

Nov. 21, 1944.

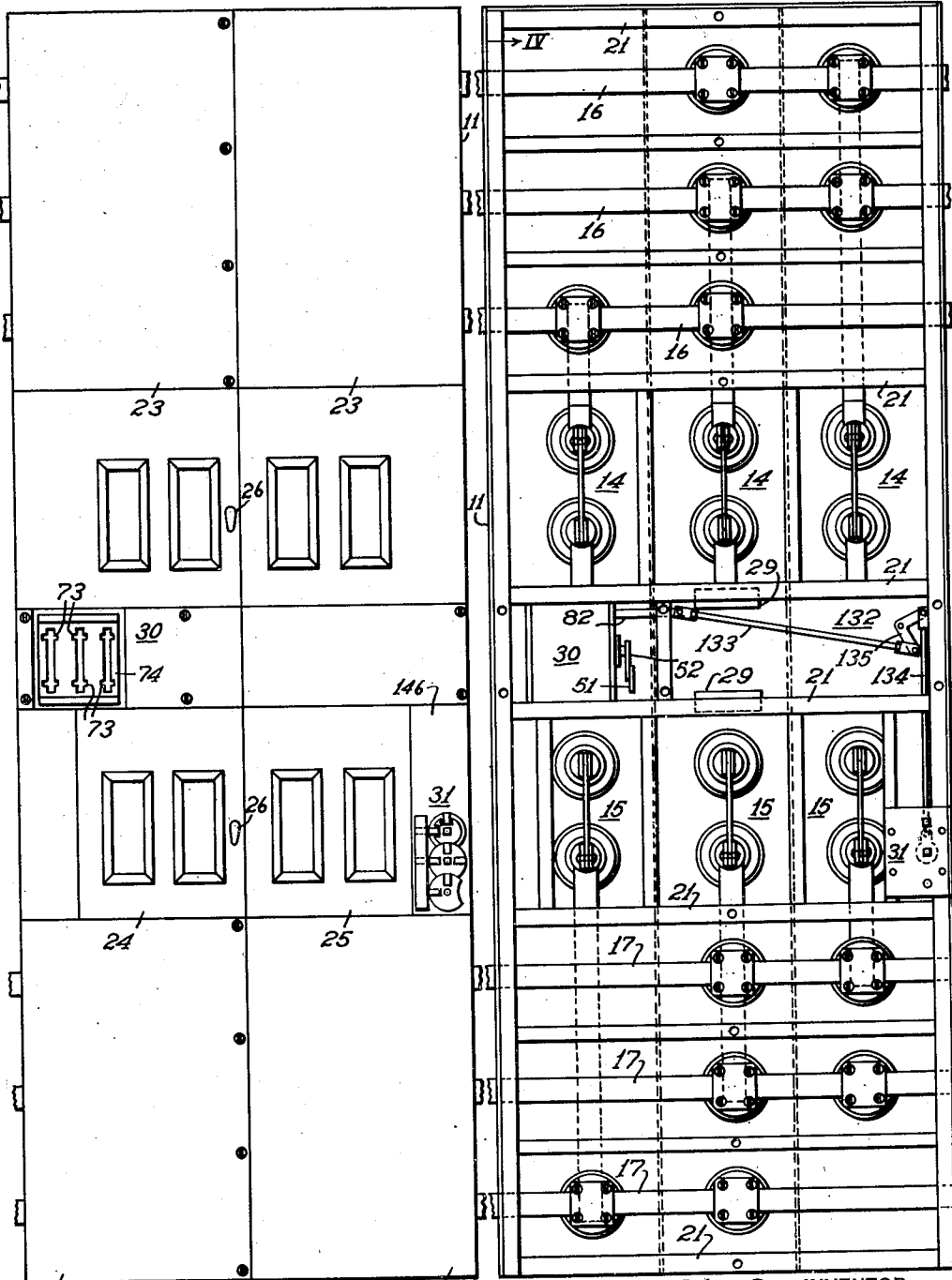
H. H. RUGG

2,363,364

SWITCHING APPARATUS

Filed July 12, 1941

8 Sheets-Sheet 1



23 WITNESSES: *Fig. 1.*
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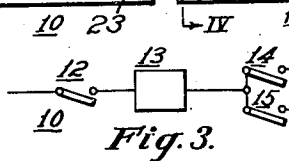


Fig. 2. INVENTOR
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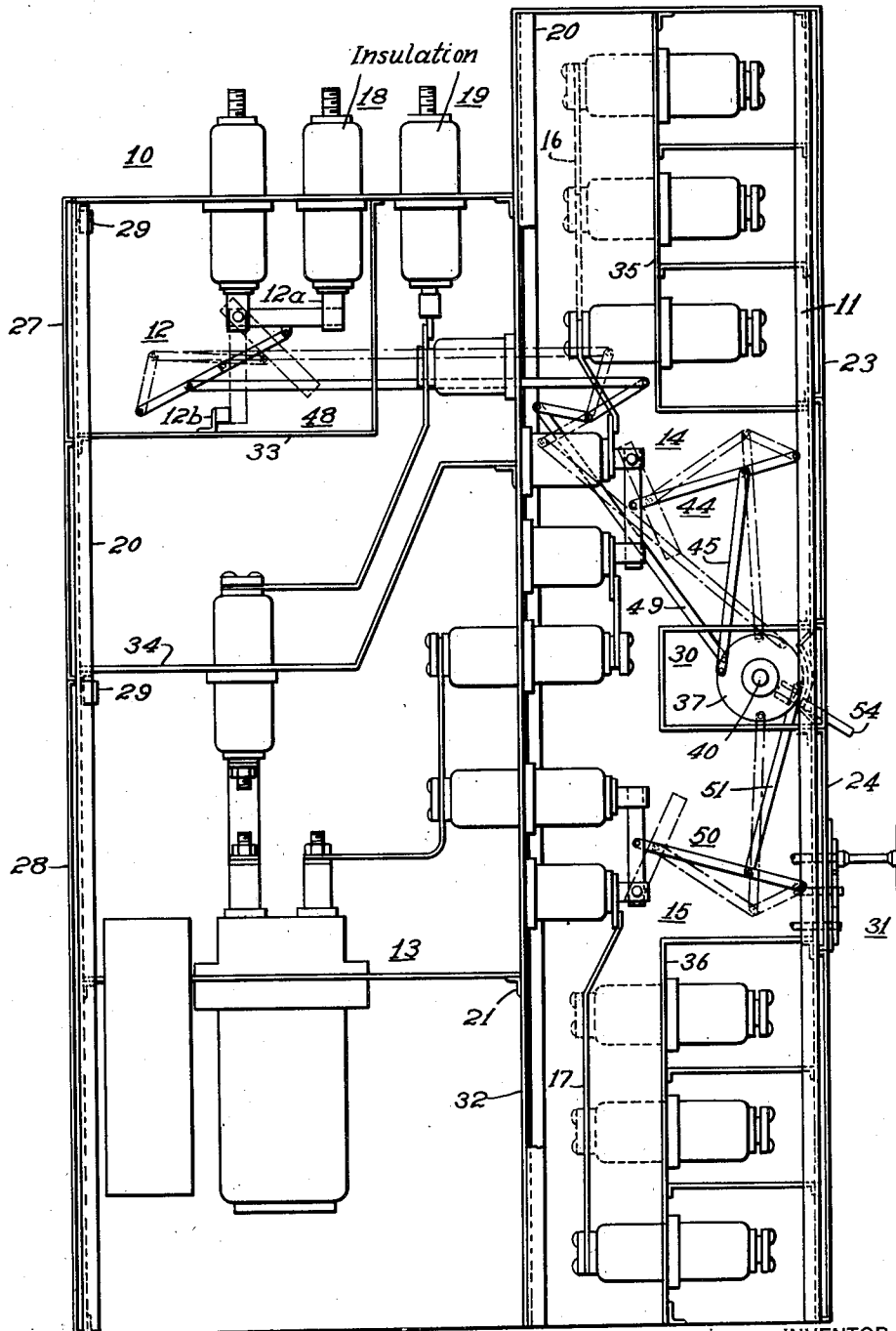
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8 Sheets-Sheet 2



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Fig. 4.

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SWITCHING APPARATUS

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Fig. 5.

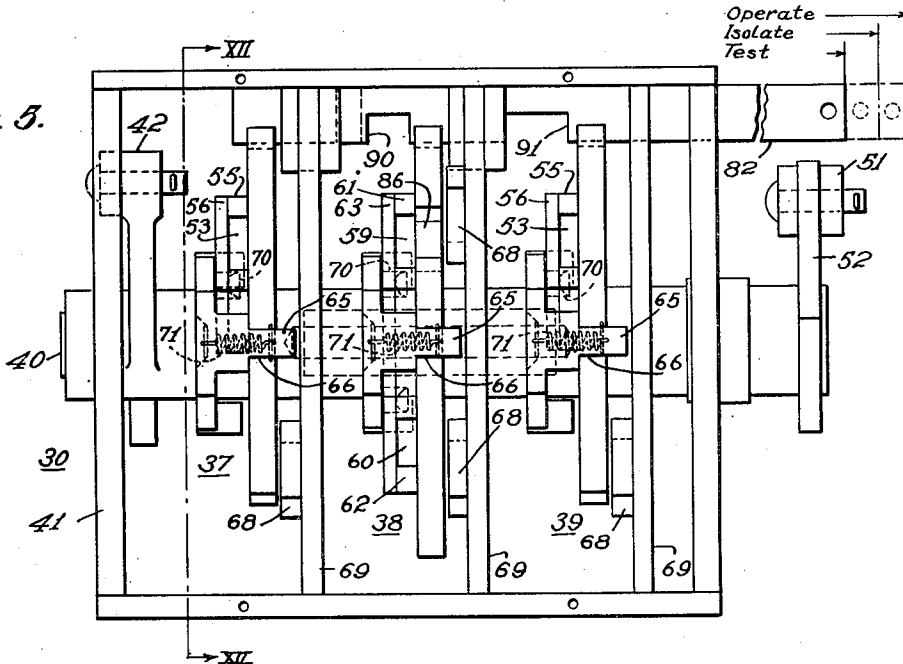
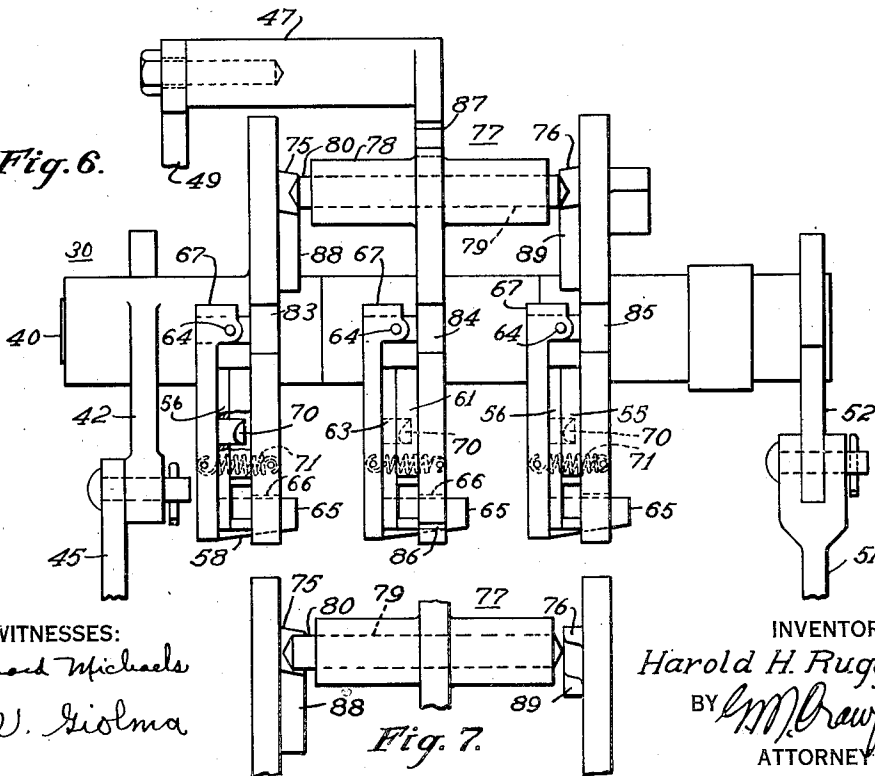


Fig. 6.



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Fig. 7.

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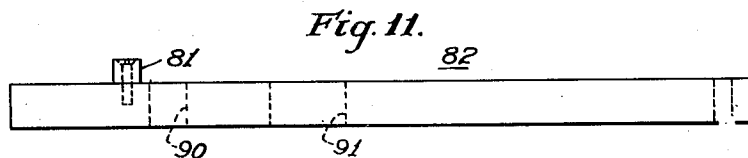
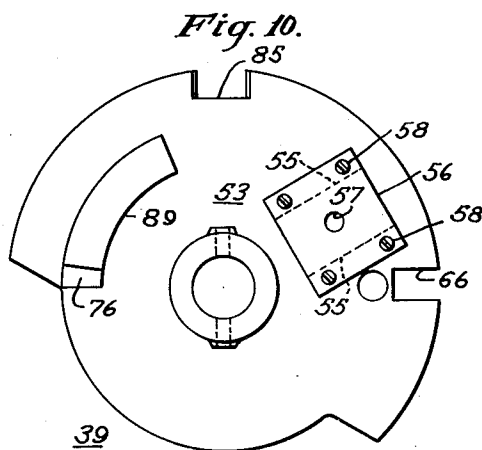
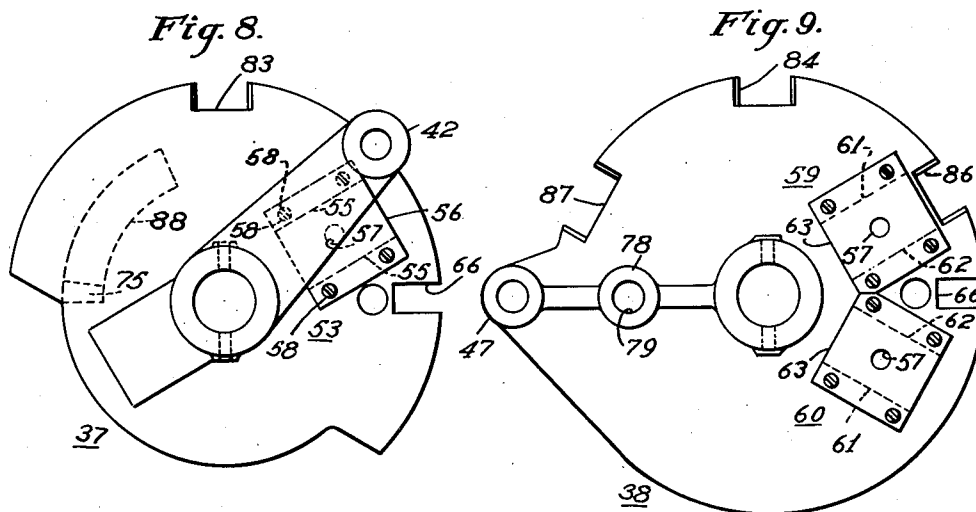
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SWITCHING APPARATUS

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SWITCHING APPARATUS

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Fig. 15.

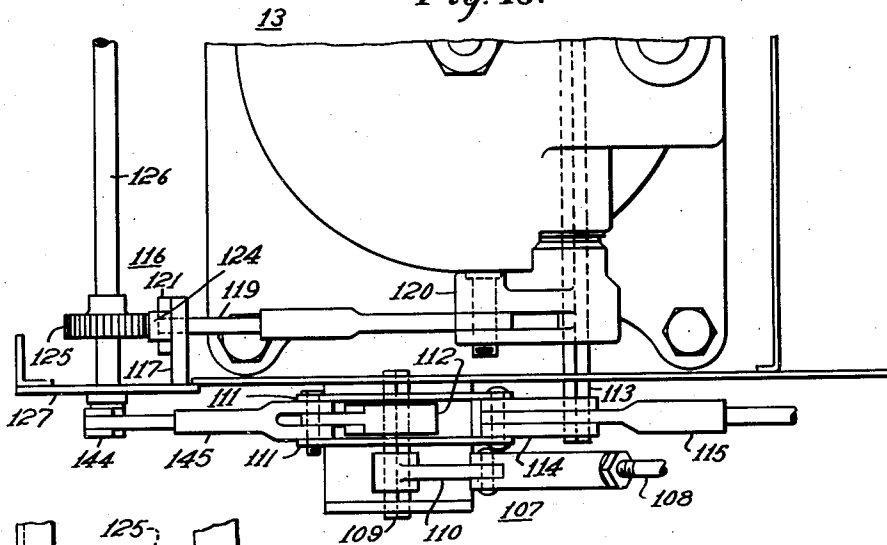


Fig. 16.

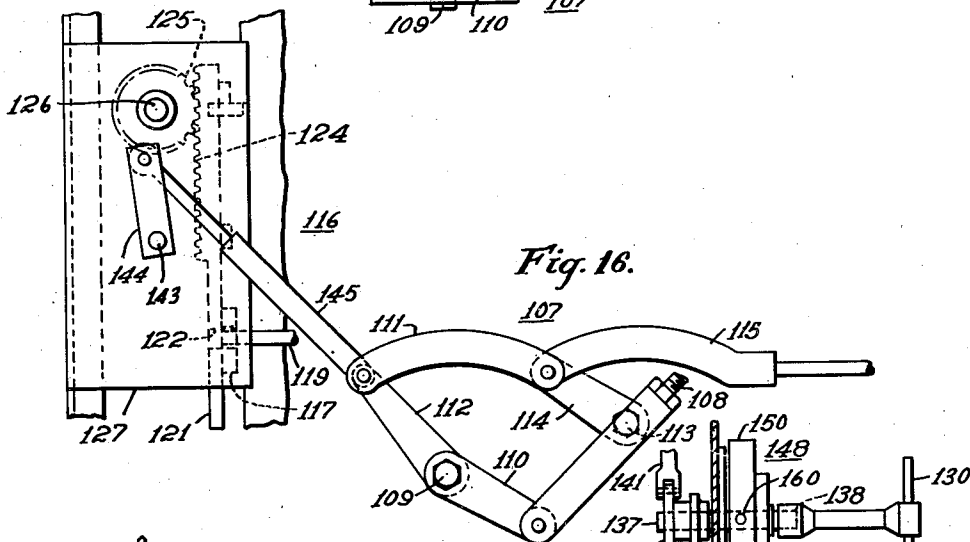
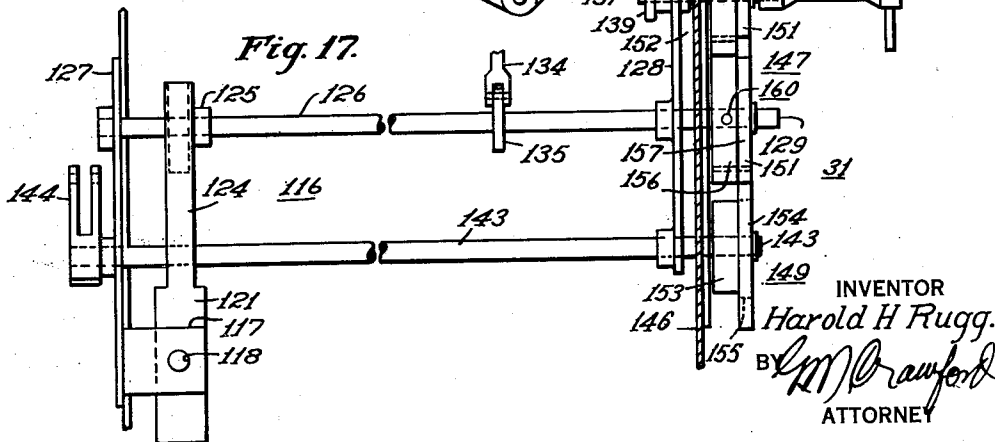


Fig. 17.



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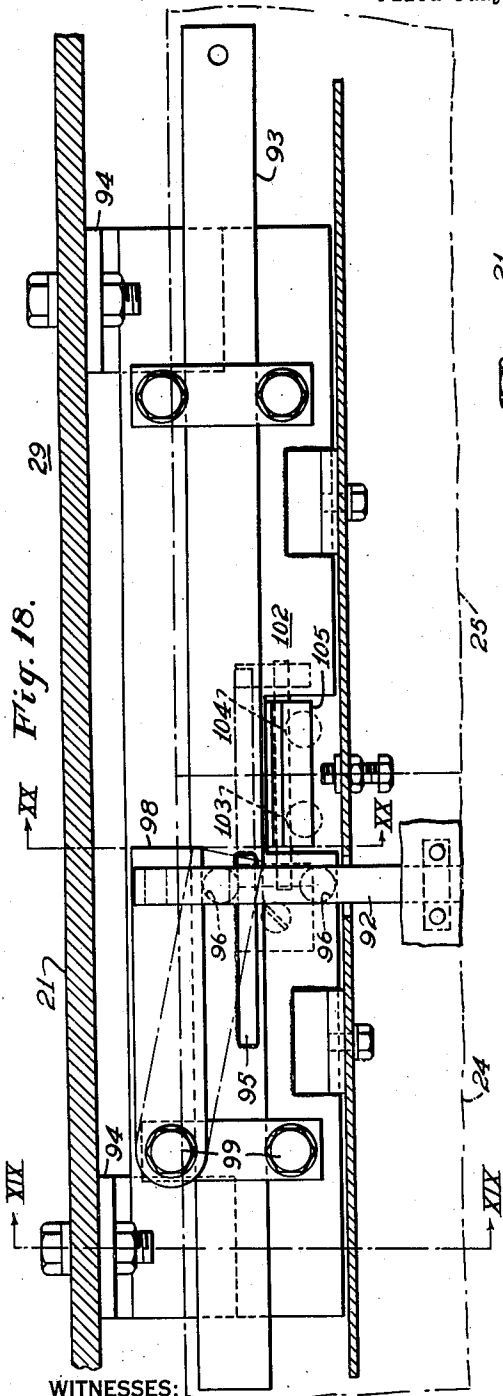
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SWITCHING APPARATUS

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8 Sheets-Sheet 7



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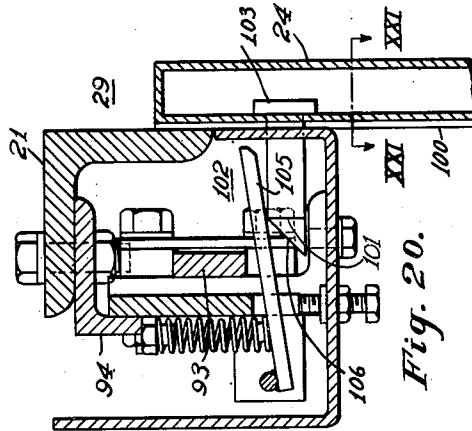


Fig. 20.

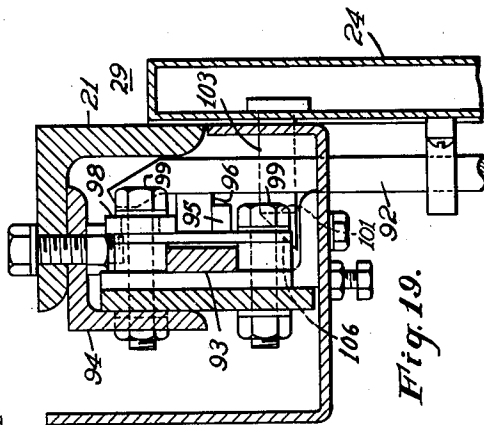


Fig. 19.

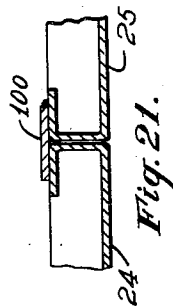


Fig. 21.

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SWITCHING APPARATUS

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Fig. 23.

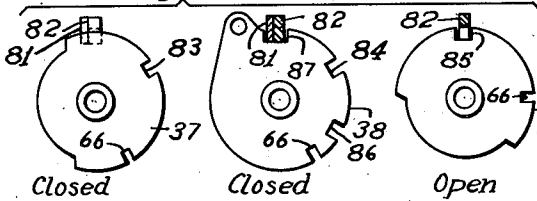


Fig. 27.

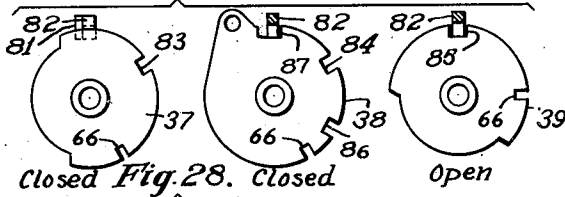


Fig. 28. Closed

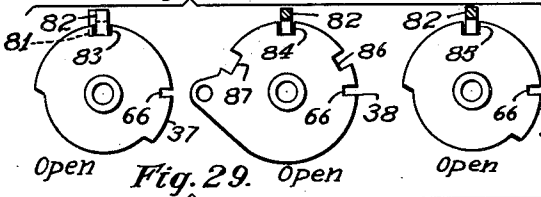


Fig. 29. Open

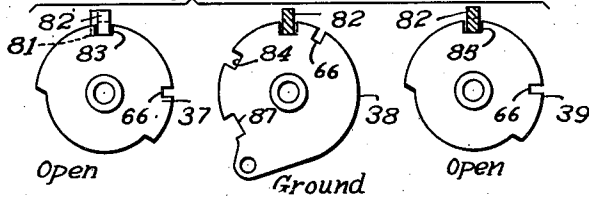


Fig. 31.

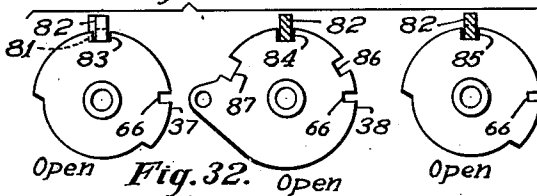
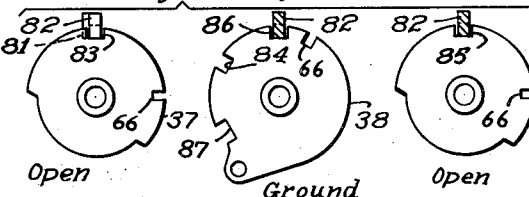


Fig. 32. Open



Ground

Fig. 22.

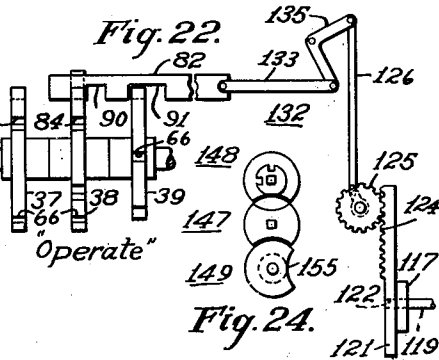


Fig. 24.

Fig. 25.

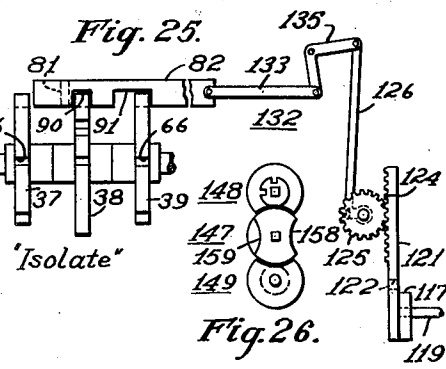


Fig. 26.

Fig. 30.

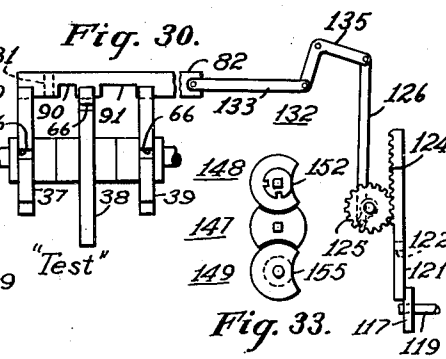


Fig. 33.

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UNITED STATES PATENT OFFICE

2,363,364

SWITCHING APPARATUS

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Pennsylvania

Application July 12, 1941, Serial No. 402,147

22 Claims. (Cl. 175—298)

My invention relates, generally, to switching apparatus and it has reference in particular to interlocking systems for switching apparatus.

Generally stated it is an object of my invention to provide for interlocking a plurality of switching devices in a simple and effective manner so as to insure operation thereof in predetermined relations and prevent operations in other of said relations.

More specifically it is an object of my invention to provide for interlocking a pair of bus selector disconnecting switches with each other, with a line isolating disconnecting switch, with a circuit breaker, and with the doors of the compartments in which the switches and circuit breaker are positioned, so as to insure against any of the doors being opened while the switches or circuit breaker are closed, to prevent the disconnecting switch from being opened or closed while the circuit breaker is closed, and to prevent both of the bus selector switches from being opened while the circuit breaker and the line isolating disconnecting switch are closed.

Another object of my invention is to provide for so interlocking a pair of bus selector switches with a line isolating switch for connecting them to an incoming or outgoing line that only one or the other of the selector switches may be opened when the line isolating switch is closed, and both of the selector switches may be either opened or closed when the line isolating switch is open.

Yet another object of my invention is to provide for mechanically interlocking a disconnecting switch with a circuit breaker so that the disconnecting switch cannot be opened or closed unless the circuit breaker is open, and the circuit breaker cannot be closed unless the disconnecting switch is locked either closed or open.

It is also an important object of my invention to prevent the doors of the circuit breaker, disconnecting switch, and selector switch compartments from being opened unless all of said switching devices are open and prevent the closing of any of said devices until all of the doors are closed and locked.

Still another object of my invention is to provide for so interlocking the line isolating disconnecting switch and bus selector disconnecting switch operating mechanisms with the circuit breaker operating mechanism that the interlocking means may be operated to "test," "isolate," or "operate" positions in a predetermined order wherein the switches and circuit breakers are operable in different predetermined relations, but

may not be transferred directly from the "test" to the "operate" position or vice versa.

A still further object of my invention is to provide for so controlling the operation of a door lock device and a switch lock mechanism of switching apparatus that the operator may be able to tell at a glance whether or not the door lock device or switch lock mechanism is free to be operated to a desired position.

An important object of my invention is to provide for mechanically interlocking a plurality of switching devices with each other and with the door lock devices of their respective compartments, and indicating to the operator by means of interlocking indicating members associated with the operating mechanisms of the switching devices and the door lock devices whether or not any one of said devices may be operated to a given position without first operating another of said devices in order to free said one device for the desired operation.

Other objects will in part be obvious, and will in part be explained hereinafter.

In accordance with my invention, a switching system for connecting an incoming or outgoing line to one or more buses may comprise a line isolating disconnecting switch for connecting a circuit breaker to an incoming or an outgoing line or circuit and a pair of bus selector switches for connecting the circuit breaker to a pair of buses. The disconnecting switch and selector switches may be so associated that a movable member actuated in response to operation of the line isolating disconnecting switch so interferes with the operation of the selector disconnecting switches that only one or the other of the selector switches may be opened when the line isolating switch is closed. Lock devices are provided for the doors of the line isolating disconnecting switch, selector switch and circuit breaker compartments, a movable stop member is provided for locking the circuit breaker in the open position, and a lock member is provided for controlling the operation of the switch operating mechanisms in accordance with the position of the circuit breaker. An indicating interlock is provided between a shaft actuated in response to the position of the circuit breaker, and shafts operatively connected to the door lock devices and the lock member of the switch operating mechanism, by providing them with rotating members which overlap and interfere with each other, and have cut-away portions which permit rotation of one relative to another when the devices with which

they are associated are so related as to permit operation of the device associated with the said one member. When a given device is in such a position that another of the devices cannot be operated without first operating the given device, then the indicating member connected to the given device is in interlocking relation with the interlock member of the device it is desired to operate, and the operator may see this condition at a glance and may therefore remedy it by first operating the given device.

For a more complete understanding of the nature and scope of my invention reference may be had to the accompanying drawings in which:

Figure 1 is a rear elevational view of a switching unit embodying the features of the invention;

Fig. 2 is a rear elevational view of the same unit with the covers and doors removed to show the interior arrangement of the switching apparatus;

Fig. 3 is a schematic diagram of a switching system embodying the principal features of the invention.

Fig. 4 is a sectional view of the switching unit taken along the line IV—IV of Fig. 2 to show the interior arrangement of the switching apparatus and devices;

Fig. 5 is an enlarged rear elevational view of the switch operating mechanism with the covers removed;

Fig. 6 is an enlarged plan view of the switch operating mechanism with the frame removed;

Fig. 7 is an enlarged partial view of the switch operating mechanism with the operating members in a different position;

Fig. 8 is an enlarged end elevational view of the operating member for one of the bus selector switches;

Fig. 9 is an enlarged end elevational view of the operating member for the disconnecting switch;

Fig. 10 is an enlarged elevational view of the operating member for the other bus selector switch;

Fig. 11 is an enlarged plan view of the lock member for the switch operating members;

Fig. 12 is a sectional view of the switch operating mechanism taken along the line XII—XII of Fig. 5;

Fig. 13 is an enlarged partial rear elevational view of the switching unit of Fig. 1 showing the interlock indicating members;

Fig. 14 is a partial rear elevational view of the switching unit of Fig. 1 with the covers and doors removed to show the door lock operating mechanism;

Fig. 15 is an enlarged partial plan view of the circuit breaker operating mechanism and movable stop member;

Fig. 16 is an enlarged partial front elevational view of the circuit breaker operating mechanism and movable stop member;

Fig. 17 is an enlarged partial side elevational view of the door lock, switch lock and circuit breaker interlock and indicating means;

Fig. 18 is an enlarged partial rear elevational view of the switching unit of Fig. 1 showing details of the door lock device.

Fig. 19 is a cross sectional view taken along the line XIX—XIX of Fig. 18;

Fig. 20 is a cross sectional view taken along the line XX—XX of Fig. 18;

Fig. 21 is a partial cross sectional view of the doors taken along the line XXI—XXI of Fig. 20;

Fig. 22 is a diagrammatic rear elevational view of the switch operating members, lock member and circuit breaker stop member in the "operate" position;

Fig. 23 is a composite diagrammatic view in end elevation of the switch operating members corresponding to the positions of the lock member and stop member in Fig. 21;

Fig. 24 is a diagrammatic rear view of the indicating interlocking means in the "operate" position;

Fig. 25 is a diagrammatic rear elevational view of the switch operating members, lock member and circuit breaker stop member in the "isolate" position;

Fig. 26 is a diagrammatic rear view of the indicating interlock members in the "isolate" position;

Figs. 27, 28 and 29 are composite diagrammatic end elevational views of the switch operating members in different positions corresponding to the positions of the lock member and stop member shown in Fig. 23;

Fig. 30 is a diagrammatic rear elevational view of the switch operating members, lock member and circuit breaker stop member in the "test" position;

Figs. 31 and 32 are composite diagrammatic end elevational views of the switch operating members in the different positions that they occupy in the "test" position; and

Fig. 33 is a diagrammatic rear view of the indicating interlock means in the "test" position.

Referring to Figs. 1, 2, 3 and 4, the reference numeral 10 may denote a switching unit comprising, a housing 11 having positioned therein a line isolating disconnecting switch 12 for connecting a circuit breaker 13 to a suitable incoming or outgoing line or circuit, having an operating terminal 12a and a ground terminal 12b, and bus selector disconnecting switches 14 and 15 for connecting the circuit breaker to upper and lower buses 16 and 17, respectively. The circuit breaker may be connected to one terminal of the switch 12, or insulating bushings 18 and 19 may be provided for making connections to an external reactor (not shown) which may be connected therebetween. Only one circuit breaker, one disconnecting and grounding switch, and one set of bus selector switches are shown in Fig. 3, as the connections for each phase are similar and to show all of them would unduly confuse the drawings.

The housing 11 for the grounding and disconnecting switch 12, circuit breaker 13 and bus selector switches 14 and 15 may be of any suitable construction, comprising, for example, vertical frame members 20 having a plurality of transverse frame members 21 at spaced intervals to provide a substantially rigid frame structure. Means such as the panel members 23 may be provided for enclosing the buses, being fastened to the frame members in any suitable manner. Doors 24 and 25 having handles 26 may be provided for enclosing the bus selector switches at the rear of the unit, and doors 27 and 28 may be provided at the front for gaining access to the switch 12 and circuit breaker 13. Lock devices 29 may be provided for locking the doors. Operating means 30 may be provided at the rear of the housing for operating the switches, and indicating interlocking means 31 may be provided for interlocking the operation of the switches, door lock devices and circuit breaker, and indicating to the operator the relations therebetween. In

order to provide for ready access to the operating means, lock devices and interlocking means, the panel sections of the unit adjacent thereto may be made removable.

A partition 32 may be provided for separating the selector switches and the circuit breaker. Partitions 33 and 34 may be provided for enclosing the line isolating disconnecting switch and the circuit breaker, respectively, while additional partitions 35 and 36 may be provided to isolate the bus structures 16 and 17 from the bus selector switches.

Referring to Figs. 1 through 12, it may be seen that the operating means 30 for the switches may, for example, comprise a plurality of rotatable operating discs or members 37, 38 and 39 mounted on a shaft 40 in a frame 41 adjacent the rear of the unit. The disc 37 may be provided with an arm 42 for connection to the bus selector switch 14 through a suitable lever mechanism 44, including a lever member 45 connected to the arm 42. The operating member 38 may be provided with a laterally projecting boss 47 adjacent the edge for effecting connection to the line isolating disconnecting switch 12 through a suitable lever mechanism 48, including a lever 49 which may be connected to the boss 47. The operating members 37 and 38 may be rotatably mounted on the shaft 40, while the operating member 39 may be secured to the shaft 40 and connection effected to the bus selector switch 15 through a lever mechanism 50, including a lever 51 which may be connected to an arm 52 secured to and rotatable with the shaft 40.

In order to provide for rotating the operating members 37, 38 and 39 to operate the switches to which they are connected, the operating members may be provided with suitable sockets 53 for receiving a detachable operating handle 54 in the manner illustrated in Fig. 12. The sockets 53 of the operating members 37 and 39 may be similar comprising, for example, as shown in Figs. 8 and 10, side members 55 secured to the members in spaced relation and having covers 56 with openings 57 therein secured thereto by means such as the screws 58. The operating member 38 may be provided with two socket members 59 and 60 comprising side members 61 and 62 secured to the operating member and having covers 63 with openings 57 therein to provide spaced sockets which may be approximately 60° apart for receiving the operating handle 54 to operate the switch from the open to either the ground or disconnect position.

In order to lock the operating members of the switches in any position to which they are operated when the operating handle is removed, suitable lock means may be provided such as, for example, the dogs 67, which, as shown in Figs. 5, 6 and 12, may be pivotally connected to hub portions of the operating members by means of pins 64. The dogs 67 may be provided with projecting teeth 65 which project through slots 66 in the operating members into corresponding slots formed by means of spaced stop members 68 on vertical supports 69 secured in the frame 41 adjacent the operating members. Means such as the projections 70 may be provided on the dogs 67 which may be normally positioned in the socket 53 when the handle 54 is not positioned therein. Springs 71 may be provided for normally retaining the dogs adjacent the operating members with the teeth 65 positioned between the stop members 68. The teeth 65 may be freed from the stop member 68, for example, by the handle 54,

which may engage and actuate the projection 70 out of the socket 53 when the handle is inserted in the socket. Means may be provided for preventing the handle from being inserted in or removed from any of the sockets except upon the completion of an operation such as, for example, the transverse pin 72 on the handle and the slots 73 in the cover 74 of the operating mechanism shown in Fig. 1.

With the isolating switch in the open position the operating member is positioned as shown in Fig. 5 with the sockets 59 and 60 substantially equal distances above and below the axis of rotation, and in alignment with the upper and lower transverse slots 73 of the cover member 74. The handle 54 may be inserted in either socket to operate the switch 12 to either the closed or ground positions (provided that the indicating interlocking means is operated as hereinafter described, to free the operating member for such operations). To operate the switch to the ground position the handle 54 may be inserted in the socket 60 and actuated upwardly until it is aligned with the upper transverse slot 73, when the handle may be removed for operating others of the switches. To operate the switch 12 to the closed or operate position the handle 54 may be inserted in the socket 59 which is the only one accessible, and actuated downwardly to open the switch. The handle may then be removed and positioned in the upper socket 59 and again actuated downwardly to rotate the member 38 clockwise. When the socket 59 is aligned with the lower transverse slot 73 the switch is closed, and the handle may be removed.

In order to insure that only one or the other of the bus selector switches can be opened while the disconnecting switch is closed, suitable interlocking means may be provided, such as the interlock device 77. As shown in Figs. 6, 7, 8 and 10 the operating members 37 and 39 may be provided with suitable projections 88 and 89 on the adjacent sides having sloping end cam portions 75 and 76, respectively. The operating member 38 may, as shown in Figs. 6, 7 and 9, be provided with a laterally extending boss 78 having an opening 79 therein, wherein may be positioned a slidable pin 80. As best shown in Figs. 6 and 7 the pin 80 may be of such length, and the boss 78 may be so positioned relative to the projections 88 and 89, that the sloping surfaces 75 and 76 of the projections interfere with the ends of the pin 80 when it is attempted to operate the operating members 37 and 39 to the open position while the operating member 38 of the disconnecting and grounding switch is in the closed position. The pin 80 may be of such length that only one of the operating members 37 or 39 may be operated to the open position when the operating member 38 is in the closed position, by actuating the pin 80 to clear one or the other of the projections 88 and 89. When the pin 80 has been actuated to clear one of the projections, complete interference with the other projection results, preventing the operation of its associated selector switch.

For the purpose of interlocking the operations of the line isolating and bus selector switches with the operations of the circuit breaker 13 and of the door lock devices 29 so as to permit only predetermined operations of the switches under certain conditions, suitable means may be provided such as the lock member 82, which may be adapted to interfere with, and prevent rotation of the operating members 37, 38 and 39 under

certain predetermined conditions. The operating members may, as shown in Figs. 8, 9 and 10, be provided with peripheral slots 83, 84 and 85 for receiving portions of the lock member 82 when the operating members are in the open position. The operating member 38 of the line isolating and grounding switch 12 may be provided with an additional similar slot 86 for locking the line isolating switch in the grounding position, and also a slot 87 which is substantially wider than the other peripheral slots for locking the operating member in the closed position.

Referring to Figs. 5 and 10, it will be seen that the locking member 82 may comprise an elongated rectangular bar which may be slidably mounted in the frame 41, so as to be positioned in the peripheral slots in the operating members. The lock member 82 may be operated to three different positions; namely, "operate," "isolate" and "test." As shown in Fig. 5, the lock member is in the "test" position at the extreme left end of its travel. The "isolate" and "operate" positions are indicated by the dotted vertical lines at the right-hand end of the bar. Slots 90 and 91 may be provided on the lower side of the bar to provide for rotation of the operating members 38 and 39 therethrough in predetermined positions of the lock member, and the length of the member may be such that the left-hand end, as shown in Fig. 5, will be free of the operating member 37 when the slot 90 is in alignment with the operating member 38, and interferes with the operating member 37, when the lock member is in the extreme left or "test" position as shown in Fig. 5. The slot 91 may be wider than the slot 90, being sufficiently wide to provide for clearance of the operating member 39 in both the extreme right-hand position or "operate" position and in the intermediate or "isolate" position.

In the "test" position, the three operating members are locked with their respective switches in the open position. In the "operate" position, the operating member 38 is locked with the switch 12 in the closed position, while the operating members 37 and 39 are free from interference with the lock member. In the "isolate" position, all of the operating members are free from interference with the locking member.

In order to prevent the stop member 82 from being operated directly from the "test" position at the extreme left as shown in Fig. 5 to the "operate" position at the extreme right, without requiring the switches to be operated to the "isolate" position, a suitable stop member 81 may be positioned on one side of the lock member adjacent the slot 90, so as to prevent the lock member from being directly transferred from the "test" to the "operate" position while the lock member is positioned in the slot 91 of the operating member 38, without first operating the line isolating switch to the closed position so that the relatively wide slot 87 of the operating member 38 is in alignment with the lock member 82 to permit the stop member 81 to pass therethrough. Before the line isolating disconnecting switch can be operated to the closed position other interlocking means hereinafter described, require the circuit breaker to be opened and the lock member to be operated to the "isolate" position.

Referring to Figs. 14 and 18 through 20, the reference numeral 29 denotes generally a lock device such as may be used for locking the doors 24 and 25 of the selector switch compartments, or the doors 27 and 28 of the compartments in

which the line isolating disconnecting switch 12 and the circuit breaker 13 are located. As shown particularly in Figs. 18 and 19, the door 24 may be provided with lock means, such as, for example, the slidable locking bar or rod 92, which may be operatively connected to the handle 26 so as to be actuated in the vertical direction to interlock with the transverse frame member 21. Suitable means may be provided for retaining the rod 92 in the locked position such as, for example, the sliding lock member 93 which may be supported from the transverse frame member 21 by means of brackets 94 so as to be slidable longitudinally. A projection or shelf portion 95 may be provided on the outer side of the lock member 93 which is adapted to be positioned under a projection 96 on the bar or rod 92 to retain the bar or rod in the locked position.

In order to prevent the lock member 93 from being moved to the locked position before the doors are closed and the lock bar or rod 92 is actuated to the locked position, a suitable stop member 98 may be provided, which may be pivoted at one end by a bolt 99 so that the other end engages the adjacent end of the projection 95 when the lock member 93 is moved to the open position. In order to move the lock member 93 to the closed position the stop member 98 must first be raised from the dotted position to the position shown in full lines, by closing the doors and locking them. The projection 96 on the door lock bar or rod 92 lifts the stop member 98 so that it clears the projection 95, permitting the lock member 93 to be moved to the left, whereby the projection 95 is positioned beneath the projection 96 of the door lock bar or rod 92, thus retaining it in the locked position.

As shown in Fig. 21, the door 24 which carries the lock bar or rod 92 may be adapted to maintain the door 25 in the closed position by reason of interference with a projection 100 on the door 25 which is positioned behind the inner edge of the door 24 in the closed position. With a view to insuring that the door 25 is closed before the door 24 carrying the lock bar or rod 92 is closed, an interlock device 102 may be provided. As shown in Figs. 18, 19 and 20 the doors 24 and 25 may be provided with projecting pins 103 and 104 adapted to cooperate with a pivoted blocking or interfering member 105 to insure that the door 25 is closed before the door 24. In order to secure this result, the pin 104 may be provided with a sloping end portion 106 which is adapted to raise the pivoted latch member 105 when the door 25 is closed thus permitting the pin 103 of the door 24 to pass beneath the latch member. The pin 103 of the door 24 may be provided with a square cut or abrupt end portion 101 which engages the outer end of the latch member 105 if the door 24 is closed first, thus preventing the door from being closed sufficiently to operate the lock bar or rod 92 to lock the door.

Referring to Figs. 15 and 16, the reference numeral 13 denotes generally one of the circuit breakers, while the numeral 107 may denote generally the operating mechanism thereof. For example, the lever 108 of the operating mechanism may rotate the jackshaft 109 by means of a crank 110. Parallel links 111 connected to the jackshaft 109 by means of a crank 112 may operate the main operating shaft 113 of the circuit breaker through the crank 114. A connecting link 115 may provide for connection to the circuit breakers of the other phases.

In order to prevent the closure of the circuit breaker 13 under certain operating conditions, suitable means may be provided such as, for example, the stop device indicated generally by the numeral 116 in Figs. 15, 16 and 17. The stop device may for example comprise a stationary guide member 117 having an opening 118 to receive a slidable pin 119 which may be connected to the shaft 113 by a crank lever 120, and a slidable stop member 121 having an opening 122.

In order to control the operation of the switches 12, 14 and 15, the circuit breaker 13, and the door lock devices 29 in predetermined relations, connection may be made therebetween by means of the indicating and interlocking means 31. For example, the stop member 121 may be actuated by means of a rack portion 124 having teeth adapted to be engaged by a pinion 125 mounted on a rotatable shaft 126 which may be a part of the indicating and operating means 31.

As shown in Figs. 13 and 17, the shaft 126 may be supported by bearing plates 127 and 128 at the front and rear of the housing and may have a rectangular end portion 129 projecting from the housing at the rear to which a detachable handle 130 may be attached for operating the stop member. An operating connection between the stop member 121 of the circuit breaker and the lock member 82 of the switch operating means may be provided, as shown in Figs. 2 and 17, by a lever system 132 which may include a lever 133 connected to the lock member 82 and a lever 134 which may be connected to the shaft 126 by a crank lever 135. The connection may be such that when the lock member 82 is in the "operate" position, the opening 122 of the stop member 121 is aligned with the opening 118 of the guide member, so that the circuit breaker may be closed. When the lock member 82 is in the "isolate" position, the stop member blocks the opening 118 and the circuit breaker is locked open. When the lock member 82 is in the "test" position the stop member 121 is clear of the opening 118 in the guide member and the circuit breaker may be operated.

An additional shaft member 137 may be provided adjacent the shaft 126 having a similar rectangular end portion 138 for receiving the handle 130. Operation of the movable lock member 93 of the door lock device 29 may be effected from the shaft member 137 by means of a crank arm 139 attached to the shaft member 137 and a suitable lever system 140 including a lever 141 for operatively connecting the lock members 93 to the crank arm 139.

As shown in Figs. 15, 16 and 17, another shaft member 143 may be provided adjacent the shaft member 126, also extending through the bearing plate 128 and projecting beyond the rear of the housing 11. The shaft member 143 may be operatively connected to the circuit breaker operating mechanism 107 in order to rotate with the operation of the circuit breaker, by means such as the crank lever 144 and a connecting lever member 145, which may be connected to the crank member 112 of the circuit breaker operating mechanism.

In order to indicate the instantaneous position of the door locks, switch operating mechanism, and circuit breaker, and indicate to the operator which of these must be operated, and in what order they must be operated to secure a desired condition in the system, means such as

the indicating interlock means 31 may be provided. As best shown in Figs. 13 and 17, the shafts 126, 137 and 143 may be provided with interfering indicating interlock members 147, 148 and 149, respectively. The indicating interlock members 148 may, for example, comprise a substantially circular inner disc portion 150 positioned adjacent a removable panel member 146 and an outer hub portion 151 of reduced diameter. The disc 150 may be provided with an arcuate cut-away portion 152 on one edge to receive an overlapping portion of the indicating interlock member 147, thus preventing rotation of the indicating interlock member 148 or shaft 137 while the indicating interlock member 147 is in the position shown, with a portion positioned in the cut-away portion 152. The indicating interlock member 149 may comprise a inner hub portion 153 of reduced diameter positioned in substantially the same plane as the disc portion 150 of the indicating interlock member 148, and a substantially circular outer disc portion 154 positioned adjacent the hub portion 150 so as to be in a different plane than the circular disc portion 150 of the indicating interlock member 148. The disc portion 154 may be provided with a substantially arcuate cut-away portion 155 on the periphery adapted to receive a portion of the indicating interlock member 147 when the circuit breaker is in the open position, so as to permit movement of the indicating interlock member 147 relative thereto.

The indicating interlock member 147, which is mounted on the shaft 126 intermediate the other indicating interlock members, may be provided with substantially circular inner and outer disc portions 156 and 157, which may be positioned respectively in the planes of the disc members 150 and 154, and adapted to interfere therewith. A substantially arcuate cut-away portion 158 may be provided in the inner and outer disc members 156 and 157 on one side so as to provide for rotation of the indicating interlock members 148 and 149 relative thereto in predetermined positions. An additional arcuate cut-away portion 159 may be provided in the outer disc member 157 on the opposite side to receive the overlapping portion of the indicating interlock member 149. The indicating interlock members 147 and 148 may be provided with indicia 160 having detents 161 in the discs 150 and 156 in alignment therewith for receiving spring actuated pins 162 to retain them in the positions to which they may be operated.

Referring to Figs. 22, 23 and 24, the stop member 121 and the lock member 82 are shown in the "operate" position, in which the movable pin 119 is free to move through the openings 118 and 122 to the left, so that the circuit breaker 13 may be closed. The operating member 38 of the line isolating switch 12 is locked in the closed position by the locking member 82 and the stop member 81 which are positioned in the relatively wide slot 87. In this position the operating members 37 and 39 of the bus selector switches 14 and 15 are free to open or close so far as the lock member 82 is concerned. However, because of the interlock means 77 carried by the operating member 38, only one or the other of the operating members 37 and 39 may be moved to the open position to open the bus selector switch associated therewith. As shown, the operating member 39 is in the open position indicating that the lower bus selector switch 15 is open. It is however free to be closed if de-

sired, or it may be closed and the bus selector switch 14 opened.

In the "operate" position, as shown in Fig. 24, the indicating interlock member 149 interferes with the member 147, indicating that the locking member 82 of the switch mechanism cannot be operated until the circuit breaker is opened. Likewise, the member 147 interferes with the door lock member 148, indicating that the doors cannot be opened while the switches are closed. The member 149 is free to rotate, indicating that the circuit breaker may be opened or closed.

In Fig. 25, the stop member 121 and the lock member 82 are shown in the "isolate" position wherein the circuit breaker has been opened and movement of the pin 119 to the left is blocked so that the circuit breaker is locked open. The operating members 38 and 39 are positioned in the slots 90 and 91 of the lock member 82 so that they are both free to rotate relative thereto. All of the switches may be opened or closed by means of the handle 54.

As shown in Fig. 26, the indicating interlock member 149 has been rotated 90° counterclockwise so that the cut-away portion 155 is adjacent the member 147. The shaft 126 may now be rotated counterclockwise 90° to the "isolate" position, freeing all of the switch operating members. Further rotation is prevented by the right-hand end of the lock member 82 striking the operating member 37. If the positions of the switches 14 and 15 were reversed, the member 39 would prevent further movement of the lock member. In the "isolate" position the member 147 interferes with the members 148 and 149, indicating that neither the door lock devices nor the circuit breaker can be operated.

As shown in Fig. 27, the operating members 37, 38 and 39 occupy the same positions as shown in Fig. 23, the only difference being that the lock member 82 has been moved to the left by rotating the shaft 126 by means of the handle 130, so that the operating member 38 is now free to move. In this position, the switches may be opened or closed by rotating the respective operating members by means of the handle 54. Further movement of the lock member 82 to the left or to the "test" position with the operating members in the position shown in Fig. 27 is prevented by reason of the end portion of the lock member engaging the operating member 37. In order to transfer from the "operate" to the "test" position, the operating member 38 must first be operated by means of the handle 54 to the "open" position so that the interlock device 80 is moved to a position sufficiently clear of the projections 88 and 89 on the operating members 37 and 39, respectively, to enable the operating member 37 to be moved to the open position so that the slot 83 is moved in alignment with the lock member 82 as shown in Fig. 28.

From the position shown in Fig. 27, the operating member 38 may be operated by the handle 54 to either the ground position as shown in Fig. 29, in which it is free, or to the open position as shown in Fig. 28.

The switch may be locked in this position by operating the shaft 126 to move the lock member 82 to the extreme left or "test" position as shown in Figs. 30 and 31. In this position, the circuit breaker is free to operate for test purposes since the stop member 121 is clear of the pin 119, as shown in Fig. 30. Further operation of the operating member 38 to actuate the line isolating disconnecting switch to the ground position for test purposes, as shown in Fig. 32, may be effected

by first actuating the shaft 126 by means of the handle 130 to return the stop member and locking member to the "isolate" position as shown in Fig. 25, whereupon the operating member 38 may be actuated to the ground position by the handle 54 and locked by turning the shaft 126 counterclockwise to return the lock member to the "test" position at the extreme left.

By reason of the interlocking relation between the lock bar 82 and the operating members 37, 38 and 39, and the interlocking between the operating shaft 137 of the door lock mechanism, the shaft 126 of the lock member 82, and the shaft 143 which is operated in response to movement of the circuit breaker, complete interlocking of the switches, circuit breaker, and door lock mechanism, is obtained. In operating the door lock devices, the switches or the circuit breaker, the following conditions must be observed by reason of the interlock arrangements provided:

(a) The line isolating disconnecting switch cannot be opened or closed unless the circuit breaker is open.

(b) The circuit breaker cannot be closed unless the line isolating disconnecting switch and bus selector switches are open or the line isolating disconnecting switch and at least one of the bus selector switches are closed.

(c) If one bus selector switch is open the other bus selector switch cannot be opened unless the circuit breaker is opened.

(d) If both bus selector switches are opened neither can be closed unless the circuit breaker is opened.

(e) One set of bus selector switches can be closed and the other opened to transfer a circuit from one bus to the other while the circuit breaker is closed.

(f) The circuit breaker and line isolating or bus selector disconnecting switch compartment doors cannot be opened unless all the disconnecting switches are locked open, and none of the switches can be closed until the doors are all closed and locked.

(g) When the line isolating disconnecting switches and bus selector switches are locked open the circuit breaker may be operated for test.

(h) The circuit breaker is free to trip open at all times.

From the above description and accompanying drawings, it will be apparent that I have provided a simple and effective manner for interlocking a plurality of switches and a circuit breaker with the door lock mechanisms of the compartments in which they are contained. Not only are the switches, circuit breakers and door lock mechanisms required to be operated in a prescribed order by means of interlocking arrangements therebetween, but visual indication is given the operator at all times of the operating relations of the device. Thus if it is desired to perform a particular switching operation, the operator may determine at a glance which of the switches, circuit breakers, or door lock mechanisms it is necessary to operate, and in what order it is necessary to operate them to achieve the desired result.

Since certain changes may be made in the above description, and different embodiments of the invention may be made without departing from the spirit thereof, it is intended that all of the matter contained in the above description and shown in the accompanying drawings shall be considered as illustrative, and not in a limiting sense.

I claim as my invention:

1. An interlock system for switching apparatus including a circuit breaker, a disconnecting switch and a pair of bus selector switches having enclosures with doors comprising, means for controlling the operation of the bus selector switches in accordance with the position of the line isolating switch, interlock means responsive to the position of the circuit breaker for controlling the operation of the switches, lock devices for the doors of the enclosures, and means responsive to the position of said interlock means for controlling the lock devices.
2. A switching system comprising, a circuit breaker, a plurality of switch devices for connecting the circuit breaker to incoming and outgoing buses, an enclosure for the switch devices having doors with lock devices, means for effecting predetermined operation of the switch devices, lock means operable to control the operation of said means, and means associated with the lock devices, lock means and circuit breaker having interfering portions to prevent the operation of the switches and doors except under predetermined conditions.
3. The combination with a plurality of switching devices positioned in an enclosure having doors for gaining access to the devices, of lock means for the doors, operating means accessible externally of the enclosure for operating the switching devices, interlock means connecting the operating means operable to control the operation of the operating means of one of said devices in accordance with the position of another of said devices, and means connecting said interlock means to the lock means arranged to prevent operation of the doors unless the switching devices are in predetermined positions without preventing predetermined operations of the switching devices while the doors are closed.
4. A switching system comprising a circuit breaker, a pair of buses, a disconnecting switch connected between the circuit breaker and an additional bus, a bus selector switch connected between the circuit breaker and each of the distribution buses, movable control means operatively connected to the switches, interlock means operated in response to movement of the control means of the disconnecting switch for interlocking the said control means of the selector switches when the disconnecting switch is closed to prevent both of the selector switches from being opened, adjustable lock means for controlling movement of the control means, operating means for the lock means, and means responsive to the position of the circuit breaker for controlling the operation of the operating means.
5. The combination with a pair of bus selector switches and an isolating switch for connecting a circuit breaker between incoming and outgoing buses, of means for interlocking the operation of the selector switches with the circuit breaker including means operatively connected to the isolating switch, additional means operatively connected to the selector switches, interlock means operable under the control of the said means to effect an interlocking relation between the additional means so as to prevent the opening of either of the selector switches when the other is open and the isolating switch is closed, and means controlling the operation of the isolating switch in response to the position of the circuit breaker.
6. A switching system comprising, a plurality of switches, interlock means for a pair of said switches operable to prevent one of said pair from being opened when the other is open, and means operatively connected to another of the switches for controlling the operation of said means.
7. The combination with a pair of bus selector switches and an isolating switch, of a pair of rotatable operating members positioned in spaced relation and operatively connected to the selector switches, said operating members having projecting stop portions on adjacent sides, an additional rotatable operating member operatively connected to the isolating switch positioned between the aforesaid operating members, and a stop member mounted on the additional rotatable member adapted to interfere with the projecting stop portions when the disconnecting switch is closed, said stop member being movable to clear one or the other of the projecting portions only when its associated selector switch is opened, so as to prevent opening of the other selector switch.
8. An interlock for a switch system having a switch device, a circuit breaker connected to the switch device and an enclosure for the switch device and circuit breaker having doors with lock devices, means for operating the lock devices, means for operating the switch device, means for locking the switch operating means, lock means for controlling the operation of the circuit breaker, and a plurality of movable indicating interlock means operable in response to movement of the circuit breaker, locking means for the switch operating means and door lock device operating means respectively, having interfitting portions which interlock to indicate and prevent operation of the lock device operating means and switch operating locking means under predetermined conditions of the switch device, circuit breaker and door lock devices.
9. The combination with a switch device and circuit breaker positioned in enclosures having doors with lock devices, of means operable to lock the switch device in predetermined positions, means operable to actuate the door lock devices, control means responsive to the position of the circuit breaker, and a plurality of rotatable disc-like members associated in overlapping relation having cut away peripheral portions so positioned that a portion of one fits in the cut-away portion of another to prevent rotation of the latter, said members being operatively connected to and rotatable in response to movement of the said means, so as to prevent operation of the door lock devices except when the switch device is in a predetermined position and to prevent operation of the switch device lock means except when the circuit breaker is in a predetermined position.
10. An interlock system for a switch device and a circuit breaker comprising, a movable stop member for controlling the operation of the circuit breaker, a movable member operatively connected to the switch device and movable in response to operation thereof, a locking member movable into interlocking relation with movable member, and means operatively connecting the movable member and stop member so that the circuit breaker may close when the switch device is closed and the circuit breaker is locked open when the switch is free to operate.
11. Switching apparatus comprising a switch having a pair of spaced operating positions with an intermediate position, a detachable operating handle, a movable operating member oper-

able to actuate the switch to said positions having a pair of sockets for receiving the handle, and a cover member associated with the movable member having an opening so related to the sockets that both are accessible when the switch is in the intermediate position, and one of the sockets is inaccessible when the switch is operated to one operating position by the handle in the other socket.

12. The combination with a multiple position switch having an intermediate position and spaced operating positions on each side thereof, of a detachable operating handle, a rotatable member connected to the switch having circumferentially spaced sockets to receive the handle for operating the switch between the intermediate position and one or another of the spaced positions, and a cover member having an opening therein of substantially the same distance between the sockets, said opening and sockets being so related that both sockets are accessible through the opening when the switch is in the intermediate position, and the switch may be operated between the intermediate position and one spaced operating position only with the handle in one of said sockets, thus requiring a transfer of the handle in the intermediate position from one socket to the other to complete an operation between the spaced position.

13. The combination with a disconnecting switch, a pair of bus selector switches for connecting a pair of buses to the disconnecting switch, and a circuit breaker connected between the disconnecting switch and the bus selector switches, of interlocking means associated with the disconnecting switch operable to prevent more than one bus selector switch from being opened while the disconnecting switch is closed, a plurality of movable members operatively connected to the switches and provided with peripheral slots, corresponding to predetermined switch positions, a lock bar positioned in said slots having portions to interfere with movement of the movable members and having cut-away portions in predetermined positions to permit movement of the movable members, said bar being operable to "operate," "isolate" and "test" positions in which the movable members may be operated to effect predetermined operations of the switches, means responsive to the position of the circuit breaker, stop means associated therewith for locking the circuit breaker, means operatively connecting the stop means and the lock bar to lock the circuit breaker open in the "isolate" position and permit movement of the movable members so that the switches may be transferred between the open and closed positions.

14. The combination with a pair of bus selector switches, a disconnecting switch operable to "ground," "open" or closed positions and a circuit breaker connecting the selector switches to the disconnecting switch of rotatable operating members positioned in spaced relation connected to the selector switches having peripheral slots for locking the switches open and lateral projections on adjacent sides in predetermined relation, an additional rotatable operating member connected to the disconnecting switch and positioned between the said rotatable members having peripheral slots for locking the disconnecting switch in the "ground," "open" or "closed" positions and an axially movable interlock member adapted to interfere with the lateral projections of the selector switch operating members when the disconnecting switch is closed

and permit only one or the other of the selector switches to be opened, a slidable lock bar operable to "operate," "isolate" and "test" positions adapted to move in the peripheral slots of the operating members and having slots to clear the rotatable members in the "isolate" position, said bar being adapted to lock only the operating member of the disconnecting switch in the "operate" position and lock the operating members of the selector switches open and the operating member of the disconnecting switch in either the ground or open position in the "test" position, a movable stop member actuable to lock the circuit breaker open, and means connecting the stop member and lock bar so that the circuit breaker is locked open only in the "isolate" position of the lock bar.

15. The combination with a plurality of switches, a circuit breaker for connecting the switches to an incoming or outgoing circuit, and door lock devices for the compartments in which the switches and circuit breakers are positioned, of a shaft rotatable to operate the door lock devices, a rotatable shaft operable in response to movement of the circuit breaker positioned in spaced relation to said first mentioned shaft, means for locking the switches in predetermined positions, a movable stop member operable to lock the circuit breaker in the open position, an additional rotatable shaft positioned intermediate the other shafts operatively connected to the stop member and means for locking the switches, a disc secured to each shaft so that the outer two overlap the one on the intermediate shaft in different planes, said disc on the first mentioned shaft having a portion of the periphery removed to receive a portion of the disc on the intermediate shaft in one plane, said disc on said intermediate shaft having a portion of the periphery removed on one side in the plane of the disc on the first-mentioned shaft to permit rotation of said disc and a portion of the periphery removed on the other side in a different plane to receive a portion of the disc on said second-mentioned shaft and prevent rotation of the disc on the intermediate shaft, and said disc on said second-mentioned shaft having a portion of the periphery removed in said different plane to permit rotation of the disc on the intermediate shaft.

16. A lock system for a door having an elongated lock bar with a projection thereon, comprising a sliding lock member having a portion adapted to interfere with the projection in the locked position, a stop member for locking the lock member in the open position actuable upon operation of the lock bar to the locked position when the door is closed to free the lock member and permit it to be moved to interfere with said projection.

17. An interlock for a pair of doors one of which is provided with a movable lock bar and which have interfering portions so that the other door must be closed first to lock it, comprising a movable blocking member normally positioned to prevent closing of the door having the lock bar, means on the other door for actuating the blocking member when said other door is closed to permit the door having the lock bar to close, and a lock member movable to engage and retain the lock bar when it is operated to the locked position.

18. The combination with a switch device positioned in an enclosure having a door with a lock device, of shaft means for operating the

lock device, lock means controlling the operation of the switch device, additional means for operating the lock means, and rotatable indicating interlock members positioned without the housing operatively connected to the operating means for the lock device and the lock means arranged in overlapping relation one of said members having a cut-away peripheral portion to permit rotation of the other in a predetermined position.

19. The combination with a plurality of switches, of a pair of spaced rotatable operating members each operatively connected to one of the switches to operate said switch to different positions and having a cam portion on an adjacent side, and an intermediate rotatable operating member positioned between said operating members operatively connected to another of the switches to operate it to different positions and having axially movable interlocking means arranged to interfere with the cam portions of the spaced operating members and prevent simultaneous operation of both switches of the pair when the said another switch is in a predetermined position.

20. The combination with a pair of bus selector switches and a disconnect switch, of a pair of spaced apart bus selector discs rotatable about a common axis each operatively connected to one of the bus selector switches, said discs having sockets to receive a handle to operate the switches to "open" or "closed" positions, peripheral slots corresponding to said positions and projecting cam surfaces on the adjacent sides, a disconnect disc positioned between said discs rotatable about the common axis and operatively connected to the disconnect switch, said disconnect disc having a plurality of sockets to receive the handle to rotate the disc and operate the disconnect switch to "closed," "open" and "ground" positions, and peripheral slots corresponding to said positions, an axially movable interlock member mounted on the disconnect disc arranged to interfere with the cam surfaces on the bus selector discs when the disconnect switch is operated to the "closed" position to prevent simultaneous opening of the bus selector switches, and a locking bar positionable in in-

terfering relation with the discs axially movable in the peripheral slots and having recesses to receive portions of the disconnect disc and one of the selector discs operable to lock all of the discs under one predetermined set of conditions and only the disconnect disc under another predetermined set of conditions.

21. Control means for a pair of switches operable to different positions comprising, means operatively connected to each of said switches, a member positioned intermediate said means movable to a plurality of positions, and an interlock member supported by the intermediate member arranged to interfere with the said means to prevent operation of both of said switches to one position when the intermediate member is in a predetermined position.

22. The combination with a disconnect switch and a pair of bus selector switches for connecting a circuit breaker to incoming and outgoing buses, of a pair of spaced bus selector discs rotatable about a common axis, each of said discs being operatively connected to operate one of the bus selector switches to "open" or "closed" positions and provided with peripheral slots corresponding to said positions, a disconnect disc rotatable about the common axis positioned intermediate the bus selector discs operatively connected to operate the disconnect switch to "closed," "open" or "ground" positions and provided with peripheral slots corresponding to said positions, a common locking member axially movable in said peripheral slots when the switches are in predetermined positions, having recessed portions to receive portions of the discs in predetermined axial positions of the locking member so as to permit rotation of the discs in said positions, and a projection on the locking member to prevent axial movement of said member from one extreme axial position to the other extreme axial position without operating the disconnect switch to the "open" position, the slot in the disconnect disc corresponding to the "open" position being wider than the remaining slots so as to receive the projection on the locking member.

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