Jan. 31, 1933. H. P. PINKHAM 1,895,770

SWITCH OPERATING MECHANISM

Filed Aug. 25, 1931 4 Sheets-Sheet 1

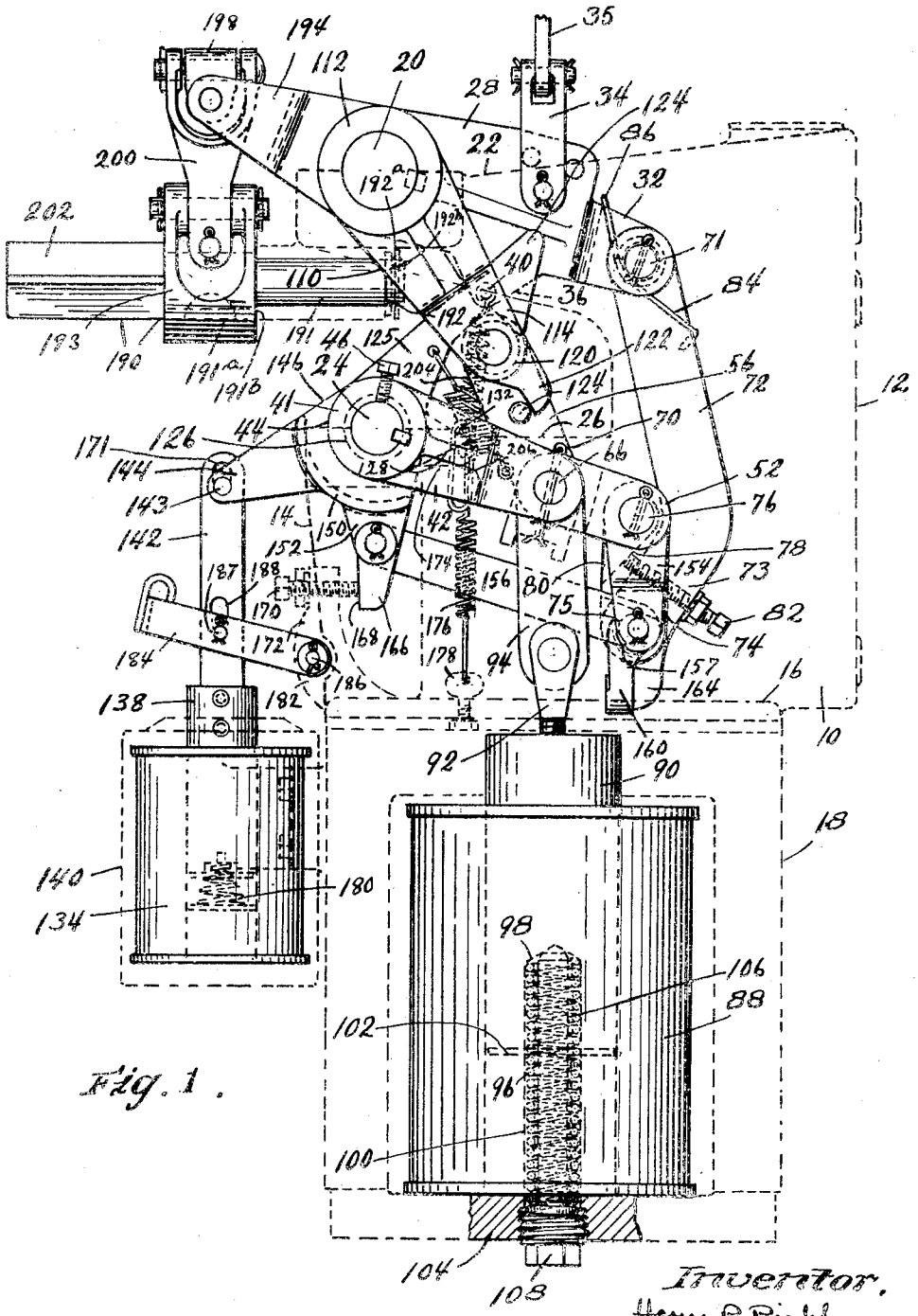


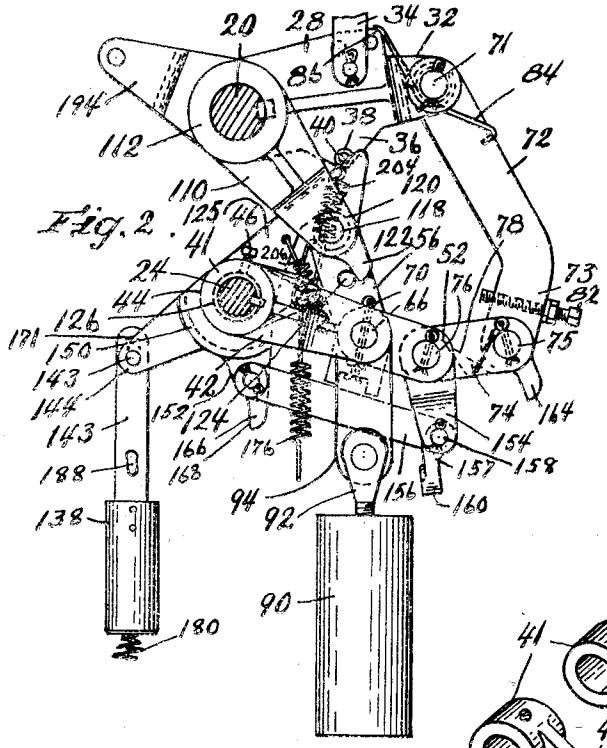
Fig. 1.

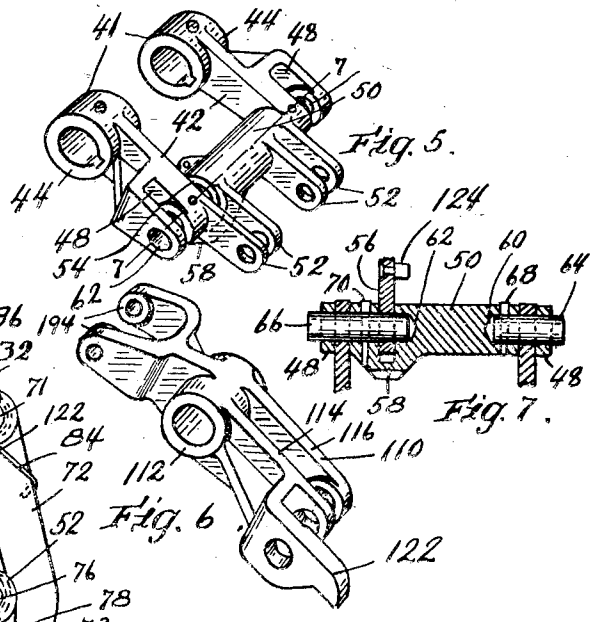
Inventor.
Henry P. Pinkham
by [illegible] Atty

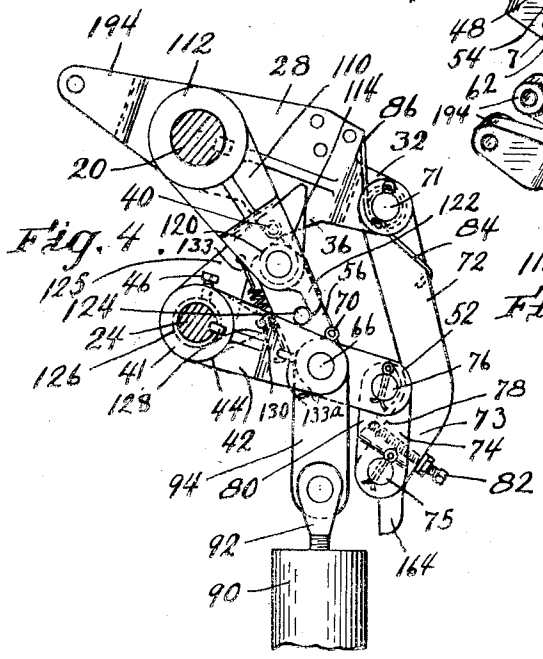
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SWITCH OPERATING MECHANISM

Filed Aug. 25, 1931 4 Sheets-Sheet 2







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SWITCH OPERATING MECHANISM

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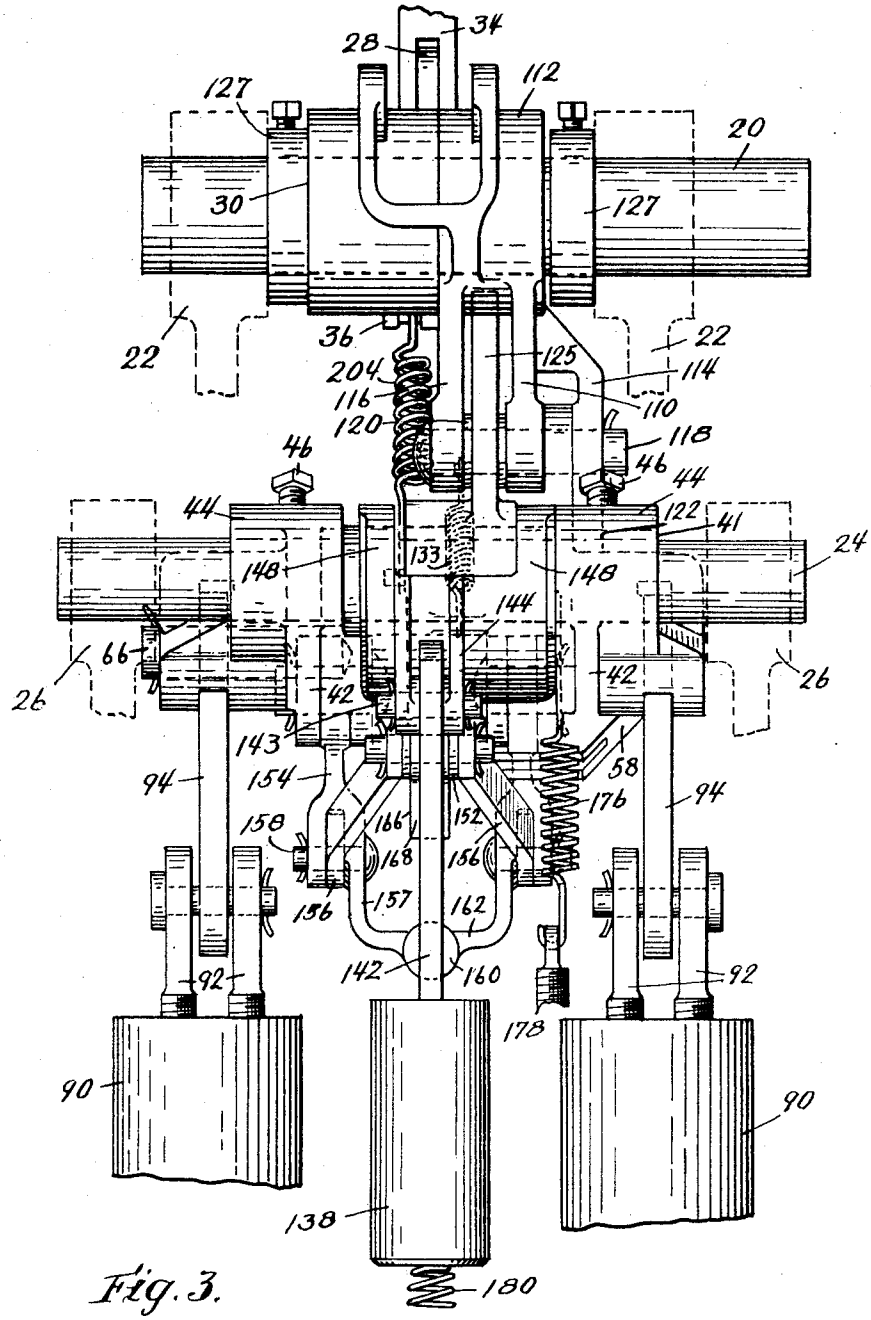


Fig. 3.

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SWITCH OPERATING MECHANISM

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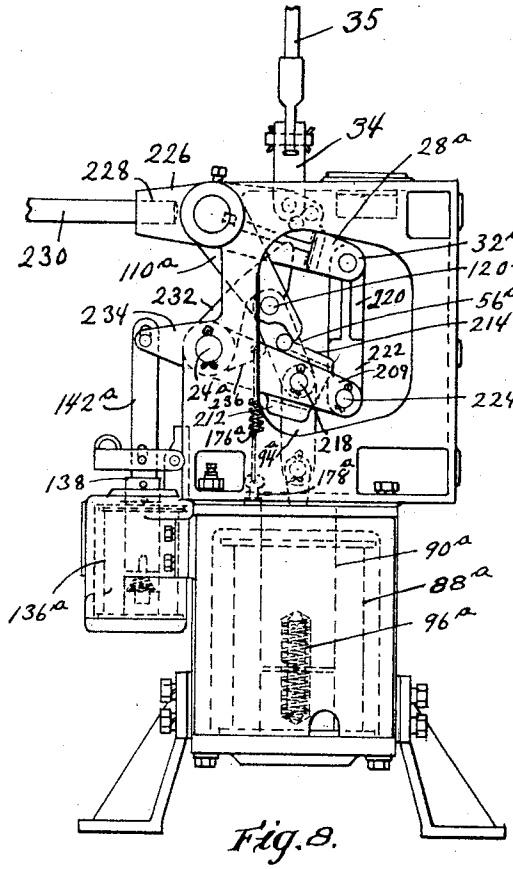


Fig. 8.

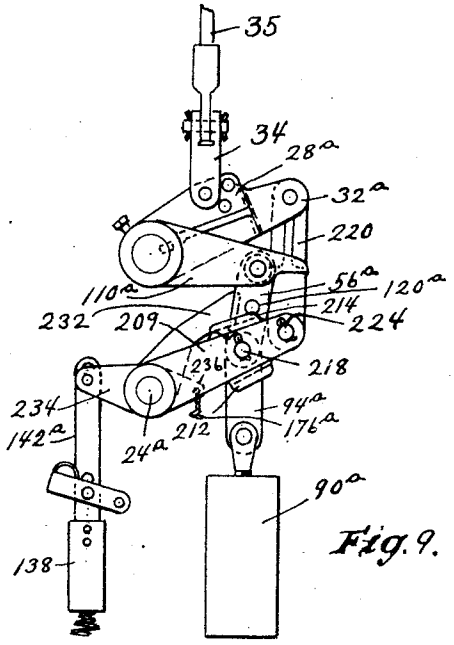


Fig. 9.

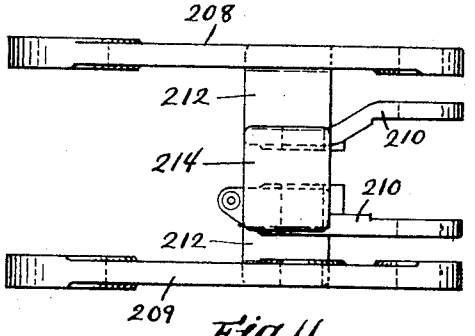


Fig. 11.

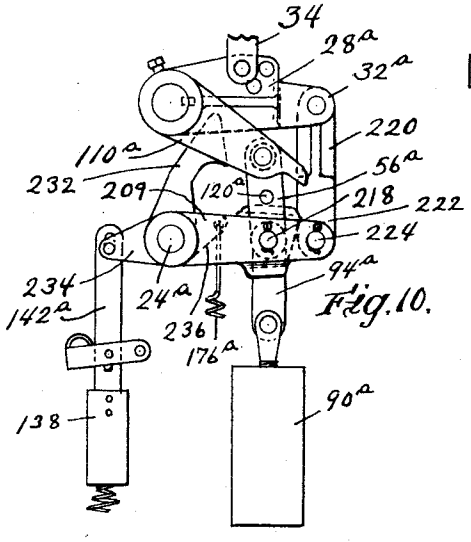


Fig. 10.

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Patented Jan. 31, 1933 1,895,770

UNITED STATES PATENT OFFICE

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SWITCH OPERATING MECHANISM

Application filed August 25, 1931. Serial No. 559,237.

This invention relates to mechanism for operating electric switches to open and close them either manually or electrically, and it constitutes an object of the invention to provide an improved operating mechanism of the type which permits the connected electric switches to move from switch closed to switch open position free from restraint due to the relatively massive closing components of the mechanism and the residual flux in the solenoid iron circuit, thus to provide for the rapid opening of the switches.

A further object of the invention is the provision of an improved switch operating mechanism which is smooth in operation and which can be moved forcibly toward open position by the power of the opening coil.

A still further object of the invention is the provision of a trip free mechanism which is very compact and economical to manufacture and which provides ample movement of the switch operating arm to accommodate a wide range of switches.

A still further object of the invention is generally to improve the construction and performance of switch operating mechanisms.

Fig. 1 is a side elevation of a solenoid actuated switch operating mechanism embodying the present invention, the outline of the supporting frame for the mechanism being indicated by dotted lines.

Figs. 2 and 3 are side and front elevations respectively of the power actuated components of the mechanism of Fig. 1, showing the position of the parts after the mechanism has been tripped and before the mechanism has arrived in full switch open position.

Fig. 4 is a view similar to Fig. 1 but with certain of the elements removed to show the closing mechanism more clearly.

Fig. 5 is a perspective view of the lower actuating crank arm.

Fig. 6 is a perspective view of the toggle crank arm.

Fig. 7 is a sectional detail through the mechanism on a line corresponding to the line 7—7 of Fig. 5.

Fig. 8 is a side elevation of a modified construction adapted for non-trip free operation.

Fig. 9 is a detail of the closing mechanism of the modification of Fig. 8 with parts removed to illustrate the closing linkages more clearly.

Fig. 10 is a detail similar to Fig. 9 but with the parts in switch open position.

Fig. 11 is a plan view of the lower crank arm of the modified construction, adapted for a single operating solenoid.

The switch operating mechanism herein illustrated is adapted to provide for the manual opening and closing of one or more electric switches connected therewith, and also for the opening and closing of the switches by electrically controlled means. The switch operating mechanism includes a rigid supporting frame 10 of more or less rectangular shape, the general outlines of which are indicated by dotted lines in Fig. 1. Said frame comprises a back plate 12 by which the mechanism may be supported on a vertical face plate, spaced side plates 14, and a bottom plate 16 to which a lower closing-coil box 18 comprising a magnet frame is suitably secured.

The operating components of the mechanism are contained largely within the frame 10 between the side walls 14 thereof and include an upper horizontal operating shaft 20 which is journalled in a pair of horizontally spaced forwardly extended arms 22 (Fig. 3) and a lower horizontal actuating shaft 24 which is disposed beneath and parallel to the shaft 20 and is journalled in similar forwardly extended arms 26 of said frame. The operating shaft 20 may in some instances constitute the operating shaft of a circuit interrupter but it is not so shown in the present embodiment of the invention. A rearwardly extended crank arm 28 has a hub 30 at its forward end, which hub is keyed to the shaft 20 between the arms 22 of the frame and adjacent the left hand arm 22 as viewed in Fig. 3. The crank arm 28 is located midway between the side walls 14 of the frame and in the vertical median line of the mechanism and has a bifurcated rear end portion 32. Said crank arm 28 constitutes the switch operating crank

of the mechanism and is adapted to be operatively connected with the operating shafts of one or more circuit interrupters by means of the clevis 34 and the operating rod 35. Said crank arm 28 is further provided with a depending portion 36 intermediate its ends which is slotted in the direction of the length of the arm and has a passage 38 extended transversely therethrough to receive a pivot pin 40 for purposes hereinafter to be described.

A lower rearwardly extended actuating crank member 41 is carried by the actuating shaft 24 intermediate the supporting arms 26 therefor. Said member, as shown most clearly in Fig. 5, comprises horizontally spaced parallel arms 42 having hub portions 44 which are mounted on and are keyed to the shaft 24 and are secured against displacement axially of the shaft by means of set screws 46. The arms 42 are provided with bifurcations 48 at their free ends, the innermost furcations of which are connected rigidly together at their free ends by a generally cylindrical connecting portion 50. Said connecting portion is provided with the further rearwardly-extended horizontally-spaced pairs of arms 52 which are located between and adjacent the arms 42. Said connecting portion 50 is formed with a slot 54 adjacent the right hand arm 42, as viewed in Fig. 3, which is open at the top to receive an upwardly extended link 56 which constitutes the lower link of a toggle hereinafter to be described. A yoke 58 is provided beneath said slot, connecting said intermediate portion 50 and the adjacent furcation of the arm 42, thus to provide an integral structure for said actuating member. As shown most clearly in Fig. 7, passages 60 and 62 extend through the bifurcated ends 48 of said member and into the cylindrical connecting portion 50 thereof and are adapted to receive pivot pins 64 and 66 respectively which are held releasably in position in said member by means of cotter pins 68 and 70.

Said operating arm 28 and said actuating member 41 are adapted normally to be releasably connected rigidly together for conjoint operation whereby to move the operating arm 28 in a switch closing direction by a similar movement of the actuating member and to hold said operating arm 28 releasably in this position, and also to permit said arm 28 to move in a switch opening direction free from a corresponding movement of said actuating member and its associated mechanism. To this end the free ends of said operating arm and actuating member are connected by an inverted tripping toggle which is normally overshot and which when overshot constitutes a rigid thrust member between said operating and actuating arms and when broken permits movement of the operating arm in a switch opening direction free from a corresponding movement of the actuating member. Said toggle includes the relatively long and generally vertical upper link 72 having the forwardly-reflexed lower end portion 73, and the shorter relatively thick lower toggle link, or block, 74, which is pivoted at one end to the lower reflexed end of link 72 on a pin 75, the end of link 74 having bifurcations between which the link 72 is received. The length of link 72 is such that, in the normal closed position of the mechanism, in which the operating crank arm 28 and the actuating member are substantially parallel, the lower bent or reflexed end portion 73 of the link is located below and extends beneath the free end of the actuating member. The free end of the upper link is pivotally supported on a pin 71 between the end furcations of the operating arm 28, and the free end of the lower toggle link is similarly pivotally connected with the rearwardly extended end of said actuating member in the space between the pairs of arms 52 thereof by means of a shaft 76 which extends through aligned passages in the ends of the arms 52 and the link 74 and is secured removably in position by cotter pins at the opposite ends thereof. Said lower toggle link 74 is formed with a longitudinal channel 78 to receive the link 72 in the toggle set position thereof, having a bottom web 80 which constitutes a stop against which an adjustable screw 82 carried by the bent portion 73 is adapted to strike, thus to determine the set position of the toggle links. As thus arranged, in the normal set and switch closed position of the toggle, the lower toggle link is extended upwardly alongside the reflexed portion 73 of link 72 so that when the toggle is broken the links move toward a straightened aligned position. As shown most clearly in Fig. 4, in the normal set position of the toggle links 72 and 74, the pivot points 71, 76 and 75 are disposed substantially in a straight line, the link 72 being received within the channel 78 of the link 74 and free from contact with the web 80 of said link 74. The adjustment of the screw 82 can be such that the pivot point 75 is disposed slightly to the left of the straight line including the pivot pins 71 and 76 thus to insure the over-shooting and consequently locking of the toggle.

The pivot pin 71 extends a substantial distance on either side of the arm 28 to receive the coils of a spring 84, one of which is disposed on each side of the arm. Said spring has a transverse connecting portion 86 which bears against the upper face of the crank arm 28 and has its lower parallel free ends reflexed inwardly to overlie and bear against the rear edge of the toggle link 72 thus constantly to urge the linkage for switch opening movement.

Electrically actuated means are provided for moving the actuating member, and

through the set tripping toggle 72, 74, for moving the operating arm 28 from switch open to switch closed position. Said means, as shown most clearly in Figs. 1 and 3, includes a pair of conjointly operating solenoids 88 which are located in spaced relation in the coil box 18 and have vertically reciprocable armatures or plungers 90 which are disposed directly beneath the bifurcations of arms 48 of said actuating member. Said armatures are operatively connected with the actuating member by means of pairs of vertically adjustable eye bolts 92 which are screw-threaded thereinto and by links 94 which are pivotally connected with said eye bolts at their lower ends and are received at their upper ends between the furcations 48 of arms 42 on the pivot pins 64 and 66 respectively.

Means are provided constantly to urge the armatures 90 and consequently the actuating member in a switch opening direction when the solenoids are not energized. Said means includes compression springs 96 which are received loosely within complemental recesses 98 and 100 in the armatures 90 and the core plugs 102 which are formed integral with the bottom cover plates 104 of the magnet frame 18, one cover plate being provided for each coil compartment. A guide pin 106 is received closely within the passage through each spring and constitutes means to maintain the spring straight during compression thereof. The bottom of the recesses 100 are normally closed by means of screw-threaded plugs 108 which permit the removal of the springs and pins through the bottom cover plates of the coil box 18.

Means are provided to hold the closing components of the mechanism releasably in the switch closed position thereof when they have been moved to this position. Said means includes a holding toggle comprising an upper crank arm 110 and the lower link 56 previously mentioned. Said upper arm, as shown most clearly in Fig. 6, comprises a hub 112 which is loosely journalled on the upper operating shaft 28 adjacent the hub 30 of the operating arm 28, and a pair of rearwardly depending spaced arms 114, 116, the former of which is bifurcated at its lower end. The arm 116 and the furcations of arm 114 are provided with aligned passages to receive a pivot pin 118 which constitutes a pivotal support for the upper end of the lower toggle link 56 which is located between the furcations of the arm 114 and which also constitutes the pivotal support for a latch roller 120 which is located between the spaced arms 114, 116. One of the furcations of arm 114, as the right hand arm when viewed in Fig. 3, has an extension 122 which is adapted to engage an outstanding pin, or boss, 124 fixed in the lower toggle link 56 in a slightly undershot straightened position of the toggle, so that the toggle can never become locked but is always free to collapse under the action of the spring urged solenoid armatures 90. A latch 125 is mounted on the actuating shaft 24 midway between the hubs 44 of the actuating member and extends rearwardly between the parallel spaced arms 114 and 116 in position releasably to engage the latch roller 120 therebetween. Said latch is journalled on a bushing 126 which bushing extends between the hubs 44 of the actuating member. The latch is free for lateral movement on said bushing but is held against such movement by the spaced parallel arms 114 and 116 between which it is movable into and out of engagement with the latch roller. Said latch, as shown most clearly in Fig. 4, has an angularly-related rearwardly-extended arm 128 which has a tripping pin 132 screw-threaded therein. A spring 133 has one end hooked into the latch 125 intermediate its ends and has its other end hooked into an ear 133*a* of said actuating member thus constantly to bias the latch into a position to engage the latch roller 120.

The operating arm 28 and the toggle crank 110 are held against lateral movement on the shaft 20 by fixed collars 127 which are disposed on opposite sides of the adjacent hubs thereof.

Means are provided for forcibly tripping the mechanism electrically. Said means includes the electro-magnetic tripping solenoid 134 having an armature or plunger 138 and contained within a magnetic coil box 140 which is suitably centrally supported on the front wall of said closing coil box 18. Said armature has a rigidly-connected upwardly-extended link 142 which is loosely connected by a pivot pin 143 with the forwardly extended bifurcated arm 144 of a tripping bell crank 146 that is journalled on the bushing 126 between the hubs 44 of the actuating member. Said tripping bell crank, as shown most clearly in Fig. 3, has the spaced hub portions 148 between which the latch 124 is located and an intermediate connecting portion 150 which is located below and in front of the hub of latch 124. The tripping bell crank is further provided with a depending arm 152 which is angularly related to the arm 144 thereof. Said arm 152 is operatively connected with a tripping yoke 154 by means of two rearwardly-extended offset thrust links 156. Said tripping yoke is of generally U-shape and has the upstanding spaced arms 157 thereof pivotally supported on the pin 76 of the actuating member, each arm being between a separate pair of the spaced arms 52 thereof. The yoke thus hangs pivotally from said pin 76. Said arms 157 are provided at their lower ends with bifurcations between which the rearwardly extended ends of links 156 are pivotally supported on pins 158. Said tripping yoke

has a depending lug 160 formed integral with the middle connecting portion 162 thereof which is located in the vertical median line of the mechanism and in the switch closed position thereof is directly in front of a similar depending projection 164 of the toggle link 72, so that counterclockwise rotation of the tripping yoke causes the lower pivoted end of link 72 to be moved to the right beyond the line including pivot pins 71, 76, thus to break the toggle. The switch mechanism opens by its weight or by accelerating springs, not shown, when the toggle is broken.

The downwardly directed arm 152 of the tripping bell crank 146 has a depending lug 166 provided with a front abutment face 168 that is adapted to engage a horizontal set screw 170 adjustably screw-threaded in an upstanding projection 172 of the base plate 16 of the frame. The tripping bell crank 146 is further provided with a rearwardly extended arm 174 to which is hooked one end of a retractile spring 176, the other end of which is hooked into a vertical stud 178 which is adjustably screw-threaded into the base plate 16. Said stud 178 permits the tripping bell crank to be held against the stop 170 with a variable pressure. The upper end of the armature link 142 has a slot 171 in which the pin 143 is located, and a coil spring 180 is secured to the lower end of the solenoid armature 138 and bears against the core plug 181 which forms a part of the bottom cover plate for the coil box 140, thus constantly to urge the tripping armature upwardly into a position in which pin 143 is disposed in the bottom of slot 171. As thus arranged, upon downward movement of the armature 138 the link 142 strikes the tripping bell crank a hammer blow. The tripping solenoid is adapted to have considerable power so that it not only breaks the toggle 72, 74 but moves the toggle links forcibly a substantial distance in a switch opening direction, thus to effect the full opening of the switch quickly. This operation of the solenoid is enhanced by having the tripping yoke pivoted concentrically with the toggle links 74 so that both can move together for a substantial distance under urge of the solenoid and thus the toggle link 74 can continue its movement independently of the yoke.

Means are provided for manually tripping the mechanism. To this end the upstanding projection 172 is provided with a forwardly extended ear 182 to which the parallel spaced arms of a tripping lever 184 are pivoted on a pin 186. Said tripping lever extends forwardly beyond and straddles the armature link 142 and is provided with a tripping pin 187 intermediate its ends which extends through a vertically elongated slot 188 in said link 142. The pin 186 normally lies in the bottom of the slot so that upon depressing the forwardly extended end of the tripping arm 184 manually the armature can be moved downwardly and cause the tripping bell crank 186 to be rotated in a counterclockwise direction to trip the mechanism in the manner above described. By reason of the slot, however, the tripping lever 184 is not caused to move downwardly at the tripping speed of the solenoid upon electrical tripping of the mechanism so that the solenoid does not have to accelerate said lever when operating.

Means are provided for closing the switch manually. Said means includes a horizontal shaft 190 which is disposed normal to and below the operating shaft 20. Said shaft has a long cylindrical bearing portion 191 which is journalled in a suitable passage in a thickened portion of the left hand side wall 14 of the frame, and has a somewhat enlarged cylindrical crank attaching portion 191*a* in front of the frame which provides a shoulder 191*b* for the front end of the bearing portion. The rear end of the shaft has a reduced end portion 192 which projects beyond the frame and which carries a through pin 192*a* and a shoulder washer 192*b* of suitable thickness, thus to hold the shaft against displacement in the frame. A crank arm 193 is keyed to the enlarged portions 191*a* and extends to the right of the shaft 190 as the mechanism is viewed from the front and has its ends located substantially in the same vertical plane as an integral forwardly extended arm 194 of the toggle crank 110. Said arm 194 and crank arm 193 are both provided with bifurcated ends which are operatively connected together by means of a universal joint including the upper and lower links 193 and 200 respectively. Said shaft 190 is provided at its forwardly extended end with a squared portion 202 which is adapted to receive the socket of a suitable handle, not shown, for rotating the shaft. The arrangement is such that the rotation of the shaft in one direction will cause the toggle crank 110 to be moved in a clockwise direction as viewed in Fig. 1, thus to straighten the holding toggle, which in this case becomes an operating toggle, and closes the switch.

Means are provided which are operative in the latter part of the tripping movement of the mechanism to release the holding toggle 110, 56. Said means, as here specifically shown, includes a spring 204 which has its upper end pivotally supported on the pin 40 between the bifurcations in the lower edge of said operating crank 28. The bottom end of the spring is formed with an elongated loop 206 in which the tripping pin 132 of latch 125 is slidably received. The length of the loop 206 is such that only in the latter part of the opening movement of the crank 28 does the end of the loop 206 engage the pin and

effect the release of the holding latch 124. The loop 206 also serves to hold the latch 124 against the bias of its spring 133 from rotating unduly in a clockwise direction while the toggle is in a collapsed position. Upon closing movement of the operating crank arm the loop is automatically lowered and permits the latch to drop into a position to re-engage the roller 120.

The operation of the mechanism is as follows:

With the mechanism in a switch closed position illustrated in Fig. 1 the inverted tripping toggle comprising the links 72, 74 is in its folded over-shot position and the straight holding toggle comprising crank arm 110 and link 56 is held by the latch 124 in a straightened and under-shot position against the bias of the springs 96 which constantly urge the armatures 90 and consequently the actuating member 42 in a switch opening direction. The tripping bell crank 146 is also biased into an inoperative position under the action of spring 176 which urges the abutment face 168 thereof against the set screw 170. Consequently the mechanism will remain in this position until tripped. Upon energization of tripping solenoid 134 the armature 140 thereof is attracted downwardly, thus causing link 142 to engage pin 143 and rotate the tripping bell crank 146 in a counterclockwise direction. The counterclockwise movement of the tripping bell crank causes a similar counterclockwise movement of the tripping yoke 154 due to the rearward thrust of the links 156 and causes the lug 160 to engage the lug 164 of the tripping toggle link 72 and thereby force the toggle in an opening direction and permit the operating crank arm 28 to move in a counterclockwise and switch opening direction free from restraint of the relative massive closing components comprising the actuating member 42 and its connected armatures 90 and the manual closing mechanism above described. By reason of the particular inverted toggle construction provided, wherein the toggle links normally lie in a collapsed on-center position, it is possible to provide a very compact mechanism and still provide for ample angular rotation of the operating crank arm upon breaking the tripping toggle. As shown in Fig. 2, in the latter opening movement of the operating crank 28 the spring 204 is elevated into a position in which the bottom of the loop 206 engages the tripping pin 132. Further movement of the operating crank arm 28 causes the holding latch 124 to release its engagement with the latch roller 120 and permit the collapse of the holding toggle under the action of the springs 96. The springs 96 cause the actuating member 42 to move in a counterclockwise direction sufficiently to permit the tripping toggle 72, 74 to be moved into its over-shot position ready for subsequent switch closing movement upon energization of the closing coil windings 88 or by means of the manual operating handle. The tripping action of the mechanism by manipulation of the lever 184 will be obvious.

As shown in Figs. 8 through 11, a somewhat modified mechanism is illustrated employing a single closing solenoid and adapted for non-trip free operation. As shown most clearly in Fig. 11, the actuating member comprises outer spaced parallel arms 208, 209, and a pair of inner spaced parallel arms 210 which are located between and in spaced relation with the outer arms adjacent the free ends thereof. Each of said arms 210 is rigidly connected with the adjacent outer arm by a bottom yoke 212 and said inner arms 210 are similarly rigidly connected by a top yoke 214. A passage is provided transversely through the inner arms 210 and the outer arm 209 to receive a short shaft 218 which constitutes the pivotal support for the lower toggle link 56*a* which is received between the adjacent arms 209 and 210. Said pin 218 also constitutes the pivotal support for the upper end of the solenoid operating link 94*a* which is received between the inner arms 210 beneath the yoke 214 of the actuating member. The operating arm 28*a* is rigidly operatively connected with the actuating member by means of a vertical link 220 which is pivoted at its upper end between the bifurcations 32*a* of the operating crank arm and which has bifurcations 222 at its lower end that are pivotally supported between the spaced inner and outer arms of the actuating member on shaft 224. The toggle crank arm 110*a* of the holding toggle has an angularly-related forwardly-directed integral arm 226 which is fitted with a socket 228 to receive an operating handle 230. The toggle comprising the crank arm 110*a* and link 56*a* comprises a switch closing and holding toggle and is held in a switch closed position thereof in a straightened under-shot position by means of a latch 232 which is formed integral with a tripping arm 234 pivotally mounted on the actuating shaft 24*a* between the outer spaced arms 208, 209 of the actuating member. Said tripping arm is also provided with an integral rearwardly extended arm 236. A spring 176*a* connects the end of arm 236 with a stud 178*a* which is adjustably screw-threaded into the base plate of the frame, thus constantly to bias the latch into a position to engage the latch roller 120*a*.

With the mechanism in the switch closed position shown in Fig. 8 energization of the winding 136*a* of the trip coil causes the link 142*a* thereof to rotate the tripping arm 234 and the latch 232 in a counterclockwise direction into the position shown in Fig. 10, thus to release the latch from holding engagement with the roller 120*a*. Under the

upward thrust of the spring 96*a* beneath the closing armature 90*a* of the closing solenoid the actuating member and consequently the operating arm 28*a* will be rotated conjointly in a counterclockwise direction into the switch open position of Fig. 9. The switch can be closed again either by raising the operating handle 230 to cause the latch 232 to engage the latch roller 120*a* or by energizing the winding 88*a* of the closing solenoid.

The construction may be otherwise modified without exceeding the scope of the invention.

I claim:

1. Operating mechanism for electric switches including an upper horizontal operating shaft having an operating crank arm, a lower horizontal actuating shaft having an actuating arm, a normally-set inverted tripping toggle releasably connecting said operating and actuating arms for conjoint operation in a switch closing direction, power actuated closing mechanism operatively connected with said actuating arm, means constantly biasing said actuating arm in a switch opening direction, and means releasably holding said actuating arm against the action of said biasing means including a holding toggle having one end thereof pivotally connected with said arm intermediate its ends and having its other end pivotally supported on said operating shaft.

2. Operating mechanism for electric switches including an upper horizontal operating shaft having an operating crank arm, a lower horizontal actuating shaft having an actuating arm, means releasably connecting said arms for conjoint switch closing movement including an over-shot inverted tripping toggle, power actuated closing means operatively connected with said actuating arm, means constantly biasing said closing means in a switch opening direction, a holding toggle having one end thereof operatively connected with said arm intermediate its ends and having its other end pivotally supported on said operating shaft, a latch for holding said toggle releasably in an under-shot position, and tripping means for breaking said tripping toggle and subsequently for tripping said latch whereby to release said actuating arm for switch opening movement.

3. Operating mechanism for electric switches including an upper horizontal operating shaft having an operating arm, a lower horizontal actuating shaft having an actuating arm, a tripping toggle releasably connecting said arms for conjoint rotation in a switch closing direction comprising a normally-set inverted toggle, power actuated means operatively connected with said actuating arm, means constantly biasing said actuating arm for movement in a switch opening direction, means including a latch for releasably holding said actuating arm in switch closed position against its bias, and means for tripping the mechanism including means to break said tripping toggle and thereafter to release said latch.

4. Operating mechanism for electric switches including a mechanism supporting frame, an upper horizontal shaft journalled in said frame having a rearwardly extended operating arm, a lower horizontal shaft having a rearwardly extended actuating arm, a normally set tripping toggle releasably connecting said arms for conjoint switch closing movement comprising pivotally connected upper and lower links, said upper link having a lower forwardly directed angularly related portion which terminates beneath the free end of said actuating arm, power actuated closing means operatively connected with said actuating arm, means constantly biasing said closing means and consequently said actuating arm in a switch opening direction, means including a normally straightened toggle for holding said actuating arm releasably in switch closed position against its biasing means, tripping means for breaking said tripping toggle, and means operatively only in the final switch opening travel of said operating arm for releasing said holding toggle and permitting said actuating arm to move to a switch open position.

5. Operating mechanism for electric switches including an upper horizontal operating shaft having an operating arm, a lower horizontal actuating shaft having an actuating arm disposed below and normally parallel with said operating arm, means releasably connecting said arms operatively together for conjoint switch closing movement including a normally set inverted tripping toggle comprising an upper link having a lower angularly related portion which terminates beneath the free end of said actuating arm and a lower toggle link which is disposed alongside said upper link, power actuated closing means operatively connected with said actuating arm, means constantly biasing said closing means and consequently said actuating arm toward a switch open position thereof, a normally straightened toggle for holding said actuating arm releasably against its bias, tripping means for breaking said tripping toggle, and means responsive to the final travel of the operating arm in a switch opening direction for releasing said holding toggle whereby to permit said actuating arm to move into a position to reset said tripping toggle for subsequent switch closing movement of the mechanism.

6. Operating mechanism for electric switches comprising a switch operating arm, switch closing mechanism including an actuating arm, a normally set over-shot toggle

releasably connecting said arms for conjoint switch closing movement having an upper toggle link terminated in a reflexed lower end portion which is located beneath the free end of said actuating arm, and a lower toggle link which pivotally connects said lower reflexed end portion with the free end of said actuating arm, switch-closing means operatively connected with said actuating arm, means biasing said arm and closing means constantly in a switch opening direction, a normally set holding toggle pivotally connected with said actuating arm at one end thereof and having a fixed pivotal support for its other end, a tripping member pivotally supported on the free end of said actuating arm independently of said over-shot toggle having provision for engaging the lower reflexed end of said upper toggle link and breaking said over-shot toggle, means for actuating said tripping member whereby to effect the switch opening movement of said operating arm free from corresponding movement of said actuating arm, and means responsive only to the final switch opening movement of said operating arm for releasing said holding toggle whereby to permit said closing mechanism to move into a switch opening position to reset said tripping toggle for subsequent switch closing movement of said operating arm.

7. Operating mechanism for electric switches including an upper horizontal operating shaft, a lower horizontal actuating shaft, operating and actuating crank arms fixed to said respective shafts, an over-shot inverted toggle releasably connecting the free ends of said arms operatively together for conjoint switch closing movement, power actuated closing means operatively connected with said actuating arm, a tripping member pivoted to the free end of said actuating arm and depending therebelow in position to engage the joint of said toggle, a tripping lever operatively connected with said tripping member for swinging said tripping member about its pivotal support into engagement with said toggle, whereby to break said toggle and permit said operating arm to move to a switch open position thereof.

8. Operating mechanism for electric switches including an upper horizontal operating shaft having a rearwardly extended operating arm, a lower horizontal actuating shaft having a rearwardly extended actuating arm, a normally set inverted toggle releasably connecting the free ends of said arms for conjoint switch closing movement, said toggle comprising upper and lower toggle links having their common pivotal connection disposed beneath the free end of said actuating arm, power actuated closing means operatively connected with said actuating arm, a tripping member pivotally connected at its upper end with the free end of said actuating arm having a toggle engaging portion thereof located in front of the common pivotal connection of said tripping toggle, and tripping means operatively connected with said tripping member for breaking said tripping toggle, whereby to permit switch opening movement of said operating arm independently of a corresponding movement of said actuating arm.

9. Operating mechanism for electric switches including an upper horizontal operating shaft having a rearwardly extended operating arm, a lower actuating shaft having a rearwardly extended actuating arm, means releasably connecting said arms at their free ends for conjoint switch closing movement including an over-shot inverted toggle comprising upper and lower toggle links pivotally connected respectively at their remote ends with said operating and actuating arms and having a common pivotal connection which is normally located beneath the free end of said actuating arm, power actuated closing means operatively connected with said actuating arm, means constantly biasing said arms for upward movement, means to hold said actuating arm releasably against its bias, a tripping member pivotally connected with the free end of said actuating arm and depending therebelow having provision for engaging said tripping toggle to urge the common pivotal connection of said toggle links over-center whereby to break said toggle, and means governed by the breaking of said tripping toggle for releasing the holding means for said actuating arm, whereby to permit said arm to move upwardly into a toggle resetting position.

10. Operating mechanism for electric switches including an upper horizontal operating shaft having a rearwardly extended operating arm, a lower actuating shaft having a rearwardly extended actuating arm, means releasably connecting said arms at their free ends for conjoint switch closing movement including an over-shot inverted toggle comprising upper and lower toggle links pivotally connected respectively at their remote ends with said operating and actuating arms and having a common pivotal connection which is normally located beneath the free end of said actuating arm, power actuated closing means operatively connected with said actuating arm arranged to move said actuating arm and through said normally set tripping toggle to move said operating arm into a switch closing position, a tripping member pivotally supported at the free end of said actuating arm concentrically with said lower toggle link and depending below said arm arranged to engage and break said tripping toggle, and means to hold said actuating arm releasably against movement during the initial opening movement of said operating arm and subsequently to release said

actuating arm for movement in a switch opening direction to reset said tripping toggle for subsequent switch closing movement of the mechanism.

11. Operating mechanism for electric switches including an upper horizontal operating shaft having a rearwardly extended operating arm, a lower actuating shaft having a rearwardly extended actuating arm, means releasably connecting said arms at their free ends for conjoint switch closing movement including an over-shot inverted toggle comprising upper and lower toggle links pivotally connected respectively at their remote ends with said operating and actuating arms and having a common pivotal connection which is normally located beneath the free end of said actuating arm, power actuated closing mechanism operatively connected with said actuating arm, means constantly biasing said actuating arm for switch opening movement, means releasably holding said actuating arm against its bias, means to break said tripping toggle whereby to permit opening movement of said operating arm free from said actuating arm including a U-shaped tripping member which is pivotally connected to the free end of said actuating arm and depends therebelow, said member having a yoke portion which is disposed in position to engage said tripping toggle and urge the common pivotal connection thereof into an under set position.

12. Operating mechanism for electric switches including an upper horizontal operating shaft having a rearwardly extended operating arm, a lower actuating shaft having a rearwardly extended actuating arm, means releasably connecting said arms at their free ends for conjoint switch closing movement including an over-shot inverted toggle comprising upper and lower toggle links pivotally connected respectively at their remote ends with said operating and actuating arms and having a common pivotal connection which is normally located beneath the free end of said actuating arm, power actuated closing mechanism operatively connected with said actuating arm, means constantly biasing said actuating arm for switch opening movement, means releasably holding said actuating arm against its bias, means to break said tripping toggle whereby to permit opening movement of said operating arm free from said actuating arm including a U-shaped tripping member which is pivotally connected to the free end of said actuating arm and depends therebelow, said member having a yoke portion which is disposed in position to engage said tripping toggle and urge the common pivotal connection thereof into an under set position, a tripping bell crank pivotally supported on said actuating shaft having angularly related depending arms one of which is operatively connected with said tripping member, and tripping means operatively connected with the other arm of said bell crank.

13. Operating mechanism for electric switches including an upper horizontal operating shaft having a rearwardly extended operating arm, a lower actuating shaft having a rearwardly extended actuating arm, means releasably connecting said arms at their free ends for conjoint switch closing movement including an over-shot inverted toggle comprising upper and lower toggle links pivotally connected respectively at their remote ends with said operating and actuating arms and having a common pivotal connection which is normally located beneath the free end of said actuating arm, means including a holding toggle releasably holding said actuating arm in a switch closed position, a U-shaped tripping member having its parallel arms pivoted at their upper ends to the free end of said actuating member concentrically with said lower toggle link, and having a lower yoke portion which is adapted to engage the portion of the tripping toggle beneath said actuating arm whereby to break said toggle, a tripping bell crank pivotally supported on said actuating shaft having angularly related depending arms, a thrust link connecting one of said arms with said tripping member, and means operatively connected with the other of said arms for rotating said tripping bell crank in a mechanism tripping direction, and means responsive to the switch opening movement of said operating arm for releasing the holding means on said actuating arm.

14. Operating mechanism for electric switches including an upper horizontal operating shaft having a rearwardly extended operating arm, a lower horizontal operating shaft having a similarly rearwardly extended actuating arm, an over-shot inverted toggle releasably operatively connecting said arms for conjoint switch closing movement, power actuated means operatively connected with said actuating arm, a normally under-set holding toggle having one end operatively connected with said actuating arm and having its other end pivotally supported on said operating shaft, a latch for holding said toggle pivotally supported on said actuating shaft having means for biasing it constantly into toggle engaging position, a tripping bell crank pivotally supported on said actuating shaft having angularly related depending arms, a tripping solenoid connected operatively with one of said arms, a U-shaped tripping member having its parallel arms pivotally connected at their upper ends with the free end of said actuating arm and having a depending yoke portion which is disposed in position to engage and break said tripping toggle, a link pivotally connecting

said tripping member with a depending arm of said tripping bell crank, and means associated with said operating arm arranged to engage and release said holding latch in the final switch opening movement of said arm.

15. Operating mechanism for electric switches including a pivoted operating arm, a pivoted actuating arm located beneath and normally parallel with said operating arm, means releasably connecting the free ends of said arms for conjoint switch closing movement including an inverted tripping toggle comprising an upper link which is pivotally connected with said operating arm and which extends beneath the free end of said actuating arm, and a lower toggle link which is pivotally connected at its upper end with the end of said actuating arm, means to adjust the relative position of said toggle links whereby to maintain said toggle releasably in an overshot position, power actuated closing means operatively connected with said actuating arm intermediate the ends thereof, a holding toggle having one end thereof pivotally connected with said actuating arm intermediate its ends and having its other end pivoted on a fixed support, a latch roller carried by said holding toggle intermediate its pivotal end supports, means to bias said latch constantly in position to engage said latch roller, and tripping means for said mechanism arranged first to break said tripping toggle and thereafter to release said latch, said means including a depending tripping member pivoted to the free end of said actuating arm and located in front of the common pivotal connection of said tripping toggle, and a tripping solenoid having an armature which is operatively connected with said tripping member for rotating said tripping member about its pivotal support to collapse said tripping toggle.

16. Operating mechanism for electric switches including a pivoted operating arm, a pivoted actuating arm, means operatively connecting said arms at their free ends for conjoint switch closing movement, power actuated means operatively connected with said actuating arm, a toggle for releasably holding said actuating arm in the switch closed position thereof, a latch controlling the collapse of said toggle, means to bias said latch into a toggle engaging position, a solenoid including an armature having a lost motion connection with said latch for moving it against its bias, and resilient means constantly biasing said armature toward an unoperated position thereof.

17. Operating mechanism for electric switches including an operating shaft having an operating arm, an actuating shaft having an actuating arm which is normally disposed in parallel relation with said operating arm, means operatively connecting the free ends of said arms for conjoint switch closing movement, a toggle comprising upper and lower toggle links for holding said actuating arm releasably in switch closed position, said lower toggle link having a pivotal connection with said actuating arm intermediate its ends and said upper toggle link having a pivotal connection with said operating shaft, a latch roller at the common pivotal connection of said toggle links, a latch pivoted on said actuating shaft adapted to engage said latch roller in the switch closed position of said actuating arm, a tripping solenoid including an armature having an operative connection with said latch and adapted when energized to move downwardly to release said latch, and spring means for constantly biasing said armature upwardly into an unoperated position thereof.

In testimony whereof, I have signed my name to this specification.

HENRY P. PINKHAM.