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3,031,601

CIRCUIT PROTECTIVE APPARATUS

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Fig. 1.

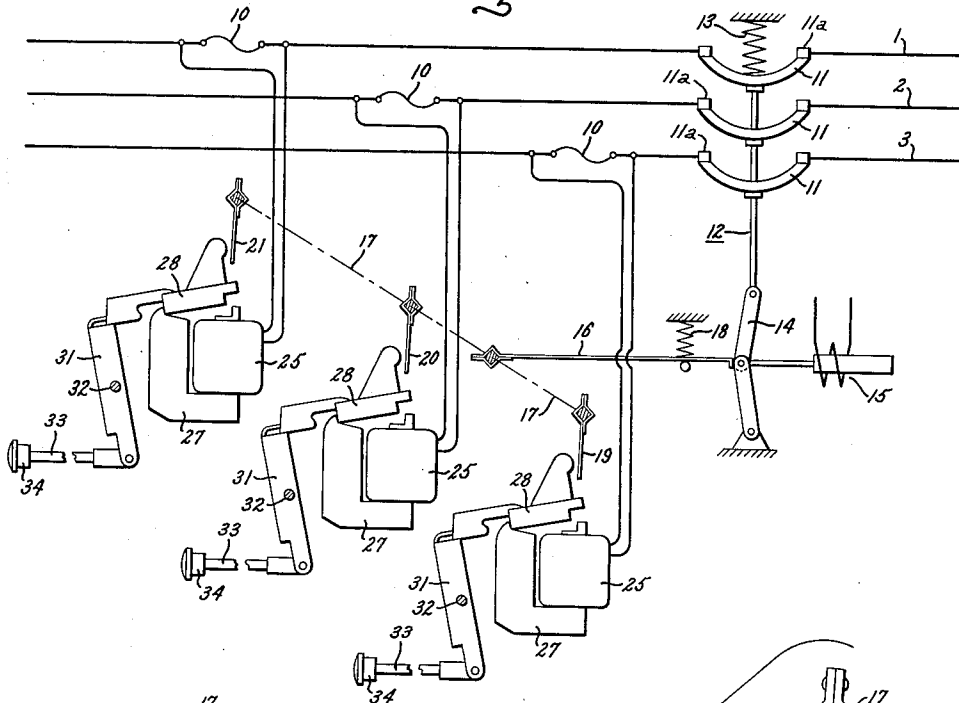


Fig. 3.

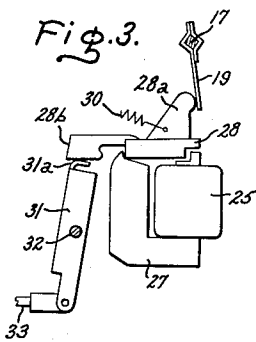
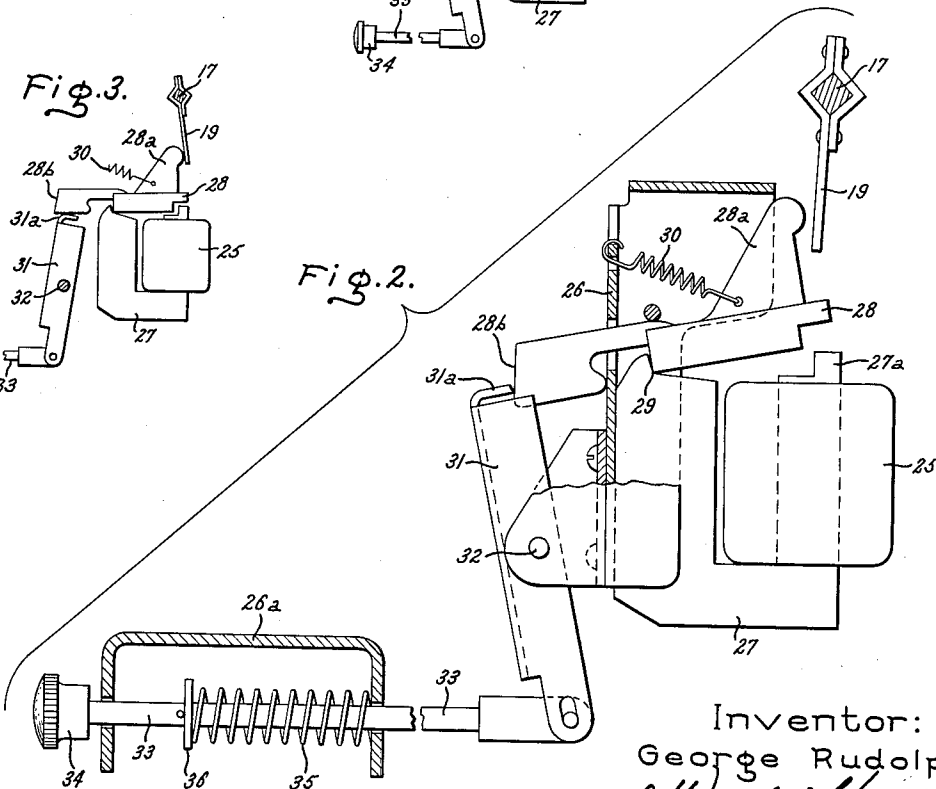


Fig. 2.



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CIRCUIT PROTECTIVE APPARATUS

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5 Claims. (Cl. 317-46)

My invention relates to circuit protective apparatus of the series-connected fuse and circuit breaker type, and more particularly to fuse actuated tripping and lockout means for the circuit breaker in such a combination.

As indicated in Patent 2,358,215, Darling, it has been known for some time that a fuse of the current-limiting type connected in series circuit relation with an overload responsive automatic circuit breaker and having its interrupting characteristics coordinated with the interrupting characteristics of the circuit breaker will cooperate therewith more effectively to protect an electric circuit against overload and short circuit currents than can be done with either of the devices separately. It has also been recognized that for safety purposes, and also to prevent single phasing in the event that only one of the three fuses in a typical three-phase circuit is ruptured, means should be provided for tripping the circuit breaker and thus interrupting all phases of the circuit in response to the rupturing of any one or more of the series-connected fuses. In a typical arrangement of this character, however, such as shown in Patent 2,928,997, Edmunds, the circuit breaker tripping apparatus is automatically reset on opening of the circuit breaker, so that the circuit breaker may be manually reclosed immediately without replacement of the blown fuse. This arrangement also fails to give any indication of the location of the ruptured fuse, or even of the fact that circuit breaker tripping occurred as a result of fuse operation.

Accordingly it is a principal object of my invention to provide circuit breaker tripping means responsive to interruption of a series-connected fusible element to trip the circuit breaker and positively preclude its reclosure in the absence of deliberate breaker resetting and fuse replacement.

It is a further object of my invention to provide tripping means for a multi-phase circuit breaker which is responsive to rupture of a series-connected fuse in any one phase of the circuit to trip the circuit breaker and lock itself in tripping position.

It is still another object of my invention to provide, in a multi-phase circuit breaker, lock-out type tripping means responsive to rupture of a series-connected fuse in any phase to indicate the faulted phase and the nature of the interrupting action.

In carrying out my invention in one preferred embodiment for a typical three-phase circuit, I provide a three-phase circuit breaker having thermal or magnetic overload-responsive means, or both, in each phase of the circuit, all arranged to actuate a common movable trip shaft the movement of which for any reason is effective to release the circuit breaker mechanism for automatic opening movement of the contacts. In series with the circuit breaker contacts there is provided in each phase of the circuit a fusible element, preferably in the form of a fuse of the current-limiting type. For each phase of the circuit there is provided an electromagnet having a movable armature responsive to rupture of the fuse in that phase to actuate the trip shaft of the circuit breaker. Positioned in mechanical interlocking relation with each such tripping armature is provided a movable blocking lever which is normally held by the electromagnet armature in a latched unblocking position and is released by actuating movement of the armature to move into a position to block return movement of the armature. Connected to

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the blocking lever is a manual reset shaft the released movement of which indicates the fact and location of fuse operation and the manual return movement of which serves to reset the blocking lever and electromagnet armature. Preferably the fuse-responsive electromagnet is connected to be energized by voltage appearing across the associated fuse when ruptured.

My invention will be more fully understood and its various objects and advantages further appreciated by referring now to the following detailed specification taken in conjunction with the accompanying drawings in which:

FIG. 1 is a schematic electro-mechanical diagram of a three-phase circuit breaker-fuse protective combination illustrating the fuse-responsive circuit breaker tripping mechanism in schematic perspective view;

FIG. 2 is a detailed side elevational view of the fuse-responsive lockout tripping mechanism, showing the mechanism in its normal latched or untripped position; and

FIG. 3 is a partial side elevational view of the mechanism in a locked out tripped condition.

Referring now to the drawing and particularly to FIG. 1, I have shown a circuit including line conductors 1, 2 and 3, each having connected in series circuit relation therewith a fusible element 10 preferably of the current-limiting type, and the separable contacts 11, 11a of a three-phase circuit breaker 12. The movable circuit breaker contacts 11 are interconnected for simultaneous operation as indicated, and are biased to open position by means of an actuating spring 13. A common latch-type operating mechanism 14 is provided for moving the circuit breaker contacts to closed position (as shown) and holding them latched in that position against their bias. The closing means is schematically indicated as an electromagnet 15, and the latching means is shown as a movable stop member 16 mounted upon a rotatable tripping shaft 17, and biased to latching position by a spring 18.

The circuit breaker tripping shaft 17 is provided with three actuating arms 19, 20 and 21, each of which is associated through a similar electromagnetic tripping mechanism with one phase of the three-phase circuit. Each tripping mechanism comprises an electromagnet having an actuating winding 25 connected in parallel circuit relation with the fuse 10 in the associated phase of the circuit 1, 2, 3. These tripping mechanisms are identical in structure and are shown in greater detail at FIG. 2.

At FIG. 2 I have shown one of the fuse-responsive circuit breaker tripping mechanisms arranged to engage the actuating arm 19 of the tripping shaft 17. The tripping mechanism comprises a supporting member or frame 26 having mounted thereon an electromagnet comprising a magnetizable core member 27 carrying the actuating winding 25 and a pivotally mounted movable armature member 28. The electromagnetic armature 28 is pivotally seated upon one leg of the core 27 at a point 29 intermediate the ends of the armature, and is biased to unattracted position by a spring 30. The armature 28 is shown in its unattracted position and is pivotally movable to an attracted position in engagement with a pole piece 27a of the core member 27. The armature is provided at one end with a laterally projecting actuating arm 28a arranged to engage and move the trip lever 19 when the armature is moved to attracted position. At its opposite end the armature 28 is provided with a latching shoulder 28b arranged for interlocking engagement with a movable blocking member 31. The blocking member is shown as a pivotally mounted bar or lever pivoted intermediate its ends upon the frame 26 at a point 32. To the end of the blocking lever 31 remote from the armature 28 is connected a reset and indicating rod 33 which passes through a portion 26a of the

frame 26 and has at its end an indicating and reset button 34. The blocking member 31 is biased to move into a blocking position beneath the latch shoulder 28b of the armature 28 by means of a compression spring 35 encircling the reset rod 33 and interposed between the frame portion 26a and a seating washer 36 fixed to the rod 33.

At its end opposite the reset rod 33, the blocking member 31 is provided with a projecting finger 31a arranged to be engaged by the latching shoulder 28b when the armature 28 is in its unattracted position, thereby to hold the blocking lever 31 against its bias and in an unblocking position. It will be evident that when the armature 28 is moved to its attracted position, the armature rotates in a clockwise direction, as viewed in the drawing, raising the latching shoulder 28b out of the path of the finger 31a and permitting the finger 31a to move in a clockwise direction under the latching shoulder 28b. In this position, which has been illustrated in FIG. 3, the blocking member 31 positively mechanically blocks return movement of the armature 28 to its unattracted position until such time as the blocking member is returned to its normal latched position by manual movement of the reset shaft 33. Upon such manual return of the blocking lever 31 to its latched position shown, the finger 31a is removed from beneath the end of the armature 28. The armature is then free to return to its unattracted position under the action of its biasing spring 30, and in this position it engages the finger 31a in the manner shown in FIG. 2, thereby to latch the blocking member 31 in its unblocking position shown.

It will now be evident from the foregoing description that in operation, rupture of any one of the circuit fuses 10 will cause the line voltage appearing across the open fuse to be applied to the actuating winding 25 of the associated tripping magnet, thereby to attract the armature 28 of that magnet and to actuate the circuit breaker trip shaft 17. When the armature 28, associated with the faulted phase, is actuated to engage the trip shaft, it releases its interlocked blocking lever 31 for movement under its bias to blocking position beneath the latching end of the armature. Such movement of the blocking member 31 moves the reset rod 33 connected thereto to a position to indicate that the circuit breaker tripping occurred as a result of fuse operation, and further indicates which phase of the circuit was responsible for the tripping. In this blocking position of the interlocked tripping armature and indicating linkage, as is clearly shown in FIG. 3, the armature 28 is positively and mechanically blocked from return to its unattracted position and thus held in tripping engagement with the associated arm 19, 20 or 21 of the trip shaft 17. In this manner the trip shaft 17 is positively held in its tripping position and is thus disabled from latching closed the operating mechanism 14 of the circuit breaker 12. The circuit breaker operating mechanism is preferably of the trip-free type such as shown for example in Patent 2,549,441, Favre, so that any effort to manually reclose the circuit breaker with the trip shaft 17 held in its tripping position will be ineffective.

While I have illustrated only one preferred embodiment of my invention by way of illustration, various modifications will occur to those skilled in the art. For example, it is evident that actuation of the trip shaft 17 may be accomplished by engagement between the trip shaft and the blocking member 31, rather than between the trip shaft and the armature 28. In like manner it will be evident that mechanical means such as a switch responsive to rupturing of the circuit fuses may be utilized to energize the electromagnet 25 in place of the shunt circuit connection shown. It will be further apparent that the movable blocking member may be provided with means for positively locking the circuit breaker operating mechanism in open circuit position as well as for blocking the circuit breaker trip mechanism in its

tripped position. Accordingly, therefore, I wish to have it understood that I intend in the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

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

1. An electric circuit protective apparatus comprising a circuit breaker having a pair of relatively movable co-operating switch contacts connected in series circuit relation with a fusible element, operating mechanism for opening and closing said switch contacts including means biasing said switch contacts to open circuit position and latching means for retaining said switch contacts in closed circuit position in opposition to said biasing means, tripping means for releasing said latching means including a movable trip member, an electromagnet including an actuating winding and having an armature movable to attracted position to actuate said trip member to a releasing position, a movable blocking member biased to a position to engage and mechanically hold said armature in said attracted position, a movable latch member actuated by said armature upon movement to its unattracted position to retain said blocking member against its bias in an unblocking position, manually operable resetting means for moving said blocking member from said blocking position to said unblocking position, and means responsive to circuit interruption by said fusible element for energizing said electromagnet.

2. An electric circuit protective apparatus comprising a circuit breaker having a pair of relatively movable co-operating switch contacts connected in series circuit relation with a fusible element, operating means for opening and closing said contacts including means biasing said contacts to open-circuit position and latching means for retaining said switch contacts in closed circuit position in opposition to said biasing means, tripping means for releasing said latching means including a movable trip member, an electromagnet including an actuating winding and having an armature movable to attracted position to actuate said trip member to a releasing position, a movable blocking member biased to a position to engage and mechanically hold said armature in said attracted position, said armature including a latching shoulder positioned when said armature is in its unattracted position to engage said blocking member and retain it against its bias in an unblocking position, manually operable resetting and indicating means connected to said blocking member for returning said blocking member to said unblocking position, and means responsive to circuit interruption by said fusible element for energizing said electromagnet.

3. An electric circuit protective apparatus comprising a circuit breaker having a pair of relatively movable co-operating switch contacts connected in series circuit relation with a fusible element in each phase of a multiphase circuit, operating mechanism for simultaneously opening and closing said switch contacts including means biasing said switch contacts to open-circuit position and latching means for retaining said contacts in closed-circuit position in opposition to said biasing means, tripping means for releasing said latching means including a movable trip member, and a tripping mechanism associated with each phase of said circuit, each said tripping mechanism comprising an electromagnet including an actuating winding and having an armature movable to an attracted position to actuate said trip member to a releasing position, a movable blocking member associated with each said armature, each said blocking member being biased to a position to engage and mechanically hold its associated armature in attracted position, each said armature including a latching shoulder positioned when said armature is in its unattracted position to engage the associated blocking member and retain said blocking member against its bias in an unblocking position, separate manually operable resetting and indicating means connected to each said blocking member for individually returning said blocking

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members to their unblocking positions, and means responsive to circuit interruption by the fusible element in each said circuit phase to energize a respective one of said electromagnets.

4. An electric circuit protective apparatus as claimed in claim 3 in which the electromagnets are connected for energization across the terminals of the fusible elements respectively.

5. An electric circuit protective apparatus comprising a circuit breaker having a pair of relatively movable co-operating switch contacts connected in series circuit relation with a fusible element, operating mechanism for opening and closing said switch contacts including means biasing said switch contacts to open circuit position and latching means for retaining said contacts in closed circuit position in opposition to said biasing means, tripping means for releasing said latching means including a movable trip member, an electromagnet including an actuating winding and having an armature biased to an unat-

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tracted position, a movable blocking member biased into latching engagement with said armature in said unattracted position and releasable by movement of said armature to said attracted position to move into blocking engagement with said armature and prevent return movement of said armature, means operable in response to movement of said armature to said attracted position to actuate said trip member to a releasing position, and means responsive to circuit interruption by said fusible element to energize said electromagnet to attract said armature.

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