructed of magnetic material and is biased for rotation in the counterclockwise direction about pin 53 by means of spring 54 against the adjustable stop 55. An insulating member 56 is secured to the upper end of the armature 52 by means of a bolt or rivet 57. A contact member 14 is secured to the upper end of insulating member 56 and a terminal connector 58 is connected with contact 14. The contact 15 is disposed for cooperative engagement by the contact 14 when armature 52 is moved in the clockwise direction about pin 53. Contact 15 is electrically connected with connector 59 and is mounted on an insulating member 60. The impedance 13 for convenience is shown in Fig. 2 but is not included in the drawing of Fig. 1. From Fig. 2 it will be observed that when contact 14 engages contact 15 impedance 13 will be placed in parallel with the main operating coil 9. In this way a portion of the current which normally would flow through coil 9 when relay contact 12 is not in engagement with contact 11, flows through the shunt circuit comprising impedance 13 and the auxiliary contacts 14 and 15. Obviously the impedance 13 could be inserted in series with the main coil if desired. Thus, by means of a suitable choice of a spring 54 and by suitable adjustment of adjusting screw 55, the value of current through relay coil 10 which will cause armature 52 to close contacts 14 and 15, can be determined. Obviously, when the electro-responsive mechanism comprising the invention is used in conjunction with the circuit breaker of the type shown in Fig. 1, it would be desirable to arrange the elements so that the contacts 14 and 15 would close only when the fault or overload current would be extremely severe such as to cause damage to the breaker mechanism. Furthermore the auxiliary armature could be used to insert a suitable impedance in the circuit of relay coil 10 to limit the force developed thereby.

While a particular embodiment of the invention has been shown and described, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the invention in its broader aspects and it is therefore intended in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

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

1. A circuit interrupter comprising relatively movable main contacts, electromagnetic means in series with said main contacts for separating said contacts in response to current therethrough in excess of a predetermined value, a relay having an operating winding in series with said electromagnetic means and main contacts and having contacts in parallel with said electromagnetic means, said relay being operable in response to the flow of current through its operating winding in excess of a predetermined value to open its contacts and thereby to render said electromagnetic means effective to open said main contacts, an auxiliary armature mounted on said relay and movable from a normal position to an operated position in response to the flow of current through said operating winding which is different in magnitude than the magnitude of current required to operate said relay contacts, auxiliary contacts controlled by said auxiliary armature, and impedance means controlled by said auxiliary contacts and arranged to control the magnitude of current through said electromagnetic means upon operation of said auxiliary armature.

2. A circuit interrupter comprising relatively movable main contacts, electromagnetic means in series with said main contacts for separating said contacts in response to current therethrough in excess of a predetermined value, a relay having an operating winding in series with said electromagnetic means and main contacts and having contacts in parallel with said electromagnetic means, said relay being operable in response to the flow of current through its operating winding in excess of a predetermined value to open its contacts and thereby to render said electromagnetic means effective to open said main contacts, an auxiliary armature mounted on said relay and movable from a normal position to an operated position in response to the flow of current through said operating winding substantially greater in magnitude than the magnitude of current required to operate said relay contacts, and means controlled by said auxiliary armature for reducing the magnitude of current through said electromagnetic means.

3. A circuit interrupter comprising relatively movable main contacts, electromagnetic means in series with said main contacts for separating said contacts in response to current therethrough in excess of a predetermined value, a relay having an operating winding in series with said electromagnetic means and main contacts and having contacts in parallel with said electromagnetic means, said relay being operable in response to the flow of current through its operating winding in excess of a predetermined value to open its contacts and thereby to render said electromagnetic means effective to open said main contacts, an auxiliary armature mounted on said relay and movable from a normal position to an operated position in response to the flow of current through said operating winding substantially greater in magnitude than the magnitude of current required to operate said relay contacts, normally open auxiliary contacts controlled by said auxiliary armature, and impedance means arranged in series with said auxiliary contacts, said impedance means and said auxiliary contacts being in parallel with said electromagnetic means

4. A circuit interrupter comprising relatively movable main contacts, electromagnetic means in series with said main contacts for separating said contacts in response to current therethrough in excess of a predetermined value, a relay having a frame structure of magnetic material and an operating winding in series with said electromagnetic means and main contacts and having contacts

in parallel with said electromagnetic means, said relay being operable in response to the flow of current through its operating winding in excess of a predetermined value to open its contacts and thereby to render said electromagnetic means effective to open said main contacts, auxiliary relay means mounted on said frame structure and operable from a normal position to an operated position in response to current in the operating winding of said relay substantially greater in magnitude than the magnitude of current required to operate said relay contacts, normally open auxiliary contacts controlled by said auxiliary relay, and impedance means arranged in series with said auxiliary contacts, said impedance means and said auxiliary contacts being in parallel with said electromagnetic means.

5. A circuit interrupter comprising relatively movable main contacts, electromagnetic means in series with said main contacts for separating said contacts in response to current therethrough in excess of a predetermined value, a relay having an operating winding in series with said electromagnetic means and main contacts, and having a first armature controlling contacts in parallel with said electromagnetic means, said first armature forming a portion of a flux path for said relay, said first armature being operable in response to the flow of current through said operating winding in excess of a predetermined value to open its associated contacts thereby to render said electromagnetic means effective to open said main contacts, an auxiliary armature mounted on said relay and forming a supplementary flux path for the flux established by said operating winding, said auxiliary armature being movable from a normal position to an operated position in response to the flow of current through said operating winding which is different in magnitude than the magnitude of current required to operate said first armature, auxiliary contacts controlled by said auxiliary armature, and impedance means controlled by said auxiliary contacts and arranged to control the magnitude of current through said electromagnetic means upon operation of said auxiliary armature.

6. A reclosing circuit interrupter comprising a pair of relatively movable main contacts, spring means for biasing said contacts toward contact engaging position, operating electromagnetic means in series with said main

contacts for separating said main contacts against the action of said spring biasing means in response to fault currents, a control relay having a winding in series with said electromagnetic means and main contacts and having normally closed contacts in parallel with said electromagnetic means, said control relay being operable in response to flow of current through its winding in excess of a predetermined magnitude to open its contacts and thereby to render said electromagnetic means effective to open said main contacts, and auxiliary relay means oeprable in response to flow of current through said main contacts greater than the current required to operate said control relay for reducing the effective ampere turns of said electromagnetic means.

7. A reclosing circuit interrupter comprising a pair of relatively movable main contacts, spring means for biasing said contacts toward contact engaging position, operating electromagnetic means in series with said main contacts for separating said main contacts against the action of said spring biasing means in response to fault currents, a control relay having a winding in series with said electromagnetic means and main contacts and having normally closed contacts in parallel with said electromagnetic means, said control relay being operable in response to flow of current through its winding in excess of a predetermined magnitude to open its contacts and thereby to render said electromagnetic means effective to open said main contacts, and means including an auxiliary armature operable in response to flow of current through said main contacts which is greater than the current required to operate said control relay for reducing the effective ampere turns of said electromagnetic means.

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