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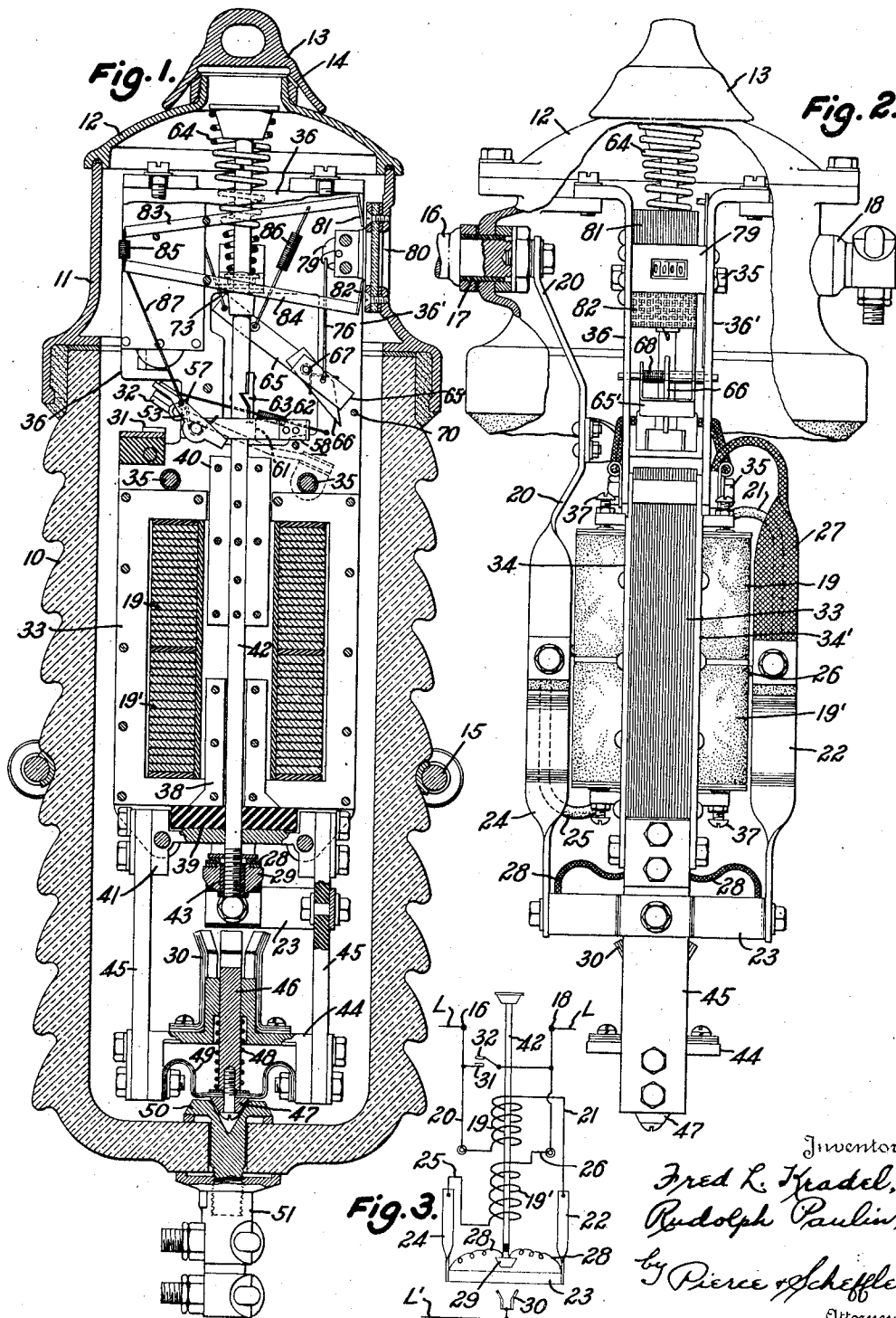
F. L. KRADEL ET AL

2,400,936

LINE SHORTING CONTACTOR

Filed May 7, 1943

3 Sheets-Sheet 1



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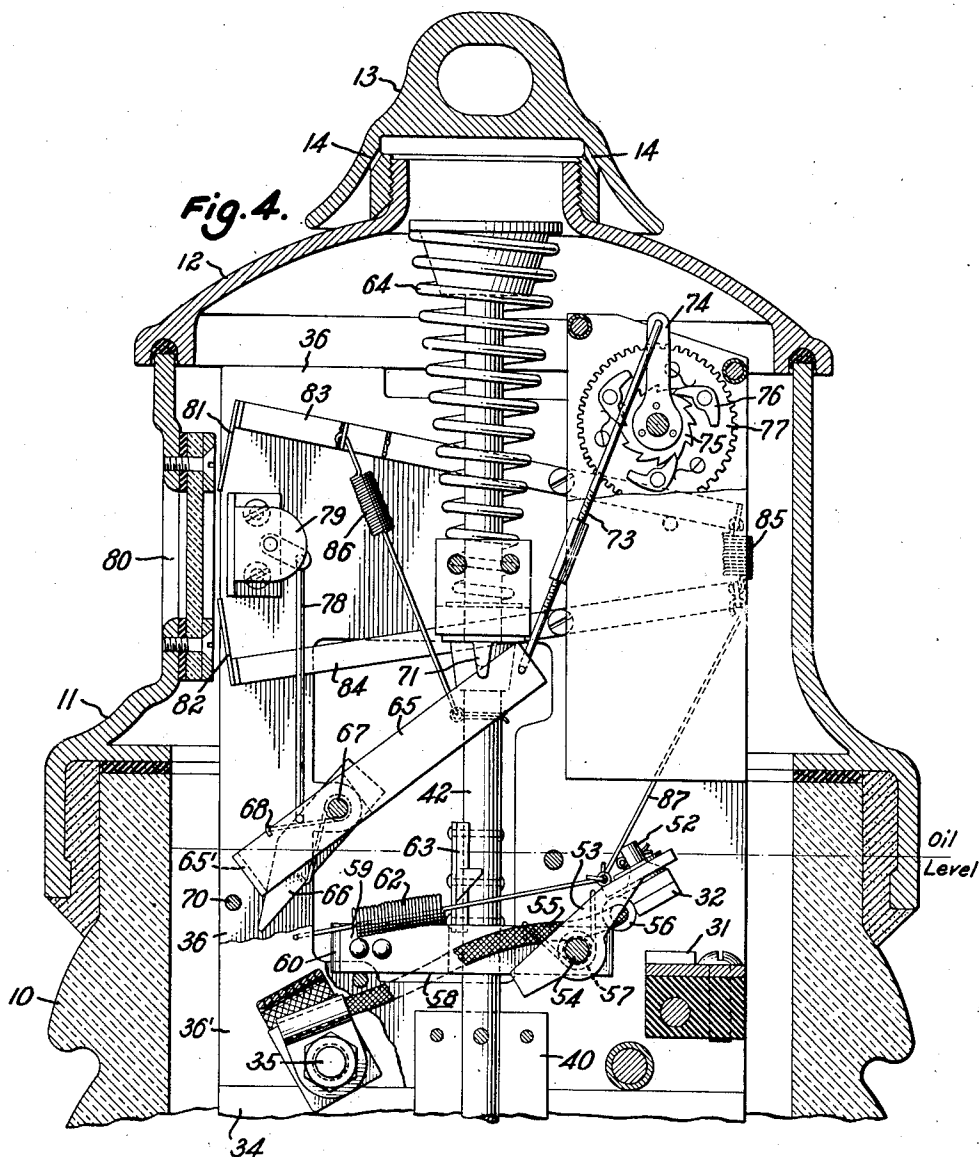
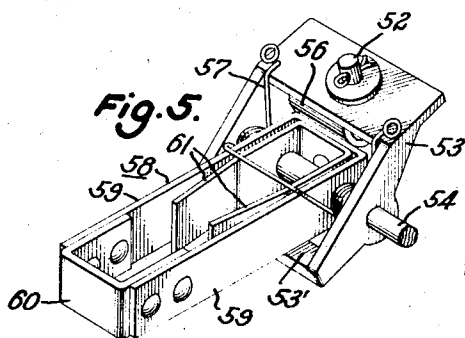
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UNITED STATES PATENT OFFICE

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LINE SHORTING CONTACTOR

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13 Claims. (Cl. 200—97)

This invention relates to line shorting contactors that are employed on electrical distribution systems to suppress the flow of a fault current by establishing a metallic short circuit across the line at a point between the current source and the fault.

Protective systems that include line shorting contactors are described and claimed in the co-pending application of George A. Matthews, Ser. No. 333,875, filed May 7, 1940, "Apparatus for protecting power lines", which became Patent No. 2,334,571 on November 16, 1943; and the present invention relates particularly to novel mechanical constructions for switch devices that have the operating characteristics of the line shorting contactors described in that application.

An object of the present invention is to provide line shorting contactors that include blocking mechanisms of relatively simple construction for preventing a reclosure of the shorting contactor immediately after a fault-actuated closure and opening thereof. An object is to provide a line shorting contactor that includes a counter for registering the number of operations thereof, and associated signal vanes for indicating the condition of the shorting contactor, i. e., normal open condition, closed, or open but locked against reclosure.

These and other objects and the advantages of the invention will be apparent from the following specification when taken with the accompanying drawings in which:

Fig. 1 is a vertical section through a line shorting contactor embodying the invention;

Fig. 2 is a fragmentary side elevation of the same as seen from the right of Fig. 1;

Fig. 3 is a schematic circuit diagram of the line shorting contactor;

Fig. 4 is a fragmentary sectional view, on a larger scale, of the upper part of the device as seen from the rear of Fig. 1;

Fig. 5 is a perspective view of the part of the mechanism for blocking a reclosure of the line shorting contactor; and

Figs. 6, 7 and 8 are schematic views illustrating the control and indicating mechanism in, respectively, normal position, contactor closed position, and contactor locked-out position.

The protective switch or line shorting contactor is a fully automatic self-contained unit within a chamber comprising a hollow insulator 10 having an approximately cylindrical metal casting 11 cemented to its upper end to receive the domed cover 12 that terminates in a flanged oil filler opening to which the filler cap 13 is threaded.

The cap 13 has a flange or skirt that flares away from the cylindrical threaded section to cover vent openings 14 that extend through the cap, and the top portion of the cap is formed as a lifting ring. The lower end of the insulator 10 is closed except for a central bore through which a line shorting circuit connection extends, as will be more fully described hereinafter. The outer surface of the insulator is preferably of the usual petticoat type or is otherwise circumferentially grooved to receive a supporting bracket 15 by which the shorting contactor is mounted on a pole at any desired point in the circuit.

A source or line terminal 16 enters the casting or shell 11 through an insulating bushing 17, and a load terminal 18 is integral with the shell 11. The operating winding of the contactor preferably comprises two coils 19, 19' of the same or of different designs that may be connected to the terminals 16, 18 in parallel or in series, the series connection providing a mid-point tap that adapts the contactor for use at a point along the line at which there may be a reversal of the direction of current flow under some operating conditions. The series connection of the coils 19, 19' is illustrated in Figs. 1, 2 and 3. A connecting strap 20 joins the line terminal 16 to the lower end of coil 19, and the lead 21 from the upper coil end extends downwardly along the coil and is secured to the strap 22 that is bolted to one end of a yoke 23. A strap 24 connects the other end of the yoke 23 to the lower terminal of coil 19', and the upper coil terminal 26 is bolted to the flexible jumper 27 that extends to the metallic supporting structure and thereby to the line terminal 18. Flexible jumpers 28 connect the opposite ends of the yoke 23 to the shorting contact 29, Fig. 3, that is moved into engagement with the cooperating contact 30 upon a predetermined current flow through the coils 19, 19'.

The coils are connected in series in one conductor L of a two-wire distribution system by means of the terminals 16, 18, and the other contact 30 of the shorting contactor is connected to the other conductor L', i. e., the distribution circuit is short-circuited by a closure of the contacts 29, 30 upon the occurrence of a fault that results in excessive current flow. The shorting contactor closes in from 1/2 to 2 cycles, on a 60 cycles per second distribution system, and results in a heavy current flow through the metallic short-circuit that operates the circuit protective equipment, for example the circuit breakers of a distribution system such as illustrated in the co-pending Matthews application, and stops the flow

of current at the fault point, thereby protecting the line conductors against burnoff. The interruption of current flow at the circuit breaker deenergizes the coils 19, 19', and the shorting contactor opens and is prevented from reclosing for a preselected period during which the protective equipment operates through a series of reclosures to a locked-out condition in the event of a permanent fault. The mechanism for delaying a reclosure of the shorting contactor preferably includes both a mechanical lock-out that will be described later and a switch, comprising contacts 31, 32, for shunting the coils 19, 19'.

The coils 19, 19' each comprise a single or multiple layer solenoid wound from flat copper bar and having both terminals at one end of and at diametrically opposite sides of the coil. The coils are mounted within a laminated yoke 33 and reversely arranged to locate all terminals at the level of a transverse plane at the center of the coil assembly. This terminal design and coil arrangement simplifies the construction of the circuit elements for connecting the coils in series or in parallel. Skeleton plates 34, 34' are riveted to the outer sides of the magnetic yoke 33 and are secured by bolts 35 to an upper pair of skeleton plates 36, 36' that have integral ears for securing the skeleton frame assembly to and grounding it upon the casting 11. The operating coil or coils 19, 19' are anchored in fixed position by pressure screws 37 that extend through lugs of the frame plates 34, 34'.

The lower central section 38 of the yoke rests upon a rubber cushioning member 39 and serves as a stop for the armature 40, the cushioning member 39 being supported on a plate 41 that is secured to the plates 34, 34'. The armature 40 comprises laminations bolted to the switch rod or plunger 42 that extends above the armature to carry a part of, and to actuate, the control mechanism. The movable contact 29 is secured to and insulated from the plunger 42 by a bushing 43 of insulating material. The cooperating contact 30 comprises a cylindrical assembly of resilient strips of a copper or bronze alloy carried by a bridge member 44 that is suspended below the supporting plates 34, 34' by straps 45 of insulating material. The conducting yoke 23 is mounted on one of the insulating straps 45. The bridge 44 has a central bore for guiding the stem 46 that carries a conical contact 47 and is pressed by spring 48 towards a terminal assembly at the base of the insulator 10. Flexible jumpers 49 connect the bridge 44 to the contact 47 to provide a low resistance path for current flow when the shorting contactor is closed. The fixed terminal assembly comprises a stud 50 having a conically recessed head to receive the contact 47, and a stem that extends through the insulator 10 and has a lower end upon which the terminal member 51 is threaded.

When the coils 19, 19' are connected in parallel, the yoke 23 is not necessary and the shorting contact 29 is mounted directly upon the plunger 42 that is grounded on the supporting structure and thereby electrically connected to the terminal 18.

The mechanism for blocking a reclosure of the line shorting contacts 29, 30 is illustrated in Figs. 1 and 4, and different stages of one operating cycle are shown somewhat diagrammatically in Figs. 6-3. The stem 52 of the movable contact 32 of the shunting switch extends through and can rock on a double arm or bridge member 53 that

is pivotally supported on a fixed shaft 54, and a flexible jumper 55 extends through a sleeve 56 of the movable contact assembly and its ends are bolted to the supporting frame, preferably by the same bolt 35 that clamps the flexible jumper 27 to the frame plate 36', to provide a low resistance connection between the movable contact 32 and the line terminal 13. The bridge member 53 is urged clockwise by a helical spring 57 that has ends bearing on member 53, intermediate side sections coiled about the shaft 54 and a central section engaging the operating and control arm 58; and the angular movement of the bridge member 53 is limited by the engagement of its crossbar 53' with the operating arm 58, see Fig. 5.

The operating and control arm 58 is pivoted on the shaft 54 and comprises a U-shaped member 59, hardened steel end bar 60 that connects the side bars of member 59, and a U-shaped or double-armed leaf spring 61 within the member 59 and riveted to the end thereof. The bridge member or contact-carrying arm 53 and the operating arm 58 are urged counterclockwise, i. e., towards open circuit position, by the coil spring 62 that is connected between the arm 53 and the supporting plates 36'. The ends of spring 61 flare inwardly and co-operate with a downwardly directed spear-shaped member 63 on the plunger 42 to form a one-way coupling between the plunger arm 58 and the plunger 42. The spear-shaped member 63 spreads the ends of springs 61 when the plunger moves down in response to a predetermined current flow through the coils 13, 15'. Upon interruption of current flow through coils 13, 19', the plunger 42 is lifted by the spring 64, and the control arm 58 is then turned clockwise, to close the shunting contacts 31, 32, by engagement of the upper radial surfaces of the member 63 with the ends of the leaf springs 61.

The mechanism for mechanically locking the shunting contacts in closed position includes the locking lever 65 and trigger 66 that are pivotally mounted on the plates 36, 36' by a shaft 67, the lever 65 and trigger 66 being normally retained in approximate alignment by a spring 68. The tail of the trigger 66 normally rests against the crossbar 65' of lever 65, and it strikes a stop pin 70 to arrest the trigger in locking position when the lever 65 is forced down by the lug 71 that is fixed to the plunger 42.

The lever 65 is coupled by a link 73 to the arm 74 of a time delay mechanism that imposes substantially no delay upon the clockwise movement of lever 65 upon downward movement of plunger 42 to close the shunting contacts 29, 30, and that delays the return movement of the lever into unlocking position. The time delay mechanism may be of any desired type and, as illustrated, the arm 74 is secured to a shaft carrying a ratchet wheel 75 that is coupled by pawls 76 or overrunning clutch to a gear 77 of an escapement mechanism, not shown. Rotation of arm 74 and shaft by link 73 coils a spring, not shown, that tends to rotate the arm 74 clockwise to lift the link 73 and locking lever 65. Gear 77 is loose on the shaft, but is driven through the pawl and ratchet mechanism when the shaft is rotated clockwise, thus delaying the lifting of the link 73 and locking lever 65.

The lever 65 is connected by link 78 to the operating arm of a "Veeder" counter 79 that is mounted within the casting 11 at a window 80 through which the counter is normally exposed to view.

Signal vanes 81, 82 are carried by levers 83, 84, respectively, for movement into line with the window opening when the shorting contacts 29, 30 are closed and when the shorting contacts are open but locked against closure. The vanes 81, 82 are of different colors, for example red and yellow respectively, to indicate the different conditions of adjustment of the shorting contactor. The signal vanes are normally moved away from the window opening by the spring 85 that joins the levers 83, 84, and the vanes are moved into operative positions by a resilient connection 86 from plunger 42 to lever 83, and by a link 87 from the bridge member 53 to the lever 84.

The method of operation of the shorting contactor will be apparent from a consideration of Figs. 6, 7 and 8 that illustrate the positions of the several elements of the control mechanism when, respectively, (1) the contactor is in normal inactive condition, (2) when the shorting contacts 29, 30 are closed, and (3) when the shorting contacts 29, 30 are open and locked against reclosure. A fault on the line L, L' results in excessive current flow through the windings 19, 19' and the plunger 42 is moved downwardly by the armature 40 to close the shorting contacts 29, 30. The control and indicating mechanisms are then in the positions illustrated in Fig. 7. The control arm 58 has not changed position but the spear member 63 on plunger 42 has forced aside the leaf springs 61 and moved below the same. Lever 65 was forced down by the lug 71 on plunger 42, and set the time delay mechanism by pulling down the arm 74. The trigger 66 moved clockwise with lever 65 until its tail engaged the stop pin 70, and the counter 79 was actuated by the lever 65. The vane 81 was moved downward into line with the window opening 80 by its spring connection 85 to the plunger 42.

Upon interruption of current flow through the coils 19, 19', by operation of the circuit breakers or otherwise depending upon the design of the protective equipment, the plunger 42 is lifted by the spring 64 to open the shorting contacts 29, 30. The control mechanism elements then occupy the positions illustrated in Fig. 8. The control arm 58 is turned clockwise by the spear member 63, thereby closing the contacts 31, 32 that shunt the coils 19, 19' and block a reclosure of the shorting contacts. The end bar 60 of the control arm forces the trigger 66 aside as the arm 58 is lifted, and then rests upon the end surface of the trigger when the spear member 63 moves above the leaf springs 61 and the arm 53 is turned counterclockwise by the spring 62. This partial return movement of the arm 58 brings the ends of the leaf springs 61 against or closely adjacent the sloping surfaces of the spear member 63 and mechanically locks the plunger against downward movement. The signal vane 81 moved out of the window opening when the plunger 42 lifted but the vane 82 was moved into the window opening by the link 87 when the shunting contacts closed. The lever 65 is rotated counterclockwise by the link 73 and the time delay mechanism and, after a preselected interval, the crossbar 65' of the lever 65 engages the tail of the trigger 66 and moves the trigger out of the path of the control arm 58. The control arm 58 is then moved counterclockwise by the spring 62, and thereby the shunting contacts 31, 32 are opened and the mechanical lock against reclosure is removed. All parts then occupy their normal positions as illustrated in Figs. 1, 3, 4 and 6.

The operating coils 19, 19' and restoring spring 72 are so related that the shorting contacts 29, 30 close substantially instantaneously, i. e., in from $\frac{1}{120}$ to $\frac{1}{30}$ of a second, upon the occurrence of a fault, thus suppressing the flow of fault current by placing a metallic short circuit upon the line. The short circuit current actuates a circuit interrupter (fuse or circuit breaker) to remove the voltage from the line, and the shorting contacts are then opened by the restoring spring 64 and are locked out for a predetermined period to permit the circuit interrupter mechanism to operate through a series of reclosures to a lockout in the event of a permanent fault. The great majority of all faults are of a transient nature, however, and normal service is usually restored upon the first reclosure of the circuit interrupter mechanism.

There is considerable latitude in the design, construction and relative arrangements of the several elements of the shorting contactors and it therefore is to be understood that various changes may be made in the disclosed constructions without departure from the spirit of our invention as set forth in the following claims.

We claim:

1. A line shorting contactor of the type including a normally open switch having a fixed and a movable contact for connection to opposite sides of a power distribution line, electrically actuated switch closing means including a plunger carrying the movable contact for closing said switch, and blocking means operative upon an opening of said contacts to prevent reclosure thereof for a predetermined interval, characterized by the fact that said blocking means comprises a pivotally mounted arm, a one-way coupling for moving said arm into actuated position upon a switch-opening movement of said plunger, said coupling comprising a member on said plunger and spring means on said arm in the path of said member and deflectible therefrom by the member on a switch-closing movement of said plunger, spring means tending to return said arm from its actuated position, and means including a time-delay mechanism for controlling the return of said arm from its actuated position.
2. A line shorting contactor as recited in claim 1, wherein said blocking means includes a normally open switch for rendering said switch closing means inoperative, and means movable by said arm on displacement into actuated position to close said second switch.
3. A line shorting contactor as recited in claim 1, wherein said blocking means includes means on said plunger and cooperating with said arm for locking said plunger against switch-closing movement when said arm is in actuated position.
4. A line shorting contactor as recited in claim 1, wherein said member on said plunger and said spring means on said arm have cooperating surfaces locking said plunger against switch-closing movement when said arm is in actuated position.
5. A line shorting contactor as recited in claim 1, wherein said blocking means includes a normally open switch for rendering said switch closing means inoperative, and means movable by said arm on displacement into actuated position to close said second switch; and said member on said plunger and said spring means on said arm have cooperating surfaces locking said plunger against switch-closing movement when said arm is in actuated position.
6. In a line shorting contactor, a normally open switch having contacts for connection to opposite

sides of a power distribution line, electrically actuated means including a plunger for closing said switch, and means mechanically locking said plunger against a switch-closing movement upon a switch-opening movement thereof; said locking means including a pivotally mounted control arm, a one-way coupling including a member on said plunger for moving said control arm to actuated position upon a switch-opening movement of said plunger, a pivoted trigger member engageable with said control arm when in actuated position to prevent return thereof to normal non-actuated position, and time-delay means for moving said trigger member out of engagement with said control arm, thereby rendering said locking means inoperative.

7. In a line shorting contactor, the invention as recited in claim 6, in combination with switch means operable by movement of said control arm to actuated position to render said electrically actuated means inoperative.

8. In a line shorting contactor including normally open switch contacts and means including a plunger for closing said switch contacts; blocking means to prevent reclosure of said switch contacts upon an opening thereof, said blocking means comprising a pivotally mounted control arm and means for moving the same into actuated position upon a switch-opening movement of said plunger, a trigger, a locking lever operable by said plunger on a switch-closing movement thereof to move said trigger into the path of return movement of said control arm, and means including said locking lever and a time-delay mechanism for moving said trigger out of the path of return movement of said control arm.

9. In a line shorting contactor including a pair of normally open switch contacts and means including a plunger for closing said switch contacts; blocking means for preventing a reclosure of the switch contacts upon an opening thereof, said blocking means comprising a control arm, a resilient one-way coupling of said plunger to said control arm for moving the latter to actuated position upon a switch-opening movement of the plunger, and locking means for preventing return

of said control arm from actuated position, said locking means including a locking lever and means on said plunger for moving said locking lever into actuated position upon a switch-closing movement of said plunger.

10. In a line shorting contactor, the invention as recited in claim 9 wherein said control arm comprises a pivotally mounted member having side bars at opposite sides of said plunger; and said resilient one-way coupling includes a leaf spring secured within said mounted member and having inwardly flared ends, and a spear-shaped member on said plunger for pressing aside and moving beyond the ends of said leaf spring member upon a switch-closing movement of said plunger.

11. In a line shorting contactor, the invention as recited in claim 9, in combination with means operated by said control arm for rendering said contact-closing means inoperative upon movement of said control arm into actuated position.

12. In a line shorting contactor, a pair of normally open switch contacts electrically actuated means for closing said switch contacts upon excessive current flow, means for separating said switch contacts upon a removal of voltage after a closure of said switch contacts, means for blocking reclosure of said switch contacts for a predetermined interval after an opening thereof, a counter operated by said blocking means for registering the number of closures of said switch contacts, a signal vane, and means operable by said electrically actuated means to move said signal vane to prevent observation of said counter simultaneously with a closure of said switch contacts.

13. In a line shorting contactor, the invention as recited in claim 12, in combination with a second signal vane, and means for displacing the second signal vane into position to block observation of said counter, said displacing means being operable by said blocking means upon actuation thereof to block a reclosure of said switch contacts.

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