Feb. 18, 1936. J. F. TRITLE 2,031,516

CIRCUIT CONTROLLER

Filed Oct. 31, 1934

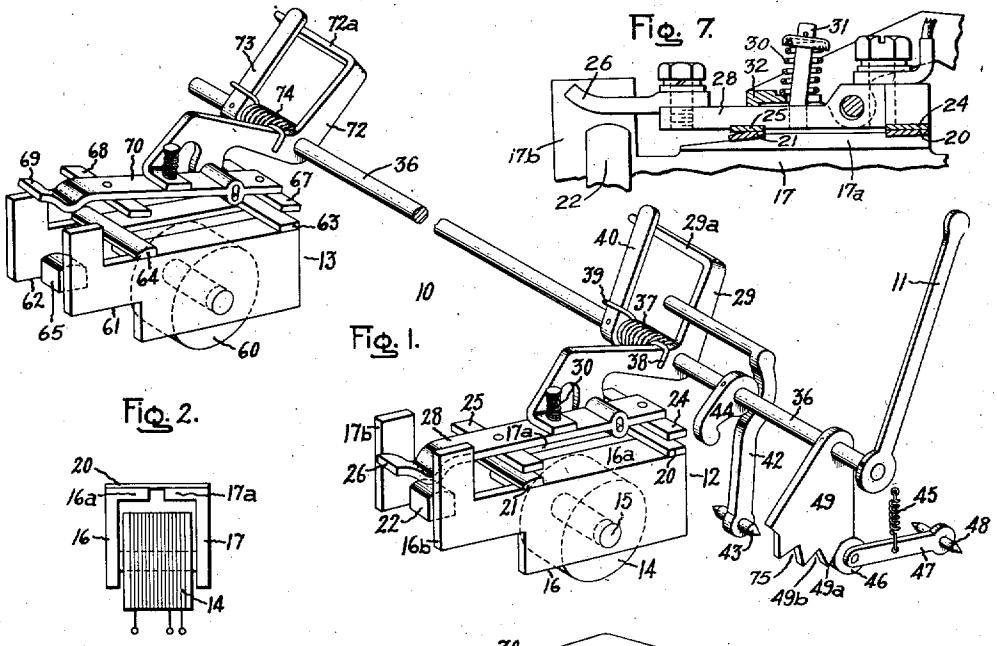


Fig. 1.

Fig. 7.

Fig. 2.

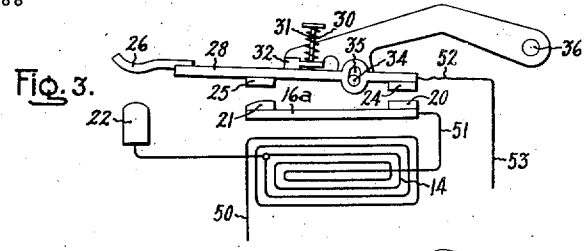


Fig. 3.

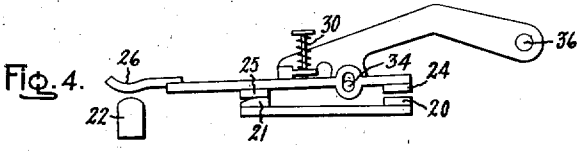


Fig. 4.

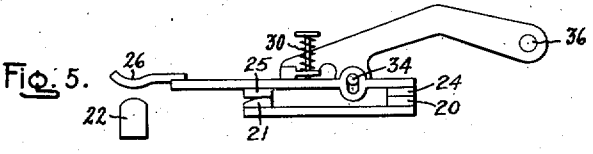


Fig. 5.

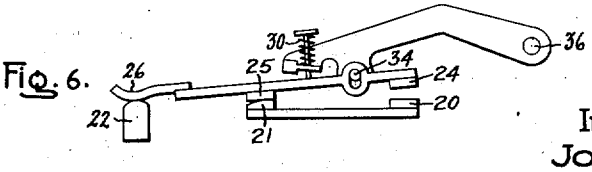


Fig. 6.

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Patented Feb. 18, 1936 2,031,516

UNITED STATES PATENT OFFICE

2,031,516

CIRCUIT CONTROLLER

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Application October 31, 1934, Serial No. 750,834

11 Claims. (Cl. 200—87)

My invention relates to circuit controllers of the type arranged to carry large values of current, and has for an object the provision of a simple and inexpensive controller which operates efficiently to make and break the electrical circuit and which insures a minimum resistance to current flow.

My invention is particularly applicable to controllers used in connection with direct current railway motors. Heretofore, in the design of controllers much has been desired in minimizing arcing at the contacts and in providing low resistance current-carrying contacts which are unaffected by electric arcs. For example, with low resistance contacts, any arcing between them eventually roughens their surfaces to cause a greatly increased contact resistance. Furthermore in case of an overload, the contacts may weld together to prevent proper operation of the controller.

In carrying out my invention in one form thereof, I provide a circuit controller with three pairs of contacts, one pair being formed of high conductivity material, the second pair being formed of a good contact making material, and the third pair being formed of an arc-resistant material. A switch member resiliently mounted on an actuating arm is arranged so that the circuit is first completed between the second pair of contacts. The resulting current flow energizes a magnet coil which in magnetically attracting the switch member causes it to rotate about the second pair of contacts and operate with a snap action the first pair of low resistance contacts into engagement. To open the circuit the magnet coil in biasing the switch member to the closed circuit position cooperates with the actuating arm which arm first opens the first pair of contacts and then closes the third pair of arcing contacts, the third pair of contacts short circuiting a portion of the coil. The resulting reduction in the magnetic force causes the resilient means to operate the switch member to break the circuit, the arcing contacts being the last to open. Since only a portion of the coil is short circuited the remainder of the coil is effective to produce a magnetic flux across the arcing contacts to cause the quick extinguishment of the arc formed between them.

For a more complete understanding of my invention, reference should now be had to the accompanying drawing wherein I have shown in Fig. 1 an exploded perspective view of a controller embodying my invention; Fig. 2 illustrates the manner in which the magnet coil is mounted between the blowout plates; Figs. 3 to 6, inclusive, illustrate diagrammatically various positions of the controller of Fig. 1 as it is operated between open and closed circuit positions while Fig. 7 is a sectional elevation of a portion of the controller.

Referring to the drawing, I have shown my invention in one form as applied to a controller 10 operable by a handle 11 to complete a plurality of circuits in a predetermined sequence. It is to be understood that any number of circuits can be controlled by adding additional control units to the controller. For the purpose of simplifying the description only two control units, 12 and 13, have been shown. The control unit 12 consists of a coil 14 provided with a plurality of turns and mounted on a magnetizable core 15 between a pair of magnetizable blowout plates 16 and 17. As shown in Figs. 1 and 2, the plates 16 and 17 have portions 16*a* and 17*a* formed at right angles to the sides of the blowout plates, the inwardly extending ends of the portions 16*a* and 17*a* being spaced apart from each other. A stationary contact 20 formed of silver or other suitable high conductivity material is secured to the portions 16*a* and 17*a*, while a second stationary contact 21 formed of a good contact making material such as copper or tungsten, is secured to the portions 16*a* and 17*a* in spaced relation with the contact 20. A third stationary contact 22 formed of arc-resisting material, such as silver-molybdenum or carbon, is mounted between the ends 16*b* and 17*b* of the plates but electrically insulated therefrom. As shown, the contact 22 is in spaced relation with the ends 16*b* and 17*b*.

Cooperating movable contacts 24, 25 and 26 formed respectively of silver, tungsten and silver-molybdenum are mounted on a switch member 28 carried by an actuating arm 29. A spring 30 encircling a pin 31 which is secured to the switch member 28 biases the switch member 28 into engagement with an extension 32 formed integrally with the actuating arm 29. A pin 34 (Fig. 3) secured to the arm 29 in spaced relation with the extension 32 extends into a slot 35 provided in the switch member 28. The actuating arm 29 is mounted on an operating shaft 36 but is free to rotate independently of the shaft. By means of a spring 37 encircling the shaft, one end 38 of the spring engaging the actuating arm 29 and the other end 39 engaging a member 40 rigidly secured to the shaft, a force can be applied by the rotation of the shaft in a counter-clockwise direction, as viewed in Fig. 1,

to the actuating arm 29 in a direction to rotate it towards the closed circuit position. The extension 29a provided on the actuating arm 29, a lever 42 pivoted at 43 and a cam 44 rigidly secured to the shaft 36, cooperate to operate the switch member 28 to the open circuit position in a manner which will later be described more in detail.

In order to operate the switch member 28 to the closed circuit position the operating handle 11 is rotated in a counter-clockwise direction, as viewed in Fig. 1, against the bias of a spring 45 which normally urges a roller 46 mounted on a lever 47 pivoted at 48 against a notched positioning cam 49 secured to the shaft 36. The roller 46 and the notched cam 49 serve to predetermine different circuit controlling positions for the handle 11. Thus as the handle moves in the counter-clockwise direction a substantial force must be applied to cause the roller 46 to ride over the crest 49a of the cam. As soon as it passes this crest, however, the spring 45 in biasing the roller against the cam assists in moving the shaft 36 until the roller 46 nests within the depression 49b. The effect of the spring 45 is to insure a rapid movement of the handle 11 causing a quick or snap action engagement of the contacts 21 and 25.

During the initial counter-clockwise rotation of the shaft 36 the member 40 operating on the end 39 of the spring 37 increases the force in the coil spring, this force being immediately applied by the opposite end 38 of the spring to the actuating member 29 to cause rotation of the actuating member 29 in a counter-clockwise direction. As shown in Figs. 3 and 4 the position of the switch member 28 on the extension 32 is such that the movable contact 25 engages its cooperating stationary contact 21 before either of the other pairs 20, 24 or 22, 26 engage.

Consequent to the closing of the contacts 21 and 25 a circuit is completed for the flow of current from a supply line indicated at 50, by the magnet coil 14, conductor 51, portions 16a and 17a, contacts 21 and 25 and by a flexible conductor 52 to the other supply line indicated at 53. The coil 14 immediately produces a strong magnetic attractive force on the switch member 28 to operate it with a snap action in a clockwise direction about the contacts 21 and 25 as a fulcrum, causing the silver contacts 20 and 24 to be operated into engagement one with the other. The final position of the switch member 28 is shown in Figs. 5 and 7, the pin 34 occupying a position in the upper end of the slot 35. The spring 37 and the magnetic attractive force between the magnetizable members 16a, 17a, and 28 insures high contact pressure between the related pairs of contacts 21, 25 and 20, 24. The circuit making function performed by the contacts 21 and 25 prevents arcing as the silver contacts 20 and 24 close. As will be understood by those skilled in the art, the absence of arcing at the silver contacts eliminates pitting of the contacts and insures throughout the life of the controller a current path through these contacts of high electrical conductivity.

If it is now desired to operate the switch member 28 to the open circuit position, the operating handle 11 is rotated in a clockwise direction. The arm 40, rotating with the shaft 36, at once engages the extension 29a to rotate actuating arm 29 in a clockwise direction. As the actuating arm 29 rotates in the clockwise direction, it gradually increases the compression of the spring 30 so that a gradually increasing force is applied through the pin 31 to the switch member 28 in a direction to move it to the open circuit position. This opening force, however, is opposed by the magnetic attractive force produced by the coil 14. The coil 14, the magnetic plates 16 and 17, and the pin 34 are arranged so that the magnetic attractive force exerted on the switch member 28 is greatest adjacent the contacts 21 and 25. The opening force is applied through the pin 34 at a point to the right of the contacts 21 and 25. Consequently, this opening force rotates the switch member 28 about the contacts 21 and 25. Good electrical contact is maintained between these contacts 21 and 25, however. As shown, the contact 21 is rounded somewhat to insure a maximum contact area during the rotation of the member 28. Due to the rotation of the member 28 the silver contacts 20, 25 are first separated, the arcing contact 26 then moving into engagement with its associated arcing contact 22 as shown in Fig. 6.

While the switch member 28 is in its fully closed position, Figs. 5 and 7, only a small air gap exists between the switch member and the magnetic frame formed by the blowout plates 16 and 17 so that the major portion of the magnetic flux traverses the switch member. As the switch member 28 rotates about the contacts 21 and 25, the air gap between the switch member 28 and the ends 16a and 17a of the frame increases. A greater proportion of the magnetic flux is thereby shifted between the ends 16b and 17b of the frame or blowout plates 16 and 17 preparatory to the opening of the circuit at the contacts 22 and 26.

Continuing with the operation of my invention, the closing of the arcing contacts 22, 26 short circuits all but the three outer turns of the coil 14, thereby causing a sudden diminution in the magnetic attractive force. The spring 30 thereupon operates the switch member 28 to the open circuit position with a snap action. The contacts 21 and 25 separate just prior to the separation of contacts 22 and 26 so that the current is transferred to the arcing contacts 22 and 26. Since the outer three turns of the blowout coil remain in the circuit the magnetic flux produced between the pole pieces 16b and 17b is sufficient to cause a rapid extinguishment of the arc.

In case it is desired to control a plurality of circuits in predetermined sequence additional control units are provided. Thus for example, the unit 13 identical with the unit 12, is provided with a coil 60, magnetizable plates 61 and 62, stationary contacts 63, 64 and 65, movable contacts 67, 68 and 69 mounted on a movable switch member 70 secured to an actuating arm 72 loosely mounted on the shaft 36. A member 73 secured to the shaft applies a closing force to the actuating arm 72 through the coil spring 74 and also operates against an extension 72a of the arm 72 to operate the switch member 70 to the open circuit position. As shown, the member 73 and the actuating arm 72 are angularly spaced in a clockwise direction from the member 40 and its associated actuating arm 29 so that the operating handle 11 must rotate through a greater distance before the initial closure of the contacts 64 and 68. Consequently, the device 12 completes its circuit making function before the device 13 is operated. The closure of the device 13 occurs as the roller 46 moves into the depression 75 provided on the notched

positioning cam 49, the additional travel of the shaft 36 being permitted by the spring 37.

When the controller 10 is used to connect a plurality of motors first in series for starting and then in parallel for full speed operation, it is necessary to close a plurality of contacts in sequence to effect the acceleration of the motors and the partial transition of the series connected motors. The final step in the transition from series to parallel is accomplished by the opening of a contact. This desired sequence of operation well understood by those skilled in the art, is obtained in accordance with my invention by means of the cam 44 secured to the shaft 36, this cam being angularly positioned with respect to the member 42 so that the cam will engage the member 42 after the last unit, for example the unit 13, has been operated to the closed circuit position. This operation will be clear by first assuming that the operating handle 11 has been rotated to close the devices 12 and 13. Further rotation of the handle 11 rotates the cam 44 into engagement with the member 42 causing this member to rotate about its pivot 45 in a clockwise direction to rotate the actuating arm 29 towards the circuit opening position. The operation is then identical with the circuit opening operation by the clockwise rotation of the handle 11, the arm 29 serving gradually to increase the energy stored in the spring 30. As before the switch member 28 rotates in a counter-clockwise direction first opening the silver contacts 20, 24 and then closing the arcing contacts 22, 26 to short circuit the major portion of the coil 14 and causing the switch member 28 to be operated to the open circuit position with a snap action.

It will be understood that any number of contacts may be operated to the closed circuit position in a predetermined sequence and that during any point in the operation any one of the contacts may be opened without reversing the direction of movement of the operating handle by a suitable arrangement of the actuating arms with respect to the operating members for the desired operation.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I, therefore, contemplate by the appended claims to cover any 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 in the United States is:

1. A circuit controller comprising a switch member operable between open and closed circuit positions, a coil having a plurality of turns operatively associated with said switch member, means responsive to movement of said switch member towards said closed position for energizing said coil whereupon the magnetic force produced by said coil operates said switch member to said closed circuit position with a snap action, resilient means connected to said switch member arranged to be stressed upon an initial movement of said switch member toward said open circuit position for biasing said switch member toward said open circuit position, and means responsive to said initial movement of said switch member for reducing said magnetic force whereupon said resilient means operates said switch member to said open circuit position with a snap action.

2. A circuit controller comprising a switch member, an operating member for operating said switch member between open and closed circuit positions, pivot means mounting said switch member on said operating member to provide for rotation of said switch member independently of said operating member, a coil having a plurality of turns operatively associated with said switch member, means responsive to movement of said switch member towards said closed position for energizing said coil whereupon the magnetic attractive force produced by said coil operates said switch member to said closed circuit position with a snap action, resilient means arranged to be stressed by rotation of said switch member relative to said operating member for biasing said switch member towards said open position, said coil being arranged with reference to said switch member so as to cause said switch member to rotate about a predetermined point of support when moved toward open position and thereby stress said resilient means, and means responsive to a predetermined rotation of said switch member for suddenly reducing said magnetic force so that said resilient means operates said switch member to said open circuit position with a snap action.

3. A circuit controller comprising a switch member, an actuating arm, resilient means connecting said switch member to said actuating arm for limited rotation of said switch member whereby said switch member is actuated between open and closed circuit positions by movement of said actuating arm, a coil mounted adjacent said resilient means and provided with a plurality of turns for producing a magnetic attractive force on said switch member, means operable by movement of said switch member towards said closed circuit position to energize said coil whereupon the attractive force produced by said coil causes said switch member to rotate to said closed circuit position, means for rotating said actuating arm against the bias of said resilient means, the interaction between said resilient means and said magnetic attractive force causing said switch member to rotate a predetermined distance, and means responsive to said rotation for quickly diminishing said magnetic attractive force and rendering effective thereby said resilient means for operation of said switch member with a snap action to said open circuit position.

4. A circuit controller comprising an actuating arm operable between open and closed circuit positions, a switch member, resilient means securing said switch member to said actuating arm and providing for a predetermined rotation of said switch member on said actuating arm, a coil operatively associated with said switch member for producing a strong magnetic attractive force on said switch member, magnetizable plates associated with said coil and forming a flux path between said coil and said switch member, a first pair of contacts operable by a predetermined movement of said switch member toward said closed position to energize said coil whereupon the resulting magnetic attractive force of said coil rotates said switch member with a snap action about said first pair of contacts, a second pair of contacts formed of high conductivity material connected in parallel circuit relation with said first pair of contacts and operable by said rotative movement of said switch member about said first pair of contacts to a closed circuit position, a third pair of contacts operatively associated with said switch member and arranged when closed to diminish substantially said magnetic

attractive force, said actuating means when moved toward said open circuit position rotating said switch member against the bias of said resilient means to open said second pair of contacts and to close said third pair of contacts whereupon said resilient means operates said first pair of contacts and then operates said third pair of contacts to said open circuit position with a snap action.

5. A circuit controller comprising an actuating arm operable between open and closed circuit positions, a switch member, resilient means securing said switch member to said actuating arm and providing for a predetermined rotation of said switch member on said actuating arm, a coil operatively associated with said switch member and provided with a plurality of turns, magnetizable plates associated with said coil and forming a flux path adjacent to said switch member, a first pair of contacts operable by predetermined movement of said member toward said closed position to energize said coil whereupon the resulting magnetic attractive force of said coil rotates said switch member with a snap action about said first pair of contacts, a second pair of contacts formed of high conductivity material connected in parallel circuit relation with said first pair of contacts and operable by said rotative movement of said switch member to a closed circuit position, a third pair of contacts connected in parallel circuit relation with said first and second pairs of contacts arranged when closed to short circuit a substantial number of the turns of said coil, said actuating arm when operated toward said open circuit position operating said switch member against the bias of said resilient means to open said first pair of contacts and to close said third pair of contacts whereupon the short circuiting of said coil diminishes said magnetic force to cause said resilient means to open said second pair of contacts and then to open said third pair of contacts with a snap action, said magnetic plates being provided with extensions arranged on opposite sides of said third pair of contacts so that the flux produced therebetween by said coil quickly extinguishes arcs formed between said third pair of contacts.

6. A circuit controller comprising an actuating arm operable between open and closed circuit positions, a switch member, resilient means securing said switch member to said actuating arm, a lost motion connection between said switch member and said actuating arm spaced from said resilient means and providing for a predetermined rotation of said switch member on said actuating arm, a coil operatively associated with said switch member and provided with a plurality of turns for producing a strong magnetic attractive force on said switch member, a first pair of contacts operable by a predetermined movement of said switch member towards said closed position to energize said coil whereupon the resulting magnetic attractive force of said coil rotates said switch member with a snap action about said first pair of contacts, a second pair of contacts formed of high conductivity material connected in parallel circuit relation with said first pair of contacts and operable by said rotative movement of said switch member about said first pair of contacts to a closed circuit position forming a low resistance current path, a third pair of contacts arranged when closed to short circuit a substantial number of the turns of said coil, said resilient means, said lost motion connection and said coil being so arranged that upon movement of said arm towards said open circuit position said second pair of contacts is first opened, and said third pair of contacts is closed, and then said third pair of contacts is opened by said resilient means with a snap action.

7. A circuit controller comprising a switch member, actuating means pivotally supporting said switch member intermediate its ends for operation between open and closed circuit positions, resilient means biasing said switch member against said actuating means, a first pair of contacts one of which is operable by said switch member into engagement with the other, a coil provided with a plurality of turns connected in series circuit relation with said first pair of contacts, a magnetic frame energized by said coil to produce on said switch member a magnetic force causing a pivotal movement of said switch member on said actuating means against the bias of said resilient means, a second pair of contacts one of which is operable into engagement with the other contact with a snap action by said pivotal movement of said switch member, a third pair of contacts one of which is operable by said switch member into and out of engagement with the other contact, said actuating means when moved towards said open position operating said switch member to close the third pair of contacts, and connections completed by the closing of said third pair of contacts for short circuiting a substantial number of the turns of said coil to reduce said magnetic force whereupon said resilient means operates said switch member to said open circuit position with a snap action.

8. A circuit controller comprising an operating shaft rotatable in opposite directions between open and closed circuit positions, an actuating arm mounted on and rotatable independently of said shaft, a coil spring encircling said shaft for applying a force to said actuating arm when said shaft is rotated in a circuit closing direction, a member for positively engaging said arm when said shaft is rotated in a circuit opening direction, a switch member, resilient means securing said switch member to said arm at one point thereof, a lost motion connection between said switch member and said arm and in spaced relation with said resilient means, a first pair of contacts one of which is operable by said switch member into engagement with the other, a coil provided with a plurality of turns connected in series circuit relation with said first pair of contacts, a magnetic frame energized by said coil to produce on said switch member a magnetic force to rotate said switch member in a predetermined direction about said first pair of contacts, a second pair of contacts one of which is operable into engagement with the other contact by said rotation of said switch member, a third pair of contacts one of which is operable by said switch member into and out of engagement with the other contact, said shaft when rotated in said circuit opening direction operating through said resilient connection to rotate said switch member in a reverse direction to open said first pair of contacts and to close said third pair of contacts, connections completed by the closing of said third pair of contacts for diminishing the magnetic attractive force of said coil and said frame whereupon said resilient means operates said switch member to said open circuit position with a snap action.

9. A circuit controller comprising an operating shaft rotatable in opposite directions between open and closed circuit positions, an actuating

arm mounted for rotation on said shaft and independently thereof, a coil spring encircling said shaft for applying a force to said actuating arm when said shaft is rotated in a circuit closing direction, a member for rigidly engaging said arm when said shaft is rotated in a circuit opening direction, a switch member, resilient means securing said switch member to said arm at one point thereof, a lost motion connection between said switch member and said arm in spaced relation with said resilient means, a first pair of contacts one of which is operable by said switch member into engagement with the other, a coil provided with a plurality of turns connected in series circuit relation with said first pair of contacts, a magnetic frame energized by said coil to produce on said switch member a magnetic force causing said switch member to rotate in a predetermined direction about said first pair of contacts, a second pair of contacts one of which is operable into engagement with the other contact by said rotation of said switch member, a third pair of contacts one of which is operable by said switch member into and out of engagement with the other contact, said shaft when rotated in said circuit opening direction operating through said resilient means and said lost motion connection to rotate said switch member in a reverse direction to open said first pair of contacts and to close said third pair of contacts, connections completed by the closing of said third pair of contacts for diminishing the magnetic attractive force on said switch member, said resilient connection thereupon operating said switch member to said open circuit position with a snap action, said frame being provided with extensions located on opposite sides of said third pair of contacts for producing therebetween a strong magnetic flux.

10. A circuit controller comprising a plurality of switch members operable between open and closed circuit positions, a coil operatively associated with each switch member, means responsive to a predetermined movement of said switch members towards said closed circuit positions for energizing respectively said coils, the magnetic attractive force produced by each coil operating its corresponding switch member to its closed circuit position with a snap action, resilient means connected to each switch member, an operating handle operable between open and closed circuit positions, connecting means including said resilient means between said handle and said switch members for operating said switch members in predetermined sequence from said open to said closed circuit positions, and means operable by said handle in said circuit closing direction to operate one of said switch members to said open circuit position, said operating member producing through said resilient means a force on said switch member in the circuit opening direction and means responsive to an initial movement of said switch member for reducing said magnetic force whereupon said resilient means operates said switch member to said open circuit position with a snap action.

11. A circuit controller comprising an actuating arm operable between open and closed circuit positions, a switch member, resilient means securing said switch member to said actuating arm in a predetermined position and providing for a predetermined rotation of said switch member on said actuating arm, a first pair of contacts operable into closed circuit position by predetermined movement of said actuating arm towards its closed circuit position, a second pair of contacts, means responsive to the closing of said first pair of contacts for rotating said switch member on said actuating arm to operate quickly said second pair of contacts to a closed circuit position, a third pair of contacts operable by movement of said actuating arm against the bias of said resilient means towards said open circuit position to a closed circuit position after the opening of said second pair of contacts, and means responsive to the closing of said third pair of contacts for causing said resilient means to operate said switch member to said open circuit position.

JOHN F. TRITLE.