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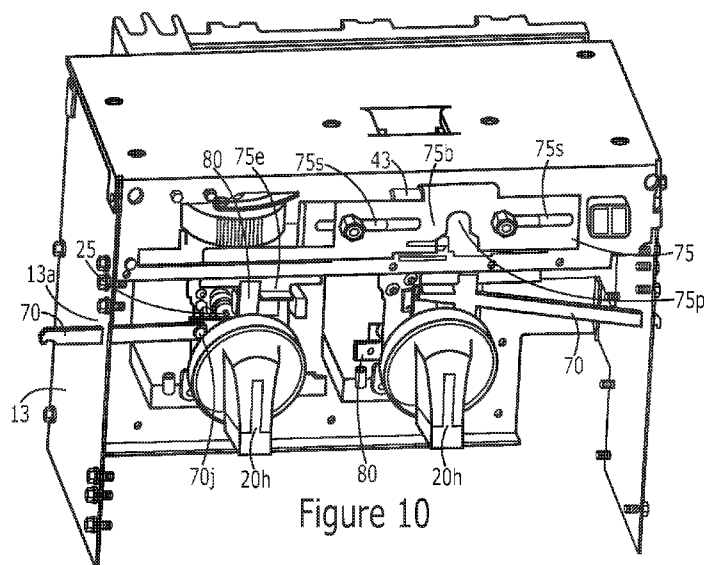


Figure 10

(57) Abstract: Motor control centers have units or buckets with one or more sliding shutters that controllably block access to a stab isolation port based on position of the operator disconnect handle using attached cams that slide the shutter right and left. A front panel of the unit or bucket may also be configured to pivot out about a long axis associated with a bottom long side thereof.

MOTOR CONTROL CENTER UNITS WITH RETRACTABLE STABS HAVING AN INTERLOCK BETWEEN OPERATOR HANDLE AND SHUTTER

Field of the Invention

[0001] The present invention relates to motor control systems and more particularly to motor control center units.

Background of the Invention

[0002] As is known to those of skill in the art, Motor Control Centers (MCC) can include cabinets or enclosures that hold multiple, typically modular, bucket assemblies of various sizes. *See, e.g.*, U.S. Patent No. 4,024,441, the contents of which are hereby incorporated by reference as if recited in full herein. Eaton Corporation has recently introduced a MCC product line with compact bucket assemblies that conveniently plug into a slot or space in an MCC cabinet. The product is sold under the product name, Freedom 2100 MCC. *See also*, U.S. Patent Application Publication Serial Number US2013/0077210, the contents of which are hereby incorporated by reference as if recited in full herein.

[0003] Motor control centers are used, for example, in some commercial and industrial applications to distribute electrical power to a variety of loads (e.g., without limitation, relatively high power electrical motors, pumps, and other loads).

[0004] The bucket assemblies (also known as "buckets" or "units") can include handles that are disposed on the front door. The handle can be a rotary handle configured to convert the rotary motion of the rotary handle to the linear or translational motion of a circuit breaker linear action lever. *See, e.g.*, U.S. Patent Nos. 6,194,983 and 7,186,933, the contents of which are incorporated by reference as if recited in full herein. The handle is typically mounted parallel with the plane of the faceplate of the molded case circuit breaker, but spaced outwardly from it by the depth of the handle mechanism. Usually, a series of linkages are utilized to interconnect the rotary motion of the rotary handle to the linear motion of the circuit breaker handle or lever.

[0005] **Figure 1**, for example, shows a portion of a prior art motor control center **100**. The motor control center **100** includes a multi-compartment enclosure **12** for receiving a plurality of motor control units **10**. Typically, each bucket **10** is a removable, pull-out unit that has a respective door **22** (which may be under a front panel). The door **22** is typically coupled to the housing **12** by hinges **28** (shown in phantom line drawing in **Figure 1**) to

permit access to motor control components of the bucket **10** while it is installed in the enclosure **12**. For example and without limitation, the door **22** permits access to a circuit breaker assembly **30**, a stab indicator **32**, a shutter indicator **34**, and a line contact actuator **36**. When the bucket **10** is fully installed and electrically connected, a user-operator may operate a disconnect handle **20h**. In a de-energized state of the motor control center **100**, the user-operator may operate an isolation feature by moving a slide **40** and inserting crank **42** through an access portal or hole **43** in the door **22** to access the line contact actuator **36** to move a number of line contacts (see, for example, stab contacts **46,48,50** of the prior art bucket **10** of **Figure 2**) to an isolated position out of (see **Figure 2**) electrical contact with power lines or buses **52** (partially shown in phantom line drawing in **Figure 2**) of the motor control center **100**. Motor control centers and units therefore (also sometimes called "subunits") are described in greater detail, for example, in commonly assigned U.S. Patent Application Publications 2009/0086414, 2008/0258667, 2008/0023211 and 2008/0022673, which are hereby incorporated herein by reference

[0006] Despite the above, there remains a need for alternate bucket configurations.

Summary of Embodiments of the Invention

[0007] Embodiments of the invention provide units with a sliding shutter to prevent access to a portal for an isolation feature which allows a user-operator to retract stabs in the units.

[0008] Embodiments of the invention provide buckets with portal shutters having separately, independently operative shutter movement for dual feeder units.

[0009] The shafts of operator mechanisms attached to a handle can be attached to interlocks that have a cam configured to slide a shutter to open and close access to an electrical portal associated with a retractable stab.

[0010] Embodiments of the invention are directed to bucket sub-assemblies configured to control access to a stab portal of a bucket unit. The sub-assemblies include first and second spaced apart operator disconnect handles, the first operator disconnect handle attached to a first inwardly extending shaft that holds a first cam, the second operator disconnect handle attached to a second inwardly extending shaft that holds a second cam. The first and second cams are configured to independently rotate. The first and second cams rotate in response to rotation of a corresponding operator disconnect handle. The sub-assemblies also include at least one shutter in communication with the first and second cams. The at least one shutter has a shutter portal and the at least one shutter is configured to

cooperate with the first and second cams to laterally slide to a position that misaligns the shutter portal with a stab isolation portal to block access to the stab isolation portal when the first and/or second operator disconnect handle is in the ON position associated with conduction.

[0011] The first and second cams can each comprise first and second drive segments, one of which slides the at least one shutter one direction and one of which slides the at least one shutter in an opposite direction.

[0012] The drive segments can include arms that reside angularly apart between about 45-135 degrees.

[0013] The arms can extend straight out from the shaft and are orthogonal to each other.

[0014] The bucket sub-assemblies can include a front panel holding the first and second operator disconnect handles. The front panel can be a single panel or side-by-side dual sub-panels that are attached along inner short sides thereof to be able to pivot outward together. The single panel or dual sub-panels can be pivotably attached to a unit housing to pivot outward along a long axis associated with a long bottom side of the front panel.

[0015] The first and second operator disconnect handles can be right and left operator disconnect handles. The bucket sub-assemblies can include right and left interlock linkages. The right interlock linkage can include a link with one end portion attached to the first shaft and pivotably attached to a right lever at an opposing end portion. The left interlock linkage can include a link with one end attached to the second shaft at one end portion and pivotably attached to a left lever at an opposing end portion. The links can extend straight outward from respective first and second shafts. The right lever can have an end portion that is configured to extend out of a right sidewall of a unit housing when the right operator disconnect handle is in the ON position and the left lever can have an end portion that is configured to extend out of a left sidewall of the unit housing when the left operator disconnect handle is in the ON position.

[0016] The at least one shutter can be a single shutter. The first and second operator disconnect handles can be right and left operator disconnect handles. The right and left cams can be configured to slide the single shutter right and left independently of each other.

[0017] The at least one shutter can be a single shutter. The first and second cams can be configured to slide the single shutter independently of each other.

[0018] The first and second operator handles can be held by a front panel that is configured to pivot outward from hinges residing at a lower opposing long end portions

thereof, and wherein the front panel engages a unit interlock to controllably lock and unlock the interlock to allow the pivoting movement only when there is non-conduction.

[0019] Other embodiments are directed to bucket assemblies. The bucket assemblies include a unit housing having a front panel and opposing laterally spaced apart sidewalls extend rearward of the front panel of the unit housing. The bucket assemblies also include a right operator disconnect handle on the front of the unit housing and attached to a right inwardly extending shaft. The right shaft holds a right cam configured to rotate in response to rotation of the right operator disconnect handle. The bucket assemblies also include a left operator disconnect handle on the front of the unit housing and attached to a left inwardly extending shaft. The left operator disconnect handle is laterally spaced apart from the right operator disconnect handle. The left shaft holds a left cam configured to rotate in response to rotation of the left operator disconnect handle. The bucket assemblies also include at least one shutter in communication with the right and/or left cam whereby the at least one shutter slides to the right and left in response to contact with the right and/or left cam. The bucket assemblies also include a stab isolation portal residing above the right and left shafts of the right and left operator disconnect handles. The at least one shutter has a shutter portal. The at least one shutter is configured to have a position that misaligns the shutter portal with the stab isolation portal to block access to the stab isolation portal when either of the right and left operator disconnect handles is in the ON position associated with conduction.

[0020] The at least one shutter is a single shutter and the right and left cams are configured to slide the single shutter independently of each other.

[0021] The bucket assemblies can also include a right interlock linkage attached to the right shaft and a left interlock linkage attached to the left shaft, each configured to rotate with respective right and left shafts.

[0022] The bucket assemblies can include a right feeder or starter held in the unit housing in communication with the right operator disconnect handle and a left feeder or starter held in the unit housing in communication with the left operator disconnect handle.

[0023] The cam can include arms that reside angularly apart between about 45-135 degrees.

[0024] The at least one shutter can include a single shutter or two adjacent shutters. The the single shutter or the two shutters can be configured with left and right cam followers residing on lower portions of the single shutter or on lower portions of the two shutters.

[0025] The bucket assemblies can include right and left interlock linkages, each with a link attached to a respective shaft at one end portion and pivotably attached to a lever at an

opposing end portion. The link can extend straight outward from a respective shaft. The lever attached to the right shaft has an end portion that can be configured to extend out of a right sidewall of the bucket assembly when the right operator disconnect handle is in the ON position and the lever attached to the left shaft has an end portion that can be configured to extend out of a left sidewall of a unit housing of the bucket assembly when the left operator disconnect handle is in the ON position.

[0026] The front panel can be a single panel that extends between the sidewalls.

[0027] The front panel can be configured as two adjacent sub-panels that are attached at inner sides thereof to be able to pivot outwardly in concert along the long axis.

[0028] Still other embodiments are directed to a motor control center (MCC). The MCC includes a housing with first and second sidewalls defining an enclosure with a plurality of compartments. The compartments are configured to removably receive a plurality of units, at least one of the units includes: (a) a unit housing having a front and opposing laterally spaced apart sidewalls that extend rearward of the front of the unit housing; (b) at least one operator disconnect handle on the front of the housing and attached to an inwardly extending shaft, the shaft holds a cam configured to rotate in response to rotation of the operator disconnect handle, the cam includes first and second arms that extend straight out from the shaft and that reside angularly spaced apart between about 45-135 degrees; (c) at least one shutter in serial communication with the first and second arms of the cam whereby the at least one shutter slides right and left in response to a follower that contacts the first and second arms of the cam; and (d) a stab isolation portal residing above the shaft of the operator disconnect handle. The shutter has a shutter portal. The shutter is configured to have a position that misaligns the shutter portal with the stab isolation portal to block access to the stab isolation portal when the at least one operator disconnect handle is in the ON position associated with conduction.

[0029] The front of the unit housing can include a pilot panel segment or sub-panel holding a plurality of pilot devices laterally spaced apart from the at least one operator disconnect handle.

[0030] The at least one operator disconnect handle can include a right operator disconnect handle with a right shaft and right cam and a left operator disconnect handle with a left shaft and left cam. The right and left cams are configured to slide the at least one shutter right and left independently of each other.

[0031] The at least one operator handle can be held by a front panel attached to the unit housing. The front panel can be configured to pivot outward from hinges residing at a

lower opposing long end portions thereof. The front panel engages a unit interlock attached to the unit housing to controllably lock and unlock the front panel to allow the pivoting movement only when there is non-conduction.

[0032] Other embodiments include methods of controlling access to a stab isolation portal of a bucket. The methods include rotating an externally accessible operator disconnect handle of a bucket or unit to an ON position, the operator disconnect handle attached to an inwardly extending shaft, the shaft holding a laterally outwardly extending interlock linkage and a cam. In response to the rotation of the operator disconnect handle, (i) an outer end portion of the interlock linkage extends out through an aperture in a sidewall of the bucket or unit and (ii) the cam forces a shutter to slide left or right to block access to a stab isolation access portal associated with a retractable stab.

[0033] The bucket can be a dual feeder or starter bucket with right and left operator disconnect handles, each having respective shafts with the cam and interlock linkage. The rotating can be carried out so that the cams of each shaft move the shutter independently of the other and are configured to slide the shutter to a position that blocks access to the stab isolation access portal unless both the right and left operator handles are in an OFF position associated with non-conduction.

[0034] Still other embodiments are directed to bucket assemblies. The assemblies include: a unit housing; and a front panel holding either (i) first and second operator disconnect handles or (ii) at least one operator disconnect handle with a pilot panel. The front panel is a single panel or side-by-side dual sub-panels that are attached along inner short sides thereof to be able to pivot outward together. The single panel or dual sub-panels are pivotably attached to the unit housing to pivot outward along a long axis associated with a long bottom side of the front panel. The front panel engages a unit interlock attached to the unit housing to controllably lock and unlock the front panel to allow the pivoting movement away from the unit housing only when there is non-conduction.

[0035] The first and second operator disconnect handles are right and left operator disconnect handles. The bucket sub-assembly can include right and left interlock linkages, the right interlock linkage comprising a link with one end portion attached to the first shaft and pivotably attached to a right lever at an opposing end portion and the left interlock linkage comprising a link with one end attached to the second shaft at one end portion and pivotably attached to a left lever at an opposing end portion. The links extend straight outward from respective first and second shafts. The right lever has an end portion that is configured to extend out of a right sidewall of a unit housing of a bucket assembly when the

right operator disconnect handle is in the ON position and the left lever has an end portion that is configured to extend out of a left sidewall of a unit housing of a bucket assembly when the left operator disconnect handle is in the ON position.

[0036] Still other embodiments are directed to a bucket assembly that includes: (a) a unit housing having a front and opposing laterally spaced apart sidewalls extend rearward of the front of the unit housing; (b) at least one operator disconnect handle on the front of the unit housing and attached to an inwardly extending shaft, the shaft holds (i) at least one cam configured to rotate in response to rotation of a respective operator disconnect handle and (ii) an interlock linkage that pivots as the shaft rotates to extend a sufficient distance to extend through an aperture in the sidewall of the unit housing and retract to be inside the unit housing; (c) at least one shutter in communication with the at least one cam whereby the at least one shutter slides to the right and left in response to contact with the cam; and (d) a stab isolation portal residing above the shaft of the at least one operator disconnect handle. The at least one shutter has a shutter portal. The at least one shutter is configured to have a position that misaligns the shutter portal with the stab isolation portal to block access to the stab isolation portal when the at least one operator disconnect handle is in the ON position associated with conduction.

[0037] Further features, advantages and details of the present invention will be appreciated by those of ordinary skill in the art from a reading of the figures and the detailed description of the preferred embodiments that follow, such description being merely illustrative of the present invention.

[0038] It is noted that aspects of the invention described with respect to one embodiment, may be incorporated in a different embodiment although not specifically described relative thereto. That is, all embodiments and/or features of any embodiment can be combined in any way and/or combination. Applicant reserves the right to change any originally filed claim or file any new claim accordingly, including the right to be able to amend any originally filed claim to depend from and/or incorporate any feature of any other claim although not originally claimed in that manner. These and other objects and/or aspects of the present invention are explained in detail in the specification set forth below.

Brief Description of the Drawings

[0039] **Figure 1** is a partial front perspective view of an exemplary prior art Motor Control Center (MCC).

[0040] **Figure 2** is a top perspective view of an example of a prior art unit of the MCC.

[0041] **Figure 3** is a front perspective view of an exemplary unit with a dual feeder configuration according to embodiments of the present invention.

[0042] **Figure 4** is a left side perspective view of another exemplary unit with a dual feeder configuration according to embodiments of the present invention.

[0043] **Figures 5A and 5B** are front views of exemplary "ON" (**Figure 5A**) and "OFF" (**Figure 5B**) operational positions of the handle shown in **Figure 4** for the associated internal disconnect according to embodiments of the invention.

[0044] **Figure 5C** is a front perspective view of the handle shown in **Figures 5A and 5B** illustrating an extended lockable configuration according to embodiments of the present invention.

[0045] **Figure 6** is a front perspective view of yet another exemplary unit with a rotary disconnect on one side and a plurality of control devices on the other side according to embodiments of the present invention.

[0046] **Figure 7** is a front perspective view of the unit shown in **Figure 6** without the top cover illustrating a retractable stab configuration and portal interlock according to embodiments of the present invention.

[0047] **Figure 8** is a front perspective view of a unit similar to that shown in **Figure 6**, but with a different handle and control device panel layout according to embodiments of the present invention.

[0048] **Figure 9** illustrates examples of a device panel for different pilot control items which can vary by product and/or customer according to embodiments of the present invention.

[0049] **Figure 10** is a front perspective view of an exemplary unit shown with the external cover over the racking (stab isolation) portal omitted to illustrate a sliding shutter that overlies the racking portal and that cooperates with an interlock mechanism according to embodiments of the present invention.

[0050] **Figure 11** is a front view perspective view of a unit with a dual feeder configuration as shown in **Figure 3**, but with the front cover/panels omitted to illustrate exemplary interlocks according to embodiments of the present invention.

[0051] **Figure 12A** is a front perspective view of an exemplary right hand linkage, illustrating the configuration of the linkage when the handle is in an OFF position according to embodiments of the present invention.

[0052] **Figure 12B** is a front perspective view of the exemplary right hand linkage, illustrating the configuration of the linkage when the handle is in an ON position according to embodiments of the present invention.

[0053] **Figure 13A** is a front perspective view of an exemplary left hand breaker linkage, illustrating the configuration of the linkage when the handle is in an OFF position according to embodiments of the present invention.

[0054] **Figure 13B** is a front perspective view of the exemplary left hand breaker linkage, illustrating the configuration of the linkage when the handle is in an ON position according to embodiments of the present invention.

[0055] **Figures 14A and 14B** are schematic illustrations of alternative shutter configurations according to embodiments of the present invention.

[0056] **Figure 15** is a bottom perspective view of internal components of an exemplary unit according to embodiments of the present invention.

[0057] **Figure 16** is a side perspective view of the unit shown in **Figure 8**, illustrating the handle sub-panel and the pilot device sub-panel joined together to be able to pivot outward and inward in concert and engage unit interlocks according to embodiments of the present invention.

[0058] **Figure 17** is a side perspective view of the unit shown in **Figure 7**, also illustrating the handle panel and the pilot device panel as a common panel to pivot outward and inward in concert and engage unit interlocks according to embodiments of the present invention.

[0059] **Figure 18** is a side perspective view of a unit illustrating a left hand linkage in the unit and a unit interlock which engages the front hinged panel shown in **Figures 16 and 17**, for example, and which is controlled by a controller for interlock control according to embodiments of the present invention.

[0060] **Figure 19** is a partial exploded view of an exemplary unit illustrating components of an exemplary operator mechanism and fuse system according to some embodiments of the present invention.

[0061] **Figure 20** is a flow chart of exemplary operation of a unit with an interlock associated with a portal shutter according to embodiments of the present invention.

Detailed Description of Embodiments of the Invention

[0062] The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which illustrative embodiments of the invention are shown. Like numbers refer to like elements and different embodiments of like elements can be designated using a different number of superscript indicator apostrophes (*e.g.*, **10**, **10'**, **10''**, **10'''**).

[0063] In the drawings, the relative sizes of regions or features may be exaggerated for clarity. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

[0064] It will be understood that, although the terms first, second, etc. may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer or section from another region, layer or section. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present invention.

[0065] Spatially relative terms, such as "beneath", "below", "lower", "above", "upper" and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the exemplary term "below" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90° or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

[0066] The term "about" refers to numbers in a range of +/-20% of the noted value.

[0067] As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless expressly stated otherwise. It will be further understood that the terms "includes," "comprises," "including" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements,

and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. It will be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element or intervening elements may be present. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0068] Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of this specification and the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

[0069] In the present disclosure, the terms "bucket" or "unit" are used interchangeably and are intended to mean a motor control center unit that may be configured to be a removable modular unit capable of being installed behind individual or combined sealed doors on the motor control center enclosure. The unit may contain various motor control and motor protection components such as motor controllers, starters, contactor assemblies, overload relays, circuit breakers, motor circuit protectors, various disconnects, and similar devices for electric motors. The unit is configured to connect to a common power bus of the motor control center and conduct supply power to the line side of the motor control devices for operation of motors or feeder circuits.

[0070] As discussed before, units may be configured as "starter units" for supplying power controlling electrical motors and pumps or as general "feeder units" for supplying feeder circuits. The terms "bucket assembly", "bucket" and "unit" are used interchangeably and refer to a structure (typically having sides of a protective metal shell) that contains either a switch with a fuse or a circuit breaker for turning power ON and OFF to a motor, or feeder circuit, typically for controlling power to motor starters. As noted above, the bucket or unit can be a feeder unit or a starter unit. The bucket can include other components such as a power transformer, a motor starter to control a single motor and PLCs (programmable logic controllers), drives and the like. The bucket can be configured as a modular device to allow the internal components to be assembled as a unit that can be easily installed into a Motor Control Center (MCC) compartment. As is well known, the bucket **10** can have a bus grid with "power stabs" **46, 48, 50 (Figure 4)** in the back that connect to bus bars **52 (Figure 2)** that carry power (current) to the compartments of a vertical section in an MCC cabinet **100**

(**Figure 1**). The bus bars are connected to larger horizontal bus bars that bring power to the vertical sections. The horizontal bus bars are usually in the top, but some MCC designs may have them in the center or bottom.

[0071] A "feeder unit" refers to a motor control center unit for supplying feeder circuits. A feeder unit may have one or more feeders or power supply lines to supply feeder circuits or devices. A feeder unit (also called a "feeder") can have a "line side", which refers to the side of the feeder configured to be directly or indirectly connected to the common power bus of the motor control center. A feeder can also have a "load side", which refers to the side of the feeder configured to be connected to and deliver current to a feeder circuit. A feeder may comprise a circuit breaker, a fuse and disconnect switch, or another configuration. The terms "feeder circuit" and "feeder device" are used interchangeably and are intended to mean circuits or devices connected to feeder units or "feeders".

[0072] A "circuit breaker", "breaker", "molded case circuit breaker", or "MCCB" is a device designed to open and close a circuit, typically allowing both manual open and close operation and automatic circuit interruption, the latter to open a circuit under certain conditions, e.g., an over-current. The circuit breaker can be for a motor starter unit or feeder unit, for example.

[0073] The terms "motor", "load", and "load device" are used interchangeably and are intended to mean devices bearing electrical load that are connected to and controlled by the motor control center. Load devices are typically motors but may also be pumps or other machinery that may comprise motors or pumps. Load devices may be connected to starter units.

[0074] The terms "operating mechanism" and "operator mechanism" are used interchangeably and refer to an assembly for opening and closing separable main contacts in a circuit breaker or for turning power ON and OFF using a switch associated with a fuse as a disconnect.

[0075] MCCs usually have a wire way for wires from respective units **10** to the motors and other loads and control wires. U.S. Patent Application Publication 2013/0077210 describes an MCC with both right and left side wireways, the contents of which are hereby incorporated by reference as if recited in full herein. The wireways are typically provided as an enclosed space in an MCC cabinet proximate but outside stacked units. MCCs can be configured in many ways. Each compartment can have a different height to accept different frame sizes of respective bucket assemblies or units **10**, typically in about 6-inch increments. The vertical bus can be omitted or not run through the full height of the section to

accommodate deeper buckets for larger items like variable frequency drives. The MCC can be a modular cabinet system for powering and controlling motors or feeder circuits. Several may be powered from main switchgear which, in turn, gets its power from a transformer attached to the incoming line from the power company. A typical MCC cabinet is an enclosure with a number of small doors arranged in rows and columns along the front. The back and sides are typically flat and mostly featureless. The buckets can be provided in varying sizes. For starter units, the size can be based on the size of the motor they are controlling. The bucket assembly can be configured to be relatively easily removable for repair, service or replacement. MCCs can have regular starters, reversing starters, soft start, and variable frequency drives. MCCs can be configured so that sections can be added for expansion if needed. The buckets or units **10** of a motor control center **100** can have the same or different configurations.

[0076] The terms "right side" and "left side" refer when the unit or MCC is viewed from the front, e.g., the front is associated with the unit **10** orientation shown in **Figures 3** and **4**, for example, with handles **20h** facing forward as shown in **Figures 3** and **4**. While the handles **20h** are shown as rotary handles, other handle configurations may be used, including, for example, push handles, levers and linearly moveable handles. It is also noted that the dual feed configurations are shown as side by side arrangements, but it is contemplated that vertically aligned handles may also or alternatively be used with the respective disconnects placed in the unit accordingly.

[0077] The term "compact" refers to units **10** held in a condensed configuration (package) relative to conventional units/buckets. The MCC structure or cabinet **100** (**Figure 1**) can be designed to receive multiple bucket units **10** ranging in various defined sizes. The units **10** can be provided in package or frame sizes of about 6 inches to about 72 inches (tall) with substantially common depth and width dimensions, known as 1X (6 inches) to 12X (72 inches) sizes. The sizes can be in single X increments, from 1X, 2X, 3X, 4X, 5X, 6X, 7X, 8X, 9X, 10X, 11X and 12X. Thus, a 5X MCC unit **10** can be about 30 inches tall. The frame sizes can be provided for a plurality of amperages, including a plurality of: 125A, 150A, 225A, 250A, 400A, 600A, 1200A and 2000A, for example. A unit **10** is typically about 7 inches deep but larger or smaller sizes may be appropriate in some embodiments.

[0078] Referring now to **Figures 3** and **4**, in some embodiments, the bucket assembly or unit **10** has a dual feeder and/or starter configuration. For the embodiments shown in **Figures 3** and **4**, the dual feeder and/or starter unit **10** includes respective right and left handles **20h** attached to a respective shaft **25** of a corresponding disconnect **D** such as a

disconnect operator mechanism **40** (**Figures 10A, 10B**). The bucket assembly **10** can be configured for DC (direct current) or AC (alternating current) operation. The bucket assembly **10** can include a front cover **11** (**Figure 6**) residing over the door **22** or panel holding the handle **20h**. The bucket assembly **10** can have a metal enclosure, frame or housing **12h** with sidewalls **13**.

[0079] In some embodiments, the bucket assembly **10** can comprise a molded case circuit breaker **10C**. Molded case circuit breakers are well known to those of skill in the art, as exemplified by U.S. Patent Nos. 4,503,408 and 5,910,760, the contents of which are incorporated herein by reference as if recited in full herein. In other embodiments, the bucket assembly **10** can be configured to house a fused disconnect switch to turn power on and off. In some embodiments, the MCC cabinet **100** (**Figure 1**) can hold both a fused disconnect switch and circuit breaker type units **10** and each can have a standardized rotary handle **20h** that controls the internal components for power on/off operation.

[0080] As shown in **Figures 3 and 4**, the unit **10** includes two (typically side-by-side) operator handles **20h** that individually communicate with respective internal disconnect and/or operator mechanisms **40** (**Figure 19**) that, in turn, connect to an internal circuit breaker **10C** or a disconnect switch **10S**, respectively. The handles **20h** can be rotary handles. **Figures 3 and 4** also illustrate interlock linkages **70** that extend through respective left and right side apertures **13a** in the sidewalls **13** of the unit.

[0081] The unit **10** can be configured so that the stab **S** is offset to reside closer to one side of the unit, e.g., so that a left side stab **46** or right side stab **50** (and/or the center stab **48**) is closer to a respective left or right side of the unit **10**. **Figures 4 and 7** show the center stab **48** as residing closer to the right side of the unit **10**, according to some embodiments.

[0082] **Figures 3, 4, 6, 7 and 8** illustrate that the unit **10** has a stab isolating portal **43** residing above the handle **20h** (**Figure 6-8**) or handles **20h** (**Figures 3 and 4**). The top cover of the unit **10** is not shown in **Figure 7** to more clearly illustrate the retractable stab **S**.

[0083] **Figure 3** illustrates one example of tandem rotary handles **20h** while **Figure 4** illustrates another exemplary embodiment of tandem rotary handles **20h**. **Figure 5A** illustrates an exemplary "ON" orientation/position of the handle **20h** while **Figure 5B** illustrates an exemplary "OFF" position. Thus, in operation, the pre-defined orientation of the rotary handle **20h** with respect to operation status can provide a visual indication to a user-operator of the conduction status of the disconnect **d**, e.g., breaker **10C** or switch disconnect **10S** (optionally with a fuse) being ON/OFF.

[0084] The term "ON" with respect to handle position/orientation refers to the associated feeder or starter of the unit **10** having conduction with the operator disconnect closed (circuit breaker closed or fused switch being ON/switch closed). The term "OFF" with respect to handle position/orientation refers to the associated feeder or starter of the unit **10** having no conduction with the disconnect open (circuit breaker open or disconnect switch OFF/switch open).

[0085] In some embodiments, if the handle **20h** is in a generally horizontal position, i.e., with the center lever **21** straight across the front of the circuit breaker as shown in **Figure 5B**, this orientation can be the OFF position and can be visually used as an indication that the contacts of the circuit breaker are open and that current is blocked. If the handle **20h** is rotated from the orientation shown in **Figure 5A**, e.g., rotated 90 degrees (typically clockwise from the orientation in **Figure 5B**), then an indication is given that the circuit contacts are closed. Where the unit **10** includes a breaker **10C**, the breaker trip position can be at about 45 degrees mid-point between ON and OFF. However, as noted above, the handles **20h** may have other configurations and are not required to be rotating handles and may use other angular orientations for ON and/or OFF.

[0086] The embodiment shown in **Figure 4** can be configured to have a "push" to pop out configuration as shown in **Figure 5C** whereby an aperture **20a** is exposed to allow a physical lock to be attached to an end of an arm **21** of the handle **20h**. For further description of this exemplary handle configuration, *see*, U.S. Patent Application Serial No. 14/174,481, the contents of which are hereby incorporated by reference as if recited in full herein.

[0087] **Figure 8** illustrates a long handle version of a handle **20h** which can provide additional torque control for some applications. An intermediate length handle may also be used for some embodiments (not shown).

[0088] **Figures 6-8** illustrate units **10** with a single handle **20h** adjacent a device or "pilot" device panel **66** configured with apertures **66a** to receive various control input members and/or indicating light devices **166** (**Figure 9**). The devices **166** can include pilot control devices, indicating lights, user inputs such as push buttons and/or selector switches and the like. There are many different variations that can be used as is well known to those of skill in the art. While six devices **166** and respective holding or receiving apertures **66a** are shown, the device panel **66** can be configured with more or less apertures **66a** and hold more or less control input members and/or indicating lights, for example.

[0089] The unit **10** can have a single continuous length panel **122** that holds both the handle **20h** and the device panel apertures **66a** as shown in **Figures 6** and **7**. The unit **10** can

be configured with the door 22 as a subpanel adjacent the separate/discrete device panel 66 as shown in **Figure 8**. Either embodiment may optionally be configured to engage one or more unit interlocks 93 (**Figures 6, 18**) and may pivot outward from a bottom edge thereof as will be discussed further below.

[0090] **Figure 10** illustrates that the unit 10 can have at least one laterally slidable shutter 75 with a portal 75p. When the portal 75p is aligned with the isolation portal 43, external access to the portal 43 is allowed. When the portal of the shutter 75p is left or right of the portal 43, the shutter body 75b resides over and blocks the portal 43. **Figure 11** illustrates that the shutter 75 can reside behind a panel 76 with an aperture 43a aligned with the access portal 43. **Figures 10 and 11** also illustrate that the unit 10 can have a FLASHGARD interlock L typically via the top surface of the unit.

[0091] As shown by **Figure 10** and **Figures 12A, 12B, 13A, 13B**, for example, the operator handle 20h can be attached to an inwardly extending shaft 25. The shaft 25 can hold the interlock linkage 70 and at least one cam 80. The shaft 25 can be part of the operator disconnect mechanism D, 40 (**Figure 19**, for example). Each of the right and left side cams 80 can be configured to move the at least one shutter 75 both right to left and left to right.

[0092] Referring to **Figures 12A, 12B, 13A, 13B**, in some embodiments, each of the cams 80 can be configured to engage a single shutter 75 that is slid left when each handle 20h is in the OFF position to open the shutter portal 43 by aligning portal 75p and is slid right when each handle 20h is in the ON position to block access to the portal 43 in response to the position of the handle 20h.

[0093] In some embodiments, the cam 80 can reside closer the front of the unit 10, e.g., closer to the handle 20h than the linkage 70. The cam 80 can have a plurality of radially-outwardly extending, circumferentially spaced apart arms 80a ("circumferentially" is used broadly to describe spacing about the shaft 25, recognizing that the shaft 25 may have a non-circular shape), at least one of which pushes the at least one shutter 75 to slide left and at least a different other at least one pushes the at least one shutter 75 to slide right. The cam 80 may have a curvilinear cam profile, e.g., with a curvature configured with outer lobes and a valley(s) rather than or in addition to the straight arms 80a to control movement of the at least one shutter 75 (not shown).

[0094] In some embodiments, the angular spacing α between the cam arms 80a on a respective shaft 25 can be between about 45-135 degrees, typically about 90 degrees. In some embodiments, the arms 80a are orthogonal to each other as shown in **Figure 12A**. The

angular spacing can substantially correspond with the angular spacing between ON and OFF for a respective handle **20h** orientation.

[0095] The shutter **75** can have a lower portion **75e** that can contact the cam **80** when the handle **20h** is in the defined positions to move into the appropriate aligned position: (i) with the shutter portal **75p** aligned with the portal **43** to open the access portal **43** or a misaligned position and (ii) with the shutter portal **75p** laterally offset from the portal **43** to block portal **43** access.

[0096] The lower portion **75e** can be referred to as a "cam follower". The cam follower **75e** moves linearly and is not required to always be in contact with the cam **80**. In some embodiments, the cam **80** is configured so that in the ON position, one arm contacts the cam follower **75e** and in the OFF position, the other arm contacts the cam follower. The cam follower **75e** may extend outwardly away from a plane associated with the shutter primary body, typically horizontally. The cam follower may extend substantially horizontally toward the front of the unit **10** or substantially horizontally toward the rear of the unit **10** and may have a different configuration. The cam follower **75e** can comprise a horizontally extending protrusion or ledge that can provide assembly tolerance so as to be able to consistently engage the drive portion of a respective cam **80** held on the shaft **25** despite build tolerances. The lateral stroke distance of the shutter **75** and/or lower portion of the shutter **75e** in each direction, right to left and/or left to right to open/close the access path to the portal **43** can be between about 0.25 inches to about 3 inches, more typically between about 1 inch to about 2 inches.

[0097] The cam **80** can be provided as a monolithic single piece body or may be provided as discrete closely spaced components held by the shaft **25** in a proper orientation to cause the respective sliding left and right lateral movement of the shutter **75**.

[0098] The linkage **70** can pivotably attached to a short outwardly extending link **71** via joint **70j** with the link **71** being shorter than the lever arm **72** of the linkage **70** (**Figures 12B, 13B**) and is typically shorter than the cam arms **80a**. The linkage **70** is typically fully extended (horizontal or substantially horizontal) in the ON position (**Figure 12B, 13B**) to extend out of the sidewall **13** and is retracted so as to be pivoted downward or upward in the OFF position (**Figure 12A**).

[0099] In some embodiments, a monolithic shaped (typically rigid metal) member **M** can define both the short link **71** and at least one of the cam arms **80a** as shown in **Figures 12B and 13A**, for example.

[00100] The shutter **75** can be provided as a single shutter that cooperates with the right and left cams **80** of both handles **20h** as shown. Alternatively, two or more separate shutters may be provided, such as one for each handle **20h** and respective cam **80**. For example, if two shutters are used, **75₁**, **75₂**, one can reside in front of the other and independently slide right and left in response to respective handle position **20h** (**Figures 14A, 14B**). In other embodiments, the two shutters can reside in the same plane and laterally move to provide the access and blocking configurations.

[00101] The unit **10** can be configured with an interlock that ensures that the unit disconnect **D** (e.g., breaker) is OPEN before allowing the unit stabs **S** to be racked in or out, and when the disconnect **D** (breaker) is closed, the interlock is configured so that the stabs **S** must remain closed. The racking system can be configured as a slow break contact arrangement and is not typically designed to breaker the electrical current.

[00102] **Figure 15** illustrates an internal compartment of exemplary compact dual feeder/starter units **10** illustrating the cams **80** closely spaced to the respective handle **20h** and illustrating that one shaft **25** can be longer than the other. **Figure 15** shows a longer shaft on the right side operator mechanism placing the operator mechanism sliders **150, 152** (**Figure 19**) further back in the unit housing **10h**, closer to the back wall **10b**. The longer shaft **25** can have a length that is between about 3 inches to about 5 inches. The longer shaft **25** can be between 1.5-10 times (e.g., 1.5X-10X) the length of the other shaft, e.g., about 1.5x, about 2X, about 3X, about 4X, about 5X, about 6X, about 7X, about 8X, about 9X or about 10X the length of the other shaft **25**. Typically the longer shaft is between about 1.5X to about 5X the length of the shorter shaft. The longer shaft **25** can be configured to have a primary shaft body attached to an extension that provides the additional length or may be a unitary body.

[00103] Referring to **Figure 16**, in some embodiments the disconnect handle **20h** on sub-panel and/or door **22** and the device sub-panel **66** can be attached at the inner sides **22i, 66i** to be able to pivot outwardly in concert via joints **66j, 22j**, for example. Referring to **Figure 17**, in some embodiments, the unit **10** can have a long (single) panel **122** that holds the handle **20h** and the pilot devices/components **166** and can be configured to pivot outward. Typically, the pivot attachment includes outer lower pivot joints **122j** at the bottom corner portions of the unit **10** as shown in **Figure 17**. With the configurations shown in **Figures 16** and **17**, the hinged panel **122** or attached sub-panels **66, 22**, can be interlocked with the unit interlock **93** as shown in **Figure 18**. The unit interlock **93** can be in communication with an electronic controller **193** that controls the release or the interlock **93**. The interlock **93** may include an automated clamp or latch **93c** that holds the lower end of the panel **122** or sub-

panels **22** and **66**, and may include a latch **93** that extends out of the sidewall **13** to prevent the panel(s) from pivoting when the interlock is engaged.

[00104] As shown in **Figure 19**, the unit **10** can include a disconnect **D** such as a molded case circuit breaker (MCCB) **10C** or disconnect switch **10S**, one or both of which can be operated by an internal operating handle mechanism **40** commonly called the "op-mech" or "operator mechanism" or "disconnect operator". The disconnect switch **10S** can include an integrated fuse or may be connected to a fuse, in some embodiments. This op-mech **40** can be configured to mount over the lever **90**, e.g., a breaker's integral lever and/or an ON/OFF switch lever of disconnect switch. The op-mech **40** allows a user to operate the circuit breaker **10C** or switch **10S** with the door **22** of the motor control center unit **10** closed. The door **22** and/or handle **20h** itself can include visual indicia **I** (**Figures 5A/5B/5C**), e.g., text and/or color, that identifies an operational status by position, e.g., Reset "R", OFF, TRIPPED and ON. The TRIPPED indicia may be omitted for fuse systems. It is noted that for ease of discussion, the dual feeders are used by way of example. However, a respective feeder can be replaced with a starter and any unit **10** can include two starter circuits, two feeder circuits or a starter and a feeder, for example.

[00105] For a circuit breaker configuration, the handle **20** can move between circuit breaker conduction to circuit breaker non-conduction. Where a rotating handle is used, typically, there is about a 90° rotation from conduction to non-conduction ("OFF" to "ON") but other defined rotational stroke distances may be used including, for example, about 45 degrees, about 120 degrees, or about 180 degrees. For a fused disconnect, a similar rotation can be used to cause the ON/OFF.

[00106] As shown in **Figure 19**, for example, the operator mechanism **40** can include a drive gear **142**, a pinion gear **144**, and an operator rack gear **146**. Generally summarized, the handle **20h** via shaft **25** is keyed to interface with the rotary drive gear **142**. Drive gear **142** interacts mechanically with pinion gear **144**. Pinion gear **144** also interacts with the linearly translating moveable rack **146**. Consequently, as the handle **20h** rotates, because it is interlocked with the drive gear **142**, the drive gear **142** rotates on its axis, thus rotating the pinion gear **144**, which then linearly moves the rack **146**. The rack **146** then moves the operator slider **152** over operator base **150** which moves to trip lever **190** as the handle **20h** moves. The operator base **150** can be stationary and affixed to an inner housing. The base **150** can have a horizontally oriented elongate slot **150s** that is aligned with a smaller slot **152s** in the operator slider **152**. The slots **150s**, **152s** cooperate to hold lever **190** (toggle) and when the operator slider with slot **152s** moves to the right (based on rotation of the handle

20h, for example), this moves the lever **190** to the right along the path defined by slot **150s**. It is noted that the lever **190** (also known as a toggle) can move laterally as shown or the circuit breaker or fuse switch may be oriented to move vertically.

[00107] The base **150** and cooperating slider **152** can be provided in different sizes with different length and width slots **150s** to accommodate smaller and larger toggles or switches **90** associated with frames of different sizes/amperage rating.

[00108] For fused switch disconnects, the gear **142** in communication with a rack gear **146** may optionally be configured to move up and down or orthogonal to the rack gear **146**. This movement can engage and move a fuse switch lever or input, up and down for ON/OFF operation. Exemplary fuses are FUSETRON™ 600V Class RK5 fuses (BU-SB13729) available from Cooper Bussmann Company, St. Louis, MO. However, the design is flexible and can accommodate other fuses including those in different classes. For additional description of an example of an operator mechanism and components thereof for fused disconnects, see, e.g., U.S. Provisional Application Serial No. 61/890,495, the contents of which are hereby incorporated by reference as if recited in full herein.

[00109] Referring again to **Figure 19**, for units **10** with circuit breakers **10C**, the operating mechanism **40** can also include a trip assist spring **143** that is in communication with the rack gear **146** to assist the handle **20h** to move to a consistent OFF position when the circuit breaker is tripped. For additional description of an example of an operator mechanism and components thereof, *see, e.g.*, U.S. Provisional Application Serial No. 61/890,495, the contents of which are hereby incorporated by reference as if recited in full herein.

[00110] **Figure 20** is a flow chart of exemplary operations that can be used to provide portal access using at least one sliding shutter. An externally accessible operator handle of a bucket or unit attached to an inwardly extending shaft and holding a laterally outwardly extending interlock linkage and a cam can be rotated to move to an ON (OPERATOR DISCONNECT CLOSED) or OFF (OPERATOR DISCONNECT OPEN) position (block **300**). The operator handle can be rotated to the ON position to (i) extend an end portion of the interlock linkage through an aperture in a sidewall of the bucket and (ii) position the cam to force a shutter to slide left or right to block access to an access portal associated with control of a retractable stab (block **310**).

[00111] The cam can comprise first and second outwardly extending arms, the arms being (circumferentially) spaced apart about the shaft (block **303**). The spacing can be about 90 degrees. The angular spacing can correspond with the angular spacing between ON and OFF for a respective handle **20h** orientation.

[00112] The bucket can be a dual starter and/or feeder with adjacent right and left operator handles, each having the shaft with a respective linkage and cam so as to have a right shaft, right linkage and right cam, and a left shaft, left linkage and left cam (block 305).

[00113] The rotating can be carried out so that when the left disconnect is closed (handle in the ON position), the left shutter covers access to the portal and when the right disconnect is closed (handle in the ON position), the right shutter covers access to the portal (block 307).

[00114] The right and left cams can contact respective linearly movable right and left followers that contact the portal shutter to slide the shutter and the cam followers so that the cam followers operate independently of each other (block 309).

[00115] The right and left cam followers can operate independently of each other to move a common shutter or move two shutters to block the stab isolation access portal 43. Moving either disconnect handle 20h to the open position OPEN can cause the shutter to open the portal 43. Both disconnect handles 20h can be required to be OPEN before the shutter portal 75 is aligned with the stab isolation portal 43 to allow access to the portal 43.

[00116] The foregoing is illustrative of the present invention and is not to be construed as limiting thereof. Although a few exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention. Therefore, it is to be understood that the foregoing is illustrative of the present invention and is not to be construed as limited to the specific embodiments disclosed, and that modifications to the disclosed embodiments, as well as other embodiments, are intended to be included within the scope of the invention.

That Which Is Claimed Is:

1. A bucket sub-assembly to control access to a stab portal of a bucket unit, comprising:

first and second spaced apart operator disconnect handles, the first operator disconnect handle attached to a first inwardly extending shaft that holds a first cam, the second operator disconnect handle attached to a second inwardly extending shaft that holds a second cam, wherein the first and second cams are configured to independently rotate, and wherein the first and second cams rotate in response to rotation of a corresponding operator disconnect handle; and

at least one shutter in communication with the first and second cams, wherein the at least one shutter has a shutter portal, and wherein the at least one shutter is configured to cooperate with the first and second cams to laterally slide to a position that misaligns the shutter portal with a stab isolation portal to block access to the stab isolation portal when the first and/or second operator disconnect handle is in the ON position associated with conduction.

2. The bucket sub-assembly of Claim 1, wherein the first and second cams each comprise first and second drive segments, one of which slides the at least one shutter one direction and one of which slides the at least one shutter in an opposite direction.

3. The bucket sub-assembly of Claim 2, wherein the drive segments comprise arms that reside angularly apart between about 45-135 degrees.

4. The bucket sub-assembly of Claim 3, wherein the arms extend straight out from the shaft and are orthogonal to each other.

5. The bucket sub-assembly of Claim 1, further comprising a front panel holding the first and second operator disconnect handles, wherein the front panel is a single panel or side-by-side dual sub-panels that are attached along inner short sides thereof to be able to pivot outward together, and wherein the single panel or dual sub-panels are pivotably attached to a unit housing to pivot outward along a long axis associated with a long bottom side of the front panel.

6. The bucket sub-assembly of Claim 1, wherein the first and second operator disconnect handles are right and left operator disconnect handles, wherein the bucket sub-assembly further comprises right and left interlock linkages, (i) the right interlock linkage comprising a link with one end portion attached to the first shaft and pivotably attached to a right lever at an opposing end portion and (ii) the left interlock linkage comprising a link with one end attached to the second shaft at one end portion and pivotably attached to a left lever at an opposing end portion, wherein the links extend straight outward from respective first and second shafts, the right lever having an end portion that is configured to extend out of a right sidewall of a unit housing of a bucket assembly when the right operator disconnect handle is in the ON position and the left lever having an end portion that is configured to extend out of a left sidewall of the unit housing of the bucket assembly when the left operator disconnect handle is in the ON position.

7. The bucket assembly of Claim 1, wherein the at least one shutter is a single shutter, and wherein the first and second operator disconnect handles are right and left operator disconnect handles, and wherein the right and left cams are configured to slide the single shutter right and left independently of each other.

8. The bucket assembly of Claim 1, wherein the at least one shutter is a single shutter, and wherein the first and second cams are configured to slide the single shutter independently of each other.

9. The bucket assembly of Claim 1, wherein the first and second operator handles are held by a front panel that is configured to pivot outward from hinges residing at a lower opposing long end portions thereof, and wherein the front panel engages a unit interlock to controllably lock and unlock the interlock to allow the pivoting movement only when there is non-conduction.

10. A bucket assembly, comprising:

a unit housing having a front panel and opposing laterally spaced apart sidewalls extend rearward of the front panel of the unit housing;

a right operator disconnect handle on the front of the unit housing and attached to a right inwardly extending shaft, wherein the right shaft holds a right cam configured to rotate in response to rotation of the right operator disconnect handle.

a left operator disconnect handle on the front of the unit housing and attached to a left inwardly extending shaft and being laterally spaced apart from the right operator disconnect handle, wherein the left shaft holds a left cam configured to rotate in response to rotation of the left operator disconnect handle;

at least one shutter in communication with the right and/or left cam whereby the at least one shutter slides to the right and left in response to contact with the right and/or left cam; and

a stab isolation portal residing above the right and left shafts of the right and left operator disconnect handles, wherein the at least one shutter has a shutter portal, and wherein the at least one shutter is configured to have a position that misaligns the shutter portal with the stab isolation portal to block access to the stab isolation portal when either of the right and left operator disconnect handles is in the ON position associated with conduction.

11. The bucket assembly of Claim 10, wherein the at least one shutter is a single shutter and the right and left cams are configured to slide the single shutter independently of each other.

12. The bucket assembly of Claim 10, further comprising a right interlock linkage attached to the right shaft and a left interlock linkage attached to the left shaft, each configured to rotate with respective right and left shafts.

13. The bucket assembly of Claim 10, further comprising a right feeder or starter held in the unit housing in communication with the right operator disconnect handle and a left feeder or starter held in the unit housing in communication with the left operator disconnect handle.

14. The bucket assembly of Claim 10, wherein the cam comprises arms that reside angularly apart between about 45-135 degrees.

15. The bucket assembly of Claim 10, wherein the at least one shutter comprises a single shutter or two adjacent shutters, wherein the single shutter or the two shutters are configured with left and right cam followers residing on lower portions of the single shutter or on lower portions of the two shutters.

16. The bucket assembly of Claim 10, further comprising right and left interlock linkages, each with a link attached to a respective shaft at one end portion and pivotably attached to a lever at an opposing end portion, wherein the link extends straight outward from a respective shaft, wherein the lever attached to the right shaft has an end portion that is configured to extend out of a right sidewall of the bucket assembly when the right operator disconnect handle is in the ON position and the lever attached to the left shaft has an end portion that is configured to extend out of a left sidewall of a unit housing of the bucket assembly when the left operator disconnect handle is in the ON position.

17. The bucket assembly of Claim 10, wherein the front panel is a single panel that extends between the sidewalls or wherein the front panel is configured as two adjacent sub-panels that are attached at inner sides thereof to be able to pivot outwardly in concert along the long axis.

18. A motor control center (MCC), comprising:

a housing with first and second sidewalls defining an enclosure with a plurality of compartments, the compartments configured to removably receive a plurality of units, wherein at least one of the units comprises:

a unit housing having a front and opposing laterally spaced apart sidewalls that extend rearward of the front of the unit housing;

at least one operator disconnect handle on the front of the housing and attached to an inwardly extending shaft, wherein the shaft holds a cam configured to rotate in response to rotation of the operator disconnect handle, wherein the cam comprises first and second arms that extend straight out from the shaft and that reside angularly spaced apart between about 45-135 degrees;

at least one shutter in serial communication with the first and second arms of the cam whereby the at least one shutter slides right and left in response to a follower that contacts the first and second arms of the cam; and

a stab isolation portal residing above the shaft of the operator disconnect handle, wherein the shutter has a shutter portal, and wherein the shutter is configured to have a position that misaligns the shutter portal with the stab isolation portal to block access to the stab isolation portal when the at least one operator disconnect handle is in the ON position associated with conduction.

19. The MCC of Claim 18, wherein the front of the unit housing comprises a pilot panel segment or sub-panel holding a plurality of pilot devices laterally spaced apart from the at least one operator disconnect handle.

20. The MCC of Claim 18, wherein the at least one operator disconnect handle comprises a right operator disconnect handle with a right shaft and right cam and a left operator disconnect handle with a left shaft and left cam, and wherein the right and left cams are configured to slide the at least one shutter right and left independently of each other.

21. The MCC of Claim 18, wherein the at least one operator handle is held by a front panel attached to the unit housing, the front panel configured to pivot outward from hinges residing at a lower opposing long end portions thereof, and wherein the front panel engages a unit interlock attached to the unit housing to controllably lock and unlock the front panel to allow the pivoting movement only when there is non-conduction.

22. A method of controlling access to a stab isolation portal of a bucket, comprising: rotating an externally accessible operator disconnect handle of a bucket or unit to an ON position, the operator disconnect handle attached to an inwardly extending shaft, the shaft holding a laterally outwardly extending interlock linkage and a cam, wherein in response to the rotation of the operator disconnect handle, (i) an outer end portion of the interlock linkage extends out through an aperture in a sidewall of the bucket or unit and (ii) the cam forces a shutter to slide left or right to block access to a stab isolation access portal associated with a retractable stab.

23. The method of Claim 22, wherein the bucket is a dual feeder or starter bucket with right and left operator disconnect handles, each having respective shafts with the cam and interlock linkage, and wherein the rotating is carried out so that the cams of each shaft move the shutter independently of the other and are configured to slide the shutter to a position that blocks access to the stab isolation access portal unless both the right and left operator handles are in an OFF position associated with non-conduction.

24. A bucket assembly, comprising:
a unit housing having a front and opposing laterally spaced apart sidewalls extend rearward of the front of the unit housing:

at least one operator disconnect handle on the front of the unit housing and attached to an inwardly extending shaft, wherein the shaft holds (i) at least one cam configured to rotate in response to rotation of a respective operator disconnect handle and (ii) an interlock linkage that pivots as the shaft rotates to extend a sufficient distance to extend through an aperture in the sidewall of the unit housing and retract to be inside the unit housing;

at least one shutter in communication with the at least one cam whereby the at least one shutter slides to the right and left in response to contact with the at least one cam on a respective inwardly extending shaft; and

a stab isolation portal residing above the shaft of the at least one operator disconnect handle, wherein the at least one shutter has a shutter portal, and wherein the at least one shutter is configured to have a position that misaligns the shutter portal with the stab isolation portal to block access to the stab isolation portal when a respective at least one operator disconnect handle is in the ON position associated with conduction.

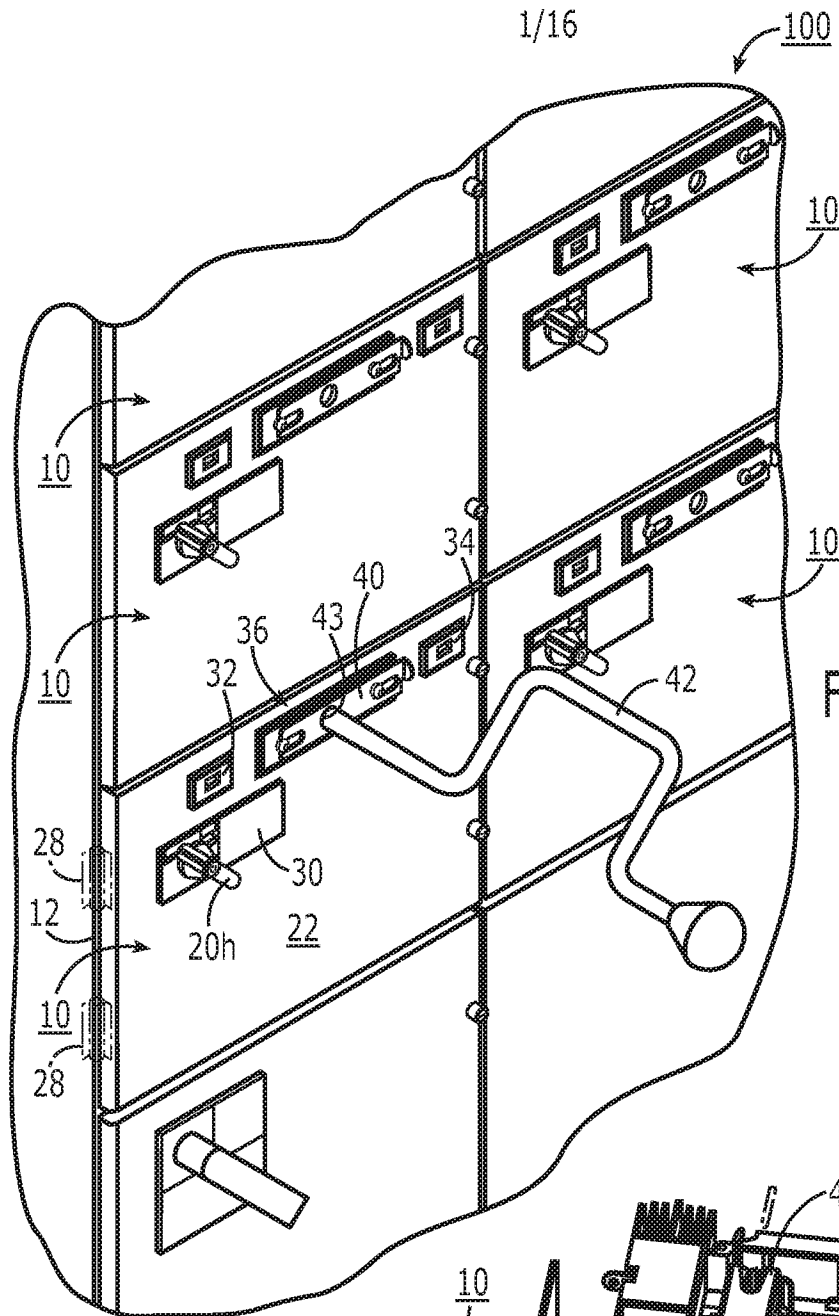
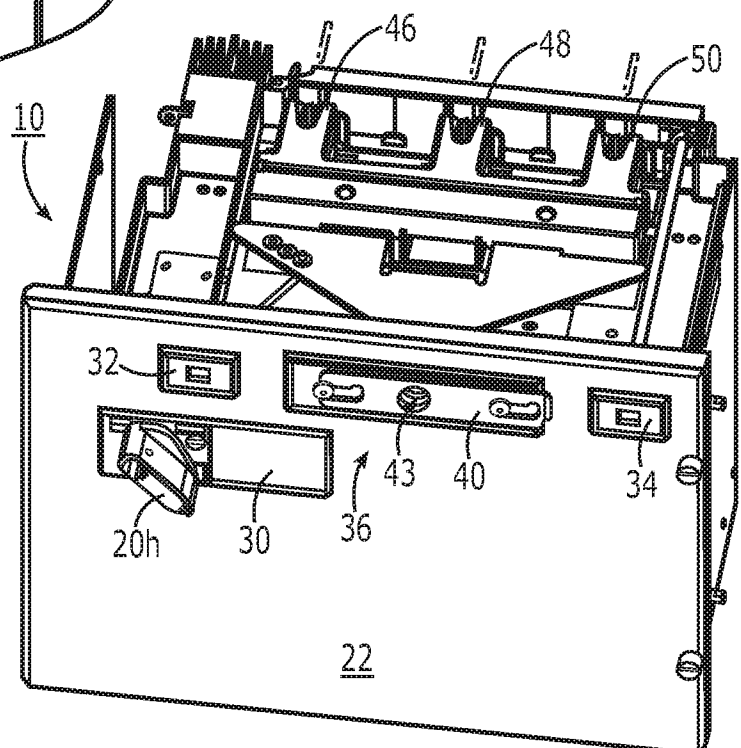


Figure 1
PRIOR ART

Figure 2
PRIOR ART



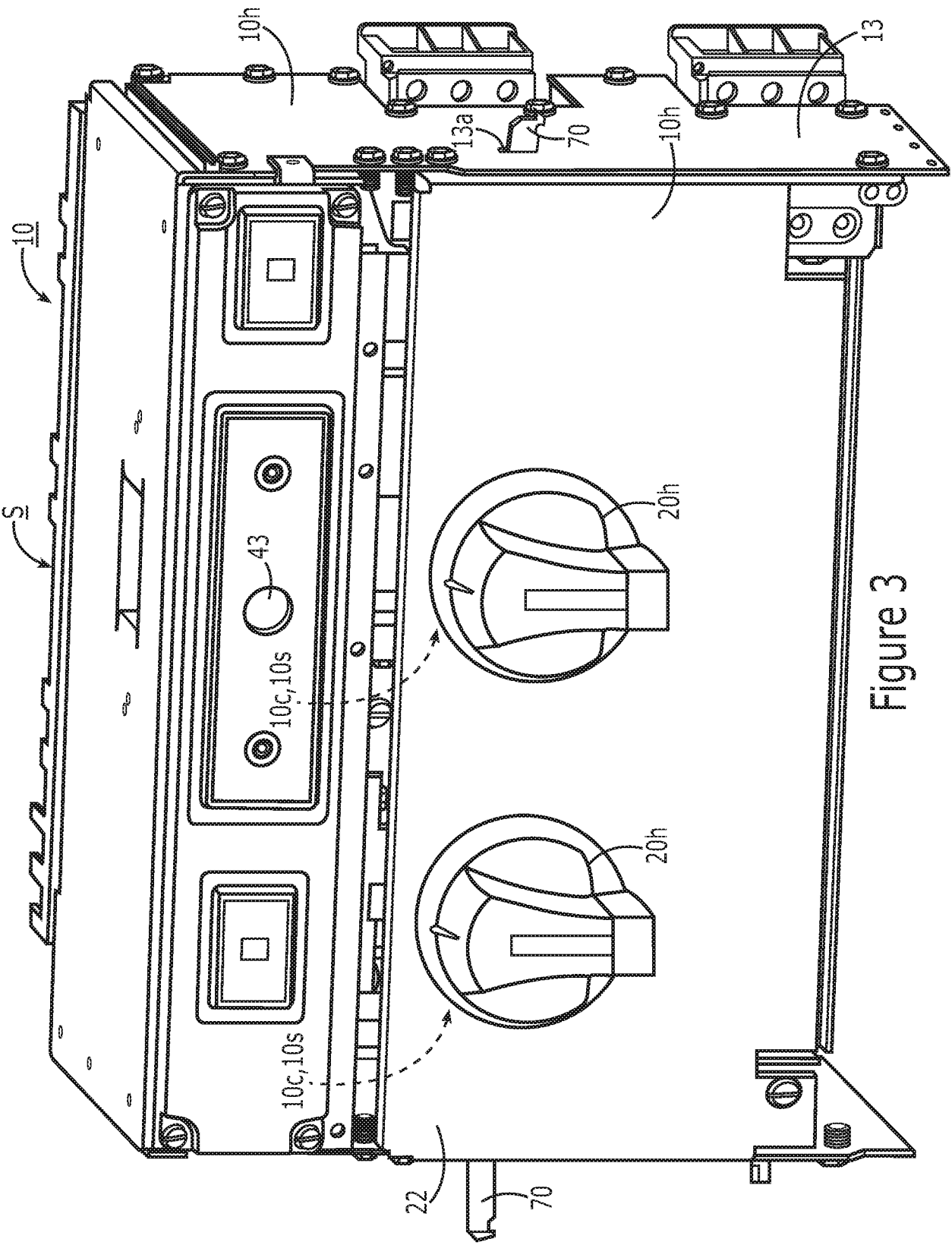


Figure 3

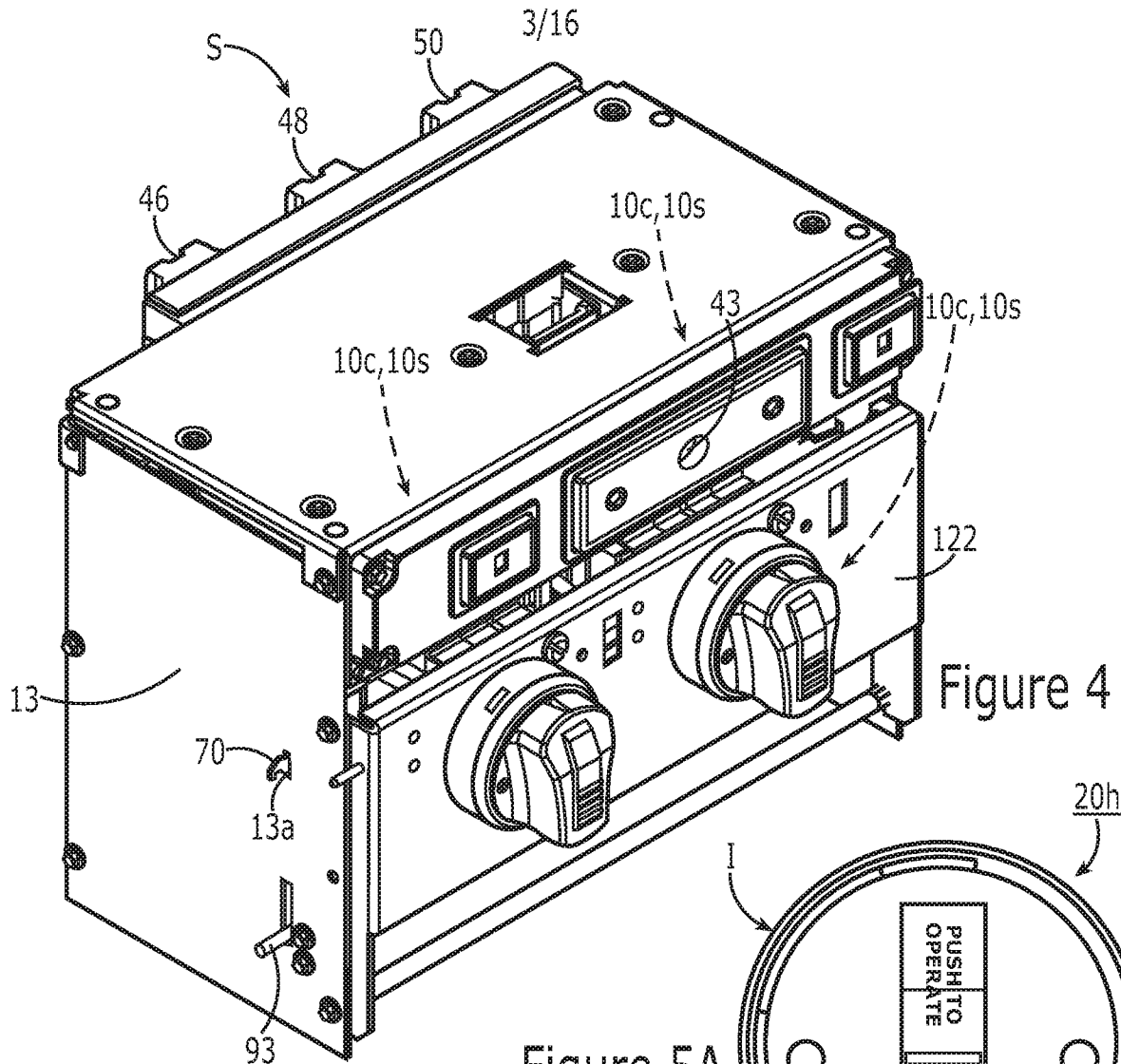


Figure 5A

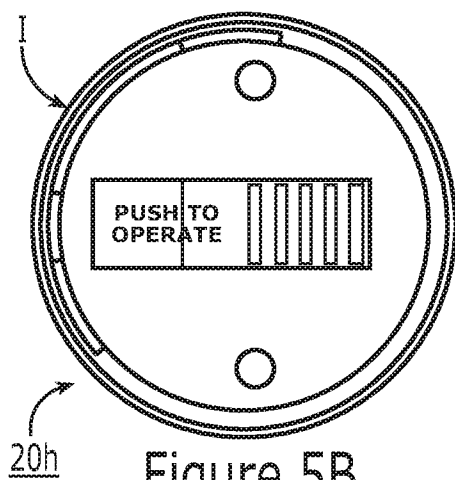
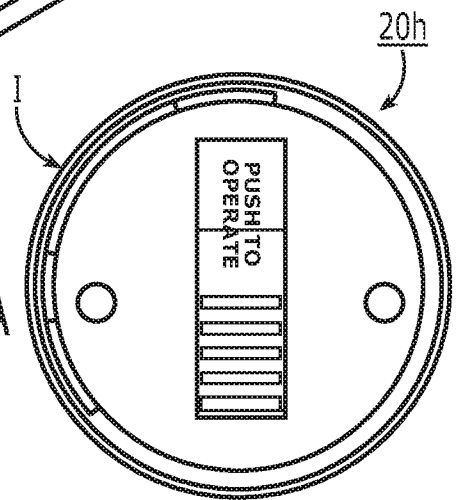


Figure 5B

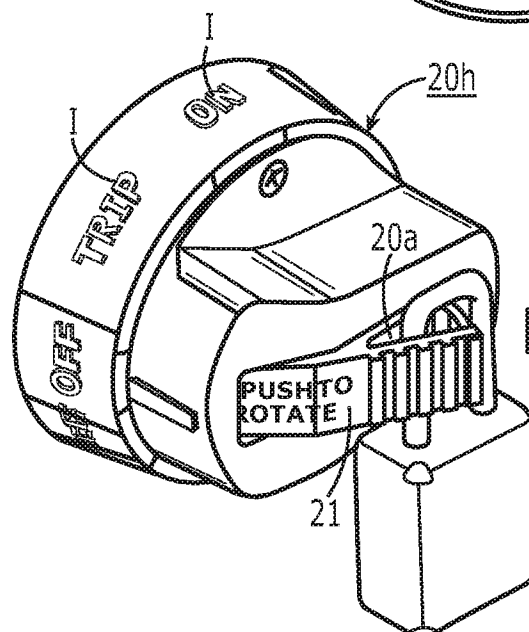
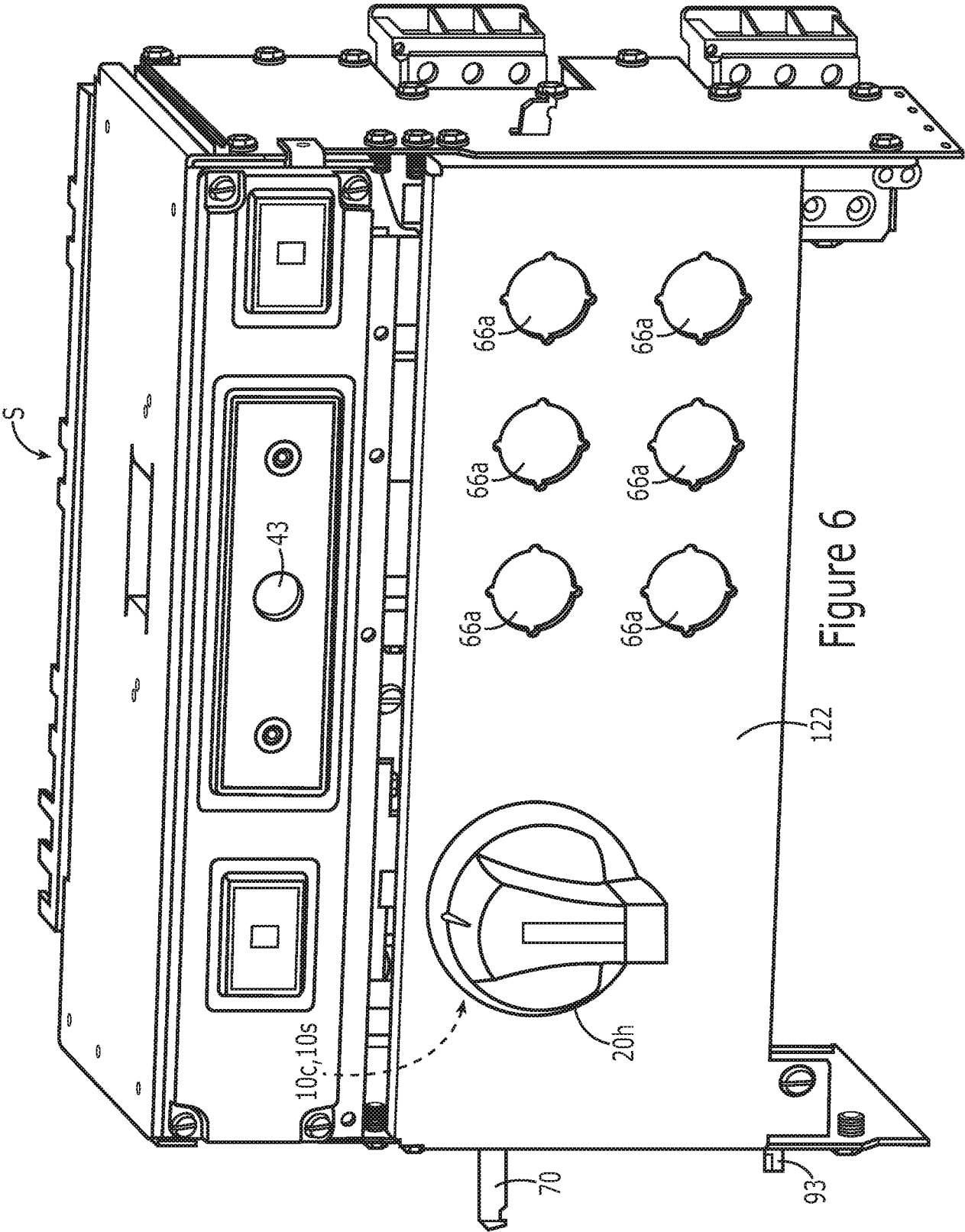


Figure 5C



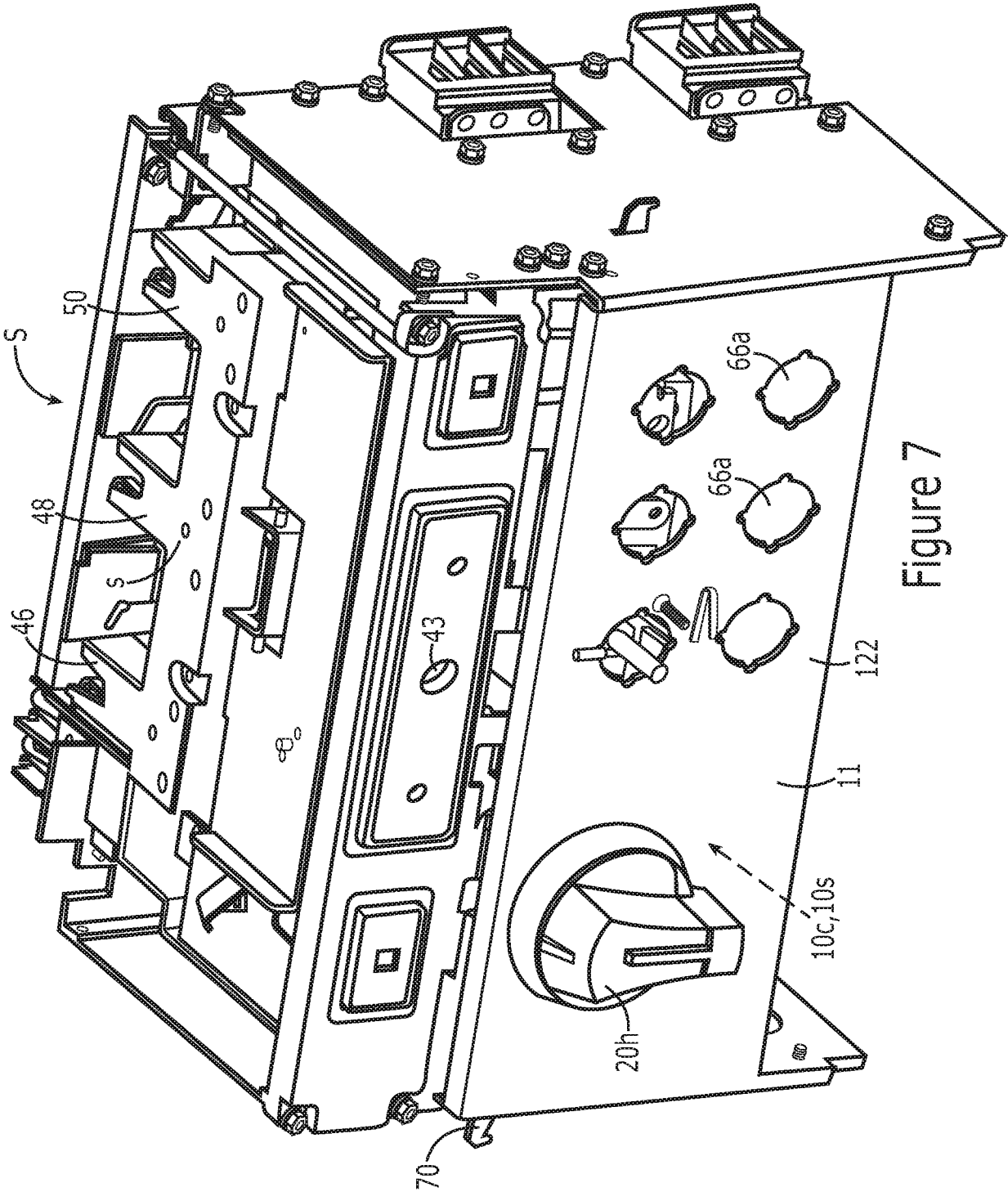


Figure 7

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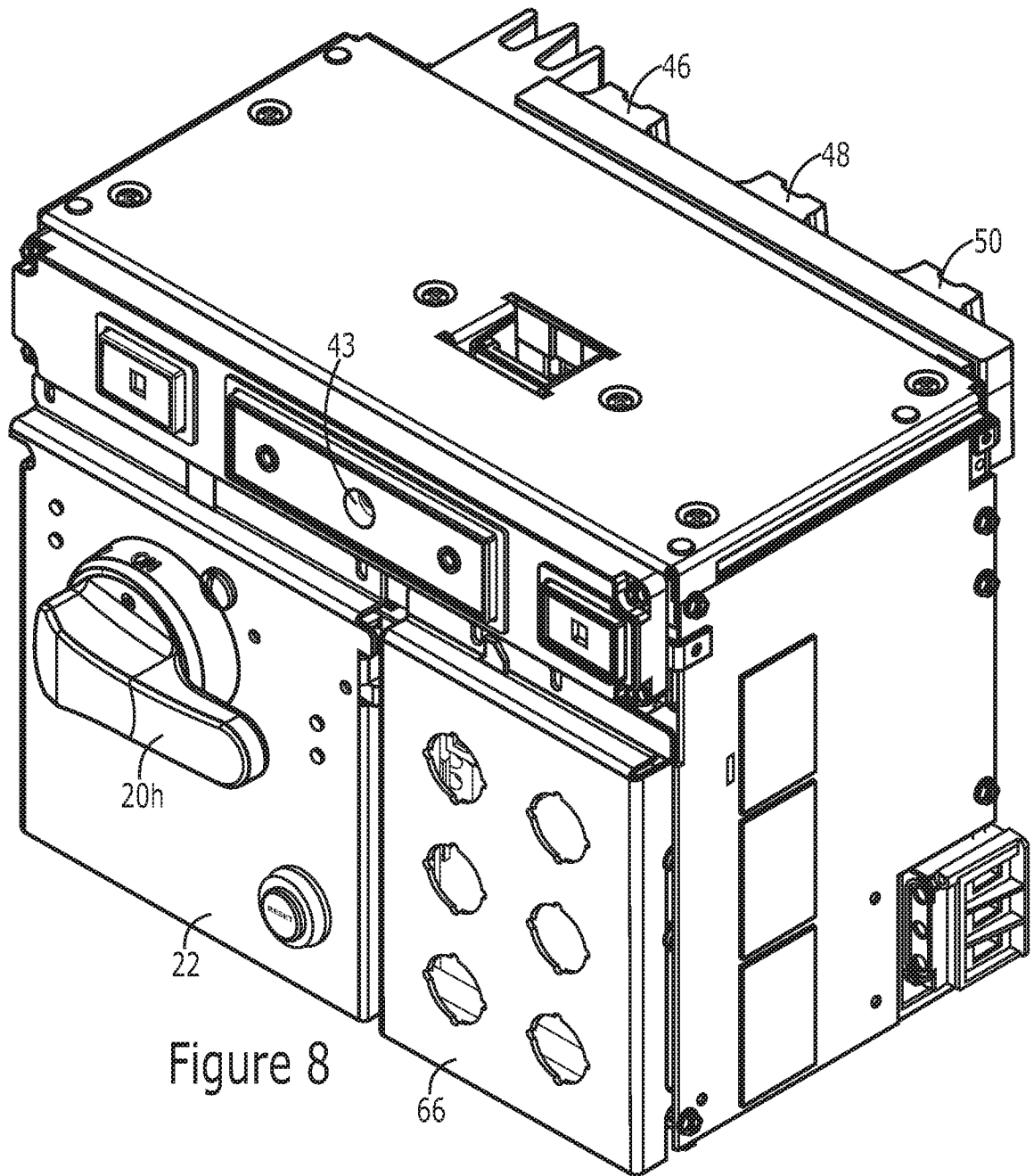


Figure 8

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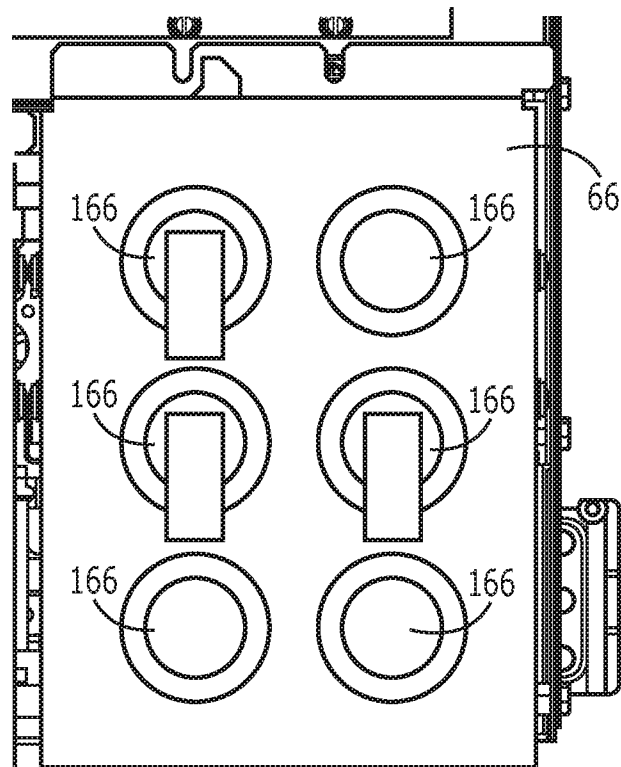


Figure 9

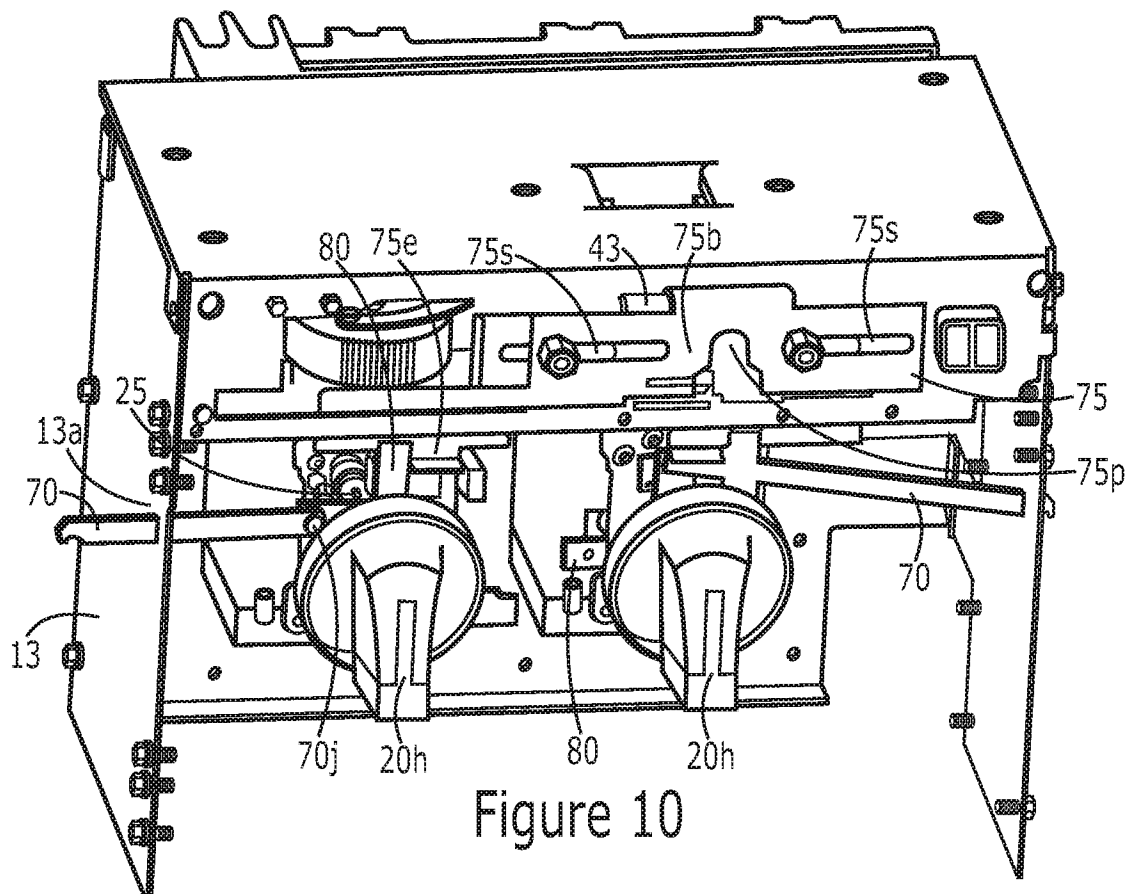


Figure 10

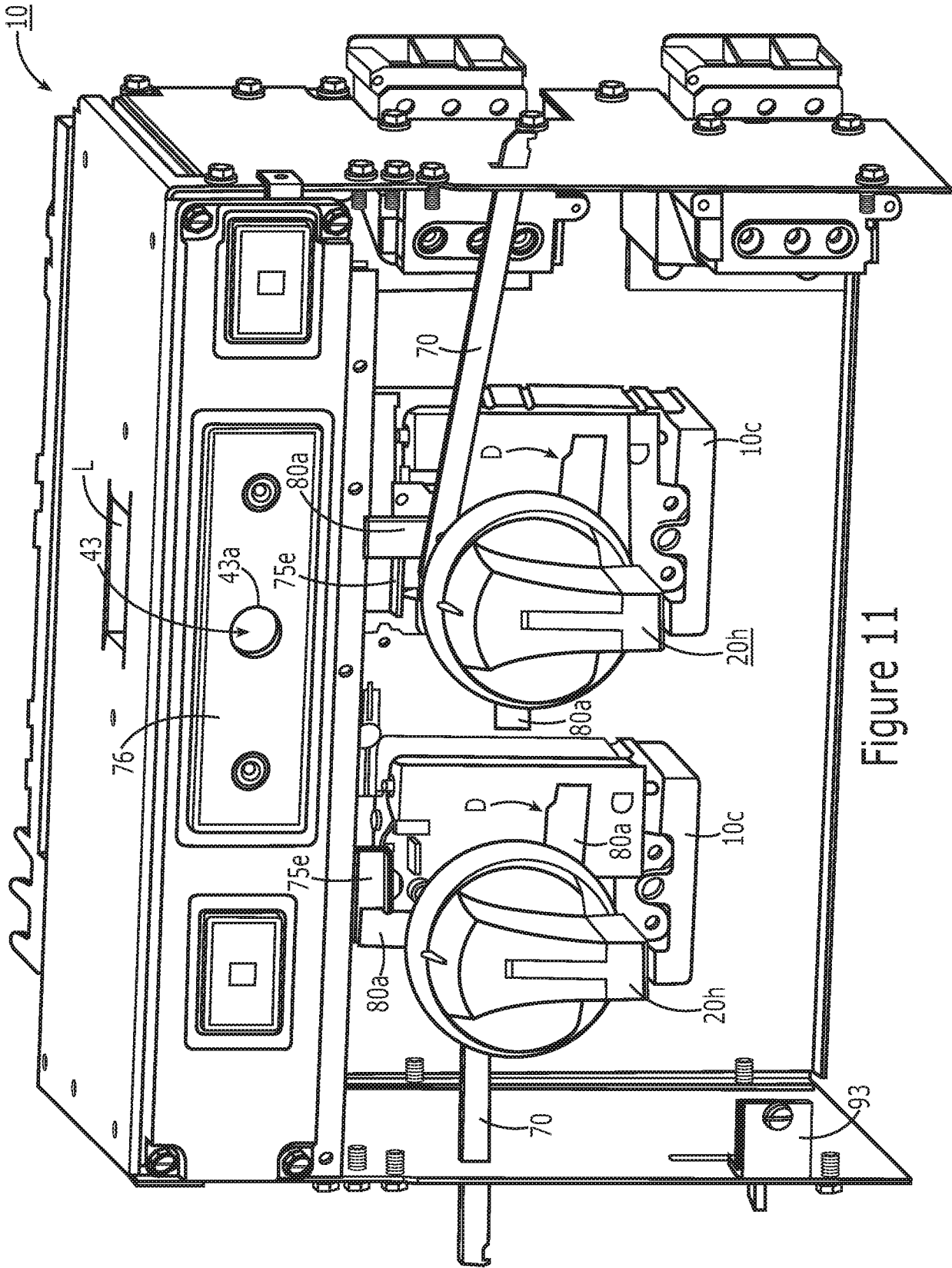
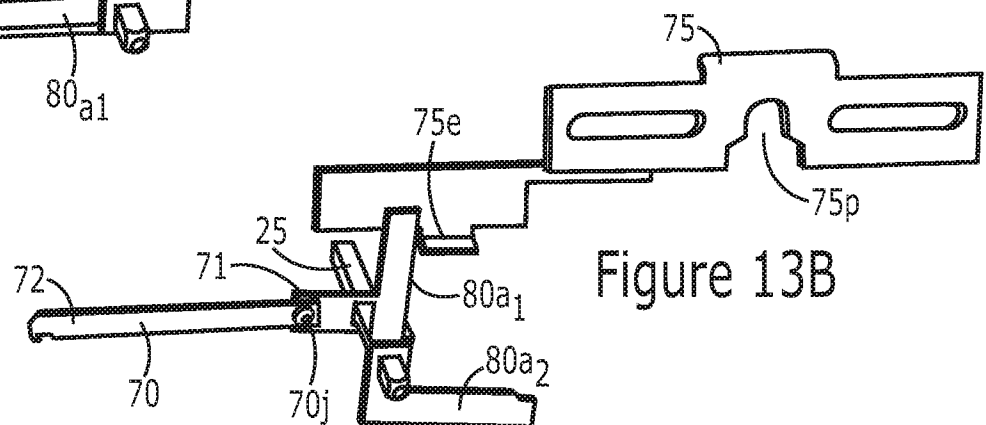
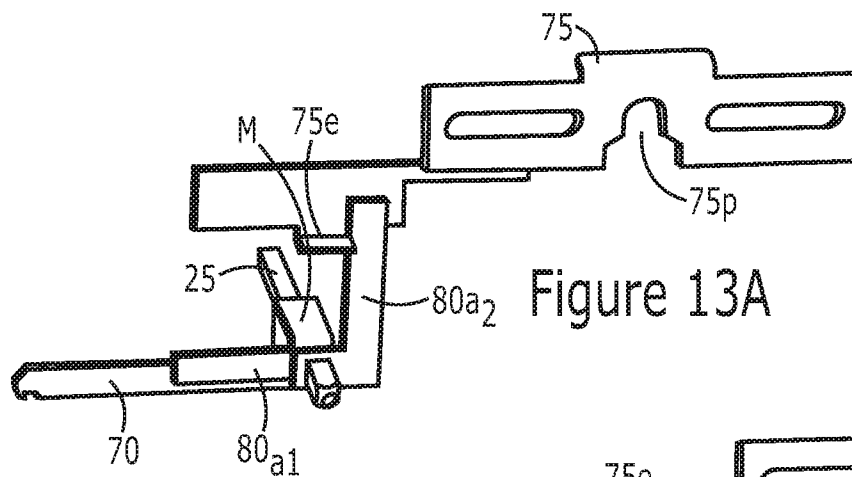
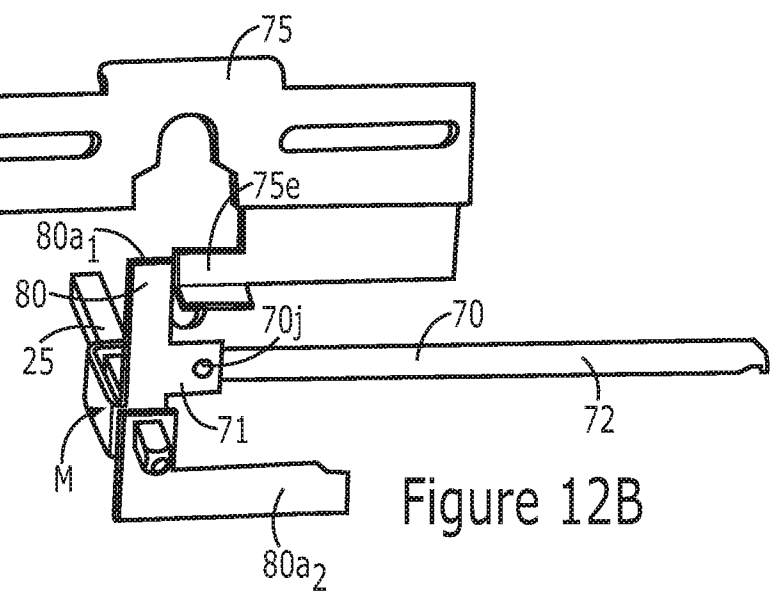
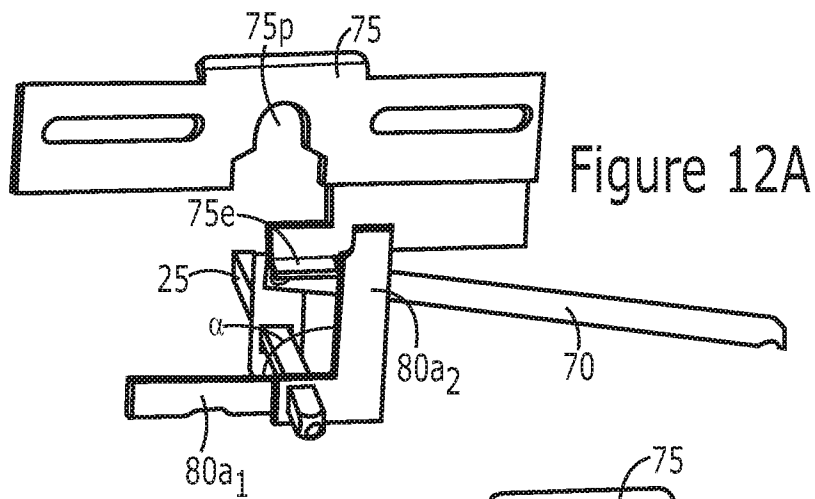


Figure 11

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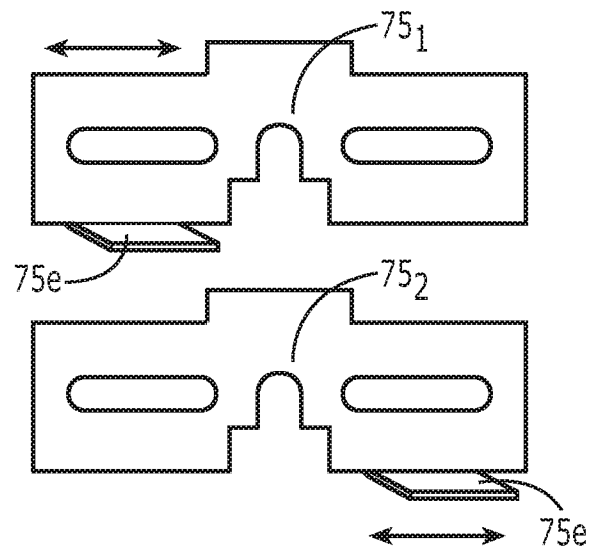


Figure 14A

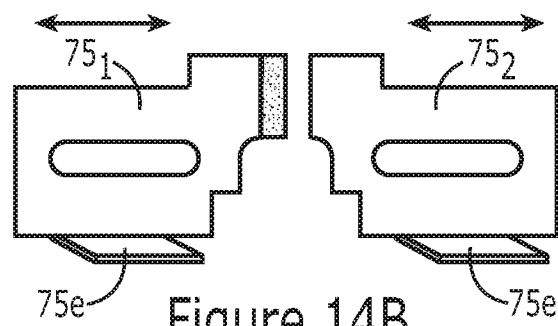


Figure 14B

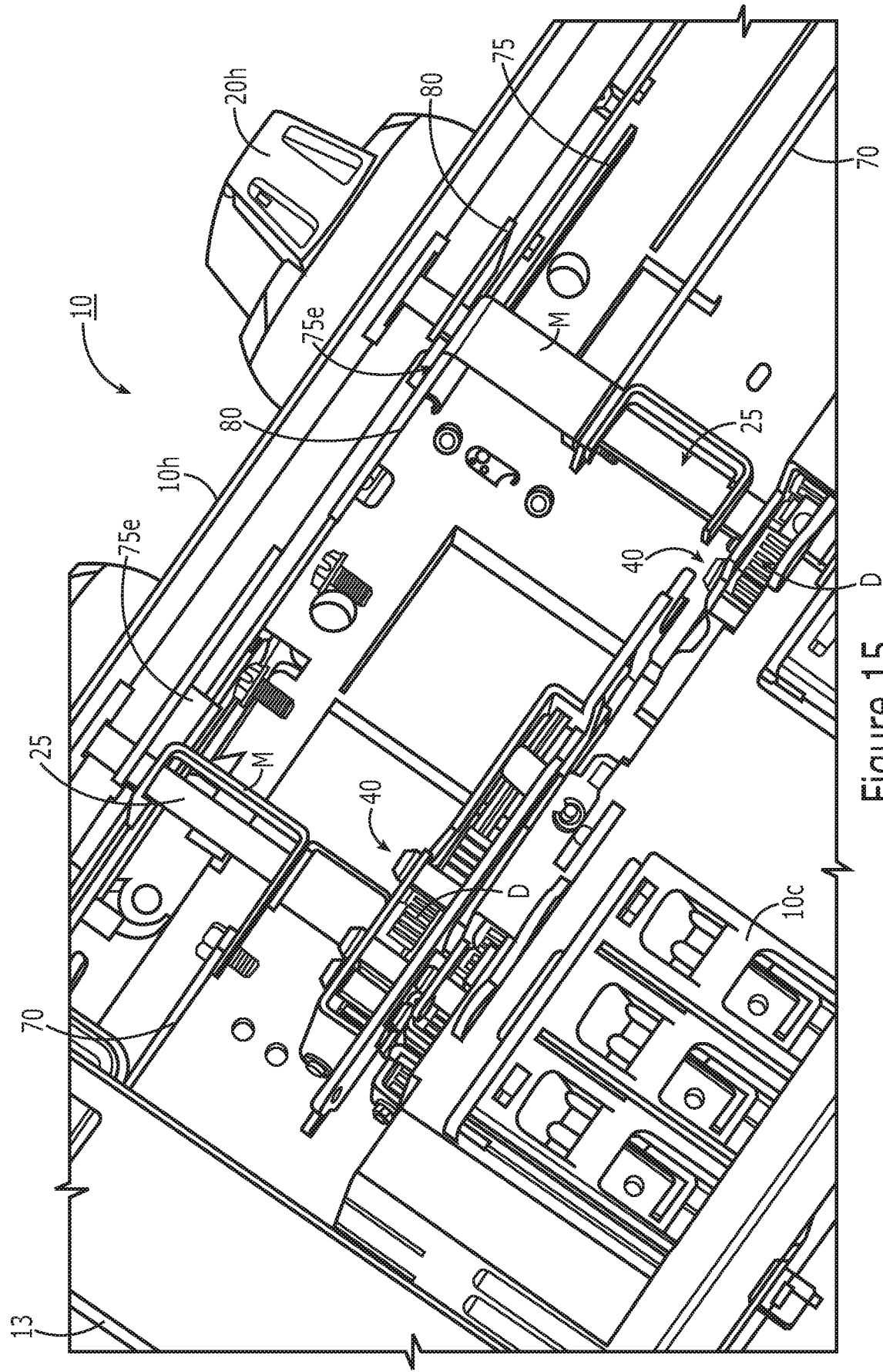
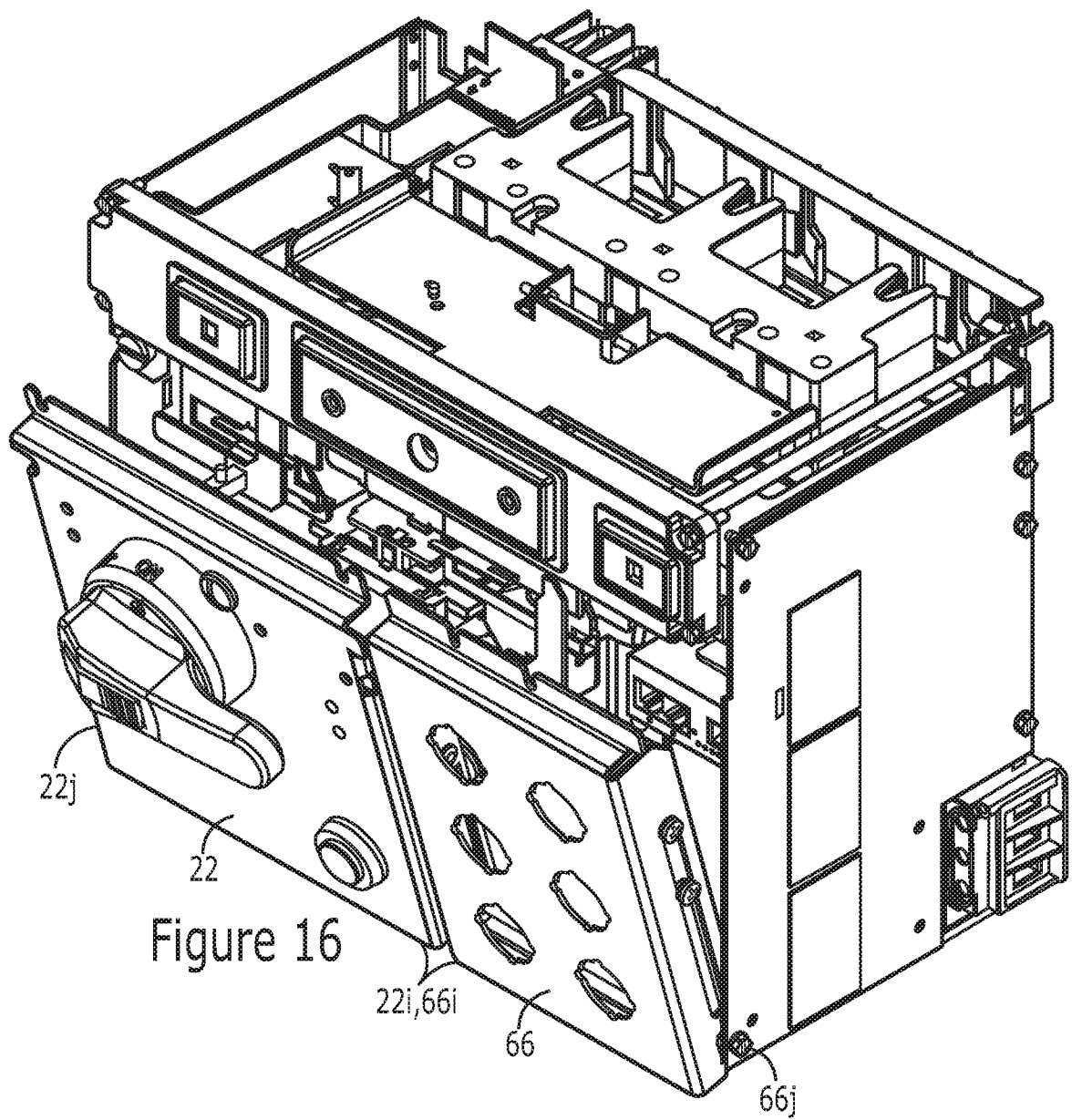
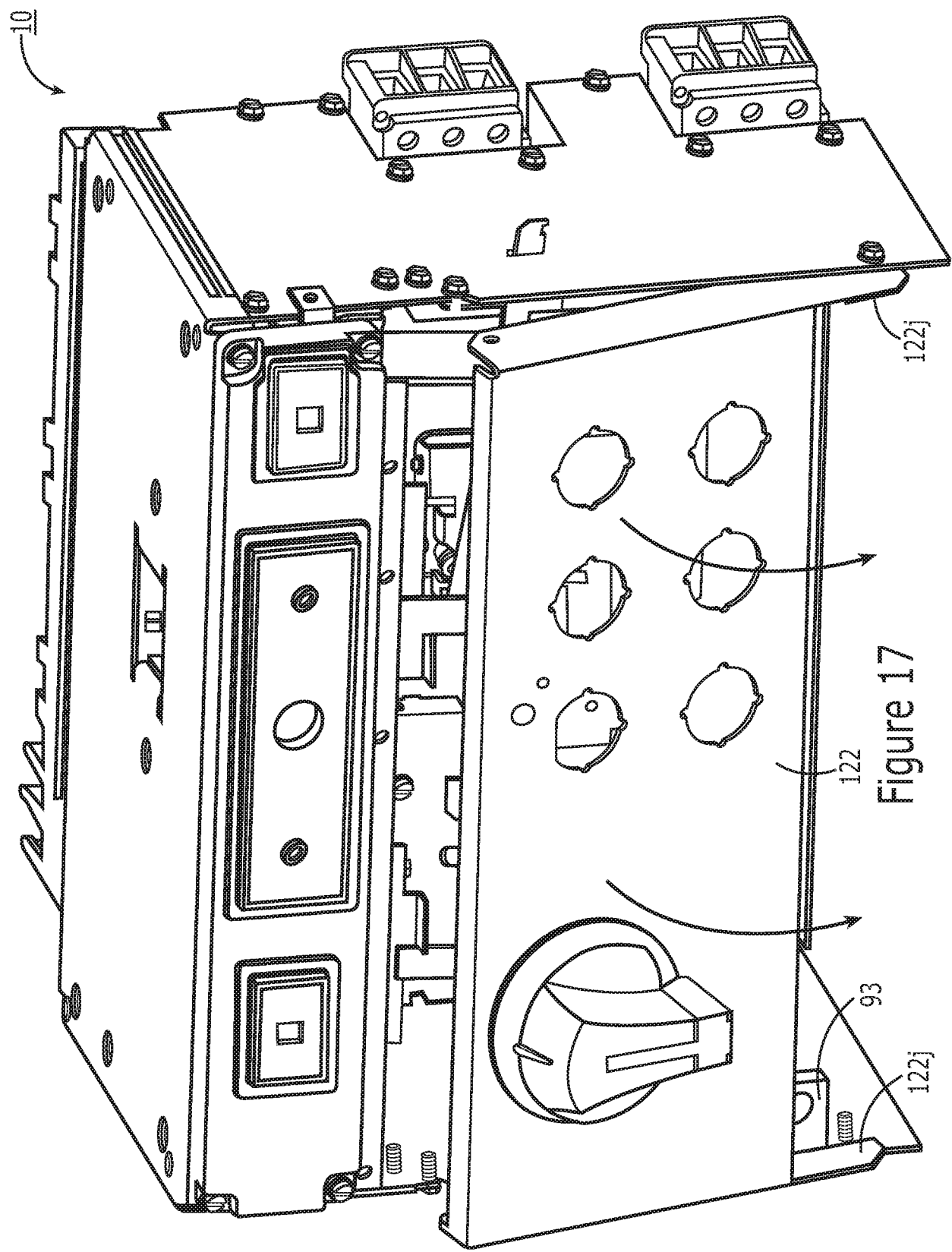


Figure 15

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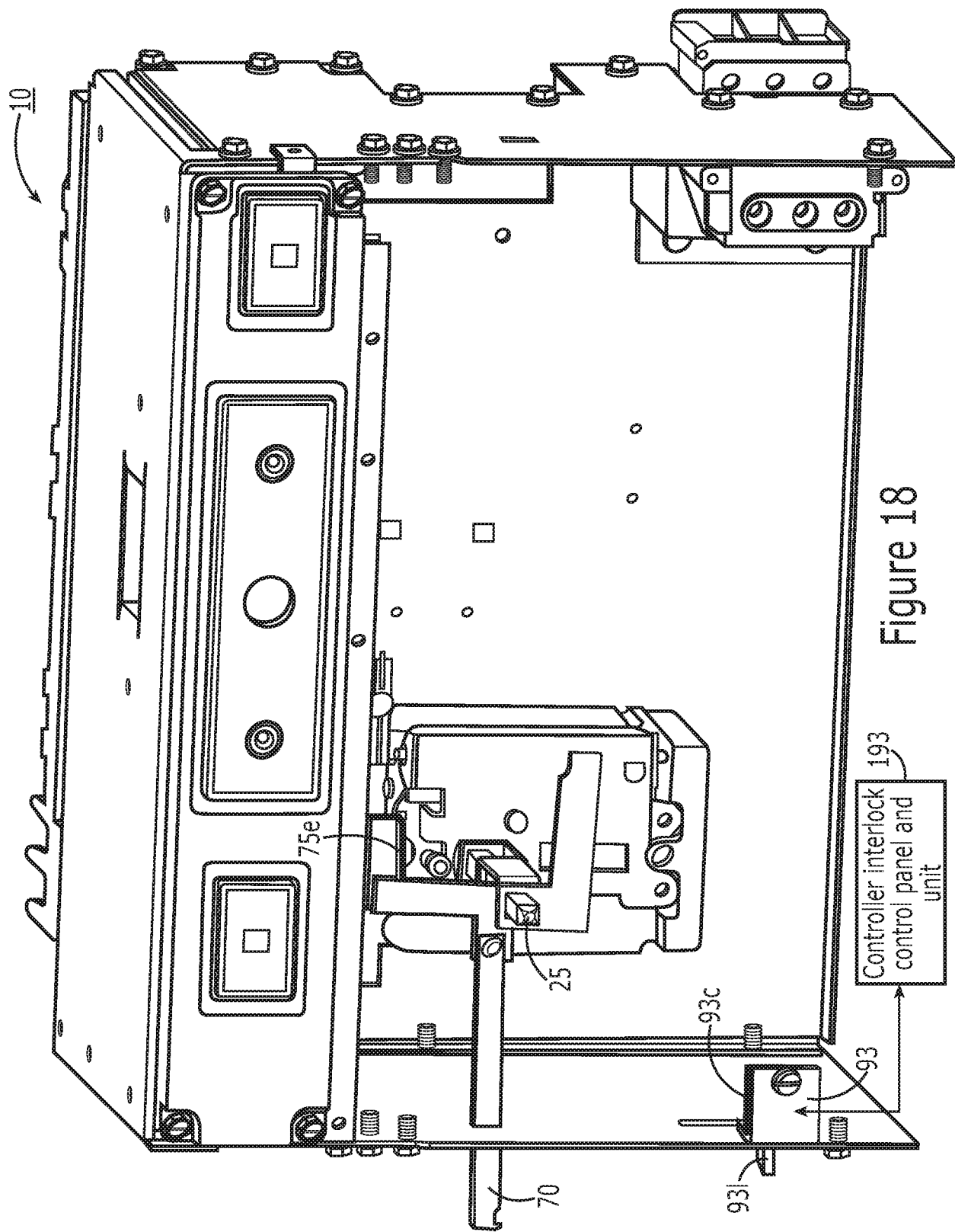


Figure 18

Controller interlock
control panel and
unit

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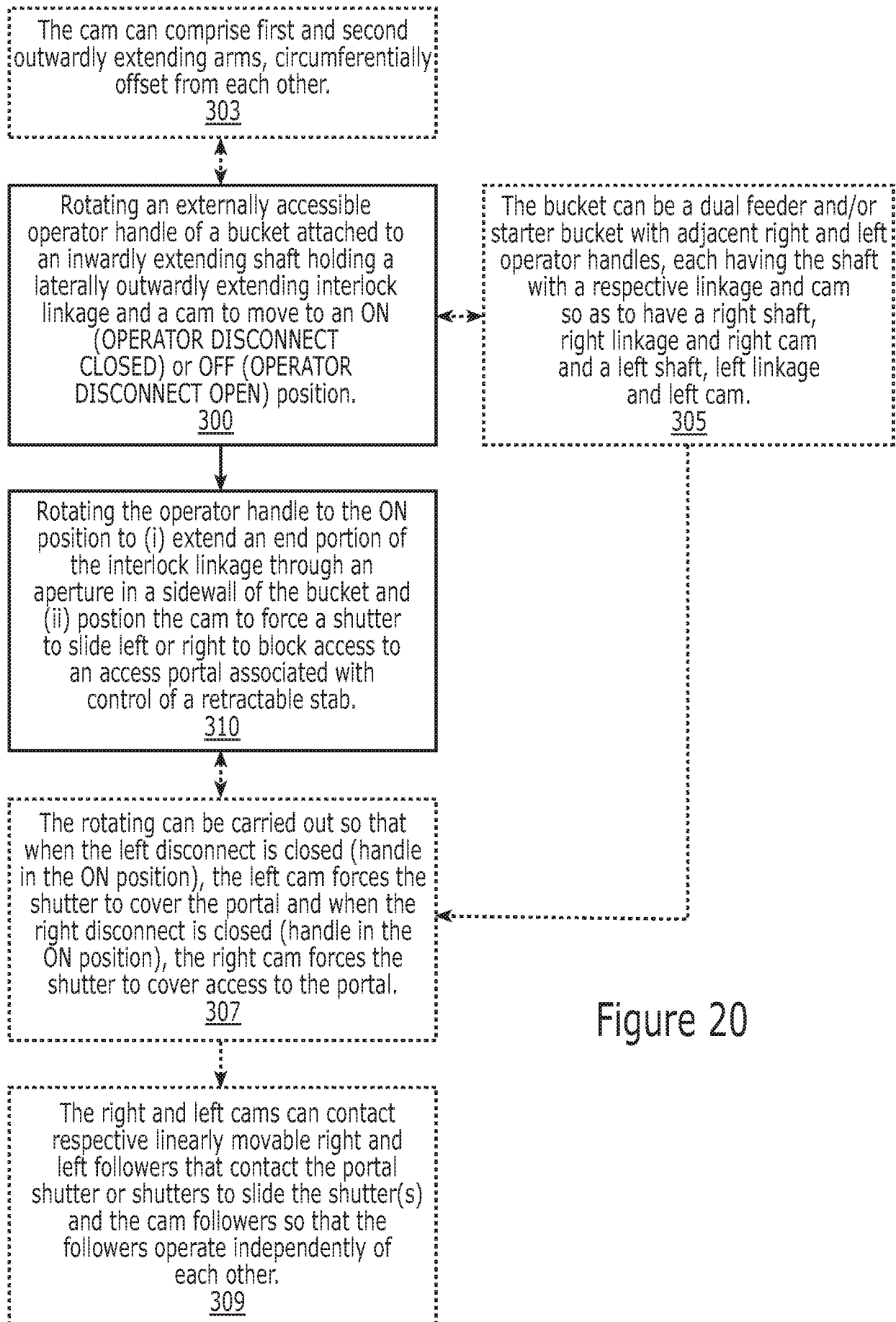


Figure 20

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2015/054356

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02B1/36 H02B11/24
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H02B H01H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2013/077210 A1 (MORRIS ROBERT ALLAN [US]) 28 March 2013 (2013-03-28) cited in the application figures 7-14 -----	1-17,23
X	US 4 086 452 A (COLLINS JAMES D) 25 April 1978 (1978-04-25) column 5, line 24 - line 35 -----	18-22,24
Y	US 2009/086414 A1 (YEE EDGAR [US] ET AL) 2 April 2009 (2009-04-02) cited in the application the whole document -----	1-17,23
A	US 2009/086414 A1 (YEE EDGAR [US] ET AL) 2 April 2009 (2009-04-02) cited in the application the whole document -----	1-24
A	US 4 486 815 A (TAKAHASHI MASARU [JP]) 4 December 1984 (1984-12-04) the whole document -----	1-24



Further documents are listed in the continuation of Box C.



See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search

11 August 2015

Date of mailing of the international search report

19/08/2015

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Authorized officer

Overdijk, Jaco

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2015/054356

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013077210 A1	28-03-2013	CA 2789763 A1 US 2013077210 A1	26-03-2013 28-03-2013
US 4086452 A	25-04-1978	GB 1516080 A US 4086452 A	28-06-1978 25-04-1978
US 2009086414 A1	02-04-2009	CA 2698957 A1 CN 101809835 A EP 2195896 A2 US 2009086414 A1 WO 2009040655 A2	02-04-2009 18-08-2010 16-06-2010 02-04-2009 02-04-2009
US 4486815 A	04-12-1984	BR 8302004 A JP H0113284 B2 JP S58186305 A US 4486815 A	27-12-1983 06-03-1989 31-10-1983 04-12-1984