W. W. WILLARD.

ELECTRIC SWITCH.

APPLICATION FILED MAY 14, 1917.

1,287,545. Patented Dec. 10, 1918.

Fig. 1.

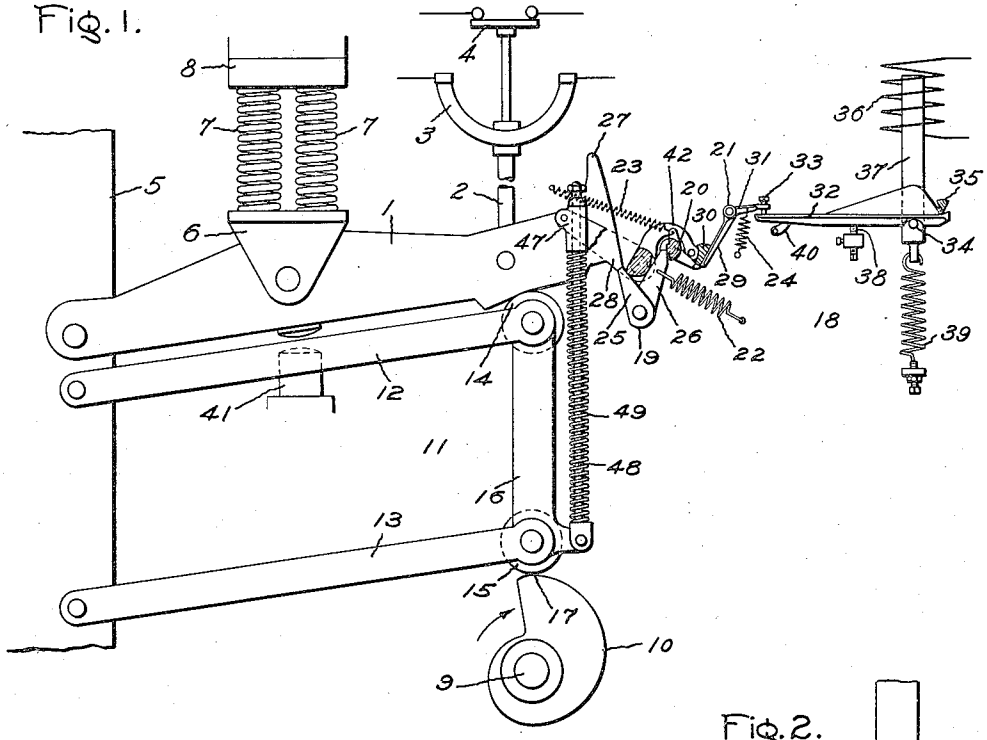


Fig. 2.

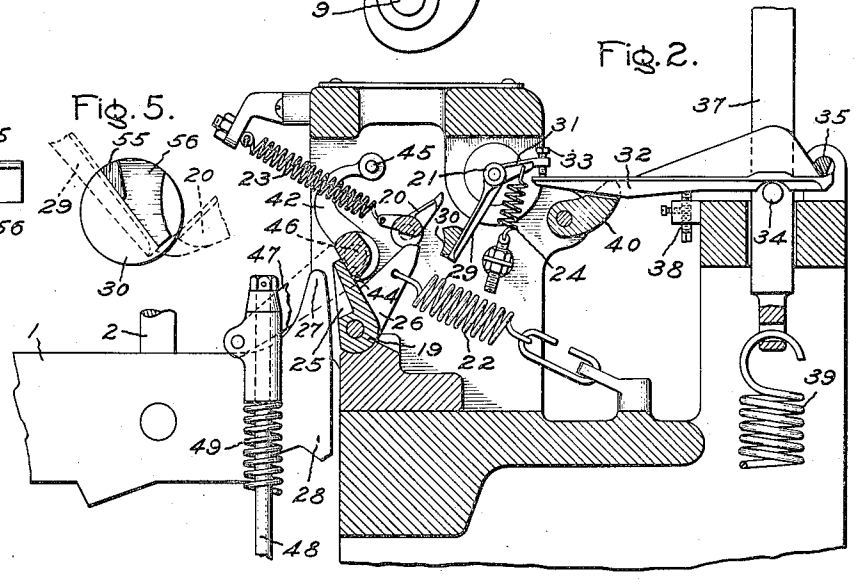


Fig. 4.

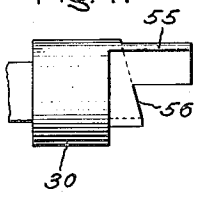
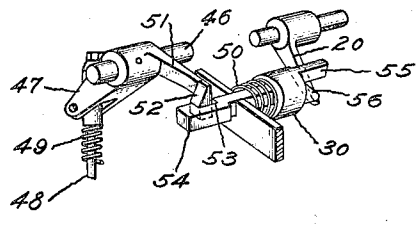


Fig. 5.

Fig. 3.



Inventor:
Waldo W. Willard,
by Albert G. Davis
His Attorney.

UNITED STATES PATENT OFFICE.

WALDO W. WILLARD, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRIC SWITCH.

1,287,545. Specification of Letters Patent. Patented Dec. 10, 1918.

Application filed May 14, 1917. Serial No. 168,337.

To all whom it may concern:

Be it known that I, WALDO W. WILLARD, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Electric Switches, of which the following is a specification.

My invention relates to electric switches and has for its object to provide an electric switch having exceedingly high speed characteristics. A further object of my invention is to provide a switch embodying an extra sensitive mechanism for restraining the switch in closed position which can be tripped with great rapidity, and which can be reset and prevented from tripping until the resetting means is moved free from the mechanism.

Automatic switches of the prior art are comparatively slow acting due, in a great degree, to the time required to release their latching mechanisms and also to the further time required to open the switch after the mechanism has been set into operation. In the switch of my invention, the opening movement of the switch is greatly accelerated by heavy spring members capable of storing up a large amount of energy which is exerted on the switch operating member as it moves to switch opening position so that a minimum time is required to open the switch. Coöperating with the operating member of the switch to hold it in switch closing position, I provide an extremely sensitive restraining mechanism comprising a system of levers adapted to withstand the excessive pressure exerted on the switch operating member. This mechanism is released or tripped by a tripping lever operative either by hand or automatically in response to predetermined conditions, whereupon the levers comprising the restraining mechanism move to tripped position accelerated by spring members. Due to the acceleration given the switch operating member, and the sensitivity of the restraining mechanism, which is accelerated in releasing, I have been able to provide a switch which can be opened in substantially five one-thousandths of a second. I also provide a resetting means which operates, as the switch is closed, to move the restraining mechanism to resetting position, the resetting means returning from resetting position to initial position so as to allow the mechanism to trip free therefrom. As a safety feature, I have provided a mechanism whereby the restraining mechanism is locked against tripping and the tripping member rendered ineffective until the return of the resetting means to its initial position.

The novel features which I believe to be characteristic of my invention will be definitely indicated in the appended claims while the features of construction and mode of operation will be understood by reference to the following description taken in connection with the accompanying drawings which show the preferred embodiments of my invention and in which:

Figure 1 illustrates an electric switch embodying the novel features of my invention, Fig. 2 is a more detailed view partly in section of the restraining mechanism for the switch in tripped position, while Figs. 3, 4 and 5 are detail views of a portion of the mechanism shown in Fig. 2.

In Fig. 1 I have shown an electric switch comprising a switch operating member 1 connected by means of an operating rod 2 to the main and secondary movable contact members 3 and 4, respectively, which coöperate with corresponding fixed contacts to open and close the circuit through the switch. The operating member 1 is pivotally mounted on a supporting structure 5 and carries pivotally related thereto, a yoke 6 to which is secured means for accelerating the switch opening movement of the member 1. This accelerating means comprises a plurality of spring or resilient members 7 secured at one end to the yoke 6 and at their opposite ends to a fixed support 8. The spring members 7 are very strong and rugged and are arranged to be compressed during the switch closing movement of the operating member 1 to store up a vast amount of potential energy which is released to accelerate the switch opening movement of the operating member. The pressure exerted on the operating member by the spring members 7 tending to move the same in switch opening direction, is approximately 8,000 pounds.

For moving the operating member 1 from switch opening to switch closing position, I provide a switch closing mechanism which is preferably of the motor operated type. For purposes of clearness, I have omitted showing the motor and control mechanism therefor, it being understood that the shaft 9 is

rotatable by the motor to rotate the cam member 10. Coöperating with the cam member 10 and with the switch operating member 1, is a cam follower or actuating member 11 comprising two parallel levers 12 and 13 pivoted at one end to the supporting structure 5 and connected at their opposite ends through roller bearings 14 and 15, with a link 16. When the shaft 9 is rotated to close the switch, the cam member 10 is rotated in the direction shown by the arrow and, due to the configuration of the cam surface, the actuating member 11 through its roller bearing 15 is raised until the roller bearing 14 engages the operating member 1 when the member 1 is moved until it reaches switch closing position, the roller bearing 14 riding along the lower surface of the operating member. The highest part of the cam surface is located at 17 so that just prior to the finish of the switch closing movement, the operating member is slightly lowered again for the reason to be hereinafter stated. When the roller 15 reaches the end of the cam surface, the actuating member 11 falls free from the operating member 1 to its initial position on the cam member 10 and the operating member is held in switch closed position by the mechanism to be described. The motor is simultaneously automatically cut off by any suitable means.

For holding the operating member in switch closing position under the great pressure exerted by the springs 7, I provide a restraining mechanism 18 which is very compact, very sensitive and capable of being tripped or released with great rapidity. This mechanism comprises coöperating levers 19, 20 and 21 coacting with the operating member 1, and pivotally mounted in bearings having a minimum of friction on a suitable supporting structure for the mechanism, as best shown in Fig. 2. The movement of levers 19 and 20 to tripping position is accelerated by the spring members 22 and 23, respectively, while the lever 21 is provided with a spring 24 for returning it from tripping to latching position. Lever 19 is provided with two arms 25 and 26 preferably integrally related and having at their ends special bearing surfaces, the bearing surface on arm 25 being in the form of an inclined plane while that on arm 26 is a bearing point. The operating member 1 is provided with a horn or extended portion 27, the purpose of which will be hereinafter described, and with another portion or nose 28 terminating in an inclined plane bearing surface which coöperates with the inclined plane bearing surface of arm 25 on lever 19. The lever 19 tends to rotate, by the pressure exerted by operating member 1, in the direction of the force exerted by its spring 22 and is accelerated in moving in this direction by the tension of its spring. The lever 19 is prevented from so moving, however, by the lever 20 which is provided with plane bearing surface adjacent to its pivot which engages the bearing point surface on arm 26 of lever 19. Lever 20 tends to rotate by the pressure exerted by arm 26 of lever 19 in the direction of the force exerted by its spring 23 and is accelerated in moving in this direction by its spring. Lever 20 is prevented, however, from rotating by its arm which terminates in a bearing surface which is engaged by a bearing surface at the end of arm 29 of lever 21. Lever 21 is arranged to take the thrust of lever 20 and thereby hold levers 19 and 20 and hence the restraining mechanism in restraining position. Spring 24 exerts a force tending to move lever 21 to latching position and a stop member 30 is provided to limit the movement of lever 21 in this position which will be described more in detail hereinafter. Lever 21 has another arm 31 which coöperates with a trip lever 32 for the switch through an adjusting means or adjustable stop 33 carried by the arm 31.

The bearing surfaces of levers 19, 20 and 21 are formed of a special alloy composition which is very hard, non-magnetic and non-corrosive thereby offering no attraction to minute iron particles floating in the air which would be attracted by magnetic steel. It has been found that with magnetic tool steel bearing surfaces that a fringe of iron particles gathered at the edges of the bearing surfaces which was wiped upon the bearing surfaces during the resetting of the mechanism and due to the excessive pressures exerted was pressed upon the bearing surfaces causing sluggishness in the mechanism and inaccuracy in its operation. To overcome this condition, a special alloy which is non-magnetic is used and the bearing surfaces thereby kept clean.

The tripping means for the restraining mechanism comprises a trip lever 32 coöperating with the arm 31 of lever 21 at one end and pivotally supported at its opposite end, to obtain a long leverage arm, between suitable bearing members 34 and 35 having a minimum amount of friction. For automatically operating the trip lever 32, in response to predetermined abnormal conditions in the circuit through the switch, I provide an electroresponsive device consisting of a relay having a coil or winding 36 and a coöperating rod or plunger 37 which carries the bearing or impact member 34 for the trip lever 32. In the normal position of the plunger 37 there is a very small space between the lever 32 and its bearing or impact member 34 and to provide a support and maintain the lever 32 in position, an adjustable stop 38 is provided. For varying the pick up point of the relay or the current required in coil 36 to actuate

the plunger 37, I may use various means but I prefer to use a spring member 39 secured to the plunger 37 at one end and to an adjustable support at its other end whereby the pull exerted by said spring on the plunger 37 can be calibrated in terms of pick up current in a manner which is well known in the art. By providing a small space between the trip lever 32 and its impact member 34, the plunger in rising gives the trip lever a quick and sharp blow which causes lever 21 to suddenly release lever 20 and allow the restraining mechanism to collapse and move to tripped position accelerated by its springs. In order that the restraining mechanism may also be tripped by hand, I provide a tripping arm 40 adapted, when actuated, to move the trip lever 32 to tripping position and cause the collapse of the restraining mechanism in a similar manner as is accomplished automatically by relay coil 36.

It will be apparent that when the switch is closed, the operating member 1 and restraining mechanism 18 are in the position shown in Fig. 1. When the relay winding 36 is sufficiently energized to overcome the tension exerted by spring 39, it moves the plunger 37, which through the impact member 34, strikes the trip lever 32 a sharp blow causing lever 21 to quickly release lever 20. The levers 19, 20 and 21 are so arranged that only a slight movement of trip lever 32 is sufficient to move the arm 29 of lever 21 out of engagement with the lever 20 whereupon lever 20 moves, accelerated by its spring 23, into tripped position releasing, simultaneously, arm 26 of lever 19 and allowing lever 19 to move accelerated by its spring 22 to tripped position. Arm 25 of lever 19 simultaneously moves out of engagement with the nose 28 of operating member 1 and permits the operating member to move accelerated by the potential energy stored in its springs 7 to switch opening position. A buffing means 41 is provided to relieve the impact of the operating member. The restraining mechanism 18 is so arranged and the levers 19 and 20 and operating member 1 so accelerated that when the trip lever 32 moves to tripping position, the restraining mechanism moves to tripped position and the operating member moves to switch opening position with great rapidity or in a time which is substantially five one-thousandths of a second. The position of the operating member 1 and the restraining mechanism, when in switch opening position is shown in Fig. 2.

In order that the restraining mechanism 18 may be moved into a position to hold the switch operating member when it is moved to switch closing position, I provide means for automatically resetting the restraining mechanism during the switch closing movement of the operating member 1. This resetting mechanism is controlled by the actuating member 11 and comprises a resetting member 42, having a projecting portion 44 and a pin 45, carried on a shaft 46 which is operatively related to an arm 47 to which is secured through a lost motion connection, a rod 48. The rod 48 is pivotally connected at its other end to a lug on the link 16 of actuating member 11. Surrounding the rod 48 between the lug on link 16 and the arm 47 is a spring member 49.

The operation of my resetting means is as follows: When the operating member 1 is moved from the position shown in Fig. 2 to switch closing position as shown in Fig. 1 by the actuating member 11 as described, the rod 48 is raised and compresses spring 49. Due to the lost motion connection, the arm 47 and hence the resetting member 42 are only moved by the energy stored in the spring 49 and the initial movement of the actuating member 11 causes the spring 49 to actuate arm 47 and through shaft 46, the resetting member 42 so that its projecting portion 44 moves arm 25 of lever 19 into frictional engagement with the horn 27 of operating member 1 which is provided to limit the movement of the lever 19. As the actuating member 11 continues its switch closing movement, the engagement of the lever 19 and the horn 27 prevents further movement of the resettting member 42 due to its restraint by projection 44. Consequently the movement of the actuating member 11 stores energy in the spring 49 until the actuating member reaches the high point 17 on the surface of cam member 10 at which point the nose 28 of operating member 1 moves slightly past the end of arm 25 of lever 19. As this occurs the restraint is removed from the resetting member 42 as its projection 44 is free to move arm 25 of lever 19 into engaging position with the nose 28. This action therefore takes place with a snap action, due to the expansion of the spring 49 and resetting member 42 is rotated to carry its pin 45 into engagement with lever 20 and force it under the end of lever 21 bringing, at the same time, its plane bearing surface into position to be engaged by the bearing surface on arm 26 of lever 19. The restraining mechanism is now in position to restrain the operating member and with the resetting means, is in the position shown in Fig. 1. After the actuating member 11 passes the high point 17 on the surface of cam member 11, it is lowered a fraction of an inch, just sufficiently to bring the operating member 1 and the bearing surfaces of the restraining mechanism into firm and positive engagement. Just after this action takes place, the actuating member 11 reaches the end of the cam surface and falls free from the operating member 1, to its

initial position on the cam member 10 and simultaneously the motor operating the cam is cut off. The actuating member 11 in returning to initial position carries the rod 48 down with it and in doing so causes the resetting member 42 to move from resetting position, as shown in Fig. 1, free from the restraining mechanism to its initial position as shown in Fig. 2.

I have found that in tripping the restraining mechanism 18, it is important that the resetting member 42 be returned to initial position free from the mechanism before the mechanism is tripped as the levers 19 and 20 move so rapidly to tripped position that there is danger of the lever 20 striking the resetting member and becoming impaired. To overcome this condition, I provide a safety or locking means controlled by the resetting mechanism for holding the restraining mechanism in position and for rendering the trip lever 32 ineffective, until the resetting member 42 returns to its initial position. For performing this function, I make use of the stop 30 for lever 21, as best shown in detail in Fig. 3. This stop is slidably mounted in the supporting frame for the restraining mechanism 18 and is biased by means of a spring 50 to move into safety or locking relation. For operating this movable stop 30, I provide an arm or retriever 51 operatively related to the arm 47 of the resetting mechanism, which carries at its end an offset or wedge portion 52 cooperating with a notch or detent 53 in one end of a bar 54 operatively related to and preferably forming an extended portion of the stop 30. The movement of the arm 51 to carry the wedge shaped portion 52 into engagement with the detent 53, moves the bar 54 and stop 30 against the action of the spring 50 out of locking position and into retrieving position. The bar 54 moves through an opening in the side of the supporting structure for the mechanism 18 and has an offset portion which engages with the supporting structure to limit the movement of the stop to safety or locking position. The stop 30 is provided with a finger 55 which extends into the path of lever 21 to limit its movement to latching position, this function of the stop having been already described, this finger 55 being sufficient to restrain the lever 21 in either the retrieving or locking position of the stop 30. The stop 30 is also provided with latching portion which is in the form of an inclined plane surface 56 which coöperates with the lever 20 in the manner and for the purpose to be described.

The operation of my safety or locking means may be described as follows: Assuming the switch is open, the restraining mechanism 18 in its tripped position, and the resetting means in its initial position, as shown in Fig. 2, then arm 47 of the resetting means is in the position best shown in Fig. 3. Arm 51 of my safety mechanism has its wedge portion 52 in engagement with the notch 53 in bar 54 and the stop 30 is thereby held in retrieving position against the action of spring 50. In this position of the stop 30, the finger 55 still acts to limit the position of arm 29 of lever 21.

During the closing movement of the switch, when the resetting means operates to move resetting member 42 to resetting position as has been described, the shaft 46 simultaneously moves the retriever or arm 51 causing the wedge portion 52 to move out of the notch 53 whereupon the bar 54 and stop 30 move, under the action of the spring 50, into locking position. This operation of the stop takes place as the pin 45 on the resetting member 42 engages the lever 20 so that as the lever 20 is forced to resetting position, the end of the lever engages the inclined surface 56 of stop 30 and moves down the inclined surface pushing, in so moving, the stop 30 in, against spring 50. When the end of lever 20 rides off the surface 56 to engage the end of lever 21, the stop 30 snaps out again, due to its spring 50, and locks the end of lever 20 against movement to tripping position, as best shown in Fig. 5. In this position the end of lever 20 is held by the portion 56 of stop 30 and by the arm 29 of lever 21 and the stop 30 prevents the release of lever 20 independent of the movement of lever 21 by the tripping member 32. It is, therefore, impossible while the stop is in this position to trip the releasing mechanism and open the switch. At the end of the switch closing movement, when the actuating member 11 falls to initial position, and moves the resetting member 42 to its initial position free from the restraining mechanism, the return of the resetting means simultaneously actuates the retriever 51, which is on the same shaft 46 as the resetting member 42, causing it to move its wedge portion 52 into engagement with the notch 53. This action moves the bar 54 and stop 30 into retrieving position thereby removing the portion 56 from engagement with the end of lever 20 and permitting the restraining mechanism to be moved into tripping position in response to said tripping member.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

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

1. In an electric switch, the combination with a switch operating member, of means for restraining said member in switch closing position, tripping means for tripping said restraining means, and resetting means for moving said restraining means from tripped to resetting position in response to the movement of said operating member from switch opening to switch closing position.

2. In an electric switch, the combination with a switch operating member, of means for restraining said member in switch closing position, means for tripping said restraining means to release said member, and an actuating member for moving said operating member from switch open to switch closing position and arranged to return to initial position when the switch is closed, and resetting means operative in response to the switch closing movement of said actuating member for moving said restraining mechanism to resetting position and movable free from said mechanism as said actuating member returns to initial position.

3. In an electric switch, the combination with an operating member, means for restraining said member in switch closing position, tripping means for said restraining means, an actuating member for moving said operating member from switch open to switch closing position, means causing said actuating member to automatically return to initial position at the finish of its switch closing movement, and means for resetting said restraining mechanism movable to resetting position by the switch closing movement of said actuating member and returnable to initial position free of said restraining mechanism by the movement of said actuating member to initial position.

4. In an electric switch, the combination with a switch operating member, means for restraining said member in switch closing position, means for tripping said restraining means to permit said operating member to move to switch opening position, switch closing means including a rotatable cam member, an actuating member operative by said cam member to move said operating member to switch closing position and adapted to return to initial position when said switch is closed, resetting mechanism for moving said restraining means from tripped to reset position in response to the movement of said actuating member in switch closing direction and movable to initial position in response to the movement of said actuating member to initial position.

5. In an electric switch, the combination with an operating member, means for restraining said member in switch closing position, tripping means for said restraining means, switch closing means including an actuating member for moving said operating member from open to switch closing position, and a rotatable cam member for moving said actuating member in switch closing direction and releasing said actuating member to permit it to return to initial position when the switch is closed, a resetting member movable to reset said restraining means in response to the movement of said actuating member to switch closing position, means for restraining said resetting member until said operating member is in switch closing position, and means for moving said resetting member to initial position in response to the movement of said actuating member to initial position.

6. In an electric switch, the combination with a switch operating member, of means restraining said member in switch closing position, means for tripping said restraining means, means for resetting said restraining means during the movement of said operating member to switch closing position and then moving free of said mechanism, and means for holding said restraining means unresponsive to said tripping means until said resetting means is free from said restraining means.

7. In an electric switch, the combination with a switch operating member, means for restraining said operating member in switch closing position, means for tripping said restraining means, means operative to move said restraining means into resetting position and then return to initial position, and means for holding said tripping means ineffective until said resetting means is in its initial position.

8. In an electric switch, the combination with a switch operating member, of a mechanism restraining said member in switch closing position and adapted to be tripped to release said member, means for moving said operating member from switch opening to switch closing position, and a resetting means operative as said operating member moves in switch closing direction to first move said restraining mechanism into resetting position and then move free of said mechanism, and means for preventing the tripping of said mechanism until said resetting mechanism is moved free therefrom.

9. In an electric switch, the combination with a switch operating member, of a mechanism restraining said member in switch closing position, means for tripping said mechanism to release said member, an actuating member movable in one direction to carry said operating member to switch closing position and returnable to initial position when said operating member is restrained, means controlled by said actuating

member for resetting said restraining mechanism during the switch closing movement thereof and movable to initial position in response to movement of said actuating member to initial position, and means for locking said restraining mechanism against tripping until said resetting mechanism has reached its initial position.

10. In an electric switch, the combination with a switch operating member, of means for restraining said member in switch closing position, means for tripping said restraining means, means for moving said restraining means from tripping to resetting position, means for returning said resetting means from resetting to initial position, and a lug controlled by said resetting means for preventing the release of said restraining means until said resetting means is in its initial position.

11. In combination with the operating member of an electric switch, a plurality of levers having coöperating engaging bearing surfaces and coacting to restrain said operating member in switch closing position, springs tensioned to move said levers out of restraining position, a tripping member for releasing said levers, and a resetting member operative to move said levers to resetting position and return to initial position during the switch closing movement of said operating member.

12. In combination with a switch operating member, of restraining means comprising a system of levers coacting to maintain said member in switch closing position, engaging surfaces for said levers of a non-magnetic material, and a member for moving said levers into tripping position.

13. In combination with a switch operating member, accelerating means for moving said member in switch opening direction with great rapidity, a plurality of members coacting to restrain said member in switch closing position, means for moving said members to releasing position to permit said operating member to move under its accelerating means to switch opening position, and accelerating means for moving said members to releasing position with great rapidity.

In witness whereof, I have hereunto set my hand this 12th day of May, 1917.

WALDO W. WILLARD.