Oct. 13, 1931. C. THUMIM 1,827,626

SWITCH OPERATING MECHANISM

Filed May 20, 1930

Fig. 1.

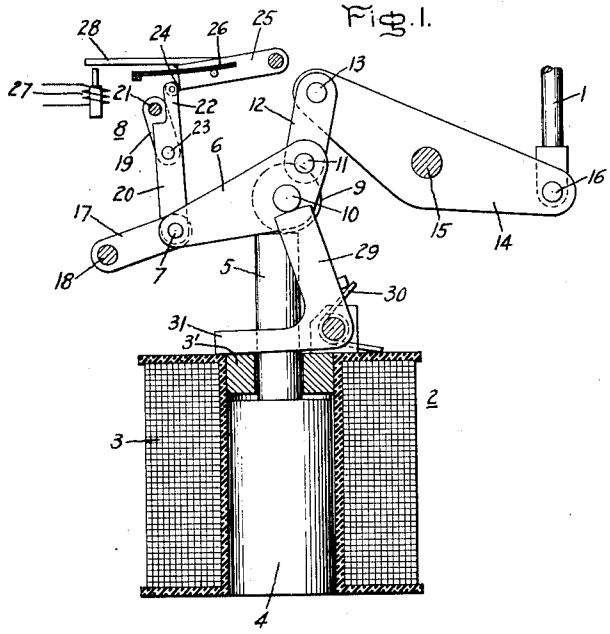


Fig. 2.

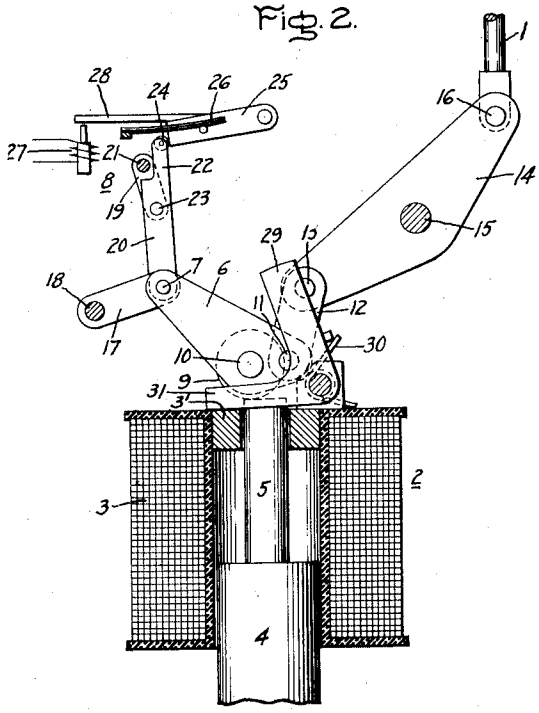
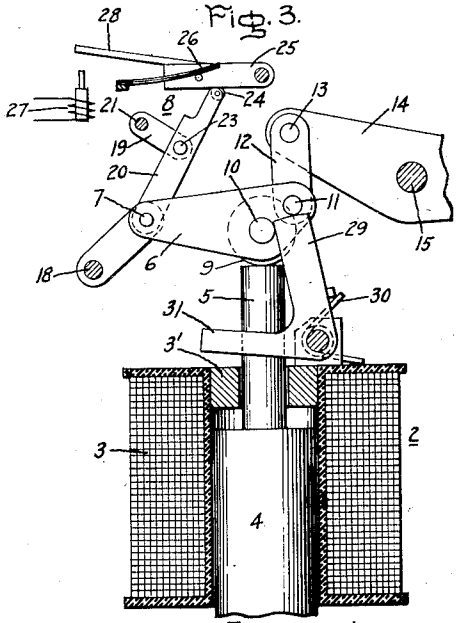


Fig. 3.



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UNITED STATES PATENT OFFICE

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SWITCH OPERATING MECHANISM

Application filed May 20, 1930. Serial No. 454,109.

My invention relates to switch operating mechanism.

In the operation of a switch adapted to carry large currents, the reacting magnetic and other forces opposing the closing movement thereof may be very great, particularly during the latter part of the closing stroke. In switch operating mechanism of the so-called trip-free type wherein the switch may be mechanically released or tripped with respect to its operating mechanism during any part of a closing operation for allowing free opening movement of the switch, these opposing forces react to a certain extent on the tripping mechanism thereby tending to increase the resistance to tripping unless compensated for in some manner. This is disadvantageous, particularly when the opposing forces greatly increase as the switch contacts approach each other, since the tripping mechanism is rendered less sensitive at a time when it should be most sensitive to the tripping force. In certain instances, the operating force is not constant throughout the switch closing stroke, as in solenoid operators, with the result that the necessary tripping force also tends to vary with the variation in operating force.

It is an object of my invention to provide an improved switch operating mechanism which shall have means for maintaining substantially constant the necessary tripping force in all operating positions of the switch mechanism notwithstanding appreciable variations in the switch operating and opposing forces.

It is a further object of my invention to provide an improved switch operating mechanism which is simple and rugged in construction and which is sensitive to the tripping force in all positions thereof.

My invention will be more fully set forth in the following description referring to the accompanying drawings, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

Referring to the drawings, Fig. 1 is a view, partly in section, of switch operating mechanism embodying my invention in the closed circuit position thereof; Fig. 2 is a view of the mechanism illustrated in Fig. 1 in the open circuit position; and Fig. 3 is a view of the same mechanism in an intermediate tripped position.

By way of example, but without limitation thereto, my invention is illustrated in Fig. 1 as embodied in solenoid operated mechanism comprising a switch operating member, as the rod 1, suitably connected to a switch (not shown), actuating means generally indicated at 2 comprising in the present instance a solenoid energizing coil 3, a polepiece or armature 3′, and a magnetizable solenoid plunger 4 having a non-magnetic extension 5 secured thereto, and a floating lever 6 operatively related in a manner hereinafter described to the actuating means 2 and the switch operating rod 1. It shall be understood of course that the actuating means may comprise other arrangements, as for example, a cam follower driven by a motor operated cam. The floating lever 6 is provided with a pivot 7 which is adapted to be held stationary under predetermined conditions by the tripping means 8 so that the floating lever 6 may be rotated about the pivot 7 by the actuating means to cause switch closing movement of the rod 1.

Referring more particularly to Fig. 2 wherein the actuating means is deenergized and the mechanism is in the open circuit position, the upper end of the non-magnetic member 5 is engaged by a roller or equivalent 9 secured by the pin 10 to the floating lever 6. The floating lever is likewise connected as at 11 to a link 12 connected at 13 to a main lever 14. The main lever 14 rotates about a fixed pivot 15 and is connected at its opposite end at 16 to the switch operating rod 1. It will therefore be noted that the pivots 10, 11 and 13 are comprised in a toggle interconnecting the actuating means and the switch operating rod.

Coacting with the tripping means 8 for maintaining the pivot 7 of the floating lever stationary is a link 17 pivoted at 18 likewise forming with the floating lever a toggle having the pivot 7 as its center. The tripping

means for restraining the pivot 7 comprises a toggle 19—20 having a fixed pivot 21 and a connection with the pivot 7. Link 20 of the toggle is provided with a portion 22 extending beyond the center connection 23 of the toggle having a roller or the like 24 adapted to engage a pivoted tripping lug 25 normally biased, as by a leaf spring 26, into engagement with the roller. The lug 25 is adapted to be actuated by the usual tripping magnet 27 which engages the extension 28 of the tripping lug to move it clockwise out of engagement with the roller 24, thereby removing the restraining force on the toggle 19—20.

For the purpose of maintaining the floating lever 6 in the closed circuit position illustrated in Fig. 1 when the actuating means is deenergized, there is provided a pivoted prop or support 29 normally biased as by a spring 30 in counterclockwise direction. As illustrated in Fig. 1, the prop 29 is adapted to engage the pin 10 of the floating lever to hold it and consequently the switch rod 1 in the closed circuit position notwithstanding subsequent deenergization of the actuating means. The prop is provided with suitable stop means, as an extension 31, for limiting counterclockwise movement thereof.

The operation of the mechanism is as follows:

When the actuating means 2 is deenergized and the mechanism is in the open circuit and reset position illustrated in Fig. 2 the floating lever 6 is adapted to be rotated about the restrained pivot 7 by actuation of the solenoid plunger to perform the switch closing operation. Upon energization of the solenoid winding the plunger 4 is urged upwardly against the roller 9 to rotate the floating lever 6 in a counterclockwise direction about its pivot 7 thereby causing clockwise rotation of the main lever 4 and downward or closing movement of the switch operating rod 1. During this operation the pin 10 rides along the edge of the support 29 to cam it clockwise a small extent against the bias of the spring 30. As the solenoid plunger nears the end of its upward stroke, the floating lever is rotated so that the pivots 18, 7 and 10 are nearly on a straight line, the pivot 7 however being slightly underset so that a certain thrust or force is still exerted on the tripping toggle 19—20. When the floating lever reaches the above described position, the pivoted support 29 is biased counter-clockwise by its spring underneath the pin 10 so that it is restrained from reverse or switch opening movement. The actuating means 2 may now be deenergized to permit the solenoid plunger to drop to its initial position since the pivot 7 of the floating lever is held stationary by the tripping means and the link 17, and the pin 10 is held in position by the support 29, thereby preventing counterclockwise movement of the lever 14.

During the above described closing operation, it shall be particularly noted that the pivots 10, 11 and 13 approach a straight line during rotation of the floating lever 6 so that the forces opposing the switch closing movement have less effect on the tripping mechanism as the closing operation progresses. In other words, the reacting force from the switch mechanism through the link 12 tending to produce clockwise rotation of the lever 6 about the pin 10 acts on a gradually decreasing effective length of lever arm so that the force transmitted by the pivot 7 to the tripping means tends to decrease accordingly. In practice, however, it is quite generally true that the characteristic reacting forces of the switch, due to the opening springs, magnetic forces and other causes, gradually increase as the switch contacts approach each other, the final part of the closing stroke often involving considerable resistance. Since this force reacts through the switch operating mechanism, it will be observed that the effect of this increasing opposing force is counteracted by the straightening of the toggle comprising the pivots 10, 11 and 13, so that the resultant of the opposing forces acting on the tripping mechanism tends to remain substantially constant. In considering the actuation of lever 14 by the solenoid plunger, it will be observed that the force is transmitted by lever and not by toggle action. In other words, the floating lever 6 acts directly on the lever 14 through the link 12 with a gradual increase in mechanical advantage due to decrease in the distance between the line along which the force is directed to the roller 9, and the pivot 11. This will be apparent by comparing the positions of the pivot 11 in Figs. 1 and 2. There will be accordingly a greater mechanical advantage at the later part of the closing stroke where it is most needed.

During the above described operation the solenoid plunger is urged upwardly by magnetic forces which gradually increase as it is withdrawn into the coil so that the plunger is able to exert its greatest force on the roller 9 near the end of its closing stroke. This upward thrust is of course greater than the reacting force of the breaker causing the floating lever 6 to rotate about the pivot 7. Since the components of the reacting force are along the diverging lines from the pivot 7 to the pivots 18 and 21, it will be noted that the component acting on the tripping toggle is fairly large when the solenoid plunger is at its initial position, as illustrated in Fig. 2, and that the force is nearly all transmitted through the link 17 to the pivot 18 when the plunger is at its upper end of the stroke, as illustrated in Fig. 1. In other words, the component of the reacting force acting on the tripping mechanism tends to decrease, as-

suming that the force is constant, during the switch closing movement. However, due to the fact that the reacting force gradually increases during the switch closing operation, the effect of this increase is likewise counteracted by the straightening of the toggle 6—17 so that the resultant force acting on the tripping means tends to remain substantially constant.

The tripping mechanism is accordingly sensitive to the tripping force of the trip coil in not only the closed position of the switch but also in every position thereof during the switch closing movement. Actuation of the tripping lug 25 as illustrated in Fig. 3, by the tripping coil, releases the roller 24 of the toggle 19—20, permitting it to ride underneath the lug 25 as the toggle 19—20 collapses so that the pivot 7 of the floating lever is no longer restrained. The switch reacting forces accordingly tend to rock the floating lever 6 in clockwise direction about the pin 10 which is supported on the prop 29. As the pivot 7 of the floating lever moves upwardly it likewise moves to the left by reason of the pivoted link 17 so that the floating lever 6 shifts bodily and the pin 10 rides off the supporting edge of the prop 29 to cause the floating lever 6 to drop under its own weight and the reaction of the switch to the position illustrated in Fig. 2. In Fig. 3 the mechanism is illustrated in an intermediate tripped position in which the pin 10 has moved off the supporting prop 29 and the floating lever is ready to drop.

During the above described operation, the weight of the floating lever 6 stretches or straightens the toggle 19—20, as shown in Fig. 2, for resetting the tripping mechanism so that the roller 24 engages the end of the tripping lug 25 unless the lug is still maintained out of engagement with the roller 24 by the tripping magnet. Accordingly, the mechanism is not only trip-free in all positions thereof but actuation of the mechanism is rendered impossible if the predetermined circuit conditons causing tripping of the mechanism still obtain. The tripping mechanism is rendered even more sensitive to the tripping force by reason of the extending portion 22 of the toggle link 20. This extension, by providing a longer lever arm for opposing the force tending to cause buckling of the toggle 19—20 at its mid portion, decreases the force exerted by the roller 24 on the lug 25, thereby decreasing the friction between these elements and so necessitating less tripping force to actuate the lug 25.

It will be understood that my invention is not limited to the specific elements or arrangement thereof herein illustrated and that changes or modifications may occur to one skilled in the art without departing from the spirit of my invention.

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

1. Swith operating mechanism comprising a switch operating member, actuating means therefor, a floating lever operatively related to said actuating means, tripping means for holding a portion of said floating lever stationary, said lever adapted to be rotated by said actuating means with respect to said stationaly portion during the switch closing movement, and means including a toggle interconnecting said floating lever and switch operating member for transmitting closing movement to the operating member, said toggle including a lever arm of decreasing effective length for maintaining substantially constant the resultant of the switch reacting force transmitted from the floating lever to said tripping means, concurrent with increase in said force during said switch closing movement.

2. Switch operating mechanism comprising a switch operating member, actuating means therefor, a lever having a floating pivot operatively related to said actuating means, tripping means for restraining said floating pivot so that said lever is adapted to be rotated about said pivot by said actuating means to cause switch closing movement, and means including a toggle interconnecting said lever and said switch operating member adapted to be straightened during said switch closing movement, said toggle comprising a lever arm of decreasing effective length for maintaining substantially constant the resultant switch reacting force transmitted from said lever to said tripping means concurrent with increase in said reacting force during the switch closing operation.

3. Switch operating mechanism comprising a switch operating member, actuating means therefor, a floating lever operatively related to said actuating means and switch operating member, a tripping toggle connected to and maintaining a pivot of said floating lever stationary so that said lever may be rotated by said actuating means about said pivot to effect switch closing movement, and means for causing collapse of said toggle to release said floating lever and cause switch opening movement, said floating lever comprising a lever arm of decreasing effective length for maintaining substantially constant the resultant of the reacting force transmitted from said floating lever to said tripping toggle during said switch closing movement.

4. Switch operating mechanism comprising a switch operating rod, solenoid actuating means for causing switch closing movement thereof, a floating lever operatively related to said actuating means and switch operating rod, tripping means connected to and holding a pivot of said floating lever stationary so that said solenoid actuating means may rotate the floating lever about said pivot to

cause switch closing movement, said tripping means adapted to release said pivot to cause switch opening movement of the operating rod in any position thereof, and means including a toggle associated with said tripping means tending to decrease the resultant of the reacting force transmitted to said tripping means whereby said resultant is maintained substantially constant during the switch closing movement concurrent with increase in said reacting force.

5. Switch operating mechanism comprising a switch operating rod, actuating means therefor, a pivoted lever operatively related to said actuating means and switch operating rod, means including a toggle adapted to be straightened during the switch closing operation interconnecting one portion of said lever and said operating rod, tripping means for holding the pivot of said lever stationary whereby the lever may be rotated by the actuating means to cause switch closing movement, said toggle during straightening thereof tending to decrease the resultant of the switch reacting force acting on the pivot of said lever, and means associated with said pivot for receiving an increasing thrust from said lever during switch closing movement thereof for also tending to decrease the resultant of the switch reacting force acting on said tripping means.

6. Switch operating mechanism comprising a switch operating member, an operating solenoid having a movable plunger for causing switch closing movement of said member, a floating lever having a floating pivot, and means including a tripping toggle for holding said pivot stationary whereby the floating lever may be rotated by said solenoid plunger about said pivot, and means including a toggle interconnecting the free end of said floating lever with said operating member for transmitting closing movement thereto, said toggle adapted to be straightened during rotation of the floating lever thereby tending to decrease the switch reacting force transmitted to the tripping toggle, said floating lever forming part of another toggle also tending to decrease the resultant force transmitted to said tripping toggle during the switch closing movement arranged so that said tripping toggle is sensitive to a substantially constant tripping force in all positions of the switch operating mechanism, notwithstanding increase in said reacting force during the switch closing operation.

7. Switch operating mechanism comprising a switch operating member, actuating means therefor, a floating lever operatively related to said actuating means, tripping means for maintaining a pivot of said floating lever stationary, said lever adapted to be rotated about said stationary pivot by said actuating means to cause switch closing movement, movable supporting means for holding said floating lever in closed circuit position subsequent to deenergization of said actuating means, and means including a toggle inter-connecting the free end of said lever and said switch operating member adapted to be straightened during said switch closing movement whereby the resultant switch reacting force transmitted from said floating lever to said tripping means tends to remain substantially constant concurrent with increase in said reacting force during the switch closing operation.

8. Switch operating mechanism comprising a switch operating rod, actuating means therefor, a floating lever operatively related to said actuating means and switch operating rod, means including a toggle interconnecting one portion of the floating lever and said operating rod, and means including a tripping toggle connected to and restraining a pivot of said floating lever whereby the floating lever may be rotated about said pivot by an actuating means to cause switch closing movement, said actuating means being adapted to apply force to the floating lever along a line between said pivot and first-named toggle whereby straightening of said first-named toggle during the switch closing movement tends to decrease the resultant switch reacting force transmitted through the floating lever to the tripping toggle.

9. Switch operating mechanism comprising a switch operating rod, a main lever having a fixed pivot, said lever operatively connected at one point to said rod, a floating lever connected to said lever at another point, a tripping toggle restraining one portion of said floating lever, a solenoid for rotating said floating lever about said restrained portion and transmitting circuit closing movement to said main lever, and a prop holding said floating lever in circuit closing position when said solenoid is deenergized.

10. Switch operating mechanism comprising a switch operating rod, a solenoid including a plunger causing switch closing movement of said rod, means transmitting switch closing movement to said rod including a main lever having a fixed pivot, said lever operatively connected at one point to said rod, a floating lever operatively connected at another point to said rod, a tripping toggle restraining one end of said floating lever forming a pivot, rotation of said floating lever about said pivot causing circuit closing movement of said main lever, a roller carried by said floating lever arranged to be in rolling engagement with said solenoid plunger during the switch closing operation, and a prop holding said floating lever in circuit closing position.

In witness whereof, I have hereunto set my hand this sixteenth day of May, 1930.

CARL THUMIM.