Nov. 7, 1933. W. M. SCOTT 1,933,767

AUTOMATIC CIRCUIT BREAKER SYSTEM

Filed Jan. 19, 1929 2 Sheets-Sheet 1

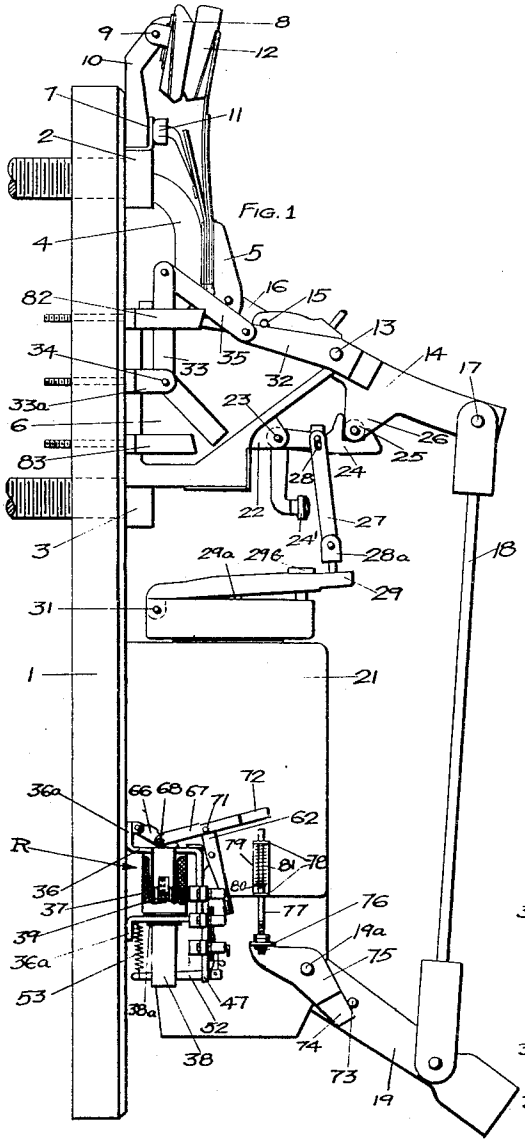


FIG. 1

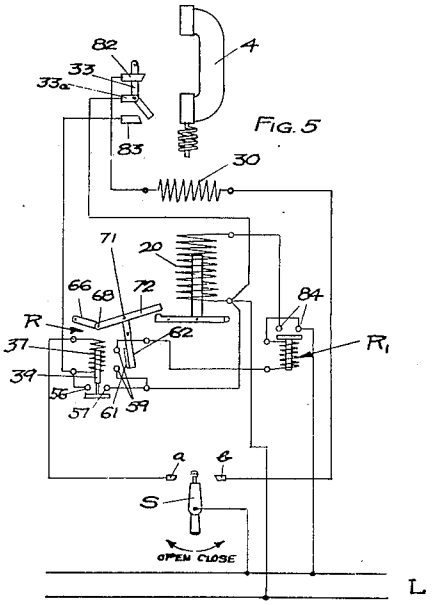


FIG. 5

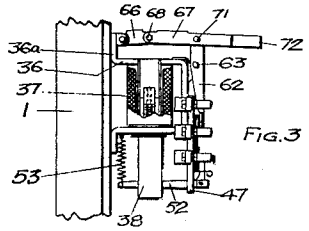


FIG. 3

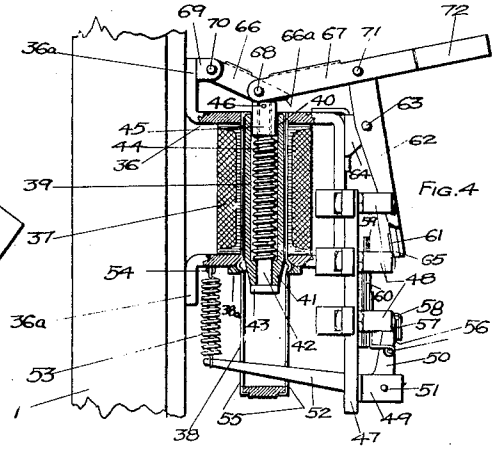


FIG. 4

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AUTOMATIC CIRCUIT BREAKER SYSTEM

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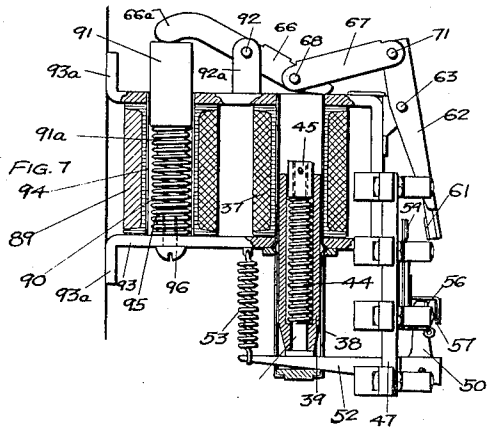


FIG. 7

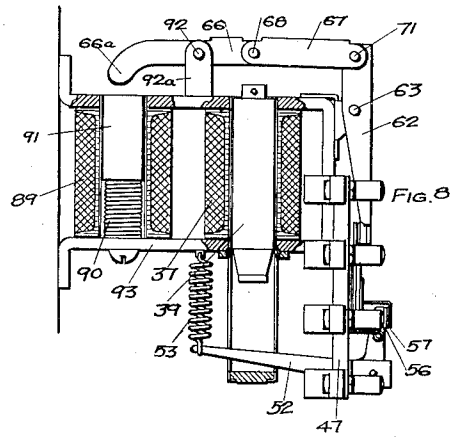


FIG. 8

FIG. 6

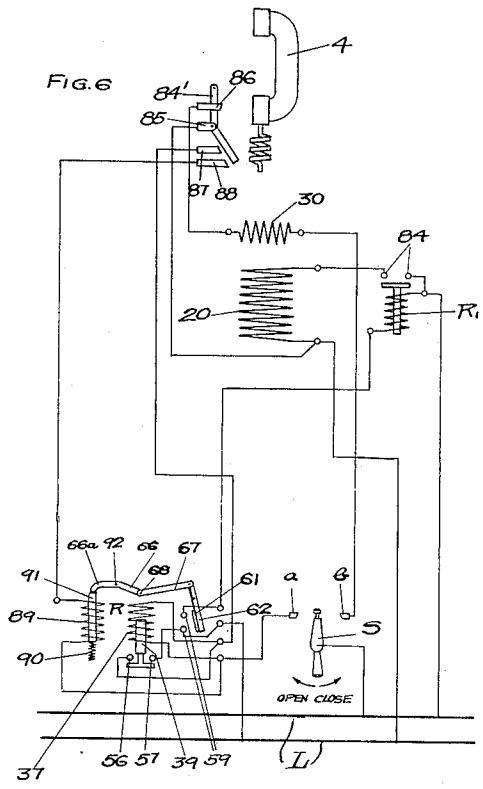
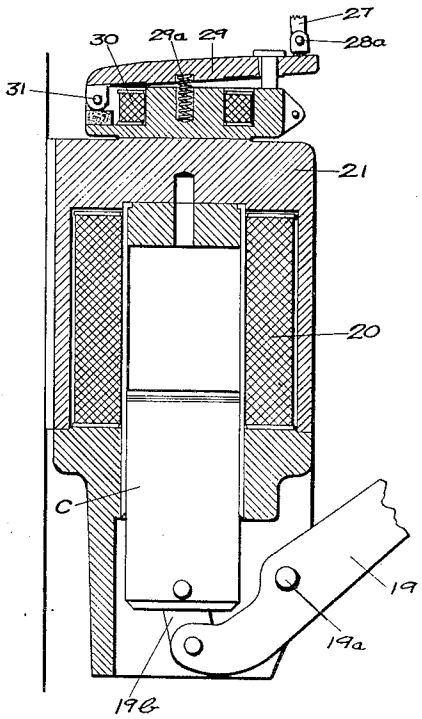


FIG. 2



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UNITED STATES PATENT OFFICE

1,933,767

AUTOMATIC CIRCUIT BREAKER SYSTEM

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Application January 19, 1929. Serial No. 333,712

26 Claims. (Cl. 200—111)

My invention relates to a control system, and particularly to a system for controlling operation or actuation of electric switches, especially automatic circuit breakers.

In accordance with my invention, a main switch as an automatic circuit breaker responsive to abnormal circuit conditions, is moved to normal position, as circuit-closing position, by an electro-motive device energized through contacts controlled or held in predetermined relative position by structure remaining or locked in a corresponding position after actuation by a movable member, detached from but adapted to engage or strike said structure and withdraw therefrom, and upon completion of movement of the main switch or breaker to its said normal position said structure is mechanically actuated or electro-magnetically controlled to cause said contacts to resume their former relative position, whereby subsequent energization of the electro-motive device may be effected only by independent control means, and uncontrolled successive operations of the the main switch or breaker, after successive movements thereof to abnormal position, is prevented.

Further and more particularly in accordance with my invention, the structure aforesaid comprises overtravelling toggle mechanism extended by ballistic impact of an electro-magnetically actuated member; and means actuated substantially upon completion of movement of the main switch, effects collapse of said toggle mechanism to effect de-energization of the electro-motive device; and more particularly, said toggle mechanism remains in its collapsed or de-energizing position until a remote control member is moved, as at the will of an operator, to re-energize electro-magnetic means for actuating said ballistic member.

My invention further resides in a system and apparatus of the character hereinafter described and claimed.

Fig. 1 is a side elevational view of apparatus constructed in accordance with my invention.

Fig. 2 is a vertical sectional view, parts in elevation, showing part of the structure of Fig. 1.

Fig. 3 is an illustration of the relay structure of Fig. 1, with parts in another position.

Fig. 4 is a generally similar view of the same relay structure, on a larger scale, with parts in a third position.

Fig. 5 is an electrical diagram illustrative of mode and connection and use of structure such as that illustrated in Fig. 1.

Fig. 6 is an electrical diagram of a modified system.

Fig. 7 is a vertical sectional view, parts in elevation, of the relay structure of the system in Fig. 6.

Fig. 8 is a view similar to Fig. 7, with parts in a different position.

Referring to Fig. 1, to the base 1 of slate or other insulating material there are secured main terminal blocks 2 and 3 which are adapted to be bridged by the movable contact member 4, here representing a laminated briding member supported by and mounted upon the arm 5 which is pivoted to the housing or bracket 6 secured upon base 1. The terminal blocks or stationary contacts 2 and 3 are connected in a circuit (not shown) which is to be controlled for supplying any suitable load, as motor or lighting load. Secured upon and in electrical contact with the terminal block 2 are the intermediate stationary metallic shunt contact 7 and the stationary shunt carbon contact 8, pivoted at 9 to the bracket 10. Cooperating with the shunt contact 7 is the movable shunt contact 11, and with the carbon shunt contact 8 cooperates the movable carbon shunt contact 12, the contacts 11 and 12 being supported by the arm 5.

Pivoted, as at 13, to the bracket 6 is a switch-actuating lever 14 having arms disposed on either side of the pivot point and to one end of which there is pivoted, as at 15, a link 16 whose other end is pivoted on the switch arm 5. To the other end of the lever, as at 17, there is pivoted a downwardly extending operating rod 18 suitably pivoted at its lower extremity to an arm 19, pivoted at 19*a*, which is operated through pivoted link 19*b* by the core C (Fig. 2), of a solenoid or closing coil 20 disposed within the casing 21 which is preferably of magnetic material.

Pivoted to the ear 22, on the housing 6, at 23 is the latch 24 adapted to engage the roller 25 carried in the extension 26 of the switch-actuating lever 14 to lock the parts in circuit-closed position. In Fig. 1 the parts are in the fully closed circuit position. The upper end of a connecting rod or link 27 is pivoted, preferably with lost motion in a slot, as at 28, to the latch 24 and the lower end thereof is pivoted to a projection 28*a* extending upwardly from the upper surface of and near one end of a pivoted armature member 29 biased upwardly against a stop member 29*b* to the position shown, by a spring 29*a* (Fig. 2) or other suitable means. Upon

energization of a tripping coil 30 disposed within the upper end of the housing or casing 21, the armature 29 rotates about its pivot 31 to retract the latch member 24 from its restraining engagement with roller 25, permitting the switch arm 5 to rotate in a clockwise direction, as viewed in Fig. 1, under the influence of a spring or other suitable means, not shown, to the open circuit position and simultaneously therewith the switch-actuating arm 14 connected thereto by the link 16 rotates in a counter-clockwise direction, effecting like movement of the arm 32 fastened to the arm 14 and rotating therewith about the shaft 13. The free end of the arm 32 is connected through link 35 to the end of a movable switch member 33 pivoted at 34 to a terminal member 33*a* fastened in any desired manner to the base 1. The latch 24 may also be actuated by pushing towards base 1, the manually operable finger 24' which is connected to or engages the latch 24 to effect rotation thereof in a clockwise direction. The latch 24 may also be, and preferably is, provided with a tail extension (not shown) movement of which may be effected by changes in degree of energization of a tripping coil connected in series with the main terminals 2 and 3 or in any other desired relation.

Mounted to the front and lower surface of panel 1 is a relay R comprising and supported by a U-shaped bracket 36 of magnetic material. The extremities of bracket 36 form lugs or flanges 36*a* which are secured, as by bolts or screws, to the panel 1. A relay coil 37 is rigidly mounted within the U-shaped bracket and is supported thereby, as is a hollow guide member or liner 38 of non-magnetic material, such as brass tubing for example. The guide tube 38 is suitably secured to bracket 36, as by collar 38*a* fastened to the lower side of the bracket and extends through openings (Fig. 4) in the upper and lower portions of said bracket.

Referring more particularly to Fig. 4, coil 37 is provided with a magnetizable core 39 adapted to move longitudinally of the axis of the coil in response to energization thereof. Core 39 is adapted to reciprocate within the non-magnetic guide member 38, and comprises a tubular portion of magnetic material having a recess 40 extending nearly the entire length thereof and terminated by an annular shoulder 41. The lower end of core 39 is provided with an axial bore within which a buffer member or rod 42 is mounted. Buffer rod 42 comprises a collar 43 which normally seats on the lower edge of core 39 and is normally biased upwardly by a spring 44, one end of which seats on the annular shoulder 41 and the other end of which bears against a collar of cap 45 secured, as by a pin 46, to the upper portion of buffer rod 42. Accordingly, spring 44 normally biases the buffer rod to the position illustrated in Fig. 4.

An insulating panel 47 is secured, as by screws or bolts, (not shown) to the lower vertical portion of bracket 36, and comprises material which is both mechanically strong and of suitable insulating characteristics, such as canvas or the like, impregnated with a phenol condensation product. Panel 47 has mounted along one edge thereof binding posts 48, and at its lower edge has mounted thereon a U-shaped bracket 49 of conducting material such as copper to which a movable switch member 50 is mounted, as by a pivot pin 51 extending between the arms of bracket 49. Switch member 50 extends within the U-shaped conducting bracket 49, and comprises an extension 52 extending through a slot (not shown) in panel 47. The outer extremity of the extension or arm 52 is secured to one end of a light tension spring 53 having its opposite end secured to a lug 54 mounted on bracket 36. Extension 52 furthermore extends freely through slots 55 in the sides of guide member 38 and is adapted to be engaged by the core member 39 in a manner hereinafter described. Mounted upon the upper end of switch member 50 is a contact element 56, electrically connected by suitable means to bracket 49, which is adapted to coact with a stationary contact 57 carried by a conducting bracket 58 mounted on panel 47.

A pair of stationary contacts, one of which, 59, is illustrated, are mounted upon the outer face of panel 47, and each comprises a resilient conducting strip 60 having its lower end suitably secured to panel 47. The aforesaid pair of contacts are adapted to be bridged by a conducting strip 61 carried at the lower end of a toggle-actuated arm 62 mounted, as by pivot 63, on the lug or bracket 64 secured to bracket 36. Arm 62 may be of any suitable material such as metal, the conducting strip 61 being insulated therefrom by an insulating strip 65 carried by arm 62. Toggle mechanism for actuating arm 62 comprises a pair of channel-shaped links 66 and 67 pivoted to each other at 68. Link 66 has its other end pivoted, as at 70, to a lug 69 carried by bracket 36, link 66 having shoulder portions 66*a* adapted to engage the under side of the channel-shaped link 67 when pivot 68 has moved upwardly a predetermined distance to an overtravelled position. Link 67 is pivoted, as at 71, to the upper end of switch arm 62 and comprises an extension 72 for a purpose hereinafter described. The aforesaid toggle mechanism is adapted to be moved by core 39 so that pivot 68 is carried beyond and above the dead center between pivots 70 and 71 to rotate switch arm 62 in a clockwise direction, thereby bridging the resiliently mounted contacts 59 by the movable contact member 61. When in this position, due to the overtravelled toggle structure, the contact member 61 is positively restrained in closed position independently of core 39, and may be considered as latched or locked in such position, subject to release only by the coaction of a tripping member, or equivalent.

Referring again to Fig. 1, arm 19 which is mechanically responsive to movements of the main breaker element 4, has mounted thereon a pin or lug 73 adapted to engage an end or extension 74 of the member 75, which is secured to casing 21 as by pivot 19*a*. The opposite end of member 75 comprises an offset portion or flange 76 having loosely connected thereto a rod 77. Rod 77 is guided for reciprocatory movement within the offset flanges 78 of a guide member 79. A collar 80 is mounted upon rod 77 intermediate flanges 78 and has seated thereon one end of a spring 81 whose other end seats against the under side of the upper flange. Guide member 79 is rigidly mounted upon casing 21 so that rotation of arm 75 in a clockwise direction causes rod 77 to move upward with respect to the guide 79, this movement however, being resisted by the action of spring 81 bearing upon collar 80. The upper portion of rod 77 extends through and beyond the upper guide flange and is adapted to engage the toggle link

extremity 72 in a manner, and for a purpose, hereinafter described.

The operation of the apparatus illustrated in Figs. 1 to 4 is as follows:

Referring now more particularly to Fig. 5, which diagrammatically illustrates the coaction of the apparatus above described, a remote switch S comprises a movable member electrically connected to one side of a line L, and is adapted to engage either contact *a* or *b*. Assuming now that the main switch member 4 is in closed position as illustrated, the auxiliary switch member 33, mechanically connected by links 32 and 35 thereto, bridges the contacts 82 and 33*a*, which forms the pivotal mounting of switch member 33, so that movement of the remote switch S to contact *b* completes a circuit across the line L through trip coil 30. As illustrated in Figs. 1 and 2, trip coil 30 is adapted to attract armature 29 against the influence of spring 29*a*, thereby disengaging latch 24 from the roller 25 to permit collapse of the toggle mechanism 14—16 and the consequent opening of the main breaker 4. It will of course be understood that the main breaker 4 may be opened in various ways, as by manually depressing the knob 24', to release latch 24, or by effecting release of the latch by either overload or underload electro-magnetic means associated with the main circuit to be protected. As the main switch or breaker moves to open position the auxiliary switch member 33 is accordingly rotated in clockwise direction through its mechanical connection with the breaker, and engages a stationary contact 83 substantially coincident with its disengagement with contact 82. The current through trip coil 30 is thereupon interrupted, since continued energization thereof is neither required nor desirable.

The main breaker, being now in its fully opened position, may be closed only by moving the remote switch S to engage contact *a*, thereupon completing a circuit through coil 37 of relay R through the auxiliary switch contacts 33 and 83. Energization of coil 37 projects core 39 upwardly therethrough with sufficient force so that it "overshoots" its normal magnetic center to ballistically engage the toggle mechanism substantially at the pivot 68 to effect extension thereof to an overtravelled position. Accordingly, contacts 59 are bridged by the conducting strip 61 to energize the coil of a second relay R_1. As core 39 moves upwardly and out of engagement with arm 52, referring now to Fig. 4, the tension spring 53 moves the switch arm extension 52 upwardly to rotate arm 50 in a clockwise direction so that contacts 56 and 57 are in engagement with each other. In Fig. 5, these contacts are diagrammatically represented as adapted to be engaged by a bridging member secured to core 39. It should be noted at this point that when coil 37 is de-energized and the core is accordingly resting upon arm 52 within the lower portion of guide 38, the weight of the core will cause arm 52 to be biased downwardly against the tension of spring 53 to maintain contacts 56 and 57 out of engagement. As core 39 is projected upwardly, its inertia causes it to travel appreciably beyond the magnetic center of coil 37 and to engage the overlying toggle mechanism substantially at pivot 68 with a sharp percussive effect. The buffer spring 44, coacting with the cap 45, tends to absorb a certain amount of the impact forces, thereby preventing the subsequent collapse of the toggle due to reaction to the blow of core 39. In other words, if core 39 were a solid metallic member and provided with no shock absorption means, the impact of the core would straighten the toggle at pivot 68, but the reaction of the links of the toggle to this impact might cause immediate collapse of the toggle structure, since it is not overtravelled to a great extent.

Referring again to Fig. 5, it will be noted that the coil 37 upon initial energization extends the toggle mechanism to bridge contacts 59 and also permits connection between contacts 56 and 57. Accordingly, relay R_1 is energized to bridge contacts 84 which in turn connect the main operating coil 20 across line L. Closure of contacts 56 and 57, it will be noted, effects a holding circuit through coil 37 of relay R as long as the remote switch S engages contact *a*.

Referring to Figs. 1 and 2, energization of the main operating coil 20 actuates core C to rotate arm 19 in a clockwise direction, thereupon causing, through the connecting mechanism 18, etc., straightening of the toggle 14—16. The main breaker element 4 is accordingly moved into engagement with contact members 2 and 3, and is held in such engagement by latch 24.

As arm 19, however, rotates in a clockwise direction during closing movement of the breaker element 4, the pin or lug 73 secured thereto engages lug 74 of arm 75 to effect rotation thereof in a clockwise direction. Pin 73 is so disposed with respect to lug 74 that it will not engage the same until near completion of the closing movement of the main breaker. Clockwise rotation of arm 75 consequently causes the trip rod 77 to move upwardly within guide 79 and to engage extension 72 of the toggle link 67. As extension 72 is raised, the toggle pivot 68 is lowered until the toggle suddenly collapses, thereupon opening contacts 59. A spring (not shown) is disposed within arm 62 at its pivot 63 for the purpose of normally biasing the bridging contact 61 to open position, and consequently biasing the toggle towards its collapsed position as shown in Fig. 4. Opening of contacts 59 de-energizes relay R_1, which in turn opens the contacts 84 to de-energize the main operating coil 20.

The main switch is now closed, and, with the exception of relay coil 37, all of the operating and control coils are de-energized. Continued energization of the coil 37 is without effect to close or to hold closed the relay switch contacts 59, 61, because such energization maintains core 39 with its mid-point substantially at the magnetic center of the coil, as illustrated in Fig. 4. As long as the core is in this position, the lever 52 will be relieved of the weight of the core 39, and the tension of spring 53 will be effective to maintain contacts 56 and 57 closed, and consequently to maintain the relay coil energized.

Assuming now that the main switch is tripped open due to some abnormal condition in the circuit controlled thereby, or by manual depression of latch 24, or otherwise, collapse of toggle mechanism 14—16 will tend to effect counter-clockwise rotation through rod 13, of arm 19, thereupon moving pin 73 away from lug 74 and also causing the auxiliary switch 33 to engage contact 83.

It will be clearly evident that the main switch must now remain in its open position until the remote switch S has been moved out of engagement with contact *a*. In other words, since reclosure of the main switch depends upon ener-

gization of the main operating coil 20, which in turn, depends upon closure of the toggle-actuated switch 59—61 to energize relay R_1, it is apparent that the toggle mechanism can only be extended after coil 37 has been de-energized to permit core 39 to drop to the lower end of guide 38, from which position it may be projected upwardly to engage and straighten the toggle.

Accordingly, rapid reclosure or "pumping" of the main switch is prevented after it has once tripped out due to abnormal conditions in the circuit it controls, or for other reasons, even though the remote switch is held in its original circuit-closing position. In order to reclose the main switch, it is necessary to move the remote switch S out of engagement with contact *a* to a neutral position, and to subsequently move it back into engagement with contact *a*. The first described operation de-energizes the relay coil 37, permitting core 39 to drop within its guide and engage the switch arm extension 52 to open contacts 56 and 57. The apparatus is now in the original starting position previously assumed, and the cycle of operations may be repeated. It is of course essential that the trip mechanism for causing collapse of the toggle come into action near the end of the circuit-closing movement, since coil 20 should be energized sufficiently long to effect positive and complete closure of the main switch.

In lieu of the mechanical connection between the main switch and toggle structure 66—67 for effecting collapse of the same from overtravelled position upon movement of the main switch to circuit-closing position, electro-magnetically-actuated means may be utilized in the manner illustrated in Figs. 6, 7 and 8, wherein a core member, normally biased to effect collapse of the aforesaid toggle, may be withdrawn out of engagement with the same by energization of electro-magnetic means in accordance with and in response to closing movement of the main switch.

Referring to Fig. 6, there is shown an auxiliary switch 84' mechanically connected to the movable element of the main switch in the manner illustrated in Fig. 1, comprising a double blade switch pivoted adjacent its center at 85. When the main switch is in closed position, as illustrated in Fig. 6, the auxiliary switch 84' is in engagement with contact 86, and when the main switch is in its open position the opposite blade of switch 84' bridges contacts 87 and 88.

Accordingly, in the illustration referred to, the circuit through the trip coil 30 may be closed by rotating the remote switch S to engage contact *b*, whereupon latch 24 (Fig. 1) is disengaged from link 14 to permit opening of the main switch, whereupon contacts 87 and 88 are bridged by the auxiliary switch, and the current through the trip coil interrupted. The pivotal support 85 of the auxiliary switch is of conducting material and is electrically connected at all times to one side of the line L.

With the main switch in open position, closure thereof may be effected by rotating the remote switch S to engage contact *a*, whereupon coil 37 of relay R, and coil 89, which are connected into parallel with each other between contact *a* and contacts 87 and 88, are simultaneously energized.

The toggle mechanism is substantially identical in structure and operation to that illustrated in Figs. 1 to 5, except for the fact that link 66 has an extension 66*a* beyond the fixed pivot 92. Extension 66*a* terminates in a downwardly extending portion disposed substantially along the longitudinal axis of core 91. When coil 89 is de-energized, a spring 90 tends to bias the core upwardly into engagement with extension 66*a*, as better illustrated in Fig. 7. Spring 90 is of sufficient strength to effect collapse of the toggle structure when coil 89 is de-energized.

As coils 37 and 89 are simultaneously energized, core 91 is drawn into coil 89 out of engagement with extension 66*a*, and core 39 is projected upwardly in the manner previously described to engage and move the links of the toggle structure to an overtravelled position, after which it falls back to substantially the magnetic center of coil 37 as illustrated in Fig. 8. Actuation of core 39 both permits completion of a holding circuit for coil 37 through contacts 56 and 57 in the manner previously described, and effects energization of the relay R_1 through the contacts 59 by the toggle-actuated contact element 61. Energization of relay R_1 accordingly closes the circuit comprising the main operating coil which in turn, through lever 19, etc., moves the main switch to closed position.

As the main switch completes its closing movement, the auxiliary switch 84' is returned to the position shown in Fig. 6 wherein contacts 87 and 88 are no longer bridged. Accordingly, coil 89 having one terminal connected to contact 88, is de-energized, thereupon permitting spring 90 to bias core 91 upwardly into engagement with the toggle link extension 66*a* and effect collapse of the toggle structure and consequent opening of the circuit of relay R_1. De-energization of the operating coil 20 follows, and, as in the system illustrated in Fig. 5, all of the control and operating windings are de-energized with the exception of coil 37 which maintains core 39 out of engagement with the switch extension 52.

Assuming now that the main switch is tripped open for any particular reason, it will be readily apparent that so long as the remote switch S remains in engagement with contact *a*, the coil 37 will remain energized to hold the core substantially in the position illustrated in Fig. 4. Accordingly, the main operating coil cannot be energized through relay R_1, which depends upon energization through the toggle-actuated switch, until the remote switch S has been moved out of engagement with contact *a* to de-energize coil 37 and to permit core 39 to drop to the lower end of the guide tube, in which position it is adapted to be projected upwardly to extend the toggle upon energization of coil 37 in response to movement of the remote switch S back into engagement with contact *a*.

It is quite obvious therefore, that when the remote switch S has been moved to engage contact *a* to effect initial energization of the main operating coil 20, and to close the main switch, there can be no repeated closure or "pumping" of the circuit breaker after it has tripped out, either due to any abnormal condition or by intentional manipulation of latch 24, as long as the remote switch remains in its initial circuit-closing engagement with contact *a*. In other words, the closure of the main switch is entirely under the control of the remote operator, who may attempt reclosure of the main switch several times by operation of remote switch S if the abnormal condition appears to

be temporary. However, if the remote switch S is permitted to remain in engagement with contact *a*, either through carelessness or other reasons, the only disadvantageous result, from the viewpoint of economical operation, is that the coil 37 remains energized. The main switch is accordingly maintained in its fully open position until the operator has first moved switch S out of engagement with contact *a* to its neutral position, and back again to engagement with contact *a*.

The electro-magnetically-actuated means for cooperating with the toggle structure 66—67 may be associated with relay R with but little variation from the structure shown in Fig. 4. A U-shaped bracket 93 of magnetic material is secured by flanges 93*a* in any suitable manner to the panel 1, and comprises supporting structure for coils 89 and 37 in addition to forming magnetic circuits therefor. A non-magnetic tubular guide member 94, having its upepr end open, is mounted centrally of coil 89 and extends through an opening in the upper part of the bracket 93. A plunger or piston-like element 91 of magnetizable material is adapted to reciprocate within guide 94 and comprises a reduced portion 91*a* forming with the main body portion an annular shoulder against which one end of spring 90 is adapted to seat. The other end of spring 90 bears against the lower side of bracket 93 and is positioned by a stud 95 suitably secured, as by a screw 96, to the bracket. Toggle link 66 is pivotally mounted at 92 on lug 92*a* secured to the upper side of the bracket, and comprises the tail-like extension 66*a* disposed above member 91. The remaining structure comprising coil 37, or 39 etc. is substantially identical to that described with reference to Fig. 4, and further description of the same is not deemed necessary.

In Fig. 7, coils 37 and 89 are both de-energized, with the result that the toggle structure is collapsed, and the switch extension 52 is biased downwardly by the weight of core 39 to effect disengagement of contacts 56 and 57.

In Fig. 8, coils 37 and 89 are both energized, with the result that the core member 91 is withdrawn into its actuating coil out of engagement with the toggle extension 66*a*, and core 39 is in equilibrium within coil 37 after it has been projected upwardly to straighten the toggle structure.

This application is related to the subject matter in my Patent No. 1,719,086, granted July 2, 1929.

It shall be understood that by the term "ballistically" used in the above specification and appended claims, is meant "impulsively", or equivalent, to signify that the transmission of force is by impulse.

What I claim is:

1. A relay comprising a coil, a core element movable within said coil, collapsible structure adapted to be engaged by said core element only upon initial energization of said coil, and a contact element movable with said collapsible structure.

2. A relay comprising a coil, a core element freely movable within said coil, collapsible structure adapted to be ballistically engaged by said core element only upon initial energization of said coil, and a contact element movable with said collapsible structure.

3. A relay comprising a coil, a core element movable within said coil, toggle structure adapted to be engaged adjacent its movable pivot by said core element only upon initial energization of said coil, and a contact element movable with said toggle structure.

4. A relay comprising a coil, a core element freely movable within said coil, collapsible structure adapted to be ballistically engaged by said core element upon initial energization of said coil to move the same to an overtravelled or locking position, and a contact element movable with said collapsible structure.

5. A relay comprising a coil, a core element movable within said coil, collapsible structure adapted to be engaged by said core element only upon initial energization of said coil, a contact element movable with said collapsible structure, and a switch member movable in accordance with initial movement of said core element.

6. A relay comprising a coil, a core element movable within said coil, contact structure adapted to be actuated to a predetermined circuit-controlling position in response to initial energization of said coil, a switch member biased to a predetermined circuit-controlling position by said core element during de-energization of said coil, and means for biasing said switch member to another position upon initial movement of said core element in response to energization of said coil, said core element adapted to be maintained in a position intermediate said structure and switch member during continued energization of said coil.

7. A relay comprising a coil, a magnetizable core element movable within said coil and to positions beyond the extremities thereof, a guide member for said core element extending below said coil, a switch member adjacent the lower end of said guide member adapted to be engaged and biased to a circuit-controlling position by said core element during de-energization of said coil, means tending to bias said switch member in opposite direction, and contact-controlling structure adapted to be moved by impact of said core element to a circuit-controlling position in response to initial energization of said coil, said core element being maintained in a neutral position out of engagement with both the aforesaid switch member and contact-controlling structure during continued energization of said coil.

8. In a relay, the combination with a coil and contact-controlling structure, of a core element adapted to actuate said structure comprising a magnetizable member, a member of non-magnetic material movable with respect thereto and adapted to strike said structure, and resilient means carried by said magnetizable member for transmitting the force of impact from said non-magnetic member to said magnetizable member.

9. In a relay, the combination with a coil and contact-controlling structure, of a core element adapted to ballistically actuate said structure comprising a magnetizable member, a member movable with respect thereto and adapted to engage said structure, and resilient means for transmitting the force of impact from said second member to said magnetizable member.

10. In a relay, the combination with a coil and overtravelled toggle structure, of a core element adapted to be projected upon initial energization of said coil to ballistically engage and extend said toggle structure to its overtravelled position comprising a magnetizable member, and a buffer member associated therewith for substantially absorbing the force of

reaction tending to cause collapse of said toggle structure.

11. In a circuit-controlling system including a main switch and electromagnetic actuating means therefor, a contact element for effecting energization and de-energization of said means, collapsible mechanism for controlling said contact element, an electro-magnetically actuated member adapted to extend said collapsible mechanism to a position whereby said contact element is locked in a circuit-controlling position, and electro-magnetic means actuated substantially upon completion of movement of said main switch to a circuit-controlling position to effect collapse of said mechanism and movement of said contact element to another position.

12. In a circuit-controlling system including a main switch and electro-magnetic actuating means therefor, a contact element for effecting energization and de-energization of said means, collapsible mechanism for controlling said contact element, an electro-magnetically actuated member adapted to extend said collapsible mechanism to a position whereby said contact element is locked independently of said member in a circuit-controlling position, and means mechanically connected to said first-named actuating means substantially upon completion of movement of said main switch to a circuit-controlling position to effect collapse of said mechanism and movement of said contact element to another position.

13. A relay comprising a coil, a core element adapted to move within said coil and beyond the ends thereof, collapsible contact-carrying structure adapted to be engaged by said core element in response to initial energization of said coil to extend the same to a circuit-controlling position, a second coil, and a core element therefor adapted to effect collapse of said structure to another position.

14. A relay comprising a coil, a core element adapted to move within said coil and beyond the ends thereof, collapsible contact carrying structure adapted to be engaged by said core element in response to initial energization of said coil to extend the same to a circuit-controlling position, a second coil, and a core element therefor biased during de-energization of said second coil into engagement with said structure to effect collapse thereof, said core element being maintained out of engagement with said structure during energization of said second coil.

15. In a circuit-controlling system including a main switch and actuating means therefor, toggle mechanism controlling energization and de-energization of said means, a movable member adapted to be impelled to effect extension of said toggle mechanism to an overtravelled or energizing position, and electro-magnetic means for first impelling said movable member to effect extension of said toggle mechanism and thereafter to withdraw said member from said toggle mechanism.

16. A relay comprising a coil, a core element adapted to be drawn to and sustained in a predetermined position within said coil after initial overtravel, and collapsible contact structure adapted to be engaged by said core element during said initial overtravel, to extend it to a circuit-controlling position in response to energization of said coil.

17. A relay comprising a coil, a core element adapted to be projected to an overtravelled position by initial energization of said coil, said element adapted to be withdrawn and maintained in another position by continued energization of said coil, and toggle-controlled contact structure adapted to be actuated to a circuit-controlling position by the kinetic energy of said element in its movement to overtravelled position.

18. A relay comprising a coil, a core element movable therein adapted to be projected to an overtravelled position by initial energization of said coil, toggle structure adapted to be extended to a locking position by impact with said element during its movement to overtravelled position, said element being immediately withdrawn from said toggle structure to a position of magnetic equilibrium with respect to said coil, and contacts controlled by said toggle structure.

19. A relay comprising a coil, a magnetizable core element movable within said coil, said element adapted to be projected beyond its position of magnetic equilibrium by initial energization of said coil and to be immediately withdrawn from said position, toggle structure adapted to be engaged and extended to an overtravelled position by impact with said element during its projected movement, and contact elements controlled by said structure.

20. The combination with relatively movable contacts, of a self-locking collapsible structure for effecting relative movement of said contacts, a coil, and a magnetizable member movable independently of said collapsible structure and actuated by said coil to actuate said collapsible structure to its self-locking position.

21. The combination with relatively movable contacts, of a self-locking collapsible structure for effecting relative movement of said contacts, a coil, and a magnetizable member movable independently of said collapsible structure and biased toward a position short of actuation of said structure, said magnetizable member upon energization of said coil moving beyond said position to actuate said collapsible structure to its self-locking position and thereafter receding toward said position.

22. The combination with relatively movable contacts, of a toggle for maintaining when in overtraveled position said contacts in a predetermined position, a coil, and a magnetizable member movable independently of said toggle and actuated by said coil to deliver a blow causing overtravel of said toggle to effect relative movement of said contacts to said predetermined position.

23. The combination with relatively movable contacts, of a toggle for maintaining when in overtraveled position said contacts in a predetermined position, a coil, and a magnetizable member biased toward a position out of engagement with said toggle, and actuated by said coil to deliver a blow causing overtravel of said toggle to effect relative movement of said contacts to said predetermined position, the magnetizable member after delivery of the blow immediately returning toward said position.

24. The combination with relatively movable contacts, of a toggle for maintaining when in over-traveled position said contacts in a predetermined position, a solenoid vertically disposed beneath said toggle, and a core member detached from said toggle movable upwardly upon energization of said coil to deliver a blow effecting overtravel of said toggle.

25. In a circuit controlling system including a

main switch and actuating means therefor, means comprising toggle mechanism for controlling energization and deenergization of said actuating means, a movable member adapted by impulse to extend said toggle mechanism to energizing position, and electromagnetic means for impelling said movable member to extend said toggle mechanism and thereupon to withdraw said member from said toggle mechanism.

26. In a circuit controlling system including a main switch and actuating means therefor, means comprising toggle mechanism for controlling energization and deenergization of said actuating means, a movable magnetic member, an electromagnetic coil adapted to impart overtravel to said member and thereafter to withdraw it to and hold it in a predetermined position, said magnetic member adapted during its overtravel to extend said toggle mechanism to energizing position.

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