

May 10, 1932.

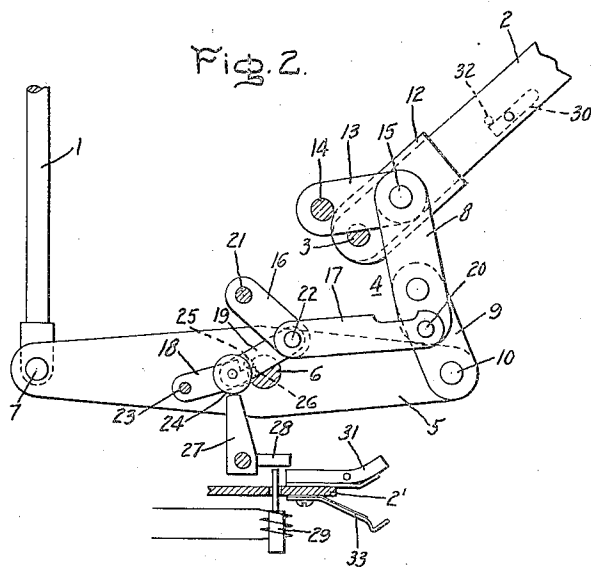
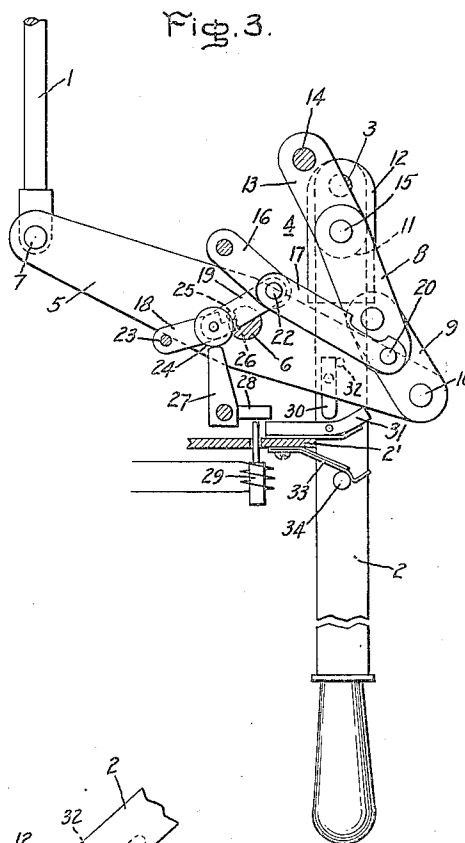
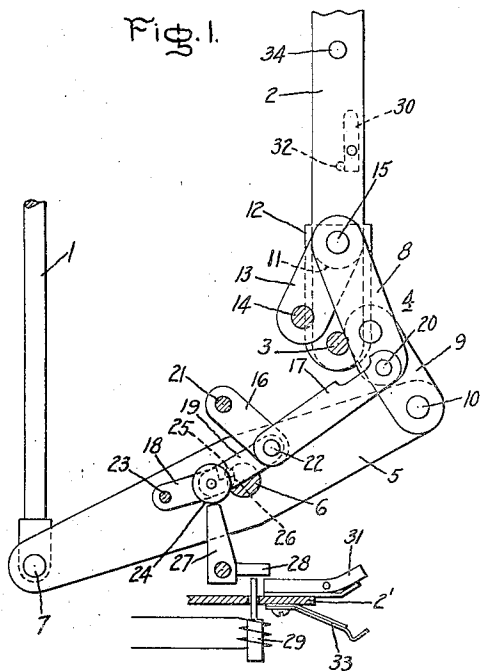
C. THUMIM

1,857,220

SWITCH OPERATING MECHANISM

Filed July 11, 1930

2 Sheets-Sheet 1



Inventor:
Carl Thumim,
by *Charles V. Toller*
His Attorney.

May 10, 1932.

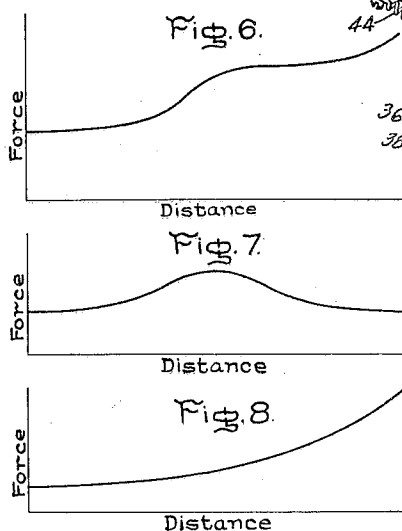
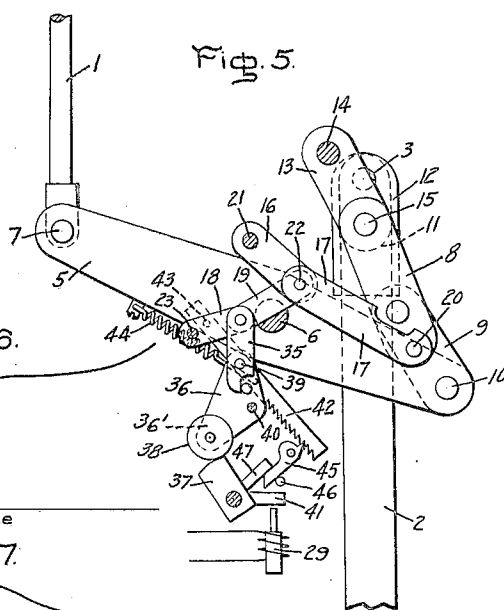
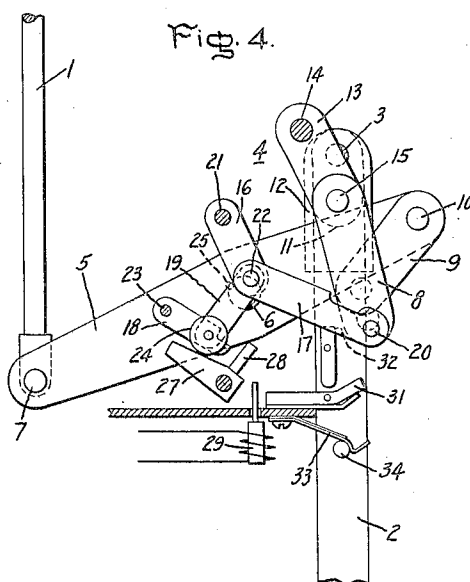
C. THUMIM

1,857,220

SWITCH OPERATING MECHANISM

Filed July 11, 1930

2 Sheets-Sheet 2



Inventor:
Carl Thumim,
by *Charles V. Tuller*
His Attorney.

UNITED STATES PATENT OFFICE

CARL THUMIM, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

SWITCH OPERATING MECHANISM

Application filed July 11, 1930. Serial No. 467,194.

My invention relates to switch operating mechanism, and more particularly to mechanism of the type wherein a switch operating member is adapted to be immediately released or disengaged with respect to the switch closing force in response to a switch tripping operation during any part of the closing operation for allowing free opening movement of the switch.

10 In switch operating mechanism of the above, or trip-free type, it is desirable, particularly when the switch closing force is applied manually, to cause a powerful closing thrust to be exerted during the final switch closing movement for the purpose of overcoming the increasing resistance of magnetic and other forces as the switch contacts approach each other. It is also desirable that the force necessary to trip the switch mechanism shall be small when the reacting forces of the switch tending to open the same are great so that the mechanism shall be sensitive to the tripping force.

25 It is an object of my invention to provide an improved switch operating mechanism which shall have means for causing a powerful closing thrust to be exerted on the switch operating member during the final closing movement thereof, and for rendering the mechanism, particularly in its closed or partially closed position, sensitive to the tripping force.

30 It is a further object of my invention to provide an improved switch operating mechanism which is both simple and rugged in construction, and efficient and rapid in operation.

40 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.

45 Referring to the drawings, Fig. 1 is a view illustrating switch operating mechanism embodying my invention in the open circuit position thereof; Fig. 2 is a view of the mechanism illustrated in Fig. 1 in a partly closed or intermediate position; Fig. 3 is a view of

the mechanism in the fully closed position; Fig. 4 is a view of the mechanism in the tripped position; Fig. 5 is a view illustrating a modification of a tripping mechanism; and Figs. 6, 7 and 8 are graphic representations of switch closing forces.

55 The specific switch operating mechanism illustrated embodying my invention comprises a switch operating member, as the rod 1, suitably connected to a circuit breaker or breakers (not shown), and a switch actuating member, as the lever 2, having a fulcrum or pivot 3. For the purpose of transmitting movement from the actuating lever 2 to the switch operating rod 1, there is provided interconnecting thrust-transmitting structure generally indicated at 4 which is operatively related to the lever 2 and a main operating lever 5 centrally pivoted at 6 and connected at its other end as at 7 to the switch operating rod.

60 The thrust transmitting structure 4 comprises a toggle 8—9, or equivalent structure adapted to move as a rigid member, having one end pivotally connected as at 10 to the main lever 5 and the other end movably connected to the actuating lever 2 in a manner hereinafter described. For the purpose of increasing the mechanical advantage, that is, the ratio of the resistance to the power applied, of the actuating lever 2 during the switch closing movement and for superimposing a toggle effect thereon so that the thrust-transmitting structure 4 shall exert a powerful closing thrust upon the switch operating rod 1, particularly at the final part of the closing stroke, the movable connection of the toggle 8—9 with the lever 2 is restrained and guided so that it is moved nearer the pivot 3 of the lever as the same is rotated to effect the circuit closing operation. Accordingly, the thrust transmitted to the main lever 5 through the toggle 8—9 becomes increasingly greater as the actuating lever is rotated, notwithstanding the fact that a constant closing force be applied to the actuating lever.

65 In the arrangement illustrated, the means for varying the mechanical advantage of the actuating lever and for combining a toggle

effect therewith comprises a roller or pin 11 secured to the toggle link 8 and guided within the channel structure 12 formed by a U-shaped member secured to the actuating lever 2. For the purpose of restraining the roller 11 so that it is moved within the guide 12 in the manner previously described, there is provided a toggle link 13 having a fixed pivot 14 at one end and pivotally connected at its other end as by the pin 15 to the link 8 and the roller 11. It will be noted, therefore, that the link 13 and the rigid toggle 8—9 form another or actuating toggle which has its joint or central pivot 15 operatively connected to the actuating lever 2. Since the radial distance from the pivot 14 to the pin 15 is less than that from the pivot 3 to the pin 15, it will be apparent that rotation of the lever 2 in a clockwise direction about the pivot 3 causes the roller 11 to move towards the pivot 3 thereby straightening the actuating toggle and increasing the mechanical advantage of the actuating lever, as illustrated in Fig. 2.

The toggle 8—9 is adapted to be held in a thrust-transmitting or rigid position by a holding toggle 16—17 and a tripping toggle 18—19. The holding toggle 16—17 is connected at one end as at 20 to a central portion of the toggle 8—9 for holding the same in a slightly underset or undertravelled position, and is provided at its other end with a fixed pivot 21. For the purpose of maintaining the central pivot of the holding toggle in a stationary position when the switch mechanism is closing or closed, the central portion of the holding toggle 16—17 is likewise connected as at 22 to one end of the tripping toggle 18—19 which has a fixed pivot 23 at the other end. The tripping toggle is provided with a roller 24 at its central portion and the travel of the toggle is limited to an underset position by a pin 25 on the link 19 coacting with a lug portion 26 of the link 18. For maintaining the toggle 18—19 in rigid or locking position, the roller 24 is adapted to be engaged by a pivoted lug or prop 27 having a weighted extension 28 extending in the path of travel of the tripping magnet armature 29. The lug 27 is normally biased by the weight of the extension 28, or by suitable spring means, in a clockwise direction to the locking position illustrated so that the roller 24 is engaged by the lug, thereby providing for resetting of the tripping mechanism for each operation.

In manually operated switch mechanism of the character above described it is important that the operator move the actuating lever to its fully closed position with a firm, positive movement. If the operator moves the actuating lever very cautiously toward closed position, as by vibrating it into the closed position, the switch contacts may be severely burned by arcing. In order that closure of

the switch contacts shall be effected only by firm positive movement there is provided means for actuating the tripping mechanism in response to reverse or backward movement of the actuating lever 2 during the switch closing movement. The reverse tripping means illustrated in Figs. 1 to 4 comprises a pivoted element or dog 30 mounted on the lever 2 and a pivoted cam element 31 mounted with respect to the lug 27. The element 30 is so positioned on the lever 2 that the lower end thereof as illustrated in Fig. 3, is adapted to engage and ride over the outer portion of the element 31 without rotating the same by reason of the fact that the element 30 is free to rotate counterclockwise and that the force applied to the element 31 is directed along the line through its pivotal center. Upon reverse or counterclockwise movement of the lever 2 from the position illustrated in Fig. 3 however, the lower end of the element 30 engages the element 31, and since the element is now restrained by the pin 32 from clockwise rotation, it cams the element 31 in a clockwise direction to engage and rotate the extension 28, causing tripping of the mechanism. A spring detent 33 for resiliently engaging a pin 34 on the lever 2 is utilized to hold the lever 2 in the closed position illustrated in Fig. 3 so that it will not be jarred to accidentally trip the operating mechanism.

In describing the operation of the mechanism illustrated in Figs. 1 to 4, reference will first be had to the graphs shown in Figs. 6 to 8.

As has been previously stated, the force opposing the closing of the breaker is not constant but increases as the closing stroke proceeds, particularly during the final part of the stroke. Fig. 6 represents graphically a typical circuit breaker characteristic curve showing the increase in force necessary to overcome the switch reaction as the closing operation, which is represented as distance, proceeds. In analyzing this curve it is seen that an abrupt increase in the applied force is required toward the latter half of the stroke, the applied force thereafter gradually increasing and again rising sharply at the final part of the stroke. It is, therefore, highly desirable that the characteristic force-distance curve of the mechanism shall approximate the characteristic curve of the breaker. With the closing mechanism of this character the closing operation may be effected smoothly and positively since the applied force anticipates, so to speak, the variations in the circuit breaker reaction.

In obtaining this desired characteristic, the combined effect of two mechanisms, namely a direct lever having a variable lever arm and a toggle, is utilized. Referring to Fig. 7, there is illustrated a characteristic curve of a direct lever having a variable lever

arm arranged so that the maximum leverage or mechanical advantage is obtained near the mid-part of the stroke. In Fig. 8 there is illustrated a characteristic force curve for a toggle which is adapted to transmit thrust by straightening movement thereof as by force applied at its central pivot. It will be noted that the force exerted by the toggle during the greater portion of its straightening movement is comparatively low, assuming of course that a constant force is applied at the central or actuated pivot of the toggle, and that the force transmitted increases very rapidly as the pivots of the toggle approach a straight line. This characteristic of a toggle is, of course, well known and need not be further discussed.

It will be apparent now that if the curve of Fig. 8 is superimposed on the curve of Fig. 7 the resultant curve will approximate the breaker characteristic curve of Fig. 6. In practice, this combination of a variable lever arm and toggle effect is obtained by operatively connecting the central pivot of an actuating toggle directly to a lever through a variable lever arm as previously described.

Assuming now that the parts of the mechanism are in the positions illustrated in Fig. 1 representing the open circuit position of the mechanism, the circuit closing movement is initiated by the operator grasping the handle of the actuating lever 2 and firmly moving it in a clockwise direction. The link 17 of the holding toggle 16—17 is so designed that the thrust toggle 8—9 moves as a rigid unit or link about the central pivot 22 of the holding toggle during closing movement of the switch. In the position illustrated in Fig. 2 the actuating lever has been rotated about 45° from the position illustrated in Fig. 1 and the main lever 5 has been rotated to move the switch operating rod 1 an appreciable distance towards its fully closed position.

During this operation the point of application of force between the lever 2 and the thrust-transmitting structure, that is, the roller 11, is moved nearer the pivot 3 and the actuating toggle is straightened so that the thrust transmitted to the switch operating rod 1 is correspondingly greater while the rate of movement of the rod is correspondingly decreased. The link 17 of the holding toggle 16—17 in moving with the toggle 8—9 tends to straighten the holding toggle so that the force exerted by the tripping toggle 18—19 for holding the central pivot 22 stationary is decreased.

When the actuating lever 2 has been rotated substantially 180° to the position illustrated in Fig. 3 abutting the stop structure 2' the roller 11 is very near the pivot 3 so that the mechanical advantage of the actuating lever is comparatively great. The maxi-

mum mechanical advantage of the lever mechanism results when the pivots 3, 14 and 15 are in line during the latter part of the closing stroke as graphically illustrated in Fig. 7. During the last 45° of rotation of the lever 2, this large mechanical advantage is superimposed on the increased effective toggle thrust so that a powerful closing thrust is exerted on the rod 1 as graphically illustrated in Fig. 6 during the final part of its closing movement. At the end of the stroke, the line of centers between the pivots 14 and 15 has shifted to the opposite side of the pivot 3 thereby causing the lever 2 to be forced firmly against the abutment 2' and held in closed position.

In this position the holding toggle 16—17 is maintained by the tripping toggle in a slightly underset position so that it may be held rigidly by a comparatively small force. This is an important feature in switch operating mechanism since the reacting forces tending to cause opening movement of the switch, unless greatly reduced when applied to the tripping mechanism, may cause so much friction due to the high pressure between the elements, that an appreciable tripping force is necessary to free the elements and trip the switch. In other words, the operating mechanism under such conditions is not sensitive to the tripping force. Since the counteracting or opposing forces acting on the switch rod 1 tend to increase as the closing operation proceeds it will be noted that the straightening of the holding toggle 16—17 coincident with the closing operation also necessitates less tripping force, thereby tending to counteract the increasing opposing forces so that the tripping force tends to remain fairly constant. In the fully closed position of the mechanism, as illustrated in Fig. 3, the thrust-transmitting toggle 8—9, the holding toggle 16—17 for preventing collapse of the toggle 8—9 and the tripping toggle 18—19, in turn preventing collapse of the holding toggle 16—17, are each slightly underset so that the resultant force exerted on the tripping lug 27 by the roller 24 is comparatively small, thereby rendering the tripping mechanism quite sensitive.

Normal tripping or opening movement of the mechanism from closed circuit position is effected by rotating the lug 27 counter-clockwise as illustrated in Fig. 4, either by actuation of the armature 29 by the tripping magnet, or by other means, so that the roller 24 forming the central portion of the tripping toggle 18—19 is no longer supported. This results in simultaneous collapse of the toggles since the central portion 22 of the holding toggle 16—17 is no longer held stationary to maintain the toggle 8—9 through the link 17 in rigid or thrust-transmitting position. Accordingly, collapse of

the toggle 8—9 releases the connection between the main lever 5 and the actuating lever 2 so that the main lever 5 is free to rotate counterclockwise as the reacting forces causing opening movement of the switch urge the operating rod 1 downwardly. It will be noted that actuation of the lug 27 during any part of the switch closing movement is effective to cause collapse of the thrust-transmitting structure for permitting immediate opening movement of the switch so that the mechanism is trip-free in all positions thereof.

After the tripping operation, the mechanism is reset for a subsequent closing operation by rotating the lever 2 counterclockwise substantially 180° to the position illustrated in Fig. 1. This operation stretches or extends the toggles to their initial positions so that the tripping lug 27 is free to move underneath the roller 24 in response to its biasing means. The mechanism is now reset as illustrated in Fig. 1, and is in readiness for another circuit closing operation.

In certain types of circuit breakers the requirements for opening of the breaker necessitate an unusually sensitive tripping mechanism so that the mechanism is tripped practically instantly in response to actuation of the trip coil. For the purpose of further increasing the sensitivity of the tripping mechanism, the mechanism illustrated in Figs. 1 to 4 is provided with another tripping toggle as illustrated in Fig. 5, this additional toggle 35—36 being interposed between the toggle 18—19 and the tripping lug 37. In other words, the modification comprises simply connecting the central pivot of the toggle 18—19 to a tripping toggle in turn maintained in an underset position by the tripping lug 37. The tripping toggle 35—36 comprises an extension 36' and a roller 38 adapted to engage the lug 37, and a central pivot 39 which is underset with respect to the fixed pivot 40 of the link 36 and the central pivot of the toggle 18—19. The tripping and resetting operations of the mechanism illustrated in Fig. 5 are substantially the same as described in connection with the mechanism illustrated in Figs. 1 to 4. Actuation of the trip coil 29 causes the lug 37, through its extension 41, to be rotated counterclockwise for allowing collapse of the toggle 35—36 and the toggles associated therewith. The additional toggle 35—36 combined with the extension 36' on which the roller 38 is mounted results in much greater sensitivity since the force required to actuate the tripping lug is obviously very small.

In Fig. 5 there is likewise illustrated another arrangement for causing tripping of the mechanism in response to reverse movement of the actuating lever during the circuit closing position. In this arrangement a

rack 42 is pivotally carried, as at 43, by the main lever 5 and is normally biased, as by a spring 44, in a clockwise direction into engagement with a pawl 45 which is limited as to counterclockwise movement by a stop pin 46 and is adapted to rotate the tripping lug 37 through its extension 47 in counterclockwise direction to trip the breaker in response to clockwise movement of the pawl 45. During closing movement of the breaker the lever 5 in its clockwise movement simply carries the rack 42 along with it, the rack riding over the coacting extension of the pawl 45. However, upon reverse or counterclockwise movement of the lever 5, the rack 42 is thrust downwardly to cause clockwise rotation of the pawl 45 and consequent tripping of the mechanism.

It shall be understood that my invention is not limited to specific details of construction and arrangement thereof herein illustrated, and that changes and 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. Switch operating mechanism comprising a switch operating member, an actuating member for effecting switch closing movement of said operating member, thrust-transmitting structure interconnecting said members, and means including a portion operatively connected to said actuating member and said thrust-transmitting structure, said portion being subject to a decreasing lever arm of said actuating member for increasing the mechanical advantage of the actuating member with respect to said thrust-transmitting structure during the switch closing movement.

2. Switch operating mechanism comprising a switch operating member, an actuating member for effecting switch closing movement of said operating member, thrust-transmitting linkage structure interconnecting said members, and means forming a joint of said linkage structure and slidably connected to said actuating member for increasing the mechanical advantage of the actuating member with respect to said structure during the last part of the switch closing movement whereby a powerful closing thrust may be exerted on the switch operating member.

3. Switch operating mechanism comprising a switch operating member, an actuating lever for effecting switch closing movement of said operating member, structure interconnecting said member and lever, and means forming part of said structure slidable with respect to the fulcrum of the lever for increasing the mechanical advantage of the actuating lever with respect to said structure during the switch closing movement whereby a powerful final closing thrust may

be transmitted through said structure to the switch operating member.

4. Switch operating mechanism comprising a switch operating rod, a pivoted actuating lever for effecting switch closing movement of said rod, a toggle adapted to be held in rigid position for transmitting thrust from said lever to said rod, said toggle having a sliding connection with said actuating lever, and a restraining link connected to said toggle for causing said sliding connection to be moved nearer the pivot of the actuating lever during switch closing movement thereof whereby a powerful closing thrust may be exerted on said switch operating rod during the final part of the closing stroke.

5. Switch operating mechanism comprising a switch operating rod, a pivoted actuating lever for effecting circuit closing movement of said rod, toggle structure adapted to be held in thrust-transmitting position inter-connecting said actuating lever and operating rod, said toggle structure having a portion movable about a fixed center, and guiding means associated with said pivoted actuating lever slidably engaging said movable portion for transmitting closing force to the operating rod, the pivot of the actuating lever and the aforesaid fixed center being so arranged that the said movable portion is restrained by said guiding means and moved nearer the pivot of the actuating lever during the switch closing movement thereby increasing the mechanical advantage of the actuating lever.

6. Switch operating mechanism comprising a switch operating member, a pivoted actuating lever for effecting switch closing movement of the operating member, a toggle connected to said actuating lever and adapted to be held in rigid position for transmitting force from said actuating lever to said operating member, and a holding toggle for maintaining said first-named toggle in rigid thrust-transmitting position, said first-named toggle adapted to move as a unit with respect to a fixed central point of the holding toggle during the switch closing operation.

7. Switch operating mechanism comprising a switch operating member, an actuating lever adapted to be rotated to effect switch closing movement of said member, a toggle operatively connected to said lever for transmitting thrust to said switch member, a second toggle for holding said first toggle in a rigid underset position, said first toggle adapted to move as a rigid unit about a central pivot of said second toggle to cause straightening movement of the second toggle to an underset position, and tripping means for holding the second toggle in rigid position, said first and second toggles being in slightly underset positions in the closed circuit position of the mechanism so that said

tripping means may be actuated by comparatively small force.

8. Switch operating mechanism comprising a switch operating rod, a pivoted actuating lever adapted to be rotated to cause switch closing movement of said rod, means including a toggle interconnecting said rod and lever for transmitting switch closing movement to said rod, said toggle having a sliding connection with said lever, a holding toggle adapted to maintain said first toggle in an underset rigid thrust-transmitting position during the switch-closing movement, and a tripping toggle adapted to be held in an underset rigid position by a movable lug for maintaining a pivot of said holding toggle stationary, said first-named toggle adapted to move as a rigid unit about said stationary pivot of the holding toggle to cause straightening movement of the holding toggle to an underset position so that the force opposing closing of the switch transmitted to said movable lug tends to decrease during said closing movement.

9. In switch operating mechanism of the trip-free type comprising a switch-operating member, an actuating member, collapsible thrust-transmitting means interconnecting said members and tripping mechanism for holding the said structure in thrust-transmitting position and for causing collapse thereof to effect circuit opening movement of the switch operating member, means for operating said tripping mechanism in response to reverse movement of the actuating member during the switch closing movement thereof comprising a movable element mounted on the actuating member and a cam element mounted with respect to the tripping mechanism, said cam element adapted to be actuated by the movable element to trip the switch only in response to reverse movement of said actuating member.

10. Switch operating mechanism comprising a switch-operating rod, an actuating lever for causing switch closing movement of said rod, and thrust transmitting structure including an actuating toggle interconnecting said actuating lever and switch-operating rod, said actuating lever being operatively connected to the actuating toggle joint through a variable lever arm whereby the closing force transmitted to said switch-operating rod is a superimposed variable leverage and toggle effect.

11. Switch operating mechanism comprising a switch-operating rod, an actuating lever for causing switch closing movement of said rod, thrust transmitting structure including an actuating toggle interconnecting said actuating lever and switch-operating rod, said actuating toggle having its joint operatively connected to said actuating lever, and means for varying the effective length of lever arm acting on said toggle joint during the switch

closing movement whereby the increased force transmitted to the switch-operating rod due to straightening of said toggle has superimposed thereon a variable force due to variation of said effective lever arm.

12. Switch operating mechanism comprising a switch-operating rod, an actuating lever for causing switch closing movement of said rod, and means including an actuating toggle having its central pivot operatively connected to said actuating lever for transmitting closing movement to the switch-operating rod, the central pivot of said actuating toggle having a sliding and constrained connection with said actuating lever so arranged that the mechanical advantage of the actuating lever with respect to said toggle is increased concurrently with straightening of said toggle during the switch closing operation.

13. Switch operating mechanism comprising a switch operating rod, an actuating lever for effecting switch closing movement of said operating rod, thrust transmitting structure interconnecting said actuating lever and switch operating rod comprising an actuating toggle operatively connected through a variable lever arm to said actuating lever, a toggle adapted to be held rigidly for transmitting thrust to said operating rod, and means for holding said toggle rigidly and in underset position comprising a holding toggle, a toggle for maintaining the holding toggle in underset position, a tripping toggle operatively connected to said last named toggle, and a tripping member for holding said tripping toggle in an underset position whereby actuation of said tripping member permits buckling of the tripping toggle and consequent collapse of said thrust-transmitting toggle.

14. Switch operating mechanism comprising a switch operating rod, a main lever connected to said rod, an actuating lever, collapsible thrust-transmitting structure interconnecting said actuating lever and main lever for transmitting switch closing movement thereto, means including a tripping toggle for holding said structure in thrust-transmitting position, and tripping means for causing collapse of said tripping toggle in response to reverse movement of said main lever comprising a rack pivotally mounted on said main lever and a pawl coacting therewith for causing collapse of the tripping toggle and consequent collapse of said thrust-transmitting structure and opening movement of the switch operating rod.

15. Switch operating mechanism comprising an actuating lever, a toggle for transmitting closing movement to switch structure, and means operatively connecting the joint of said toggle to said lever so that it is movable with respect to the longitudinal axis thereof, rotation of said lever in the circuit

closing direction shortening the lever arm acting on said toggle joint and straightening said toggle.

16. Switch operating mechanism comprising an actuating lever, a toggle having a fixed pivot at one end and operatively connected to switch structure at its other end, said actuating lever pivoted at a point intermediate the ends of said toggle, and means guiding the joint of said toggle with respect to the longitudinal axis of said lever so that said joint is acted upon by a variable lever arm during the closing operation.

In witness whereof, I have hereunto set my hand this 1st day of July, 1930.

CARL THUMIM.