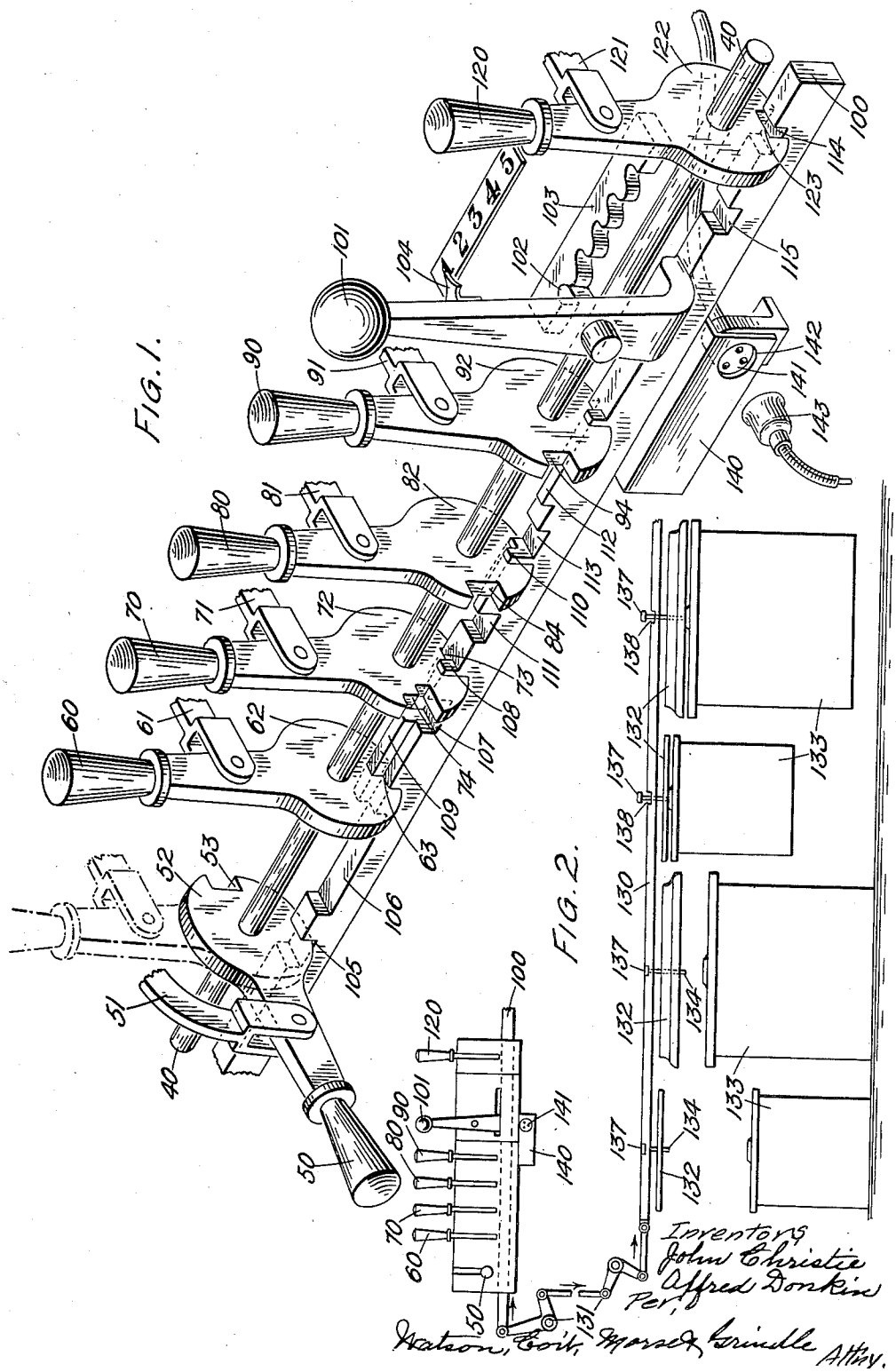
Dec. 25, 1934. J. CHRISTIE ET AL 1,985,653

ELECTRIC SWITCH GEAR

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ELECTRIC SWITCH GEAR

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FIG. 3.

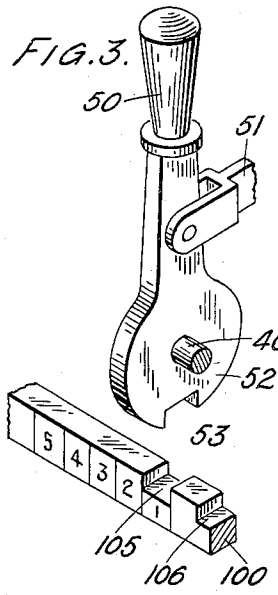


FIG. 4.

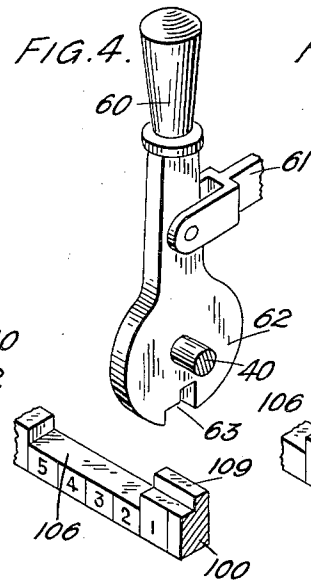


FIG. 5.

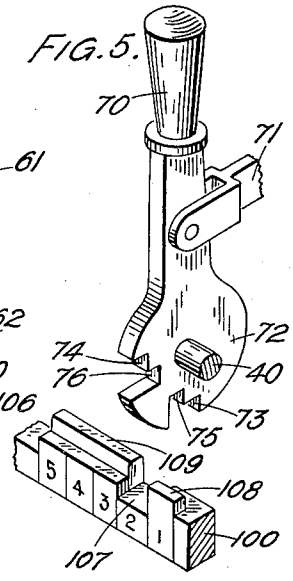


FIG. 6.

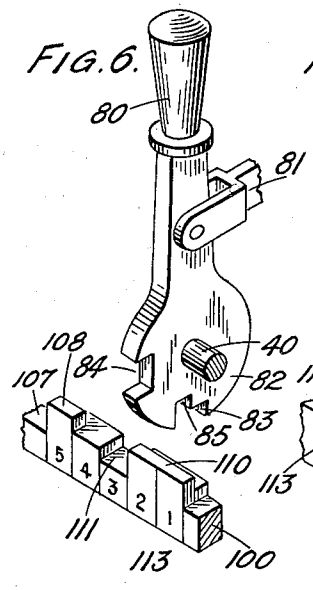


FIG. 7.

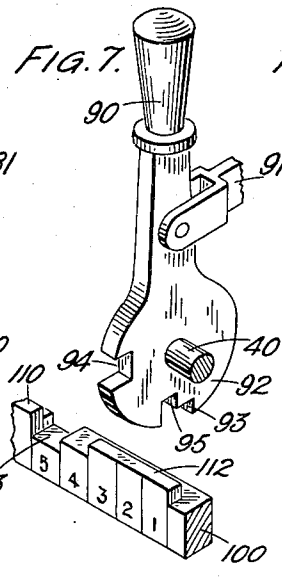
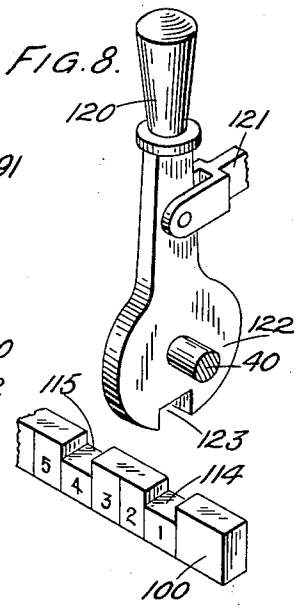


FIG. 8.



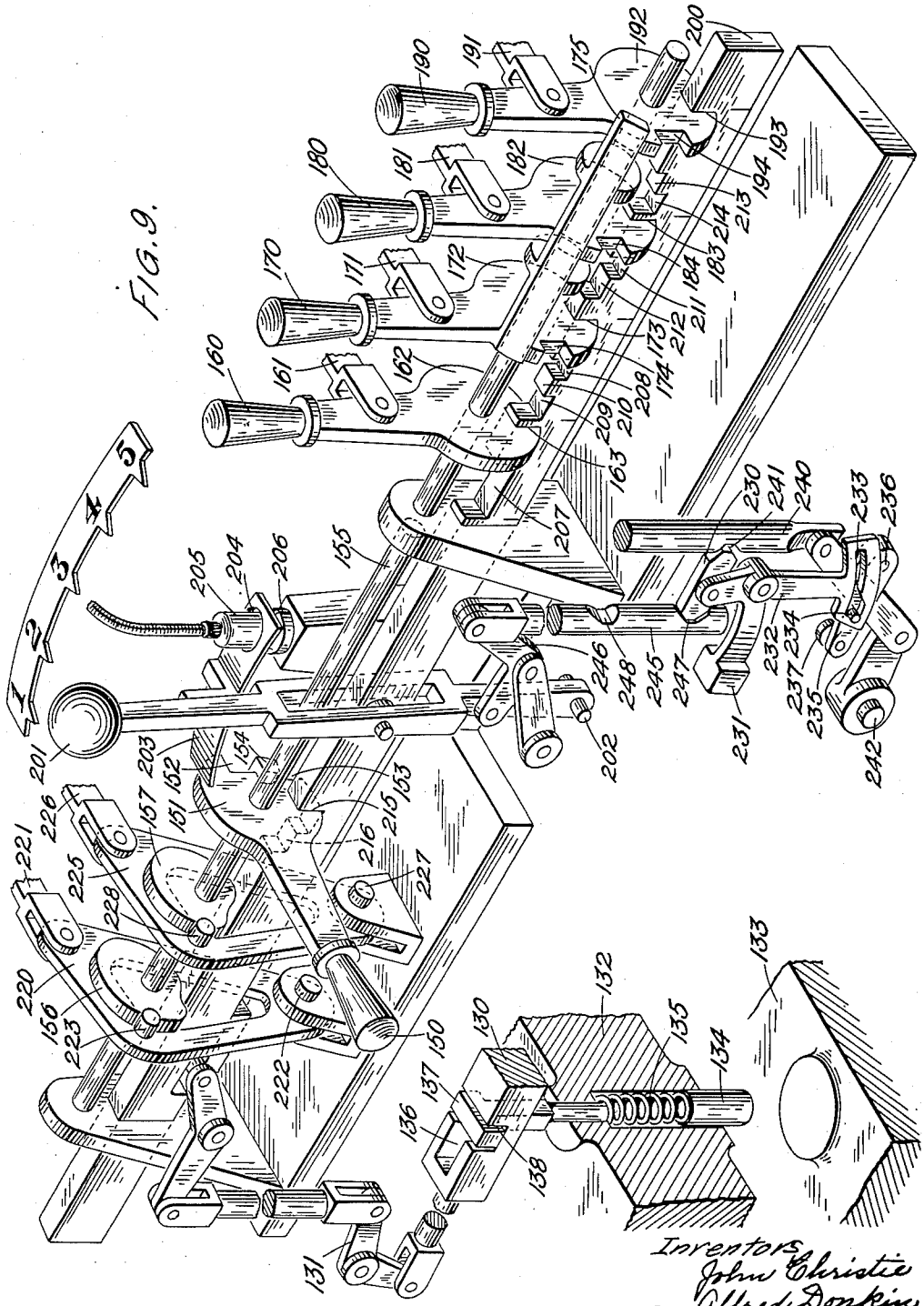
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ELECTRIC SWITCH GEAR

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FIG. 9.



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ELECTRIC SWITCH GEAR

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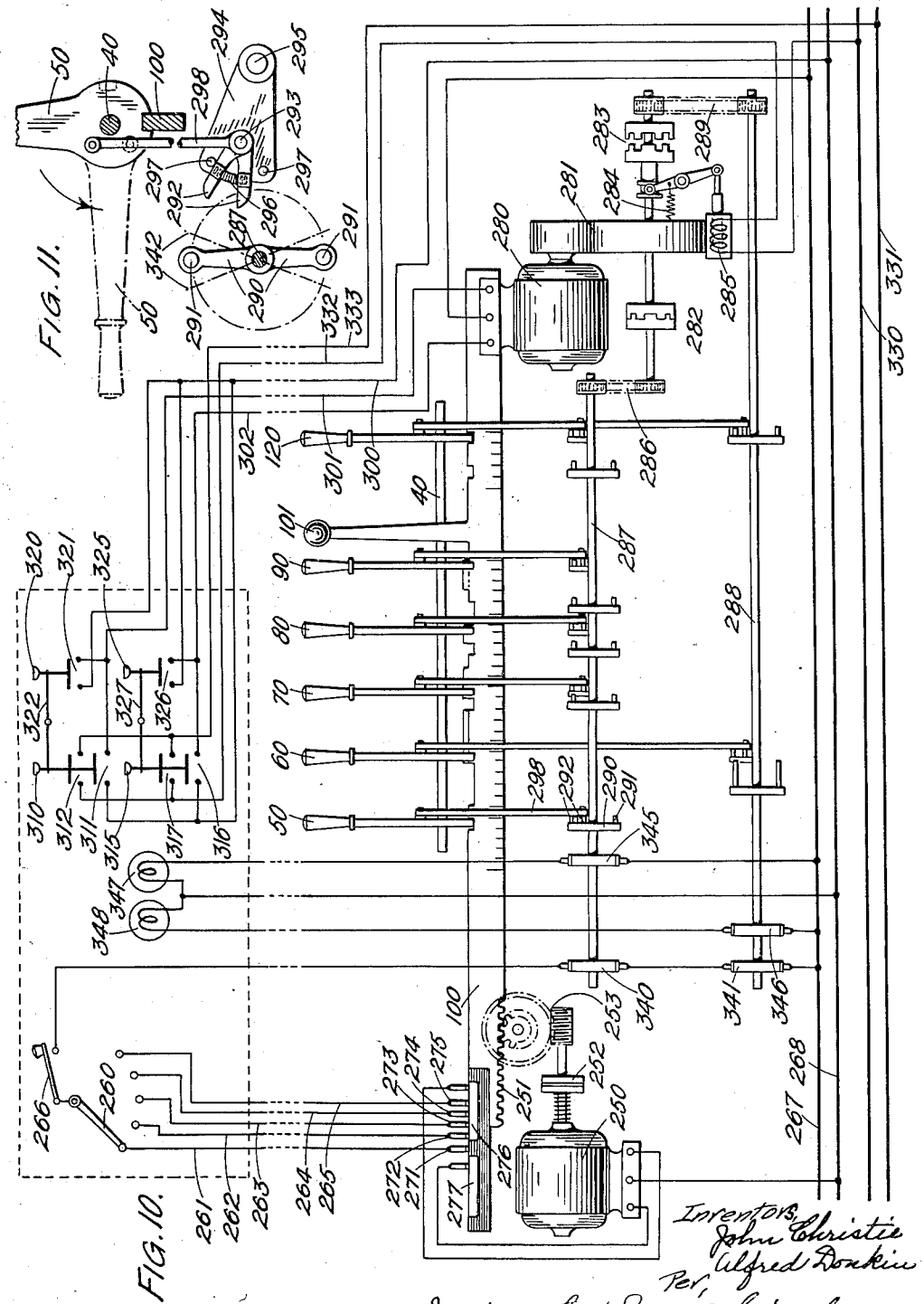


FIG. 11.

FIG. 10.

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ELECTRIC SWITCH GEAR

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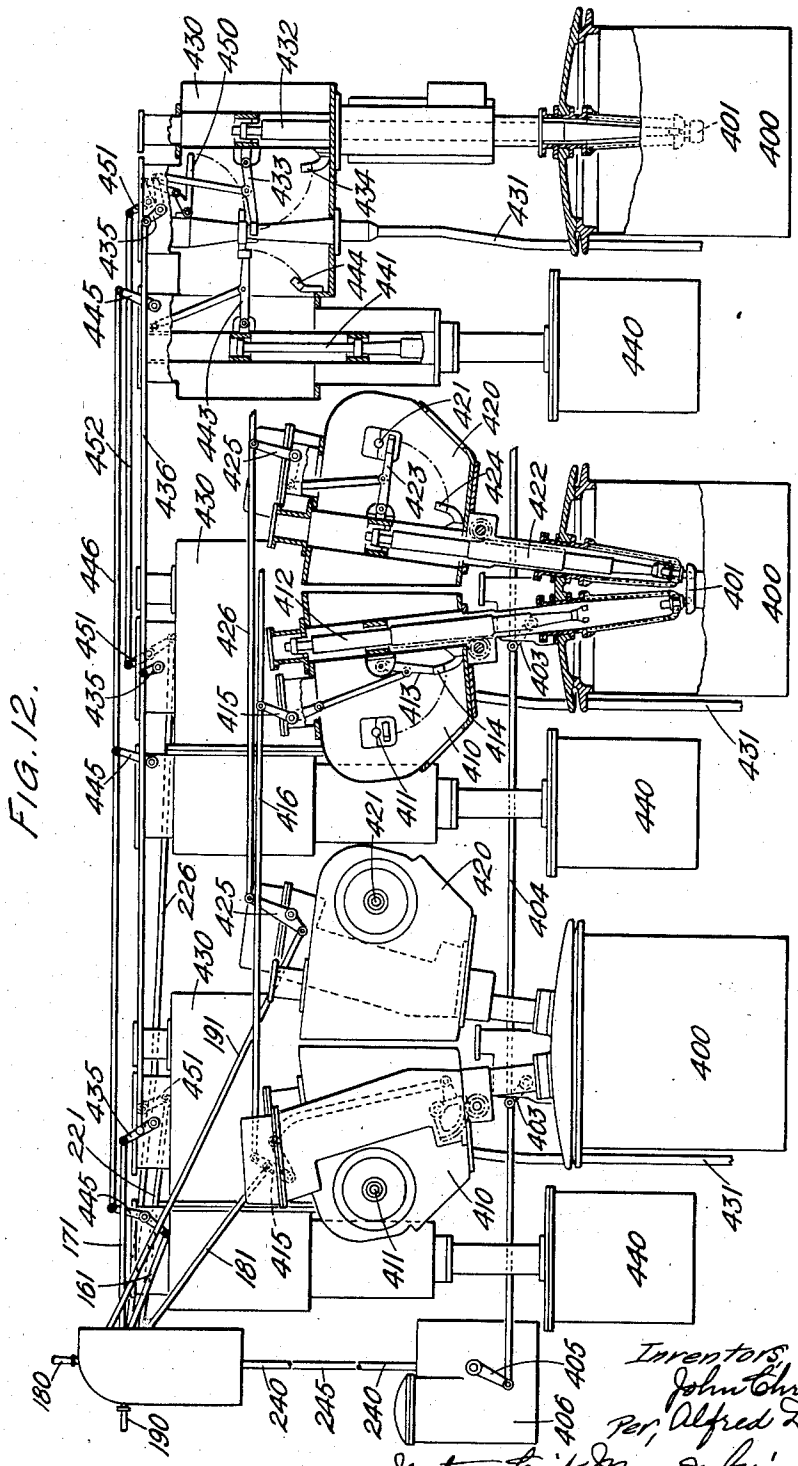


FIG. 12.

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Patented Dec. 25, 1934 1,985,653

UNITED STATES PATENT OFFICE

1,985,653

ELECTRIC SWITCH GEAR

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Application October 27, 1932, Serial No. 639,925
In Great Britain November 7, 1931

27 Claims. (Cl. 175—375)

This invention relates to electric switchgear, such for instance as metal-clad switchgear, and is especially concerned with interlocking mechanism for preventing incorrect operation of the switches forming part of the gear. Thus for example in a duplicate busbar metal-clad switchgear layout for a high voltage electric power station, wherein each oil-immersed circuit-breaker is provided with three isolating switches controlling the connections of its terminals to the two busbars and to the cable or other incoming or outgoing circuit with or without further auxiliary switches for earthing the cable and for controlling the connection to a potential transformer, it will be realized that it is of importance to interlock the various auxiliary switches with one another and with the main circuit-breaker in order to prevent disturbance of the system or damage to the apparatus or risk of injury to an operator working on the gear due to incorrect connections or to the operation of the auxiliary switches in the wrong sequence.

The present invention has for its object to provide a simple and satisfactory interlocking arrangement for a group of associated electric switches, such for example as that above referred to, which, whilst being fully effective in preventing incorrect switch-operation, shall at the same time be robust and simple to understand and to manipulate.

The arrangement according to the invention comprises in combination with a group of actuating levers respectively controlling the operation of the associated switches, a longitudinally-movable selector bar provided with slots or projections which cooperate with slots or projections on the actuating levers or on members connected thereto in such a manner as to prevent operation of any of the levers unless the selector bar has previously been moved into a position appropriate to such operation and to prevent movement of the selector bar into any operative position unless the actuating levers are in a position appropriate to such movement.

Thus interlocking mechanism for the isolating switches or other auxiliary switches associated with a main circuit-breaker or group of circuit-breakers, may comprise a common shaft on which actuating levers for the auxiliary switches are pivoted, a selector bar disposed parallel to the shaft and provided with slots or projections co-operating with slots or projections on the actuating levers or members connected thereto, and preselecting means for moving the selector bar longitudinally, the arrangement of the slots or projections being such that before any of the levers can be operated the selector bar must first be moved into a position appropriate to such lever operation and that the selector bar cannot be moved into the selected position unless the auxiliary switches are in a condition appropriate to the selected operation. Means are preferably provided whereby the selector bar or an additional locking bar associated with the preselecting means acts to prevent closing of the main circuit-breaker or circuit-breakers unless the auxiliary switches are in a condition appropriate to such closing, the arrangement being such that the selector bar remains locked against movement so long as the main circuit-breaker or circuit-breakers are closed.

Means may also be provided whereby the selector bar prevents lowering of a tank containing a circuit-breaker or other apparatus associated with the switches unless the switches are in a condition to isolate such apparatus. This may conveniently be effected by controlling the supply of electric power for the operation of the crane or other tank-lowering device by means of a switch or coupling which can only be engaged when the selector bar is in the appropriate position. An inverse interlock may also be obtained by slotting the selector bar or an interlocking bar connected thereto to receive a spring-pressed plunger, which engages in the slot and prevents movement of the selector bar so long as the tank is lowered.

In a convenient practical construction each actuating lever has a segmental extension provided with shaped peripheral slots respectively lying in the path of the selector bar in the operative positions of the actuating lever, whilst the selector bar is provided with transverse slots to permit the actuating lever to be moved from one operative position to the other when the selector bar is in the appropriate position and also with longitudinal ribs cooperating with the shaped peripheral slots in the segmental extensions of the actuating levers to permit or prevent longitudinal movement of the selector bar in accordance with the positions of the actuating levers.

The actuating levers and the selector bar may be directly operated by hand or may be controlled electrically (for example from a remote point) or alternative manual and electrical controls may be provided. For the purposes of electrical control (with or without alternative hand-control) two reversible electric motors may be provided, one of which drives the selector bar for preselecting purposes whilst the other is

an executive motor for operating the actuating levers selected by movement of the selector bar. Conveniently the energization of the pre-selecting motor is controlled by a manually-operated selector switch at the control point and by a contact device which is operated by movement of the selector bar to determine the direction of rotation of the motor in accordance with the relation between the existing position of the selector bar and the desired new position thereof and to stop the motor when the new position is reached. Each actuating lever may be operated by the executive motor through a disengageable actuating device controlled by movement of the selector bar, and in one convenient practical arrangement the executive motor and a shaft driven by the motor and carrying the driving members of the actuating devices are themselves carried by and movable with the selector bar.

The invention may be carried into practice in various ways, but the accompanying drawings illustrate some convenient practical arrangements according thereto, as applied to the control of the isolating and other auxiliary switches associated with a main oil-immersed circuit-breaker or group of circuit-breakers in a high voltage switchgear layout. In these drawings,

Figure 1 is a diagrammatic perspective view of one arrangement of interlocking mechanism for manually-operated control gear,

Figure 2 illustrates a further interlock associated with the arrangement of Figure 1,

Figures 3–8 are detached views of parts of the mechanism of Figure 1,

Figure 9 is a perspective view of a preferred arrangement of interlocking mechanism for manually-operated control gear,

Figure 10 illustrates diagrammatically a modification of the arrangement of Figure 1 to permit alternative manual and electrical control,

Figure 11 is a detail view of part of the arrangement of Figure 10, and

Figure 12 illustrates diagrammatically one form of switchgear, for which the interlocking mechanism is more especially intended.

Although the interlocking mechanism according to the invention is applicable to other forms of switchgear, it will be assumed for convenience of description that the switchgear controlled is arranged in the manner shown in Figure 12, and a brief description of the main elements of this switchgear will first be given.

The switchgear illustrated diagrammatically in Figure 12 consists of a three-phase unit comprising three main oil-immersed circuit-breakers each controlling the connections from duplicate busbars to a feeder cable in one phase. The apparatus in each phase is identical with that in the other phases, but in order to show the elements more clearly, parts have been broken away to show sections on two parallel planes in the right-hand two phases in the drawings.

The apparatus in each phase comprises an oil tank 400 for the main circuit-breaker, having two busbar chambers 410, 420 mounted above it, the two busbars 411, 421 respectively passing through these chambers. Two withdrawably mounted conductors 412, 422 extend down respectively from the two chambers into the circuit-breaker tank 400, where they both make connection with one of the main circuit-breaker contacts 401, the arrangement being such that when one of the withdrawable conductors, say 422, is in its lower operative position, its upper end makes connection through an isolating switch 423 in the chamber 420 with the main busbar 421. A similar isolating switch 413 is also provided in the chamber 410 between the reserve busbar 411 and the withdrawable conductor 412. Each withdrawable conductor is mechanically interconnected with its isolating switch, so that the opening of the isolating switch takes place simultaneously with the withdrawing of the conductor, and an earthed contact 414 or 424 is provided whereby the isolating switch when open earths the withdrawn conductor. The three isolating switches 413 for the reserve busbars are operated by levers 415 interconnected by a link 416, and the three isolating switches 423 for the main busbars are similarly operated by levers 425 interconnected by a link 426.

The other contact 401 of the main circuit-breaker is also connected through a withdrawable conductor 432 and an isolating switch 433 in a feeder chamber 430 to the feeder cable 431. An earthed contact 434 is provided in the feeder chamber for earthing the withdrawable conductor 432 when the isolating switch is open. The three isolating switches 433 for the cables are operated by levers 435 interconnected by a link 436.

An oil-immersed potential transformer 440 is also provided in each phase by the side of the main circuit-breaker tank 400 and is connected to the cable contact in the feeder chamber 430 by means of a withdrawable fuse 441 and an isolating switch 443 provided with an earthed contact 444 for earthing the transformer when the switch is open. This isolating switch is operated by a lever 445, the three levers being interconnected by a link 446.

A further auxiliary switch 450 is provided in each feeder chamber 430 for earthing the cable, this switch being operated by a lever 451. The three levers 451 may be connected together for simultaneous operation, but (as will be mentioned later in connection with Figure 9) it is often desirable to provide means for earthing one of the phases of the cable in advance of the other two phases. The levers 451 in the two phases shown on the right-hand side in Figure 12 are therefore interconnected by a link 452 but are operated independently of the lever 451 for the remaining phase. The arrangement of Figure 12 is shown more especially in association with the preferred interlocking mechanism to be described later with reference to Figure 9 and the various isolating and auxiliary switches are operated by the links 161, 171, 181, 191, 221 and 226, the ends of which are shown in Figure 9. A generally similar arrangement of operating links is employed with the arrangement of Figures 1–8, the links 161, 171, 181, 191 (respectively for the potential transformer isolators, the cable isolators, the reserve busbar isolators and the main busbar isolators) being replaced by similar links 61, 71, 81, 91, whilst the two links 221, 226 for the cable earthing switches are replaced by a single link 51.

The contacts 401, 402 of the three main circuit-breakers are operated simultaneously by levers 403 interconnected by a link 404 which is connected through a lever 405 to a main operating solenoid housed in a casing 406. The solenoid operating mechanism is interconnected (as more fully described later with reference to Figure 9) with the main interlocking mechanism for the auxiliary switches by means of the interlocking rods 240, 245.

The interlocking mechanism according to the invention will now be described.

In the arrangement of Figures 1–8 the five actuating levers 50, 60, 70, 80, 90 are arranged side by side and are all rotatably mounted on the same horizontal shaft 40, the levers standing vertically in their normal or "off" positions and being movable through a right angle into their "on" positions. The levers are arranged for direct hand operation and are connected to the operating mechanism for the associated switches through links indicated at 51, 61, 71, 81, 91. Immediately beneath and parallel to the common shaft 40, on which the levers are mounted, is a selector bar 100 which can be moved longitudinally into any one of five positions. Each actuating lever has a segmental extension 52 or 62 or 72 or 82 or 92 beneath the shaft 40 extending into the path of the selector bar 100, and the interlocking of the levers is effected by means of slots and projections in the selector bar and in the segmental extensions of the levers.

The movement of the selector bar 100 is controlled by a preselecting handle 101 carrying a spring-loaded catch 102 which can engage in any one of five notches in a fixed part 103 of the framework of the mechanism, this handle preferably carrying a pointer 104 cooperating with suitable markings on the cover of the framework to indicate the position of the selector bar 100 and, if desired, also the switch operations which can be performed in such position.

The arrangement of the slots and projections will now be described with reference partly to Figure 1 and partly to Figures 3–7, which respectively show the five actuating levers together with the associated parts of the selector bar, the lever in each case being shown spaced apart from the selector bar in order to show the slots and projections more clearly. For convenience, Figures 3–7 are also marked to indicate the five positions of the selector bar. As will be described in detail, the segmental extension on each lever has a peripheral slot at its lowermost point within which the selector bar lies when the lever is in its off position and the extensions on three of the levers also have peripheral slots within which the selector bar lies when the levers are in their on positions.

The first position of the selector bar 100, shown in Figure 1, is allocated to cable earthing. For this purpose the selector bar has a transverse slot 105 (see Figure 3) which lies opposite the cable earthing switch lever 50 when the bar is in the first position, thus enabling this lever to be operated in this position. The absence of other slots in this part of the selector bar prevents operation of the cable earthing switch lever in any other position of the bar. The peripheral slot 53 in the extension 52 of this lever permits movement of the selector bar into any of the five positions, so long as the lever is in its off position, but when the lever has been moved to its on position, the absence of a second peripheral slot prevents movement of the selector bar away from the first position.

The potential transformer isolator lever 60 (see Figure 4) cannot be operated in the first selector bar position, but can be operated in any of the other four positions, and for this purpose the selector bar is provided with a transverse slot 106 of four times the normal width. Thus whether the lever 60 is in its on or its off position, it will not prevent movement of the selector bar 100 between the second and fifth positions, but since the extension 62 on the lever 60 has one peripheral slot 63 only, the selector bar cannot be moved into the first position unless the lever 60 is in its off position.

A transverse slot 107 (see Figure 5) in the selector bar 100 permits operation of the cable isolator lever 70 in the second position only, this lever being locked against operation in all other positions. The segmental extension 72 of the lever 70 has two peripheral slots 73, 74 which are stepped and of different shapes, the slot 73 having a deepened portion 75 on one side and the slot 74 a deepened portion 76 on the other side. The selector bar 100 is provided with upstanding longitudinal ribs 108, 109 to suit the shapes of these slots. The rib 108 lies opposite the lever 70 when the bar is in the first position and is on the front half of the bar, thus corresponding to the deepened part 75 of the "off" slot 73 in the lever. The rib 109 is three times the length of the rib 108 and lies opposite the lever 70 in the third, fourth and fifth positions of the bar. This rib 109 is on the back half of the bar and corresponds to the deepened part 76 of the "on" slot 74 in the lever. Thus in the second position of the bar 100, the lever 70 can be moved from one position to the other. If it is moved to the off position, the selector bar can be moved to the first position but not to the third. If however the lever 70 is moved to its on position, the bar 100 cannot be moved to the first position but can be moved to the third, fourth and fifth positions. In order to economize space, the part of the selector bar cooperating with the lever 70 in the fifth position is the same as that cooperating with the lever 60 in the first position and the slot 63 in that lever is consequently stepped to fit the longitudinal rib 109 on the selector bar.

The segmental extension 82 on the reserve busbar isolator lever 80 (see Figure 6) has a stepped slot 83 cooperating wtih the selector bar 100 in the off position of the lever and a plain shallow slot 84 cooperating with the selector bar in the on position, the deepened portion 85 of the slot 83 being arranged to suit the rib 108 on the selector bar and also another rib 110 on that bar. Here again the same part of the selector bar is utilized both for the fifth position for the lever 80 and for the first position for the lever 70. A transverse slot 111 is provided in the selector bar which enables the lever 80 to be operated in the third position of the bar. Thus so long as the reserve busbar isolator lever 80 is in its off position the bar 100 can be freely moved to any position, whilst when this lever is moved to its on position in the third position of the bar, the bar can be moved to the fourth position but not to the fifth or to the second position.

The main busbar isolator lever 90 (see Figure 7) is similar to the lever 80 and has a stepped slot 93 and a plain shallow slot 94. The deepened portion 95 of the slot 93 cooperates with a longitudinal rib 112 on the selector bar 100, this rib being long enough to lie opposite the lever 90 in the first three positions of the bar. A transverse slot 113 in the bar is provided to permit operation of the lever 90 in the fifth position only. If the lever 90 is moved to the on position, the selector bar can be moved to the fourth but not to the third position, the bar being freely movable to any position if the lever 90 is in the off position.

Thus in the first position of the selector bar 100 the cable earthing switch lever 50 may be operated but the other four levers are locked off. In the second position the potential transformer isolator lever 60 and the cable isolator lever 70

can both be operated but the other three levers are locked off. In the third position the potential transformer isolator lever 60 and the reserve busbar isolator lever 80 can be operated, the cable isolator lever 70 is locked on and the other two levers 50, 90 are locked off. In the fifth position the potential transformer isolator lever 60 and the main busbar isolator lever 90 can be operated, the cable isolator lever 70 is locked on and the other two levers 50, 80 are locked off. In the fourth position the potential transformer isolator lever 60 can be operated, the cable earthing switch lever 50 is locked off and the cable isolator lever 70 is locked on, whilst the two busbar isolator levers 80, 90 may be both locked off or either one locked on and the other locked off. It is however impossible for both busbar isolators to be closed at the same time. This fourth position is utilized for operation of the main circuit-breakers and a further interlock is also provided in association with the actuating lever for the main circuit-breakers.

This further interlock may take various forms, but must be such as to prevent closing of the main circuit-breakers unless the selector bar is in the first or in the fourth position, and to prevent movement of the selector bar from such position so long as the circuit-breakers are closed. In the arrangement shown in Figure 1 and also in Figure 8, the selector bar 100 has two transverse slots 114 and 115, which in the first and fourth positions respectively of the selector bar permit movement of a further hand lever 120. This lever 120 has an operating link 121 and a segmental extension 122 provided with a single peripheral slot 123, the lever thus being identical in construction with the cable earthing switch lever 50. The slots 114, 115 permit the lever 120 to be moved to the on position in the first and fourth selector bar positions, but the lever is locked in the off position in the other selector bar positions, whilst the selector bar is locked against movement so long as the lever 120 is in the on position. This lever 120 may directly control the closing and tripping of the main circuit-breakers through the link 121 or may be inter-connected mechanically or electrically with a separate circuit-breaker operating device. Thus for instance in the case of circuit-breakers closed by means of a solenoid or motor, the lever 120 may operate an auxiliary contact in the energizing circuit thereof or may actuate a tripping device associated therewith. An alternative form of interlock for the main circuit-breakers will be described later with reference to the preferred arrangement of Figure 9.

The movements of the selector bar 100 are also utilized (as shown in Figure 2) to provide an interlock with the lowering mechanism for the main circuit-breaker and potential transformer oil tanks. For this purpose the selector bar 100 is mechanically coupled through a lever and link mechanism 131 to an interlocking bar 130, which passes across the top-plates 132 of the circuit-breaker and transformer tanks 133 in the three phases, the arrangement being such that the interlocking bar 130, and therefore also the selector bar 100, is locked against movement when any one of the tanks 133 is lowered. A similar interlock is also employed in the preferred arrangement illustrated in Figure 9, wherein details of the mechanism connecting a tank and the interlocking bar 130 are shown. Thus the top-plate 132 of the tank 133 contains a robust plunger 134 pressed downwardly by a spring 135 against the flange of the tank. The plunger 134 passes through a longitudinal slot 136 in the interlocking bar 130 and carries a crossbar 137 which lies in a transverse slot 138 in the bar 130 when the tank is lowered. Thus when the tank 133 is in its normal raised position the crossbar 137 lies clear of the slot 138 and leaves the interlocking bar 130 and the selector bar 100 free to move, the bars being locked against movement when the tank is lowered.

In order to prevent lowering of any tank except when the selector bar 100 is in the first position, the selector bar carries a plate 140 which covers the fixed socket member 141 of a plug and socket connection in the energizing circuit for the electrically operated crane or other tank lowering mechanism, the plate 140 having a hole 142 so arranged that the socket 141 is exposed to permit insertion of the plug 143 when the selector bar 100 is in the first position. Thus it is impossible to energize the crane for lowering a tank unless the selector bar 100 is in its first position, with all the actuating levers except the cable earthing switch lever 50 locked off, and moreover the selector bar cannot be moved from this position unless all tanks which have been lowered have been lifted again into their normal operative positions. As has been mentioned the main circuit-breakers can be operated in this position, and this facilitates inspection of the circuit-breaker contacts in movement with the tank lowered, if desired.

It will be appreciated that the particular arrangement of interengaging slots and projections may be modified in a variety of ways. Thus for instance it may in some instances be more convenient to mount the selector bar at some distance from the actuating levers, and to provide longitudinally movable links connected to the levers for interlocking purposes. It will readily be seen that an interlocking system performing the same functions as that above described can be obtained by providing a projection on each link which cooperates with suitably arranged transverse and longitudinal slots in the selector bar.

In the foregoing arrangement each lever has been described as effecting simultaneous operation of the corresponding switches in the three phases. It is often desirable however to operate the cable earthing switch in one phase in advance of those in the other two phases in order to minimize disturbance if the cable should happen to be alive. Provision is made for this in the preferred arrangement shown in Figure 9, which will now be described.

In this arrangement five hand levers 150, 160, 170, 180, 190 are provided, which are generally similar to the levers 50, 60, 70, 80, 90 of the arrangement of Figures 1–8. The cable earthing switch lever 150 is in this instance fixed on a shaft 155, on which the other four levers are freely mounted. The interlocking between the levers is effected by a selector bar 200 mounted beneath the shaft 155, this bar being movable longitudinally into any one of five positions under the control of a pre-selecting handle 201 pivoted at 202, a spring-loaded catch (not shown) generally similar to the catch 102 shown in Figure 1, being provided to locate the selector bar properly in its various positions. The handle 202 carries a plate 203 having a hole 204 through which a plug 205 can be inserted into a socket 206 when the bar 200 is in its first position but which prevents insertion of the plug in the socket in any

other selector bar position, the plug and socket controlling the energizing circuit for energizing the raising and lowering device for the circuit-breaker and potential transformer tanks.

The potential transformer isolator lever 160 has an operating link 161 and a segmental extension 162 with a single peripheral slot 163. This lever cooperates with a transverse slot 207 in the selector bar 200, the slot 207 being of such a length as to permit operation of the lever in the third, fourth and fifth positions but not in the first and second positions of the selector bar.

The cable isolator lever 170 has an operating link 171 and a segmental extension 172 with two peripheral slots 173, 174, the slot 173 cooperating with the selector bar in the off position of the lever, whilst the slot 174, which is shallower than the slot 173, cooperates with the selector bar in the on position of the lever. Cooperating with the lever 170, the selector bar has a stepped transverse slot with deep portions 208, 209 opposite the lever in the third and fifth positions and a shallow central portion 210 opposite the lever in the fourth position. Thus the lever 170 is locked off in the first and second positions of the bar and can be operated in the third or in the fifth position but not in the fourth position. The shallow slot 174 in the lever is deep enough to allow the bar to be moved into the fourth position when the lever is in its on position but prevents movement of the bar into the second and first positions unless the lever is in the off position. The lever 170 also carries an arm 175 extending across the path of the two busbar isolator levers 180, 190, so that neither busbar lever can be moved to its on position unless the cable isolator lever 170 has been moved to its on position and the cable isolator lever can only be moved to its off position if both busbar levers are in their off positions.

The two busbar levers 180, 190 are similar to one another, each having an operating link 181 or 191 and a segmental extension 182 or 192 with a deep peripheral slot 183 or 193 and a shallow peripheral slot 184 or 194 respectively operative in the off and the on positions of the lever. The selector bar 200 has a deep slot 211 and a shallow slot 212 respectively opposite the reserve busbar lever 180 in the third and fourth positions of the bar, and also a shallow slot 213 and a deep slot 214 respectively opposite the main busbar lever 190 in the fourth and fifth positions of the bar.

Thus the four levers 160, 170, 180, 190 are all locked off in the first two positions of the selector bar 200. In the third position the levers 160, 170, 180 can all be operated and the lever 190 is locked off. In the fifth position the levers 160, 170, 190 can be operated and the lever 180 is locked off. In the fourth position the lever 160 can be operated but the other three levers are locked in any one of three arrangements, namely with the three levers off, or with the levers 170, 180 on and the lever 190 off, or with the levers 170, 190 on and the lever 180 off.

It will be noticed that the arrangement of the three levers 170, 180, 190 is such as not to require the provision of a special selector bar position (namely the second position in the arrangement of Figures 1–8) for the operation of the cable isolator lever, and this enables both the first and the second positions to be used for cable earthing, the second position being utilized for earthing one phase and the first position for earthing the other two phases, so that the one phase is earthed in advance of the other by the time interval required to move the selector bar from the second position to the first. It is preferable to employ a single control lever 150 for effecting earthing in the proper sequence of the three phases, and in the arrangement illustrated this lever is movable from the off position into a mid-position in the second selector bar position and from the mid-position into the full on position in the first selector bar position. For this purpose the segmental extension 151 of the lever 150 has a deep slot 152 which cooperates with the selector bar 200 in the off position and a shallow slot 153 cooperating with the bar in the mid-position. The selector bar has a deep slot 215 opposite the lever in the first position and a shallow slot 216 opposite the lever in the second position. A lateral projection 154 is also provided on the lever between the slots 152, 153, which abuts against the side of the selector bar but can pass through the slot 215 in the bar when the bar is in the second position.

Thus, assuming that the lever 150 is in its off position, the projection 154 holds it locked in the off position unless the selector bar 200 is moved to the second position. When the bar is in the second position the lever can be moved to its mid-position the depth of the slot 216 allowing this movement and preventing further movement. The selector bar can now be moved to the first position, the projection 154 now lying on the other side of the bar, and when the first position is reached the lever can be moved to its full on position, in which it is shown in Figure 9.

The lever 150 does not itself directly operate the cable earthing switches, the operation of the switch in one phase being effected through a link 221 by a bracket 220 pivoted at 222, this bracket carrying a pin 223 with which a cam 156 on the shaft 155 engages. The operation of the switches in the other two phases is similarly effected through a link 226 by a bracket 225 pivoted at 227 and carrying a pin 228 with which a cam 157 on the shaft 155 engages. The two cams 156, 157 are so shaped that movement of the lever 150 from the off position to the mid-position operates the bracket 220 and causes one phase to be earthed, whilst subsequent movement of the lever 150 to the full on position operates the bracket 225 and thus earths the other two phases. It will be noticed that in this arrangement the second selector bar position is wholly reserved for single-phase cable earthing, and that the other operations associated with the first selector bar position in the arrangement of Figures 1–8 are still reserved for that position.

The operation of the main circuit-breakers may be effected in a manner analogous to that employed in the arrangement of Figures 1–8, or alternatively, as shown in Figure 9, by means of a longitudinally movable locking bar 230 held between two notched vertical rods 240, 245. The notched rod 245 is connected through a lever mechanism 246 to the preselecting handle 201 in such manner as to be moved up and down in accordance with the longitudinal movements of the selector bar 200, and has two notches 247 and 248 which lie opposite one end of the locking bar 230 when the selector bar is in its first and fourth positions respectively. The other notched rod 240 has a single notch 241 and is connected to a shaft 242 forming part of the circuit-breaker closing mechanism, the arrangement being such that the notch 241 lies opposite the end of the locking bar 230 when the circuit-breakers are open. The length of the locking bar 230 is such that each notched rod is locked

by the engagement of the bar in a notch, unless there is a notch opposite the other end of the locking bar. The ends of the locking bar 230 may be so shaped that the bar is moved longitudinally by vertical movement of either notched rod 240, 245 provided that the other notched member is in a position to allow such movement, or alternatively means may be provided for moving the locking bar by hand. In the example illustrated the locking bar 230 is normally biassed towards the notched rod 245 by a weight 231 carried by a lever 232 on one end of which is a shaped slot 233. Engaging in this slot is a pin 234 on a tripping lever 235 pivoted at 236, this lever carrying a roller 237 cooperating with a part (not shown) of the circuit-breaker closing mechanism, such for example as a toggle device, the arrangement being such that when the tripping lever 235 is raised the circuit-breakers are tripped and it is impossible to close the circuit-breakers without first lowering the tripping lever.

Thus when the selector bar 200 is in the first position, as shown, the weight 231 holds the locking bar 230 in engagement with the notch 247 in the rod 245 and thus leaves the other notched rod 240 free to be moved. The circuit-breakers can now be closed by operation of the closing mechanism and this will cause the rod 240 to move vertically. This vertical movement of the rod 240 will lock the bar 230 in engagement in the notch 247 and will thus prevent movement of the selector bar 200 away from the first position, so long as the circuit-breakers are closed. Tripping of the circuit-breakers will cause the rod 240 to be brought back to the position shown on the drawings with the notch 241 opposite the end of the locking bar 230. This releases the selector bar 200 and movement of the bar into the second position will cause the notched rod 245 to move down and thereby to move the locking bar 230 into engagement in the notch 241, thus locking the rod 240 against movement. At the same time the movement of the locking bar 230 will raise the weight 231 and swing the slot 233 over, thus raising the pin 234 and the tripping lever 235 and preventing operation of the circuit-breaker closing mechanism. The circuit-breakers will thus be locked open until the selector bar 200 is moved either into the fourth position or back again to the first position, when the weight 231 will move the locking bar 230 to release the rod 240 and will at the same time allow the tripping lever 235 to fall to permit closing of the circuit-breakers.

The arrangements above described provide only for direct manual operation of the actuating levers. It is often desirable however to arrange the mechanism so that it can be operated either by hand in the manner described or electrically, for example with remote control. Figures 10 and 11 show diagrammatically one convenient form of the additional equipment necessary to modify the arrangement of Figures 1–8 to permit such alternative manual or electrical control.

In the arrangement of Figures 10 and 11, a reversible electric motor 250 is provided for moving the selector bar 100 for preselecting purposes, and a second reversible electric motor 280 is provided for executive purposes, namely for the operation of the actuating levers.

The preselecting motor 250 drives a rack 251 on the selector bar 100 through a slipping clutch 252 and worm reduction gearing 253. The energizing circuit of the motor 250 is controlled partly by a contact device operated by the selector bar 100 and partly by a selector switch at the control point. In a simple arrangement the selector switch consists of a selector arm 260, which can be moved into contact with any one of five terminals connected to five pilot wires 261–265, and a key 266 for connecting the contact arm 260 to one pole 267 of a source of current, the other pole 268 of which is connected to the motor 250. The other ends of the five pilot wires are connected respectively to five fixed brushes 271–275 which can selectively engage two contact plates 276, 277 mounted on an insulating base 278 carried by the selector bar 100, the two contact plates 276, 277 being so connected to the motor 250 that the direction of rotation of the motor depends on which of the contact plates is in circuit. The arrangement of the contact plates 276, 277 is such that when the selector bar 100 is in the first position, the first brush 271 is insulated and the other four brushes 272–275 engage with the plate 276 for driving the motor 250 in the forward direction to move the selector bar 100 towards the fifth position; when the selector bar is in the second position, the second brush 272 is insulated and the third, fourth and fifth brushes 273, 274, 275 engage with the forward drive plate 276, whilst the first brush 271 engages with the reverse drive plate 277; in the third position the third brush 273 is insulated, the fourth and fifth engage with the forward drive plate 276 and the first and second with the reverse drive plate 277; and so on for the other selector bar positions. Thus, for example, if the selector bar 100 is in the second position and the selector arm 260 at the control point is moved to the fifth position and the key 266 is operated, the motor 250 will be energized to drive the selector bar 100 in the forward direction until the circuit is broken by the disengagement of the fifth brush 275 when the fifth position is reached, assuming of course that the actuating levers are in a condition to permit movement of the selector bar from the second to the fifth position. If, however, the selector bar 100 is locked, the clutch 252 in the motor drive will slip. This clutch 252 may be arranged, if desired, to break the motor circuit as soon as it is caused to slip. It will usually be desirable to provide an indicating device at the control point to indicate the position occupied by the selector bar 100 so that the operator may be informed whether the selected movement has been effected or whether the clutch 252 has slipped owing to the locking of the selector bar by the actuating levers.

The executive motor 280 is carried by the selector bar 100 so as to be movable therewith. This motor 280 is connected through gearing 281 to the driving members of a main dog clutch 282 and an auxiliary dog clutch 283, which are operated together against the action of a spring 284 by a solenoid 285 so that the two clutches cannot be simultaneously in engagement. The driven member of the main clutch 282, which is normally engaged, is connected through gearing 286 to a shaft 287 running parallel to the selector bar 100. This shaft 287 drives actuating devices for the four actuating levers 50, 70, 80, 90 controlling the cable earthing switch, the cable isolator and the two busbar isolators. A similar actuating device for the potential transformer isolator lever 60 is driven by a second shaft 288 connected through gearing 289 to the driven member of the auxiliary dog clutch 283. Two actuating devices are provided for the circuit-breaker lever 120 one driven by the shaft 287 and the other by the shaft 288, these devices being respec-

tively operative in the fourth and in the first position of the selector bar 100. The seven actuating devices, together with their driving connections from the executive motor 280, are all carried by the selector bar 100 so as to move therewith. The mechanical arrangement of each actuating device and the manner in which it cooperates with the actuating lever or with a link connected thereto may vary, but must be such that the device makes connection with the link only in those positions of the selector bar 100 in which the actuating lever should be operated. The actuating devices are all similar to one another and one convenient arrangement is shown in Figure 11 for the device associated with the lever 50. In this arrangement the device consists of two crank arms 290 oppositely mounted on the shaft 287 and each carrying a pin 291, which can engage in the slot formed between two arms 292 pivoted at 293 to a bracket 294 which is itself pivoted at 295. The two arms 292 are held apart by a spring 296 and are movable between stops 297 on the bracket 294. The bracket 294 is connected by a link 298 to the actuating lever 50. The arrangement is such that (if the selector bar is in the appropriate position) rotation of the shaft 287 in one direction (say, the clockwise direction in Figure 11) will cause one of the pins 291 to engage between the arms 292 and to move the lower arm into engagement with the lower stop 297 and will then rock the bracket 294 about its pivot 295, thus moving the actuating lever from its off position to its on position. If the shaft 287 continues to rotate in the same direction after operation of the actuating lever, the pins 91 will engage with the outside of the upper arm 292 and will slip past this arm after compressing the spring 296. Rotation of the shaft 287 in the opposite direction will in a similar manner cause the actuating lever to be moved from the on position to the off position. The various actuating devices are so positioned on the shafts 287, 288, that their pins 291 will come opposite to the corresponding arms 292 when the selector bar is moved to a position in which the associated actuating lever can be operated. The pins 291 on the actuating device for the potential transformer isolator lever 60 are made of sufficient length to engage with the associated arms 292 in the second, third, fourth and fifth positions of the selector bar.

The energizing circuit of the executive motor 280 from the busbars 267, 268 is taken through pilot wires 300, 301, 302 to the control point, where it is controlled by four push-button control switches 310, 315, 320, 325. Two of the pushes 310, 315 respectively control the closing and the opening of the potential transformer isolator (and also, in the first selector bar position, of the main circuit-breaker), whilst the other two 320, 325 similarly control the remaining auxiliary switches (and also, in the fourth selector bar position, the main circuit-breaker). Depression of either closing push 310 or 320 completes at contacts 311 or 321 an energizing circuit for the executive motor 280 to cause the appropriate shaft 288 or 287 to rotate in the closing direction, whilst depression of either opening push 315 or 325 similarly energizes through contacts 316 or 326 the executive motor to rotate the appropriate shaft in the opening direction. The two pushes 310, 315 are each provided with additional contacts 312, 317 controlling an energizing circuit from busbars 330, 331 over pilot wires 332, 333 for the solenoid 285 controlling the dog clutches 282, 283, in order to transfer the executive motor drive from the shaft 287 to the shaft 288 when these pushes are operated. As diagrammatically indicated at 322 the two closing pushes 310, 320 are mechanically interconnected to prevent them from being depressed simultaneously and a similar interconnection 327 is provided for the two opening pushes 315, 325.

In order to prevent the crank arms 290 of the actuating devices from fouling the arms 292 during movement of the selector bar, it is desirable to provide means for preventing movement of the selector bar unless the crank arms 290 on the shafts 287, 288 are in or near the vertical position. For this purpose rotary auxiliary switches 340, 341 are provided respectively on the shafts 287, 288, which are connected in series with one another in the energizing circuit of the preselecting motor 250 and act to hold that circuit open unless the corresponding crank arms 290 are in their vertical positions or are within a small angle (indicated by the dotted lines 342 in Figure 11) of the vertical. Further rotary auxiliary switches 345 and 346 are provided respectively on the shafts 287 and 288, which control circuits to indicating lamps 347 and 348 at the control station, whereby the operator at the control station will be informed as to whether or not the arms 290 on the two shafts are approximately in their vertical positions. Thus after depression of one of the control pushes the appropriate indicating lamp 347 or 348 will go out and will light again after the shaft has performed its operating movement, when the operator will release the push and bring the shaft to rest in the correct position, leaving the indicating lamp alight.

The following example will make clear the operation of the system. If the selector bar 100 is in the first position with the cable earthing switch and the main circuit-breaker closed, and it is desired to close the potential transformer isolator, the cable isolator, the main busbar isolator and the main circuit-breaker, the first operation is to depress the opening push 315. This energizes the solenoid 285 to disengage the main dog clutch 282 and engage the auxiliary dog clutch 283 and also energizes the executive motor 280 in the opening direction, so that the shaft 288 drives the two actuating devices thereon and operates the main circuit-breaker lever 120 to open the main circuit-breaker, the other actuating device rotating idly. The operator now releases the opening push 315 and depresses the other opening push 325, so that the shaft 287 is driven in the opening direction to operate the cable earthing switch lever 50 into the off position, the solenoid 285 being deenergized. The operator now moves the selector arm 260 to the second position and depresses the key 266, thus operating the preselecting motor 250 to drive the selector bar 100 to the second position. The next operation is the depression of the closing push 320, which causes the executive motor 280 to drive the shaft 287 in the closing direction. Since the selector bar 100 is now in the second position, the actuating device for the cable isolator lever 70 is operative and this isolator is consequently closed. The selector arm 260 is now moved to the fifth position and on depression of the key 266, the preselecting motor 250 is again energized to drive the selector bar 100, the movement in this case not being stopped until the fifth position is reached. Depression of the closing push 320 now causes the executive

motor 280 to drive the shaft 287 to close the main busbar isolator, and subsequent depression of the other closing push 325 causes the executive motor to drive the shaft 288 to close the potential transformer isolator. The selector arm 260 is now moved to the fourth position and the key 266 operated to bring the selector bar into the fourth position, and the final operation is to depress the closing push 320 to cause the executive motor to drive the shaft 287 to close the main circuit-breaker. Other operations can be effected as may be required by suitable operation of the control switches. Indicating lamps (not shown) are provided at the control point with suitable operating circuits to give the operator an indication of the condition of the controlled switches.

It will be appreciated that the above arrangements have been described by way of example only and may be modified in various ways within the scope of the invention.

What we claim as our invention and desire to secure by Letters Patent is:—

1. In electric switchgear the combination of a group of switches associated with one another, independently operable actuating levers respectively controlling the switches each lever having an operative and an inoperative position, a selector bar longitudinally movable into any of a number of positions, and cooperating slots and projections on the selector bar and the actuating levers for permitting in each position of the bar only such lever actuation as will not cause conflicting switching conditions to be set up and for preventing movement of the selector bar to any position unless the actuating levers are in positions appropriate to such movement, the arrangement being such that at least one of the changes of position of the selector bar can be effected while one of the actuating levers is in its operative position and another actuating lever in its inoperative position.

2. In electric switchgear the combination of a group of switches associated with one another, actuating levers respectively controlling the switches each lever having an operative and an inoperative position, a common shaft on which the actuating levers are pivoted so as to be operable independently of one another, a selector bar disposed parallel to the shaft, preselecting means for moving the selector bar longitudinally into any of a number of positions, and cooperating slots and projections on the selector bar and the actuating levers which act to prevent operation of any of the levers unless the selector bar is in a position appropriate to such operation and to prevent movement of the selector bar to any position unless the actuating levers are in positions appropriate to such movement, the arrangement being such that at least one of the changes of position of the selector bar can be effected while one of the actuating levers is in its operative position and another actuating lever in its inoperative position.

3. In electric switchgear the combination of a group of switches associated with one another, independently operable actuating levers respectively controlling the switches each lever having an operative and an inoperative position, a selector bar longitudinally movable into any of a number of positions, and cooperating slots and projections on the selector bar and the actuating levers whereby an actuating lever cannot be operated unless the selector bar has first been moved into a position appropriate to such operation and the selector bar cannot be moved into the selected position unless the actuating levers are in positions appropriate to such movement, the arrangement being such that in at least one of the positions of the selector bar at least two of the actuating levers can be operated.

4. In electric switchgear, the combination with a main circuit-breaker and auxiliary switches associated therewith, of interlocking mechanism for the auxiliary switches comprising actuating levers for the auxiliary switches, a common shaft on which the actuating levers are pivoted, a selector bar disposed parallel to the shaft, preselecting means for moving the selector bar longitudinally, cooperating slots and projections on the selector bar and the actuating levers which act to prevent operation of any of the levers unless the selector bar is in a position appropriate to such operation and to prevent movement of the selector bar unless the actuating levers are in a position appropriate to such movement, and means whereby the selector bar prevents closing of the main circuit-breaker unless the auxiliary switches are in a condition appropriate to such closing and the selector bar remains locked against movement so long as the circuit-breaker is closed.

5. In electric switchgear the combination of a group of switches associated with one another, actuating levers respectively controlling the switches each lever having an operative and an inoperative position, a common shaft on which the actuating levers are pivoted so as to be operable independently of one another, a selector bar disposed parallel to the shaft, preselecting means for moving the selector bar longitudinally into any of a number of positions, and cooperating slots and projections on the selector bar and the actuating levers for permitting in each position of the bar only such lever actuation as will not cause conflicting switching conditions to be set up and for preventing movement of the selector bar to any position unless the actuating levers are in positions appropriate to such movement, the arrangement being such that in at least one of its positions the selector bar can only be moved to a certain other position when one of the actuating levers is in its operative position.

6. In electric switchgear, the combination with a main circuit-breaker and auxiliary switches associated therewith, of interlocking mechanism for the auxiliary switches comprising actuating levers for the auxiliary switches, a common shaft on which the actuating levers are pivoted, a selector bar disposed parallel to the shaft, preselecting means for moving the selector bar longitudinally in any of a number of positions, means whereby the selector bar acts to permit or prevent the actuation of the actuating levers in accordance with its position, two members respectively connected to the preselecting means and to the main circuit-breaker closing mechanism, and a locking bar cooperating with such members and acting to lock one or other of the members against movement in accordance with the position of the other member, the arrangement being such that the main circuit-breaker cannot be closed unless the auxiliary switches are in a condition appropriate to such closing and the selector bar is locked against movement so long as the main circuit-breaker is closed.

7. In electric switchgear the combination of a group of switches associated with one another, actuating levers respectively controlling the operation of the switches, a selector bar longitudi-

nally movable into any of a number of positions, means whereby the selector bar acts to permit or prevent actuation of the actuating levers in accordance with its position, oil-immersed electrical apparatus associated with the controlled switches, a removable oil tank containing such apparatus, and means whereby the selector bar prevents removal of the tank unless the switches are in a condition to isolate the apparatus in the tank.

8. In electric switchgear the combination of a group of switches associated with one another, actuating levers respectively controlling the operation of the switches, a selector bar longitudinally movable into any of a number of positions, means whereby the selector bar acts to permit or prevent actuation of the actuating levers in accordance with its position, oil-immersed electrical apparatus associated with the controlled switches, a removable oil tank containing such apparatus, and means whereby the removal of the tank prevents movement of the selector bar.

9. In electric switchgear the combination with a main circuit-breaker and auxiliary switches associated therewith, of interlocking mechanism comprising actuating levers for the auxiliary switches, a common shaft on which the actuating levers are pivoted, a selector bar disposed parallel to the shaft, preselecting means for moving the selector bar longitudinally, cooperating slots and projections on the selector bar and the actuating levers whereby an actuating lever cannot be operated unless the selector bar has first been moved into a position appropriate to such operation and the selector bar cannot be moved into the selected position unless the auxiliary switches are in a condition appropriate to such movement, a removable oil tank containing the main circuit-breaker, and means whereby the selector bar prevents removal of the tank unless the auxiliary switches are in a condition to isolate the main circuit-breaker.

10. In electric switchgear the combination with a group of switches associated with one another, actuating levers controlling the operation of the switches, a selector bar longitudinally movable into any of a number of positions, cooperating slots and projections on the selector bar and the actuating levers whereby an actuating lever cannot be operated unless the selector bar has first been moved into a position appropriate to such operation and the selector bar cannot be moved into the selected position unless the actuating levers are in positions appropriate to such movement, oil-immersed apparatus associated with the controlled switches, a removable oil tank containing such apparatus, means whereby the selector bar prevents removal of the tank unless the auxiliary switches are in a condition to isolate the apparatus in the tank, and means whereby the selector bar is held against movement so long as the tank is removed.

11. In electric switchgear the combination of a group of switches associated with one another, actuating levers respectively controlling the operation of the switches, a selector bar longitudinally movable into any of a number of positions, means whereby the selector bar acts to permit or prevent the actuation of the actuating levers in accordance with its position, an oil-immersed electrical apparatus associated with the controlled switches, a removable oil tank containing such apparatus, a slotted interlocking bar connected to the selector bar, a spring-pressed plunger, and means whereby on removal of the tank the plunger engages in the slot in the interlocking bar and thereby prevents movement of the interlocking bar and the selector bar.

12. The combination with the features set forth in claim 11 of means whereby the selector bar prevents removal of the tank unless the switches are in a condition to isolate the apparatus in the tank.

13. The combination with the features set forth in claim 1 of an oil-immersed electrical apparatus associated with the controlled switches, a removable oil tank containing such apparatus, an electric coupling device controlling the removal of the tank, and means whereby the selector bar prevents closing of the coupling unless the switches are in a condition to isolate the apparatus in the tank.

14. In electric switchgear, the combination with a group of switches associated with one another, of interlocking mechanism for the switches comprising actuating levers for the switches each movable from one operative position to another for the operation of the associated switch, a common shaft on which the actuating levers are pivoted, a longitudinally movable selector bar disposed parallel to the common shaft and transversely slotted to permit movement of each actuating lever from one operative position to the other when the selector bar is in a position appropriate to such movement, preselecting means for moving the selector bar longitudinally, segmental extensions on the actuating levers having peripheral slots lying in the path of the selector bar in the operative positions of the levers, and projections on the selector bar cooperating with the slots in the segmental extensions of the levers to permit or prevent movement of the selector bar in accordance with the positions of the actuating levers, the arrangement of the slots and projections being such as to prevent operation of a switch unless the selector bar is in a position appropriate to such operation and to prevent movement of the selector bar into the selected position unless the switches are in a condition appropriate to such operation.

15. In electric switchgear the combination of a group of switches associated with one another, actuating levers respectively controlling the operation of the switches, a selector bar longitudinally movable into any of a number of operative positions, cooperating slots and projections on the selector bar and the actuating levers which act to prevent operation of any of the levers unless the selector bar is in a position appropriate to such operation and to prevent movement of the selector bar into any operative position unless the actuating levers are in positions appropriate to such movement, and means whereby the movements of the selector bar and of the actuating levers can be controlled electrically.

16. In electric switchgear the combination of a group of switches associated with one another, actuating levers respectively controlling the operation of the switches, a common shaft on which the actuating levers are pivoted, a selector bar disposed parallel to the shaft, preselecting means for moving the selector bar longitudinally, cooperating slots and projections on the selector bar and the actuating levers whereby an actuating lever cannot be operated unless the selector bar has first been moved into a position appropriate to such operation and the selector bar cannot be moved into the selected position unless the auxiliary switches are in a condition appropriate to such movement, and means whereby the move-

ments of the selector bar and of the actuating levers can be controlled electrically from a remote point or can alternatively be effected by direct manual operation.

17. The combination with the features set forth in claim 1, of means whereby the movements of the selector bar and of the actuating levers can be controlled electrically.

18. The combination with the features set forth in claim 1, of means whereby the movements of the selector bar and of the actuating levers can be controlled electrically from a remote point or can alternatively be effected by direct manual operation.

19. The combination with the features set forth in claim 3, of means whereby the movements of the selector bar and of the actuating levers can be controlled electrically.

20. The combination with the features set forth in claim 1, of a reversible electric motor for moving the selector bar, a second reversible electric motor, means controlled by the movements of the selector bar for selectively coupling the second motor to the actuating levers, and means for controlling the energization of the two motors.

21. The combination with the features set forth in claim 3, of a reversible electric motor for moving the selector bar, a second reversible electric motor, means controlled by the movements of the selector bar for selectively coupling the second motor to the actuating levers, and means for controlling the energization of the two motors.

22. The combination with the features set forth in claim 5, of a reversible electric motor for moving the selector bar, a second reversible electric motor, means controlled by the movements of the selector bar for selectively coupling the second motor to the actuating levers, and means for controlling the energization of the two motors.

23. The combination with the features set forth in claim 14, of a reversible electric motor for moving the selector bar, a second reversible electric motor, means controlled by the movements of the selector bar for selectively coupling the second motor to the actuating levers, and means for controlling the energization of the two motors.

24. In electric switchgear the combination of a group of switches associated with one another, actuating levers respectively controlling the operation of the switches, a selector bar longitudinally movable into any of a number of positions, cooperating slots and projections on the selector bar and the actuating levers which act to prevent operation of any of the levers unless the selector bar is in a position appropriate to such operation and to prevent movement of the selector bar into any position unless the actuating levers are in positions appropriate to such movement, a reversible electric motor for moving the selector bar, a manually-operated selector switch at a remote point controlling the energization of the motor, a contact device operated by movement of the selector bar and acting both to determine the direction of rotation of the motor in accordance with the relation between the existing position of the selector bar and the desired new position thereof and to stop the motor when such new position has been reached, and means electrically controlled from the remote point for effecting operation of the actuating levers.

25. The combination with the features claimed in claim 1 of a selecting reversible electric motor for moving the selector bar, an executive reversible electric motor, an actuating device for each actuating lever, means for connecting the executive motor to such actuating devices, means whereby the engagement and disengagement of each actuating device with the associated actuating lever is controlled by the movements of the selector bar, and means for controlling the energization of the two motors.

26. In electric switchgear the combination of a group of switches associated with one another, actuating levers respectively controlling the operation of the switches, a selector bar longitudinally movable into any of a number of positions, cooperating slots and projections on the selector bar and the actuating levers which act to prevent operation of any of the levers unless the selector bar is in a position appropriate to such operation and to prevent movement of the selector bar into any position unless the actuating levers are in positions appropriate to such movement, a reversible electric motor carried by the selector bar, a group of actuating devices for the actuating levers so carried by the selector bar as to be selectively brought into driving engagement with the associated actuating levers by the movements of the selector bar, means for connecting the motor to the actuating devices, and means for controlling the energization of the motor.

27. The combination with the features set forth in claim 2, of means whereby the movements of the selector bar and of the actuating levers can be effected by direct manual operation, and means whereby such movements can alternatively be controlled electrically from a remote point, said last-named means comprising a selecting reversible electric motor for moving the selector bar, a manually operated selector switch at the remote point, a contact device operated by the movement of the selector bar and cooperating with the remote selector switch to control the energization of the selecting motor whereby the selector bar is caused to move into a position determined by the operation of the remote switch provided that such movement is not prevented by the positions of the actuating levers, an executive reversible electric motor carried by the selector bar, means controlled by movements of the selector bar for selectively coupling the executive motor to the actuating levers, and manually operable switches at the remote point for controlling the energization of the executive motor.

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