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(71) Applicant: **SCHNEIDER ELECTRIC USA, INC.** [US/US]; 1415 S. Roselle Road, Palatine, IL 60067 (US).

(72) Inventor: **WILLIFORD, Matthew, A.**; 905 Clayton Avenue, Nashville, TN 37204 (US).

(74) Agents: **FILL, Peter, N.** et al.; c/o Locke Lord, LLP, 3 World Financial Center, New York, NY 10281-2101 (US).

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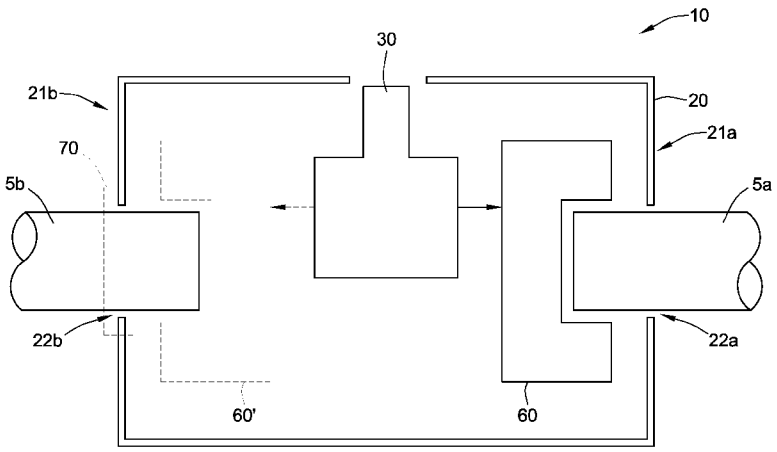

FIG. 1

(57) Abstract: A busbar connection device includes an electrically conductive collar, a moveable mechanism, and a plurality of clamp jaws. The collar is configured to receive a portion of a first busbar therein. The moveable mechanism is positioned at least partially within the collar and coupled thereto. The plurality of clamp jaws is electrically coupled to the collar and configured to move towards one another and engage the first busbar in response to the moveable mechanism being moved from a first mechanism position to a second mechanism position, thereby electrically coupling the first busbar with the collar.

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CAM ACTUATED BUS CONNECTION DEVICE

FIELD OF THE INVENTION

[0001] The present invention relates generally to busbar connection devices and, more particularly, to a cam actuated busbar connection device.

BACKGROUND OF THE INVENTION

[0002] A busbar system typically includes two or more busbars and one or more busbar connection devices for connecting two busbars together. Each busbar connection device is used to physically and electrically connect two busbars together. Typically, busbar connection devices are tightened using a torque wrench to apply a desired predetermined amount of clamping force (e.g., not too much and not too little clamping force). Such busbar connection devices can loosen over time, which require maintenance (e.g., retightening of the busbar connection device). Additionally, such busbar connection devices can fall apart into several pieces (e.g., a bolt and/or a nut can fall from the rest of the device) when being installed and/or removed from a busbar system. Also, torque wrenches require additional space around the busbar connection device to use as compared to a standard non-torque wrench. Further, torque wrenches are more expensive than non-torque wrenches.

[0003] Thus, a need exists for an improved apparatus and system that will not loosen over time, which will not fall apart during installation and/or removal, and which can be installed without requiring a torque wrench. The present disclosure is directed to satisfying one or more of these and other needs and solving other problems.

SUMMARY OF THE INVENTION

[0004] The present disclosure is directed to providing a busbar connection device that can be tightened with a standard wrench (e.g., non-torque wrench) to electrically and physically connect a pair of busbars with a repeatable and guaranteed minimum amount of contact pressure. A pair of busbars can be electrically and physically connected by positioning a busbar connection device between the busbars. The busbar connection device of the present disclosure allows for the pair of busbars to be coupled by an operator blindly by simply turning a cam rod with a non-torque wrench. Further, the busbar connection device of the present disclosure reduces and/or eliminates the chances of dropping small parts

of the busbar connection device as the components of the busbar connection device of the present disclosure are contained within and coupled to an electrically conductive collar.

[0005] The busbar connection device generally includes the electrically conductive collar, a moveable mechanism (e.g., the cam rod), and a plurality of clamp jaws. The collar is configured to receive a portion of a first busbar to be connected. The moveable mechanism is positioned partially within the collar and is configured to move between at least a first mechanism position (e.g., corresponding to an open position of the busbar connection device) and a second mechanism position (e.g., corresponding to a closed and/or tightened position of the busbar connection device). The clamp jaws are attached to the collar in a slidable manner such that the clamp jaws can be urged to move towards one another and engage the first busbar when the moveable mechanism is moved from the first mechanism position to the second mechanism position, thereby electrically coupling the first busbar with a second busbar coupled to the collar.

[0006] The second busbar can be coupled to the collar of the busbar connection device in many manners. For example, the second busbar can be welded to the collar, glued to the collar, press fitted into an aperture of the collar, screwed into the collar, attached via one or more bolts and/or screws, or, of course, coupled to the collar in the same manner that the first busbar is coupled to the collar via a second plurality of clamp jaws, etc.

[0007] In some implementations of the present disclosure, the moveable mechanism includes a cam rod making the busbar connection device a cam actuated busbar connection device. Alternatively, the moveable mechanism can include: a rack and pinion making the busbar connection device a rack and pinion actuated busbar connection device; a radial screw making the busbar connection device a radial screw actuated busbar connection device; a worm thread making the busbar connection device a worm thread actuated busbar connection device, etc.

[0008] The cam actuated busbar connection device includes an electrically conductive collar having a plurality of angled slots and a busbar aperture positioned adjacent to the angled slots. The busbar aperture is configured to receive a first busbar therethrough. Each of a plurality of electrically conductive clamp jaws is at least partially positioned within a respective one of the angled slots of the collar and is configured to slide therein between a first jaw position (e.g., open, i.e., not engaging the first busbar) and a second jaw position (e.g., closed/tightened, i.e., where the clamp jaws engage an exposed portion of the first

busbar). Each of the clamp jaws has a busbar engaging surface that is configured to electrically engage the first busbar when in the second jaw position.

[0009] In some implementations of the present disclosure, to connect the second busbar with the collar, a guide shaft is included in the cam actuated busbar connection device. The guide shaft has a threaded portion and a guide portion. The threaded portion of the guide shaft at least partially protrudes through a guide-shaft aperture of the collar and threadably engages a second busbar to aid in electrically coupling the second busbar with the collar. The collar is maintained in electrical engagement with the second busbar using the guide shaft and a spring washer (e.g., Belleville washer). In particular, the threaded portion of the guide shaft threadingly engages a threaded bore of the second busbar to hold an outer surface of the collar against an exposed portion of the second busbar. The spring washer aids in maintaining this engagement.

[0010] A jaw press plate is also positioned within the collar and has a bore portion and a plate portion. The bore portion of the jaw press plate is positioned to receive at least a portion of the guide portion of the guide shaft such that the jaw press plate can slide thereon parallel with a central axis of the guide shaft and between a first press-plate position and a second press-plate position. As the jaw press plate slides along the guide portion from the first press-plate position towards the second press-plate position, the jaw press plate engages the clamp jaws and causes the clamp jaws to move closer to one another and engage the first busbar.

[0011] The cam rod has a non-round head portion and a shaft portion extending therefrom. The shaft portion of the cam rod has one or more cams that are able to move the plate portion of the jaw press plate when the non-round head portion of the cam rod is rotated in a first direction (e.g., in a clockwise direction by a non-torque wrench) thereby causing the plate portion of the jaw press plate to directly engage respective first surfaces of the clamp jaws and cause each of the clamp jaws to move from the first jaw position (e.g., not engaging the first busbar) to the second jaw position (e.g., where the clamp jaws engage an exposed portion of the first busbar).

[0012] Each of the clamp jaws can be moved from the first jaw position to the second jaw position using the non-torque wrench to rotate the cam rod (e.g., via the non-round head portion) no more than a half turn (e.g., a half turn, a quarter turn, etc.). As such, the cam actuated busbar connection device can be switched from a loosened position (e.g.,

clamp jaws not engaging the first busbar) to a tightened positioned (e.g., clamp jaws engaging the first busbar) with a repeatable and guaranteed minimum amount of contact pressure applied on the first busbar by the clamp jaws.

[0013] The foregoing and additional aspects and implementations of the present disclosure will be apparent to those of ordinary skill in the art in view of the detailed description of various implementations and/or aspects, which is made with reference to the drawings, a brief description of which is provided next.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The foregoing and other advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings.

[0015] FIG. 1 is a block schematic of a busbar connection device according to some implementations of the present disclosure;

[0016] FIG. 2 is a perspective partial view of a busbar connection device coupling a pair of busbars according to some implementations of the present disclosure;

[0017] FIG. 3 is a perspective exploded view of the busbar connection device of FIG. 2;

[0018] FIG. 4 is a perspective exploded partial view of the busbar connection device of FIG. 2;

[0019] FIG. 5 is a perspective view of a collar of the busbar connection device of FIG. 2;

[0020] FIG. 6A is a perspective view of a first half of the collar of FIG. 5;

[0021] FIG. 6B is a perspective view of a second half of the collar of FIG. 5;

[0022] FIGS. 7A and 7B are perspective views of a clamp jaw of the busbar connection device of FIG. 2;

[0023] FIG. 8A is a perspective assembled view of several components of the busbar connection device of FIG. 2 in a first position;

[0024] FIG. 8B is a cross-sectional view of the several components of the busbar connection device of FIG. 8A in the first position;

[0025] FIG. 9A is a perspective assembled view of several components of the busbar connection device of FIG. 2 in a second position;

[0026] FIG. 9B is a cross-sectional view of the several components of the busbar connection device of FIG. 9A in the second position;

[0027] FIG. 10A is a perspective assembled view of several components of the busbar connection device of FIG. 2 in a third position; and

[0028] FIG. 10B is a cross-sectional view of the several components of the busbar connection device of FIG. 10A in the third position.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0029] Although the present disclosure will be described in connection with certain aspects and/or implementations, it will be understood that the present disclosure is not limited to those particular aspects and/or implementations. On the contrary, the present disclosure is intended to cover all alternatives, modifications, and equivalent arrangements and/or implementations as may be included within the spirit and scope of the present disclosure as defined by the appended claims.

[0030] Words of degree, such as "about", "substantially", and the like are used herein in the sense of "at, or nearly at, when given the manufacturing, design, and material tolerances inherent in the stated circumstances" and are used to prevent the unscrupulous infringer from unfairly taking advantage of the invention disclosure where exact or absolute figures and operational or structural relationships are stated as an aid to understanding the invention.

[0031] Referring to FIG. 1, a diagram of a busbar connection device 10 is shown for electrically coupling a pair of busbars 5a, 5b. The busbars 5a, 5b are round busbar conductors (e.g., busbars having a circular cross-section); however, the busbars 5a, 5b can have a variety of shapes and sizes (e.g., rectangular cross-section, square cross-section, tubular cross-section, etc.). The busbar connection device 10 includes an electrically conductive collar 20, a moveable mechanism 30 at least partially positioned within the collar 20, a plurality of clamp jaws 60 electrically coupled to the collar 20, and either a second plurality of clamp jaws 60′ electrically coupled to the collar 20 or a fixed mechanism 70. The implementation including the second plurality of clamp jaws 60′ and excluding the fixed mechanism 70 is referred to herein as "the dual clamp jaw implementation." Similarly, the implementation including the fixed mechanism 70 and excluding the second plurality of clamp jaws 60′ is referred to herein as "the single clamp jaw implementation."

[0032] In the dual clamp jaw implementation, an exposed portion of the first busbar 5a is positioned through a busbar aperture 22a in a first end 21a of the collar 20. Similarly, an exposed portion of the second busbar 5b is positioned through a second aperture 22b in an opposing second end 21b of the collar 20. In the dual clamp jaw implementation, the second aperture 22b is referred to as a busbar aperture 22b that is the same as, or similar to, the busbar aperture 22a, however, in the single clamp jaw implementation described below the second aperture 22b is referred to as a guide-shaft aperture 22b that is relatively smaller than the busbar aperture 22a. To electrically couple the first busbar 5a with the second busbar 5b, the moveable mechanism 30 is actuated using a tool (e.g., a non-torque wrench such as the tool T shown in FIGS. 8A, 9A, 10A) causing the moveable mechanism 30 to move from a first mechanism position (e.g., open) to a second mechanism position (e.g., closed/tightened).

[0033] Actuation of the moveable mechanism 30, in the dual clamp jaw implementation, from the first mechanism position to the second mechanism position causes at least a portion of the moveable mechanism 30 to engage (e.g., directly or indirectly) and urge the plurality of clamp jaws 60 to slide towards a center of the busbar aperture 22a of the collar 20, thereby moving towards one another. As the first busbar 5a is positioned within and/or between at least a portion of each of the plurality of clamp jaws 60, the plurality of clamp jaws 60 is caused to engage the first busbar 5a. Further, as the plurality of clamp jaws 60 is electrically coupled to the collar 20, such an actuation of the moveable mechanism causes the first busbar 5a to be electrically coupled to the collar 20.

[0034] Similarly, actuation of the moveable mechanism 30, in the dual clamp jaw implementation, from the first mechanism position to the second mechanism position causes at least a portion of the moveable mechanism 30 to engage (e.g., directly or indirectly) and urge the second plurality of clamp jaws 60′ to slide towards a center of the busbar aperture 22b of the collar 20, thereby moving towards one another. As the second busbar 5b is positioned within and/or between at least a portion of each of the second plurality of clamp jaws 60′, the second plurality of clamp jaws 60′ is caused to engage the second busbar 5b. Further, as the second plurality of clamp jaws 60′ is electrically coupled to the collar 20, such an actuation of the moveable mechanism 30 causes the second busbar 5b to be electrically coupled to the collar 20 and to the first busbar 5a as the first busbar 5a is also electrically coupled to the collar 20.

[0035] To electrically decouple the first busbar 5a from the second busbar 5b in the dual clamp jaw implementation, the moveable mechanism 30 is further actuated using the tool (e.g., a non-torque wrench) causing the moveable mechanism 30 to move from the second mechanism position (e.g., closed/tightened) to the first mechanism position (e.g., open). As such, the first and the second busbars 5a, 5b are free to be removed from the busbar connection device 10 as the plurality of clamp jaws 60 no longer engages the first busbar 5a in a tightened manner and the second plurality of clamp jaws 60′ no longer engages the second busbar 5b in a tightened manner. In some implementations, the further actuation of the moveable mechanism 30 using the tool includes a reverse movement where the tool is used to move the moveable mechanism 30 in a reverse direction from the second mechanism position back to the first mechanism position. In some other implementations, the further actuation of the moveable mechanism 30 using the tool includes a continued movement wherein the tool is used to move the moveable mechanism 30 further in the same direction from the second mechanism position to the first mechanism position.

[0036] In the single clamp jaw implementation, an exposed portion of the first busbar 5a is positioned through the busbar aperture 22a in first end 21a of the collar 20. However, an exposed portion of the second busbar 5b is positioned adjacent to the opposing second end 21b of the collar 20 and held in a fixed relationship thereto via the fixed mechanism 70 such that the second busbar 5b is electrically coupled to the collar 20. The fixed mechanism 70 can include, for example, a weld (e.g., the second busbar 5b is welded to the collar 20), glue (e.g., the second busbar 5b is glued to the collar 20), a relatively tight aperture (e.g., the second busbar 5b is press fitted into the relatively tight aperture of the collar 20), a screw (e.g., the second busbar 5b is attached to the collar 20 using one or more screws), a bolt (e.g., the second busbar 5b is attached to the collar 20 using one or more bolts), etc.

[0037] In the single clamp jaw implementation, to electrically couple the first busbar 5a with the second busbar 5b, the moveable mechanism 30 is actuated using the tool (e.g., a non-torque wrench), which causes the moveable mechanism 30 to move from the first mechanism position (e.g., open) to the second mechanism position (e.g., closed/tightened).

[0038] Actuation of the moveable mechanism 30, in the single clamp jaw implementation, from the first mechanism position to the second mechanism position causes at least a portion of the moveable mechanism 30 engage (e.g., directly or indirectly) the

plurality of clamp jaws 60 and causes the plurality of clamp jaws 60 to slide towards a center of the busbar aperture 22a of the collar 20, thereby moving towards one another. As the first busbar 5a is positioned within and/or between at least a portion of each of the plurality of clamp jaws 60, the plurality of clamp jaws 60 is caused to engage the first busbar 5a. Further, as the plurality of clamp jaws 60 is electrically coupled to the collar 20 and as the second busbar 5b is held in an electrically coupled relationship with the collar 20, such an actuation of the moveable mechanism 30 causes the first busbar 5a to be electrically coupled to the collar 20 and to the second busbar 5b.

[0039] To electrically decouple the first busbar 5a from the second busbar 5b in the single clamp jaw implementation, the moveable mechanism 30 is further actuated using the tool (e.g., a non-torque wrench) causing the moveable mechanism 30 to move from the second mechanism position (e.g., closed/tightened) to the first mechanism position (e.g., open). As such, the first busbar 5a is free to be removed from the busbar connection device 10 as the plurality of clamp jaws 60 no longer engages the first busbar 5a in a tightened manner.

[0040] The moveable mechanism 30 can take many forms. For example, the moveable mechanism 30 can include a cam rod 32 with cams 34a,b and a head 36 (shown in FIG. 4) making the busbar connection device 10 a cam actuated busbar connection device 10. Such a cam actuated busbar connection device 10 (and/or its components) is shown throughout FIGS. 3-10B and described in detail herein. Alternatively, the moveable mechanism 30 can include: a rack and pinion making the busbar connection device a rack and pinion actuated busbar connection device; a radial screw making the busbar connection device a radial screw actuated busbar connection device; a worm thread making the busbar connection device a worm thread actuated busbar connection device, etc.

[0041] Referring to FIG. 2, the cam actuated busbar connection device 10 is shown as electrically coupling the first and the second busbars 5a, 5b. The cam actuated busbar connection device 10 includes a housing 15 that surrounds the collar 20 and other components (e.g., the cam rod 32, the cams 34a,b, etc.) of the cam actuated busbar connection device 10 described herein. The housing 15 is made of an electrically insulating material (e.g., plastic, rubber, a combination thereof, etc.).

[0042] As best shown in FIG. 3, the housing 15 (FIG. 2) includes a first body portion 15a, a second body portion 15b, and a lid 15c. The first and the second body portions

15a, 15b can be removably coupled together (e.g., as shown in FIG. 2) to aid in preventing contaminates (e.g., water/moisture, dust, dirt, etc.) from entering the housing 15 and further aid in electrically insulating the internal components of the cam actuated busbar connection device 10 (e.g., the collar 20, the plurality of clamp jaws 60, etc.) from ground and/or other electrically conductive materials outside of the housing 15.

[0043] The first body portion 15a of the housing 15 has a busbar aperture 16a for receiving the first busbar 5a therethrough. The first body portion 15a can be coupled to the first busbar 5a using one or more clamping implements 6 (e.g., zip-ties, rubber bands, string, etc.). The one or more clamping implements 6 aid in preventing contaminates (e.g., water/moisture, dust, dirt, etc.) from entering the housing 15 and aid in electrically insulating the internal components of the cam actuated busbar connection device 10 (e.g., the collar 20, the plurality of clamp jaws 60, etc.) from ground and/or other electrically conductive materials outside of the housing 15.

[0044] The second body portion 15b of the housing 15 (FIG. 2) has a busbar aperture 16b and an access aperture 17. The second body portion 15b can be coupled to the second busbar 5b using one or more clamping implements 6 (e.g., zip-ties, rubber bands, string, etc.) in the same fashion as described above in connection with the first body portion 15a being coupled to the first busbar 5a. The lid 15c is removably coupled with the second body portion 15b such that the lid 15c can be removed from the second body portion 15b to expose the access aperture 17 and provide access to components (e.g., a head 36 of the cam rod 32 shown in FIG. 4) of the cam actuated busbar connection device 10 to tighten and/or loosen the cam actuated busbar connection device 10 as described herein.

[0045] Referring to FIG. 3, an exploded perspective view of the cam actuated busbar connection device 10 illustrates the various components and relative positioning of the same relative to the busbars 5a, 5b. The cam actuated busbar connection device 10 includes the first body portion 15a of the housing 15, the second body portion 15b of the housing 15, the lid 15c of the housing 15, the collar 20, the moveable mechanism 30, a jaw press plate 40, a biasing member 48, a clamp-jaw-retractor plate 50, the plurality of clamp jaws 60, the fixed mechanism 70, and a cam lock 80.

[0046] Referring generally to FIGS. 3, 4, 5, 6A, and 6B, the collar 20 is generally cylindrical and sized and shaped to contain a multitude of components (e.g., the cams 34a,b) therein for use in selectively coupling the busbars 5a, 5b in an electrical manner. The collar

20 is shown as split into two parts in FIGS. 6A and 6B to better illustrate the inside of the collar 20, however, the collar 20 is typically a unitary component made of an electrically conductive material (e.g., copper, aluminum, a combination thereof, etc.). The collar 20 includes and/or forms the busbar aperture 22a (best shown in FIG. 5) in the first end 21a of the collar 20, the guide-shaft aperture 22b (best shown in FIG. 5) in the second end 21b of the collar 20, a first cam-rod aperture 23a (best shown in FIG. 5), a second cam-rod aperture 23b (best shown in FIG. 6A), a cam-lock aperture 24 (best shown in FIGS. 5 and 6A), and a plurality of angled slots 25a-d extending from the first end 21a of the collar 20 towards the second end 21b of the collar 20 (best shown in FIGS. 6A and 6B).

[0047] The busbar aperture 22a (FIG. 5) is sized and shaped to receive an exposed portion of the first busbar 5a (FIG. 3) therethrough such that the plurality of clamp jaws 60 (FIGS. 3 and 4) can engage the exposed portion of the first busbar 5a (FIG. 10A best shows the plurality of clamp jaws 60 engaging the first busbar 5a). The guide-shaft aperture 22b (FIG. 5) is sized and shaped to receive a portion of the fixed mechanism 70 (best shown in FIG. 4) therethrough such that the fix mechanism 70 is able to be coupled with the second busbar 5b (Fig. 3) in, for example, a threadingly manner.

[0048] The first cam-rod aperture 23a (best shown in FIG. 5) is sized and shaped to receive a portion of the moveable mechanism 30 (best shown in FIG. 4) therethrough. In particular, the first cam-rod aperture 23a is relatively larger than the second cam-rod aperture 23b for allowing portions (e.g., cams 34a,b) of the moveable mechanism 30 to fit into the collar 20 via the first cam-rod aperture 23a. Similarly, the second cam-rod aperture 23b (best shown in FIG. 6A) is sized and shaped to receive a portion (e.g., an end portion of the cam rod 32) of the moveable mechanism 30 therethrough. In particular, the second cam-rod aperture 23b is relatively smaller than the first cam-rod aperture 23a for preventing the moveable mechanism 30 from falling out of the collar 20 once positioned partially therein through the first cam-rod aperture 23a. Specifically, the second cam-rod aperture 23b can have an inner diameter that is slightly larger than the outer diameter of the cam rod 32.

[0049] The cam-lock aperture 24 (best shown in FIGS. 5 and 6A) is positioned adjacent to (e.g., directly next to) the first cam-rod aperture 23a and sized and shaped to receive a portion of the cam lock 80 therein. As described herein, a tool (e.g., a non-torque wrench) can be used to engage and cause the cam lock 80 to slide within the cam-lock aperture 24 to allow for the actuation of (e.g., rotation) the moveable mechanism 30, which

causes the cam actuated busbar connection device 10 to be switched between a loosened position (shown in FIGS. 8A and 8B) and a tightened position (shown in FIGS. 10A and 10B).

[0050] The plurality of angled slots 25a-d (best shown in FIGS. 6A and 6B) is positioned around the busbar aperture 22a (best shown in FIG. 5). Each of the angled slots 25a-d is angled relative to the vertical Y-axis as shown in FIG. 5. In particular, each of the angled slots 25a-d is angled inward towards the vertical Y-axis as the angled slots 25a-d move from the second end 21b of the collar 20 towards the first end 21a of the collar 20. In some implementations, each of the angled slots 25a-d is at an angle relative to the Y-axis (e.g., also relative to the central axis of the guide shaft 72 shown in FIG. 4) between about thirty degrees and about sixty degrees. In some implementations, each of the angled slots 25a-d is at an angle relative to the Y-axis (e.g., also relative to the central axis of the guide shaft 72 shown in FIG. 4) between about fifteen degrees and about forty-five degrees.

[0051] Referring generally to FIGS. 7A and 7B, a representative one of the plurality of clamp jaws 60 is shown. As shown, each of the plurality of clamp jaws 60 has a track portion 62, a busbar engaging surface 64 (FIG. 7B), a first surface 65 (FIG. 7A), and an opposing second surface 66 (FIG. 7B). The track portion 62 is sized and shaped to mate with and/or correspond with the angled slots 25a-d (FIGS. 5, 6A, and 6B) of the collar 20 in a slidable manner. As shown, the track portion 62 has a "T" cross-section although various other shapes for the track portion 62 are possible (e.g., "L" cross-section, triangular cross-section, etc.).

[0052] The busbar engaging surface 64 (FIG. 7B) of each of the plurality of clamp jaws 60 is for physically and electrically engaging the first busbar 5a (FIG. 3). The busbar engaging surface 64 can be contoured (e.g., concave, convex, substantially flat, any combinations thereof, etc.) to correspond with an outer surface of the busbar (e.g., the first busbar 5a) to which the clamp jaws 60 are to be electrically coupled to provide a better connection therebetween. For example, as the first busbar 5a (FIG. 3) has a circular cross-section with a rounded exterior surface, the busbar engaging surface 64 (FIG. 7B) of each of the clamp jaws 60 is concave to correspond with the rounded exterior surface of the first busbar 5a, thereby providing a better physical and/or electrical connection between the first busbar 5a and the plurality of clamp jaws 60 when the cam actuated busbar connection device 10 is in the tightened position (shown in FIGS. 10A and 10B).

[0053] Alternatively to the first busbar 5a having a circular cross-section with a rounded exterior surface, the first busbar can have a substantially rectangular cross-section. In such alternative implementations, the busbar engaging surface of each of the clamp jaws is substantially flat to correspond with the substantially flat exterior surface of the first busbar, thereby providing a better physical and/or electrical connection between the first busbar and the plurality of clamp jaws when the cam actuated busbar connection device 10 is in the tightened position.

[0054] The first surface 65 (FIG. 7A) of each of the plurality of clamp jaws 60 is for engaging with the jaw press plate 40 (FIGS. 3 and 4) during actuation of the moveable mechanism 30 from the first mechanism position (e.g., corresponding to an open position of the cam actuated busbar connection device 10 shown in FIGS. 8A and 8B) to the second mechanism position (e.g., corresponding to a closed and/or tightened position of the cam actuated busbar connection device 10 shown in FIGS. 10A and 10B). In particular, when the moveable mechanism 30 is moved from the first mechanism position towards the second mechanism position, the cams 34a,b (best shown in FIG. 4) of the moveable mechanism 30 engage the jaw press plate 40 (best shown in FIGS. 9A and 9B), which causes the jaw press plate 40 (FIG. 4) to engage the first surface 65 (FIG. 7A) of each of the plurality of clamp jaws 60 (FIG. 4) and move the plurality of clamp jaws 60 from a first jaw position (shown in FIGS. 8A and 8B) to a second jaw position (shown in FIGS. 10A and 10B). As the track portions 62 (FIGS. 7A and 7B) of the plurality of clamp jaws 60 are confined within the angled slots 25a-d (FIGS. 6A and 6B), such an engagement by the jaw press plate 40 causes the plurality of clamp jaws 60 to move toward one another and engage the exposed portion of the first busbar 5a positioned within the busbar aperture 22a of the collar 20 (best shown in FIGS. 10A and 10B).

[0055] The second opposing surface 66 (FIG. 7B) of each of the plurality of clamp jaws 60 is for engaging with the clamp-jaw-retractor plate 50 (FIGS. 3 and 4) during further actuation of the moveable mechanism 30 from the second mechanism position (shown in FIGS. 10A and 10B) to the first mechanism position (shown in FIGS. 8A and 8B). In particular, when the moveable mechanism 30 is moved from the second mechanism position towards the first mechanism position, the clamp-jaw-retractor plate 50 engages the second surface 66 (FIG. 7B) of each of the plurality of clamp jaws 60 under force of the biasing member 48 (FIGS. 4 and 5) and moves the plurality of clamp jaws 60 from the second jaw

position (FIGS. 10A and 10B) to the first jaw position (FIGS. 8A and 8B). The biasing member 48 is attached to the clamp-jaw-retractor plate 50 (best shown in FIGS. 8B, 9B , and 10B) and a hook on the end of the fixed mechanism 70 (best shown in FIG. 8B). As the track portions 62 (FIGS. 7A and 7B) of the plurality of clamp jaws 60 are confined within the angled slots 25a-d (FIGS. 6A and 6B), such an engagement by the clamp-jaw-retractor plate 50 causes the plurality of clamp jaws 60 to move away from one another and disengage the exposed portion of the first busbar 5a positioned within the busbar aperture 22a (FIG. 5) of the collar 20.

[0056] Referring to FIG. 4, the fixed mechanism 70 includes a guide shaft 72 and a washer 79. The guide shaft 72 has a threaded portion 73, a guide portion 75, and a flange 77 separating the threaded portion 73 and the guide portion 75. The washer 79 is positioned along the threaded portion 73 of the guide shaft 72 such that the washer 79 abuts the flange 77 (best shown in FIGS. 8A, 9A, and 10A). The threaded portion 73 of the guide shaft 72 is positioned through the guide-shaft aperture 22b (FIG. 5) of the collar 20 such that the threaded portion 73 extends out of the collar 20 for threadingly engaging the second busbar 5b (best shown in FIGS. 8A, 9A, and 10A), which aids in electrically coupling the second busbar 5b with the collar 20. The washer 79 can be a spring washer (e.g., a Belleville washer) such that the washer 79 also aids in maintaining the second busbar 5b in an electrically engagement with the collar 20. After the guide shaft 72 is coupled with the second busbar 5b (best shown in FIGS. 8A, 9A, and 10A), the guide shaft 72 is rigidly positioned within the collar 20 such that the guide portion 75 of the guide shaft 72 extends into the collar 20 from the second end 21b towards the first end 21a.

[0057] The jaw press plate 40 has a bore portion 42 and a plate portion 44. As best shown in FIG. 3, the bore portion 42 is a circular hollow tube having a substantially constant inner diameter. As best shown in FIG. 4, the plate portion 44 is generally a flat circular disk with a circular aperture in the center that has a diameter substantially equal to the inner diameter of the bore portion 42. The plate portion 44 of the jaw press plate 40 is for engaging the first surface 65 (FIG. 7A) of each of the plurality of clamp jaws 60 as described herein. The bore portion 42 of the jaw press plate 40 is slidable over the guide portion 75 of the guide shaft 72 such that the jaw press plate 40 can slide on the guide portion 75 parallel with a central axis of the guide shaft 72 between a first press-plate position (shown in FIGS. 8A and 8B) and a second press-plate position (shown in FIGS. 10A and 10B).

[0058] As best shown in FIG. 4, the moveable mechanism 30 includes the cam rod 32, the cams 34a,b and the head 36. The cam rod 32 is generally a cylindrical shaft with the cams 34a,b attached to a central area of the cam rod 32 and the head 36 attached to a first end of the cam rod 32. In particular, the cams 34a,b are attached to the cam rod 32 in a spaced apart fashion such that when the cam actuated busbar connection device 10 is assembled (shown in e.g., FIGS. 2, 8A), the first cam 34a is positioned relatively above the bore portion 42 of the jaw press plate 40 (best shown in FIG. 9A) and the second cam 34b is positioned relatively below the bore portion 42 of the jaw press plate 40 (best shown in FIG. 9A). Further, the cam rod 32 can also include one or more grooves 33a,b (best shown in FIG. 4) for receiving one or more retaining rings 39a,b (e.g., e-clips), respectively, to aid in maintaining the moveable mechanism 30 within the collar 20 when assembled (shown in e.g., FIG. 8A). In particular, a first one of the retaining rings 39a is clipped onto the first groove 33a adjacent to a second end of the cam rod 32 that opposes the first end of the cam rod 32. When attached, the first retaining ring 39a abuts an outer surface of the collar 20 (best shown in FIGS. 8A, 9A, and 10A) to prevent the cam rod 32 from falling relatively downward (e.g., out of the collar 20).

[0059] The head 36 of the moveable mechanism 30 is a non-round head (e.g., shown as a hex, etc.) that is attached to or integral with the first end of the cam rod 32. The head 36 can be rotated using a tool T shown in FIGS. 8A, 9A, and 10A (e.g., a non-torque wrench), which causes the cam rod 32 and the attached cams 34a,b to rotate, which is demonstrated in FIGS. 8A-10B. As best shown in FIGS. 8A-10B, each of the cams 34a,b of the moveable mechanism 30 is positioned to move the plate portion 44 of the jaw press plate 40 when the head 36 of the moveable mechanism 30 is rotated in a first direction (e.g., counterclockwise) thereby causing the plate portion 44 of the jaw press plate 40 to directly engage the first surface 65 (FIG. 7A) of each of the plurality of clamp jaws 60 and cause each of the plurality of clamp jaws 60 to move from the first jaw position (FIGS. 8A and 8B) to the second jaw position (FIGS. 10A and 10B). The cams 34a,b are shaped such that when the head 36 of the moveable mechanism 30 is rotated, thereby causing the moveable mechanism 30 is be rotated into the second mechanism position, the moveable mechanism 30 is at equilibrium. That is, when the moveable mechanism 30 is in the second mechanism position and the cams 34a,b engage the first surface 65 (FIG. 7A) of each of the plurality of clamp

jaws 60 as shown in FIGS. 10A and 10B, no moment exists to cause the moveable mechanism 30 to move from the second mechanism position (FIGS. 10A and 10B).

[0060] As best shown in FIG. 4, the cam lock 80 includes a head portion 82 and a shaft portion 84 extending from the head portion 82. The shaft portion 84 of the cam lock 80 is positioned within the cam-lock aperture 24 (FIG. 5) of the collar 20 such that at least a portion of the shaft portion 84 can protrude through the cam-lock aperture 24 and such that the head portion 82 of the cam lock 80 is positioned within the collar 20 (best shown in FIGS. 8A, 9A, and 10A). As such, under the force of gravity when the cam actuated busbar connection device 10 is oriented as shown in FIGS. 8A-10B, the head portion 82 prevents the cam lock 80 from falling out of the collar 20. Further, as best shown in FIG. 8A, a second one of the retaining rings 39b is coupled to a second one of the grooves 33b of the cam rod 32 adjacent to the head portion 82 of the cam lock 80 such that the second retaining ring 39b aids in maintaining at least a portion of the shaft portion 84 of the cam lock 80 within the cam-lock aperture 24 in the collar 20. That is, the second retaining ring 39b prevents the cam lock 80 from falling out of engagement with the cam-lock aperture 24 and into the interior of the collar 20.

[0061] Referring to FIG. 4, the head 36 of the moveable mechanism 30 includes a first lock slot 38a and a second lock slot 38b. The first lock slot 38a is positioned on a first side of the head 36 and the second lock slot 38b is positioned on an opposing second side of the head 36. In particular, as shown, the second lock slot 38b is positioned 180 degrees from the first lock slot 38a. Alternatively, in some implementations of the present disclosure, the second lock slot 38b can be positioned 90 degrees (and/or 270 degrees) from the first lock slot 38a. Further, in some implementations of the present disclosure, the second lock slot 38b can be positioned 360 degrees from the first lock slot 38a such that the first lock slot 38a and the second lock slot 38b coincide (e.g., only one lock slot is in the head 36).

[0062] As best shown in FIGS. 8A and 10A, each of the first and the second lock slots 38a,b is sized and shaped to receive at least a portion of the shaft portion 84 of the cam lock 80 therein. As such, the cam lock 80 aids in preventing rotation of the cam rod 32 and attached cams 34a,b. That is, the cam lock 80 locks the rotational position of the cam rod 32 when engaged with either the first or the second lock slots 38a,b. While not shown, the cam lock 80 can be physically biased (e.g., not just using gravity) towards the locked position (shown in FIGS. 8A and 10A) using, for example, a biasing member (not shown) positioned

and/or coupled between the second retaining ring 39b and the head portion 82 of the cam lock 80.

[0063] Referring generally to FIGS. 8A-10B, a cycle of operation of the cam actuated busbar connection device 10 of the present disclosure begins with the first and the second busbars 5a,b being positioned within the housing 15. The second busbar 5b is positioned to abut the outer surface of the second end 21b of the collar 20. The threaded portion 73 of the guide shaft 72 is then threaded into a threaded bore (not shown) in an end of the exposed portion of the second busbar 5b to hold the second busbar 5b in an electrically engagement with the collar 20. Then the first busbar 5a is positioned through the busbar aperture 22a of the collar 20 and between the plurality of clamp jaws 60.

[0064] After the first and the second busbars 5a,b are so positioned, the cam actuated busbar connection device 10 can be switched and/or moved from a first device position and/or a loosened position (FIGS. 8A and 8B) to a second device position and/or a tightened position (FIGS. 10A and 10B) by rotating the cam rod 32 from a first rod position (FIGS. 8A and 8B) to a second rod position (FIGS. 10A and 10B), thereby electrically coupling the first busbar 5a to the second busbar 5b through the electrically conductive collar 20. By "loosened position" it is meant that the cam rod 32 is in a rotational position (e.g., the first rod position) such that the cams 34a,b are extended in the direction of arrow "A" (e.g., away from the plate portion 44 of the jaw press plate 40), which permits the clamp-jaw-retractor plate 50 to urge the plurality of clamp jaws 60 in the direction of arrow "A" – sliding within the angled slots 25a-d – such that the plurality of clamp jaws 60 move away from one another (e.g., outward), thereby providing a space between the plurality of clamp jaws 60 for the first busbar 5a to be inserted and/or removed therefrom.

[0065] In order to move and/or switch the cam actuated busbar connection device 10 from the loosened position (FIGS. 8A and 8B) to the tightened position (FIGS. 10A and 10B), the lid 15C (FIG. 3) is removed from the housing 15, which exposes the head 36 of the moveable mechanism 30. As shown in FIG. 8A, a tool T is inserted through the access aperture 17 of the second body portion 15b of the housing 15 in the direction of arrow "B" (FIG. 8A) and into engagement with the head 36. As the tool T engages with the head 36, the tool T causes the cam lock 80 to move in the direction of arrow B, thereby disengaging the shaft portion 84 of the cam lock 80 from the first lock slot 38a of the head 36. As such, the

cam rod 32 and the attached cams 34a,b are free to be rotated by the tool T between the first and the second rod positions.

[0066] The tool T is rotated in a first direction (e.g., counterclockwise) to start to tighten the plurality of clamp jaws 60 on the first busbar 5a. As shown in FIGS. 9A and 9B, the tool T has been used to rotate the cam rod 32 and attached cams 34a,b about ninety degrees from the first rod position (FIGS. 8A and 8B) towards the second rod position (FIGS. 10A and 10B). In such an intermediate position (FIGS. 9A and 9B), the cams 34a,b engage the plate portion 44 of the jaw press plate 40 and cause the jaw press plate 40 to slide along the guide portion 75 of the guide shaft 72 in the direction of arrow "C" from the first press-plate position (FIGS. 8A and 8B) towards the second press-plate position (FIGS. 10 A and 10B). As the jaw press plate 40 slides in the direction of arrow C, the plate portion 44 engages (e.g., pushes) the first surface 65 (FIG. 7A) of each of the plurality of clamp jaws 60. Such an engagement of the jaw press plate 40 causes the plurality of clamp jaws 60 to slide within and along the angled slots 25a-d from the first jaw position (FIGS. 8A and 8B) towards the second jaw position (FIGS. 10A and 10B), which causes the plurality of clamp jaws 60 to move towards one another and closer to engaging the first busbar 5a in a tightened manner.

[0067] As the tool T is further rotated in the first direction (e.g., counterclockwise), the plurality of clamp jaws 60 engage and clamp around the first busbar 5a. As shown in FIGS. 10A and 10B, the tool T has now been used to rotate the cam rod 32 and attached cams 34a,b about one hundred and eighty degrees into the second rod position. In such a tightened position, the cams 34a,b continue to engage the plate portion 44 of the jaw press plate 40 and cause the jaw press plate 40 to further slide along the guide portion 75 of the guide shaft 72 in the direction of arrow "C" to the second press-plate position. As the jaw press plate 40 continues to slide in the direction of arrow C, the plate portion 44 continues to engage (e.g., push) the first surface 65 (FIG. 7A) of each of the plurality of clamp jaws 60. Such a continued engagement of the jaw press plate 40 causes the plurality of clamp jaws 60 to further slide within and along the angled slots 25a-d to the second jaw position, which causes the plurality of clamp jaws 60 to further move towards one another and to engage the first busbar 5a in a tightened manner.

[0068] In some implementations of the present disclosure, the cam actuated busbar connection device 10 can be switched and/or moved from the loosened position

(FIGS. 8A and 8B) to the tightened position (FIGS. 10A and 10B) by no more than a half of single turn of the cam rod 32. That is, the cam rod 32 can be rotated from the first rod position (FIGS. 8A and 8B) to the second rod position (FIGS. 10A and 10B) by rotating the cam rod 32 half of a single turn or less (e.g., 180 degrees or less), which places the cam actuated busbar connection device 10 into its tightened position (FIGS. 10A and 10B). As such, the cam actuated busbar connection device 10 can be readily installed by placing the first busbar 5a between the plurality of clamp jaws 60 and then rotating the cam rod 32 no more than half of a single turn (e.g., 180 degrees or less) into its second rod position (FIGS. 10A and 10B) to fully tighten the cam actuated busbar connection device 10, thereby electrically coupling the busbars 5a,b together via the collar 20 with a repeatable and predetermined amount of clamping force.

[0069] The cam rod 32 is designed to be rotated via the head 36 such that the cam actuated busbar connection device 10 is in its tightened position (FIGS. 10A and 10B) using a non-torque wrench. For example, a standard socket wrench or even a screw driver can be used to rotate the cam rod 32 such that cam actuated busbar connection device 10 is in the tightened position (FIGS. 10A and 10B). As such, the relatively expensive and relatively physically larger torque wrench is unnecessary and unneeded to rotate the cam rod 32 via the head 36.

[0070] According to some alternative implementations of the present disclosure, each of the angled slots 25a-d can be angled outward (not shown) away from the vertical Y-axis (FIG. 5) as the angled slots 25a-d move from the second end 21b of the collar 20 towards the first end 21a of the collar 20. In such alternative implementations, each of the angled slots 25a-d can be at an angle relative to the Y-axis (e.g., also relative to the central axis of the guide shaft 72 shown in FIG. 4) between about one hundred and twenty degrees and about one hundred and fifty degrees. In such alternatives, the first busbar is substantially round and tubular and the plurality of clamp jaws 60 is modified such that a busbar engaging surface 64 (FIG. 7B) of each of the clamp jaws 60 is convex and configured to engage an inner surface of the first busbar.

[0071] While particular aspects, implementations, and applications of the present disclosure have been illustrated and described, it is to be understood that the present disclosure is not limited to the precise construction and compositions disclosed herein and that various modifications, changes, and variations may be apparent from the foregoing

descriptions without departing from the spirit and scope of the present disclosure as defined in the appended claims.

What is claimed is:

1. A busbar connection device, comprising:

an electrically conductive collar configured to receive a portion of a first busbar therein;

a moveable mechanism positioned at least partially within the collar and coupled thereto, and being configured to move between at least a first mechanism position and a second mechanism position; and

a plurality of clamp jaws electrically coupled to the collar, the plurality of clamp jaws being configured to move towards one another and engage the first busbar in response to the moveable mechanism being moved from the first mechanism position to the second mechanism position, thereby electrically coupling the first busbar with to the collar.

2. The busbar connection device of claim 1, wherein the moveable mechanism includes a cam rod including a head portion and a shaft portion extending therefrom, the shaft portion including one or more cams.

3. The busbar connection device of claim 2, further comprising a jaw press plate positioned within the collar and between the moveable mechanism and the plurality of clamp jaws, the jaw press plate including a bore portion and a plate portion, wherein the one or more cams of the shaft of the cam rod are configured to move the plate portion of the jaw press plate in response to the head portion of the cam rod being rotated in a first direction thereby causing the plate portion of the jaw press plate to engage respective first surfaces of the clamp jaws and cause each of the clamp jaws to move towards one another and engage the first busbar.

4. The busbar connection device of claim 3, further comprising a guide shaft positioned at least partially within the collar and in a fixed relationship thereto, the guide shaft including a guide portion, wherein the bore portion of the jaw press plate is configured to receive at least a portion of the guide portion of the guide shaft such that the jaw press plate is configured to slide thereon parallel with a central axis of the guide shaft.

5. The busbar connection device of claim 4, wherein the guide shaft further includes a threaded portion that at least partially protrudes through a guide-shaft aperture of the collar, the threaded portion of the guide shaft being configured to threadably engage a second busbar thereby aiding in electrically coupling the second busbar with the collar, the first busbar

being received through a busbar aperture in a first end of the collar and the second busbar being coupled to a second end of the collar that opposes the first end of the collar, the guide-shaft aperture being located within the second end of the collar.

6. The busbar connection device of claim 1, wherein the collar includes a plurality of angled slots and a busbar aperture positioned adjacent to the angled slots, the busbar aperture being configured to receive the portion of the first busbar therethrough, wherein each of the clamp jaws is at least partially positioned within a respective one of the angled slots of the collar and is configured to slide therein.

7. A busbar connection device, comprising:

an electrically conductive collar having a busbar aperture dimensioned to receive a first busbar therethrough, the collar enclosing therewithin:

a movable mechanism, and

a plurality of clamp jaws configured to be urged toward one another by action of the movable mechanism to clamp the first busbar within the collar and electrically couple the first busbar to a second busbar and to the collar, and configured to be urged away from one another by a further action of the movable mechanism to release the first busbar from the jaw clamps.

8. The busbar connection device of claim 7, wherein the moveable mechanism is configured to be rotated in a first direction from a first mechanism position to a second mechanism position by no more than half of a single turn of the moveable mechanism; and wherein in response to the moveable mechanism being in the first mechanism position, each of the clamp jaws is in a first jaw position such that the first busbar is released therefrom; and wherein in response to the moveable mechanism being in the second mechanism position, each of the clamp jaws is in a second jaw position such that the first busbar is clamped therein.

9. The busbar connection device of claim 8, wherein in response to the moveable mechanism being rotated into the second mechanism positioned from the first mechanism position, busbar engaging surfaces of the clamp jaws are configured to apply a guaranteed minimum amount of contact pressure on the first busbar.

10. A busbar connection device for electrically coupling a pair of busbars, the busbar connection device having a first device position and a second device position, the busbar connection device comprising:

an electrically conductive collar including a plurality of angled slots and a busbar aperture positioned adjacent to the angled slots, the busbar aperture being configured to receive a first one of the busbars therethrough;

a plurality of electrically conductive clamp jaws, each of the clamp jaws being at least partially positioned within a respective one of the angled slots of the collar and being configured to slide therein between a first jaw position and a second jaw position, each of the clamp jaws having a busbar engaging surface configured to electrically engage the first one of the busbars in the second jaw position;

a jaw press plate including a bore portion and a plate portion, the jaw press plate being configured to slide between a first press-plate position and a second press-plate position; and

a cam rod including a non-round head portion and a shaft portion extending therefrom, the shaft portion including one or more cams, each of the one or more cams being configured to move the plate portion of the jaw press plate in response to the non-round head portion being rotated in a first direction thereby causing the plate portion of the jaw press plate to directly engage respective first surfaces of the clamp jaws and cause each of the clamp jaws to move from the first jaw position to the second jaw position.

11. The busbar connection device of claim 10, wherein the cam rod is configured to be rotated in the first direction from a first rod position to a second rod position by no more than half of a single turn of the cam rod; and wherein in response to the cam rod being in the first rod position, each of the clamp jaws is in the first jaw position; and wherein in response to the cam rod being in the second rod position, each of the clamp jaws is in the second jaw position.

12. The busbar connection device of claim 11, wherein in response to the cam rod being rotated into the second rod positioned, the busbar engaging surfaces of the clamp jaws are configured to apply at least a guaranteed minimum amount of contact pressure on the first one of the busbars.

13. The busbar connection device of claim 10, further comprising a guide shaft including a threaded portion and a guide portion, the threaded portion of the guide shaft at least partially protruding through a guide-shaft aperture of the collar and configured to threadably engage a second one of the busbars thereby aiding in electrically coupling the second one of the busbars with the collar, and wherein the bore portion of the jaw press plate is configured to receive at least a portion of the guide portion of the guide shaft such that the jaw press plate is configured to slide thereon parallel with a central axis of the guide shaft between the first press-plate position and the second press-plate position.

14. The busbar connection device of claim 13, further comprising a clamp-jaw-retractor plate configured to engage respective second surfaces of the clamp jaws, the second surfaces of the clamp jaws opposing respective ones of the first surfaces of the clamp jaws.

15. The busbar connection device of claim 14, further comprising a biasing member attached to an end of the guide portion of the guide shaft and to the clamp-jaw-retractor plate, the biasing member being configured to cause the clamp-jaw-retractor plate to engage the respective second surfaces of the clamp jaws in response to the non-round head portion being rotated in a second direction opposite the first direction thereby causing the clamp jaws to move from the second jaw position to the first jaw position.

16. The busbar connection device of claim 10, wherein the non-round head portion of the cam rod includes a first lock slot and a second lock slot, each of the first and the second lock slots being configured to receive a portion of a cam lock therein to aid in preventing rotation of the cam rod in the first direction or in the second direction.

17. The busbar connection device of claim 16, wherein the cam lock includes a head portion and a shaft portion extending therefrom, the head portion of the cam lock being positioned within the collar, the shaft portion of the cam lock being configured to at least partially protrude through a cam-lock aperture in the collar such that at least a portion of the shaft portion of the cam lock is configured to engage the first lock slot or the second lock slot.

18. The busbar connection device of claim 17, further comprising a retaining ring coupled to the cam rod and positioned adjacent to the head portion of the cam lock such that the retaining ring aids in maintaining at least a portion of the shaft portion of the cam lock within the cam-lock aperture in the collar.

19. The busbar connection device of claim 10, further comprising a retaining ring coupled to the shaft portion of the cam rod and positioned outside of the collar to aid in preventing the cam rod from falling out of the collar.

20. The busbar connection device of claim 13, wherein the guide shaft further includes a flange portion positioned between the threaded portion and the guide portion, and in response to the threaded portion of the guide shaft threadably engaging the second one of the busbars, the flange portion being configured to engage an inner surface of the collar to aid in electrically connecting the second one of the busbars with the collar.

21. The busbar connection device of claim 20, further comprising a Belleville washer positioned between the inner surface of the collar and the flange portion of the guide shaft.

22. The busbar connection device of claim 10, wherein the first one of the busbars has a substantially round cross-section and wherein each of the busbar engaging surfaces of the clamp jaws is concave and configured to engage an outer surface of the first one of the busbars.

23. The busbar connection device of claim 22, wherein each of the angled slots is at an angle relative to the central axis of the guide shaft, and wherein the angle is between about thirty degrees and about sixty degrees.

24. The busbar connection device of claim 10, further comprising a housing having a first body portion, a second body portion, and a lid, the first body portion having an access aperture, the lid being removably coupled to the first body portion about the access aperture, the collar and the cam rod being positioned within the first body portion of the housing such that the non-round head portion of the cam rod is adjacent to the access aperture in the first body portion, the first body portion including a busbar aperture configured to receive the first one of the busbars therein and the second body portion including a busbar aperture configured to receive the second one of the busbars therein, and wherein the housing is made of an electrically insulating material.

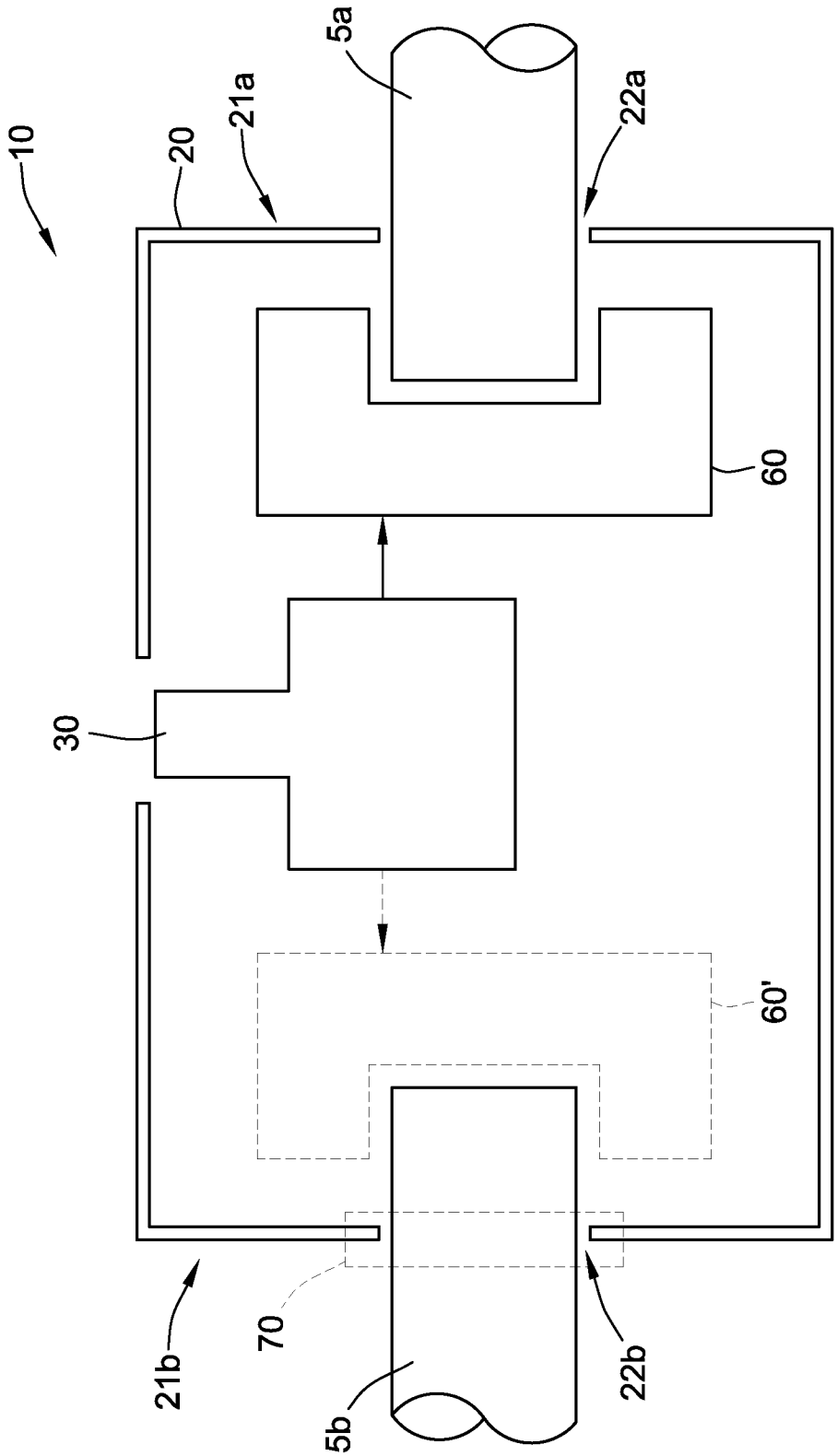


FIG. 1

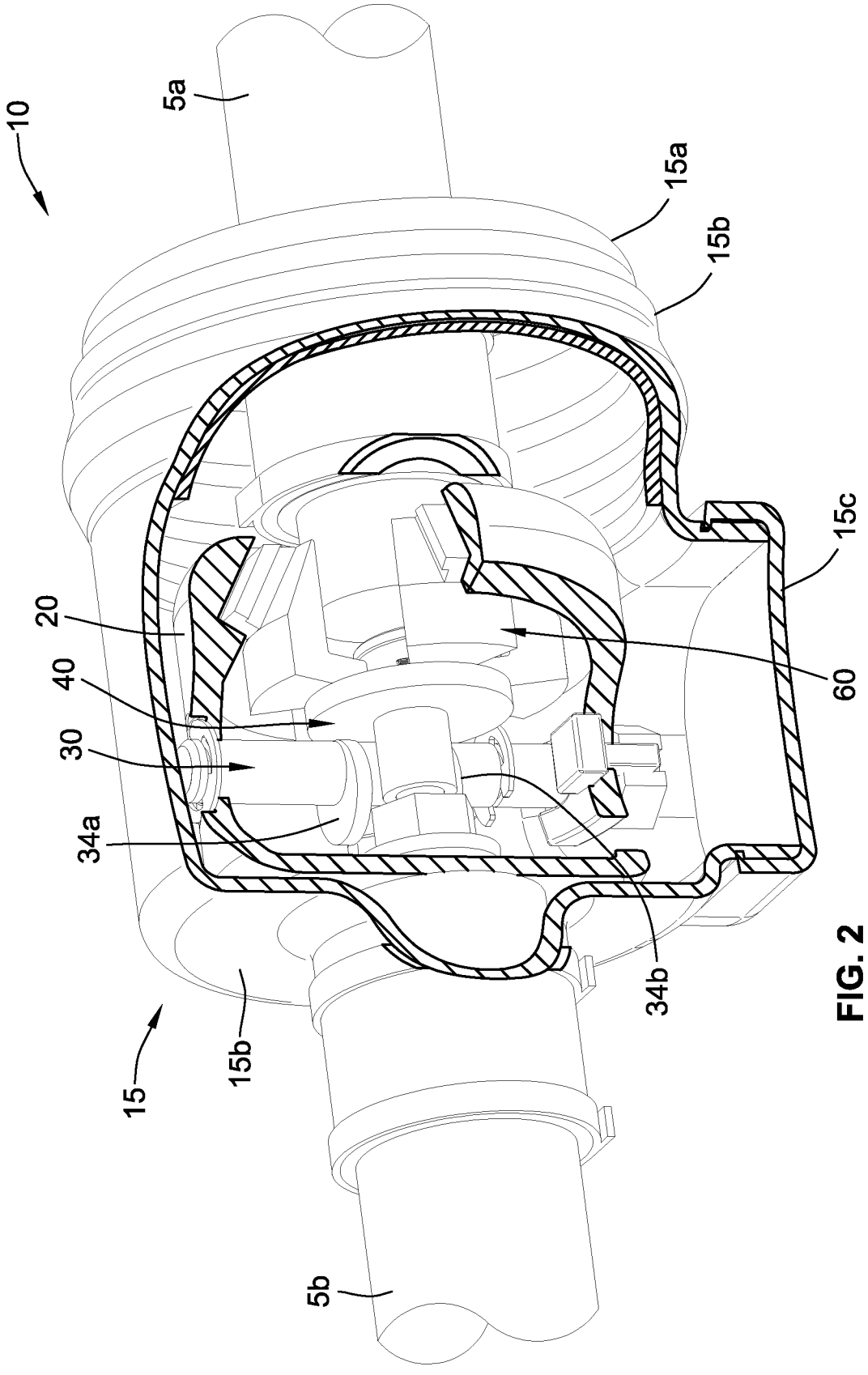
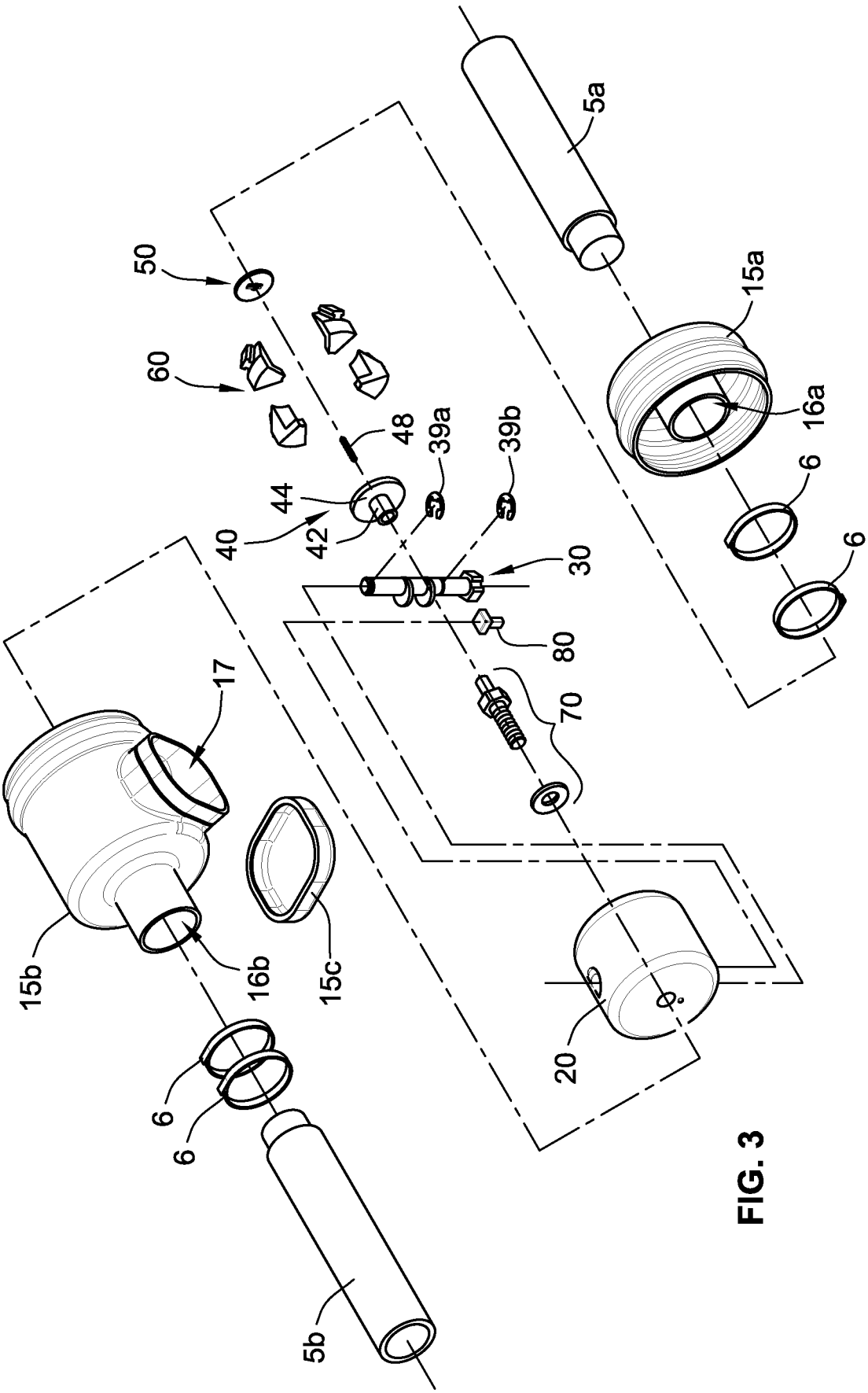


FIG. 2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6
20
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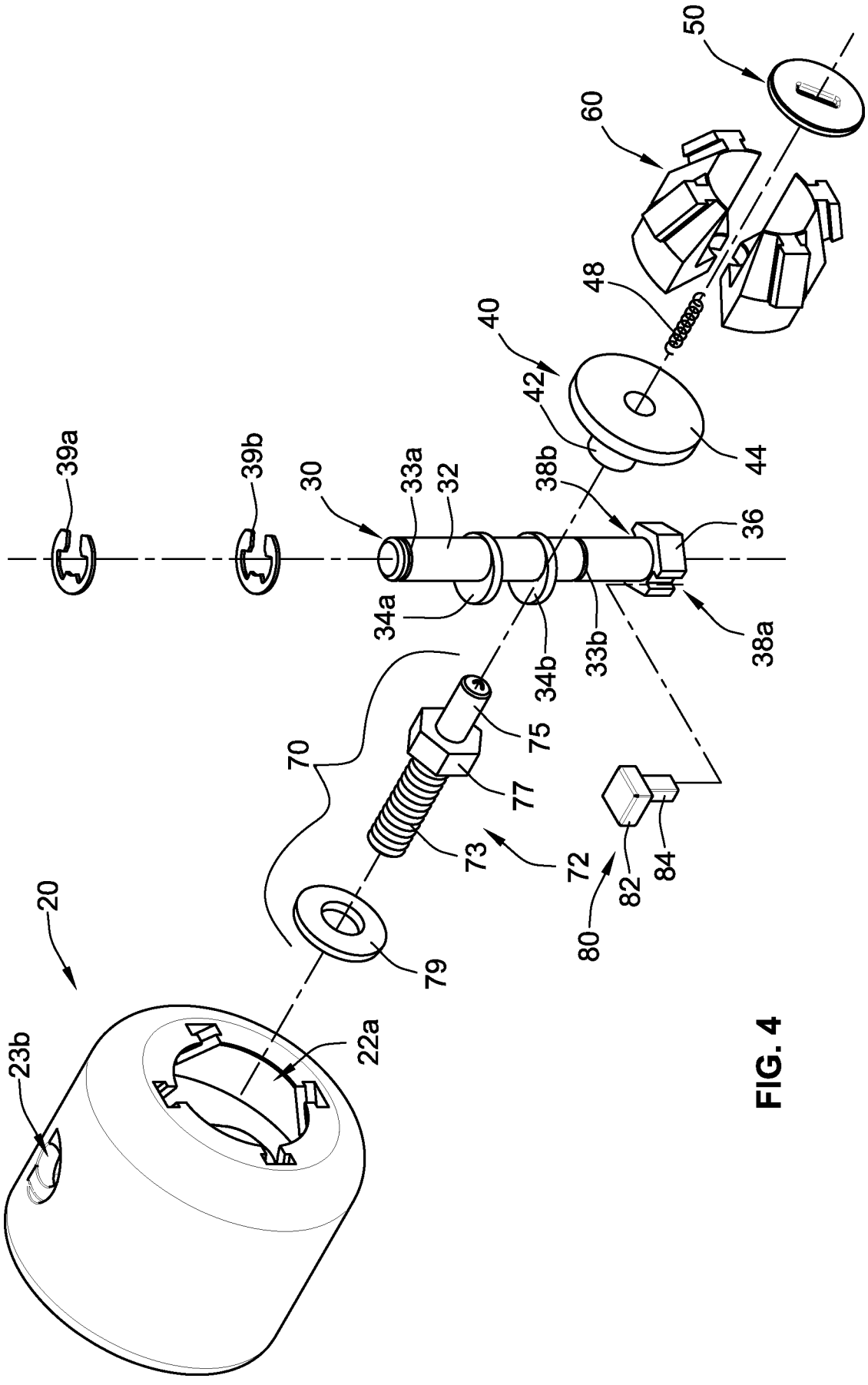
FIG. 3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23b
22a

FIG. 4

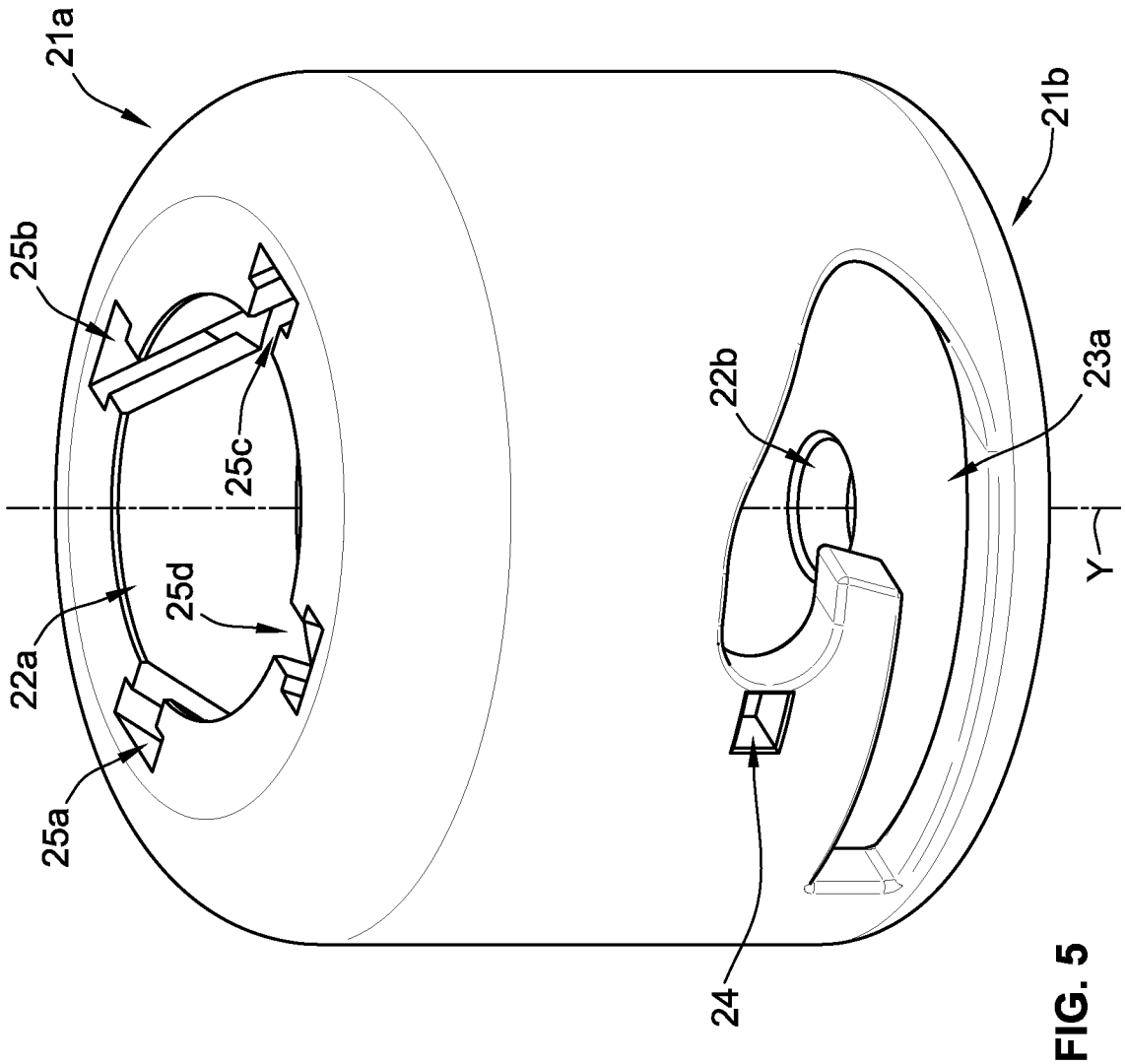

FIG. 5

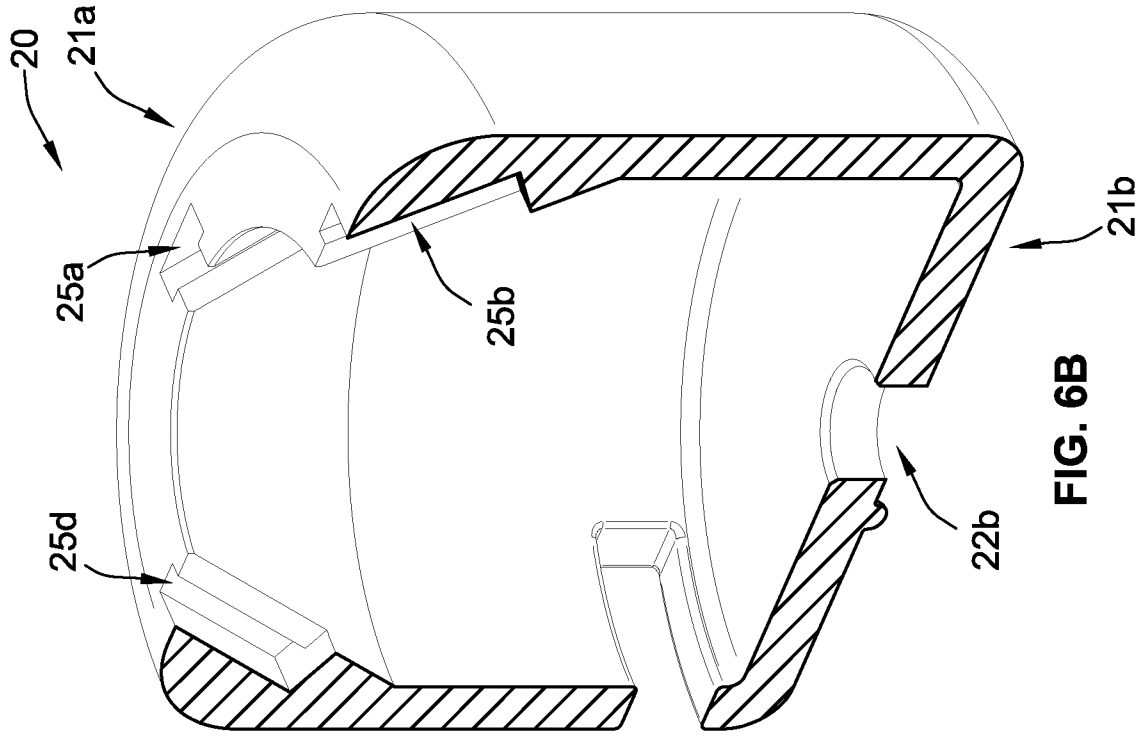

FIG. 6B

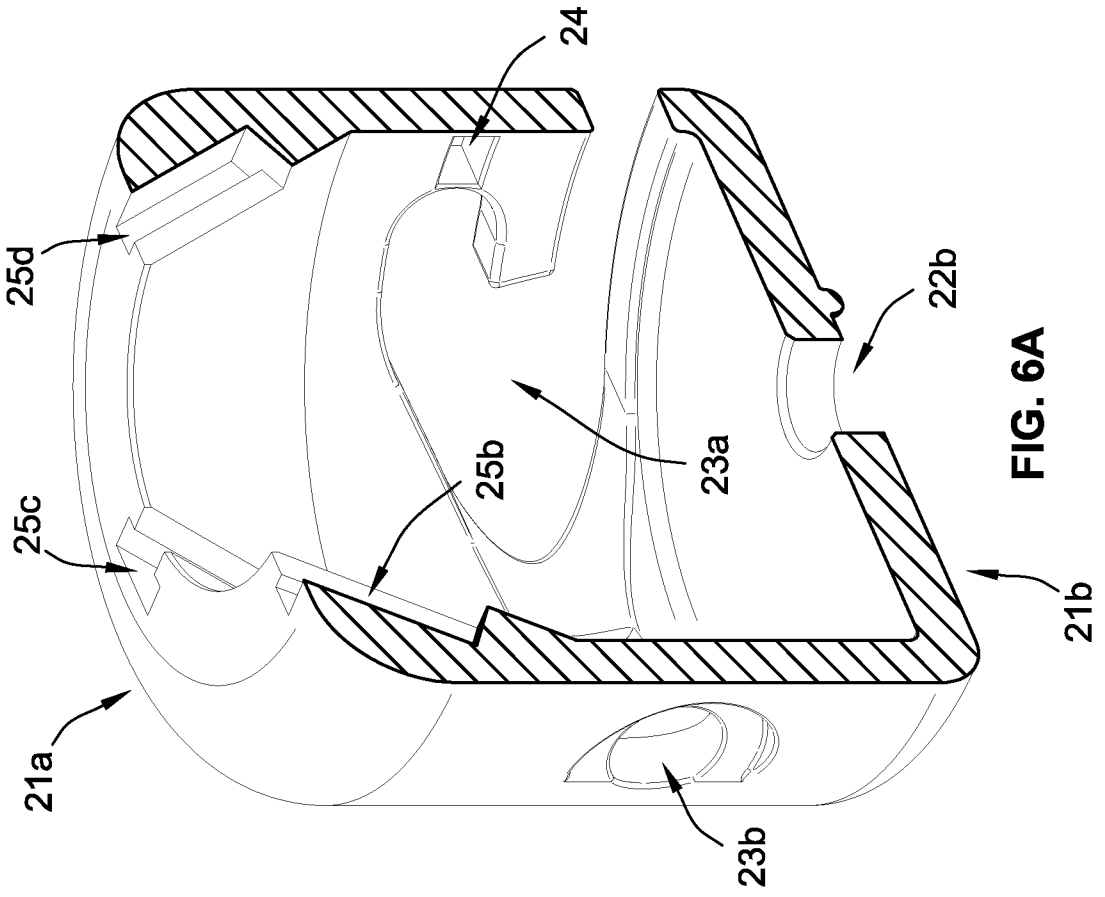

FIG. 6A

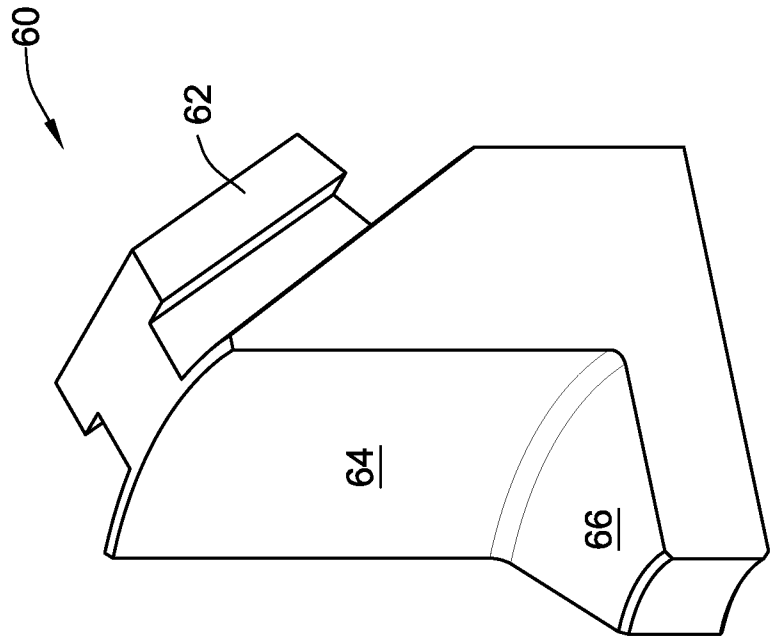

FIG. 7B

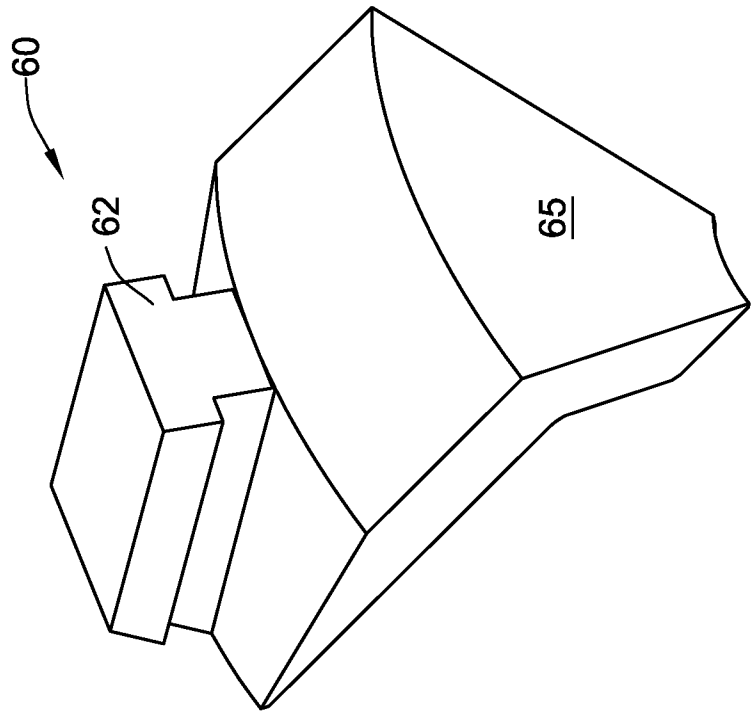

FIG. 7A

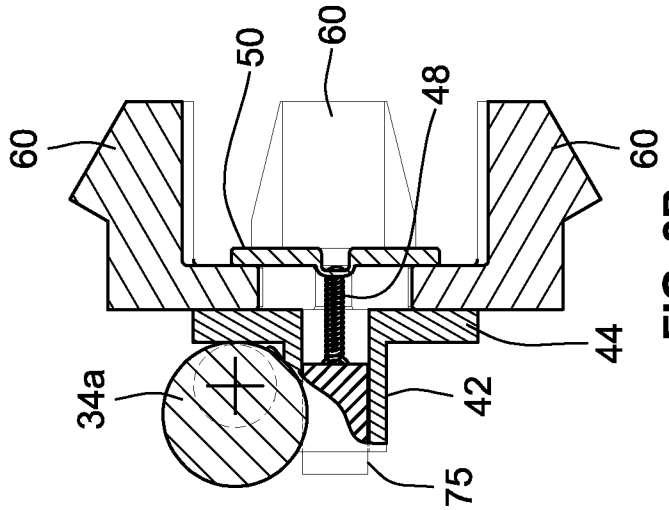
60
50
60
48
60
44
34a
42
75

FIG. 8B

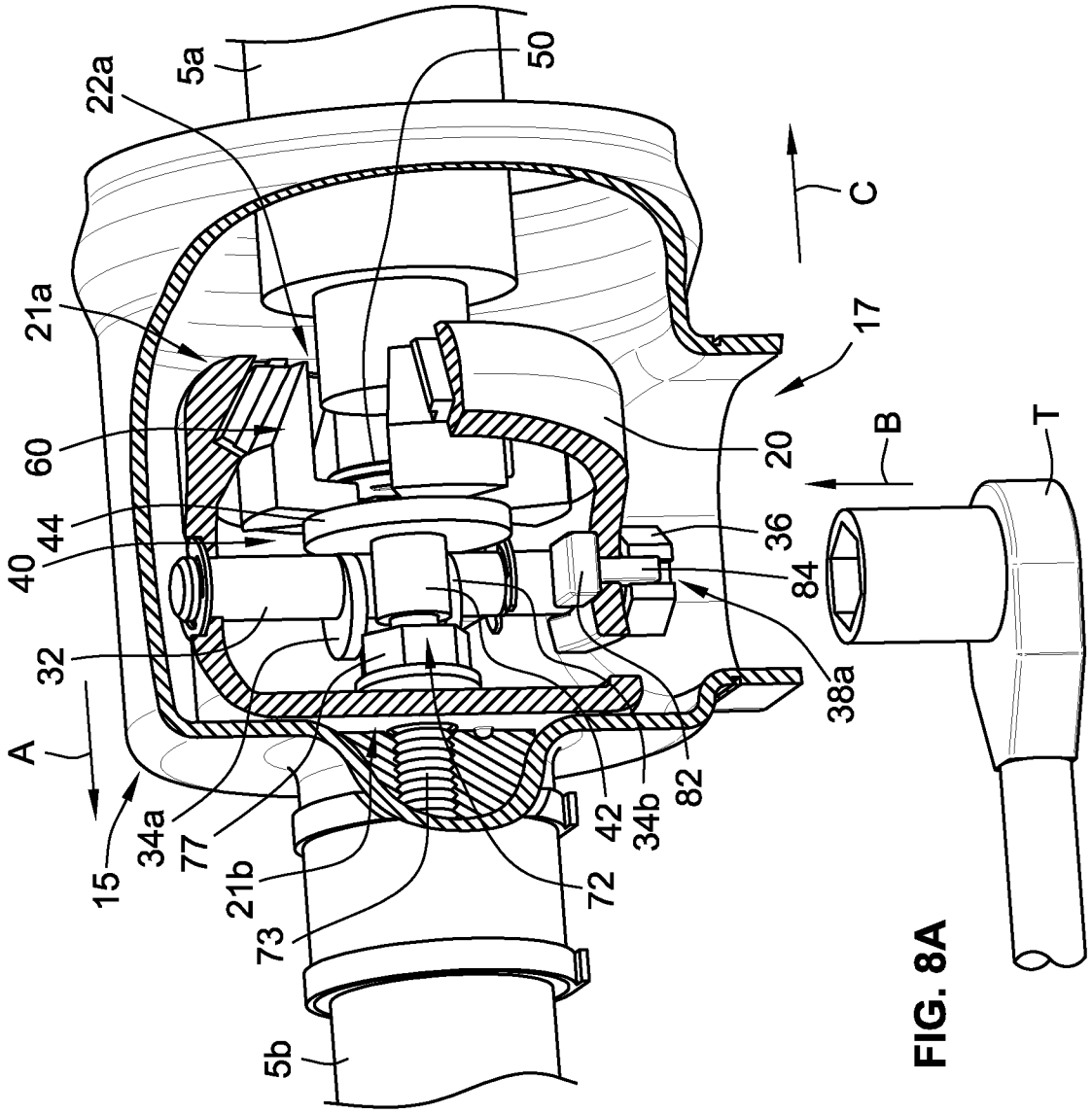
22a
5a
50
C
21a
17
60
20
B
T
44
36
40
84
32
38a
A
15
34a
77
42
34b
82
21b
72
73
5b

FIG. 8A

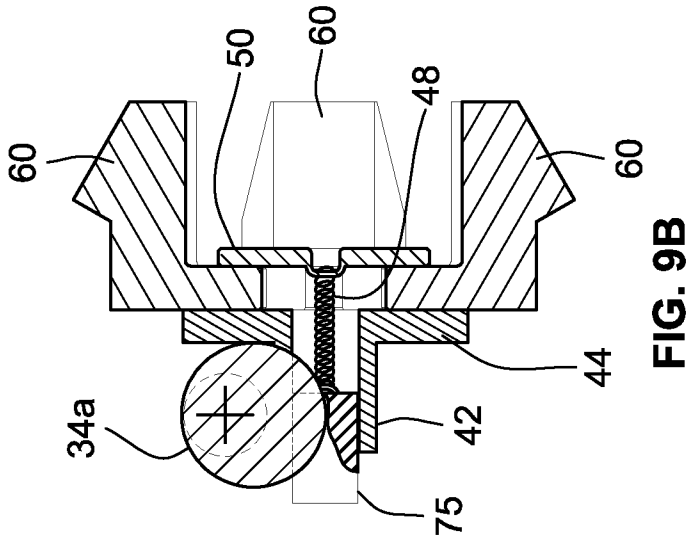
60
50
60
48
60
44
34a
42
75

FIG. 9B

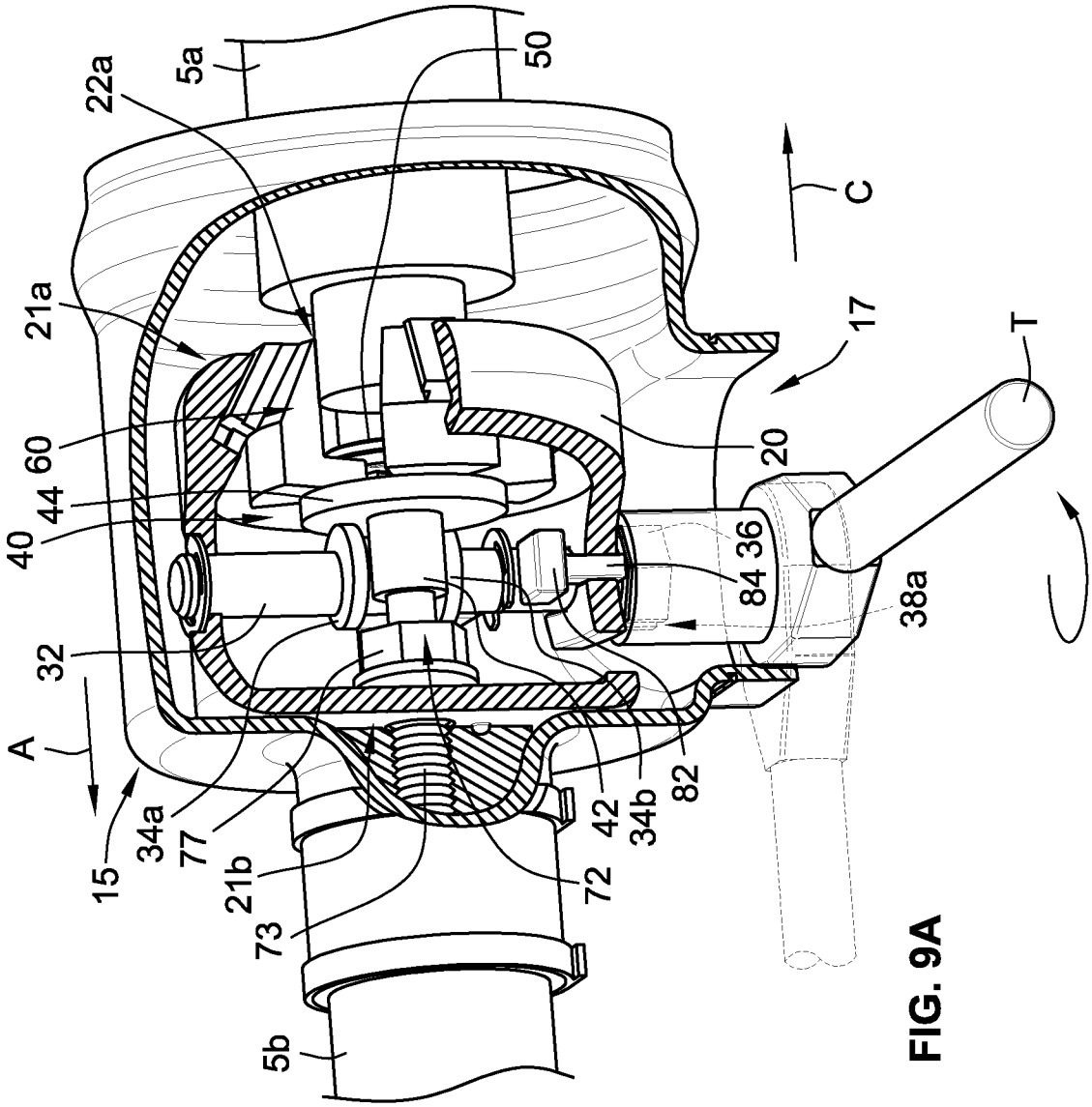
22a
5a
50
C
21a
17
T
60
44
40
20
36
84
38a
32
A
15
34a
77
21b
73
72
42
34b
82
5b

FIG. 9A

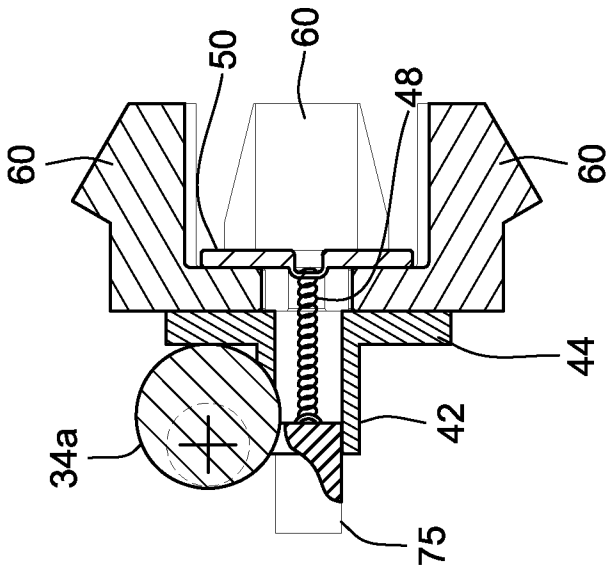

FIG. 10B

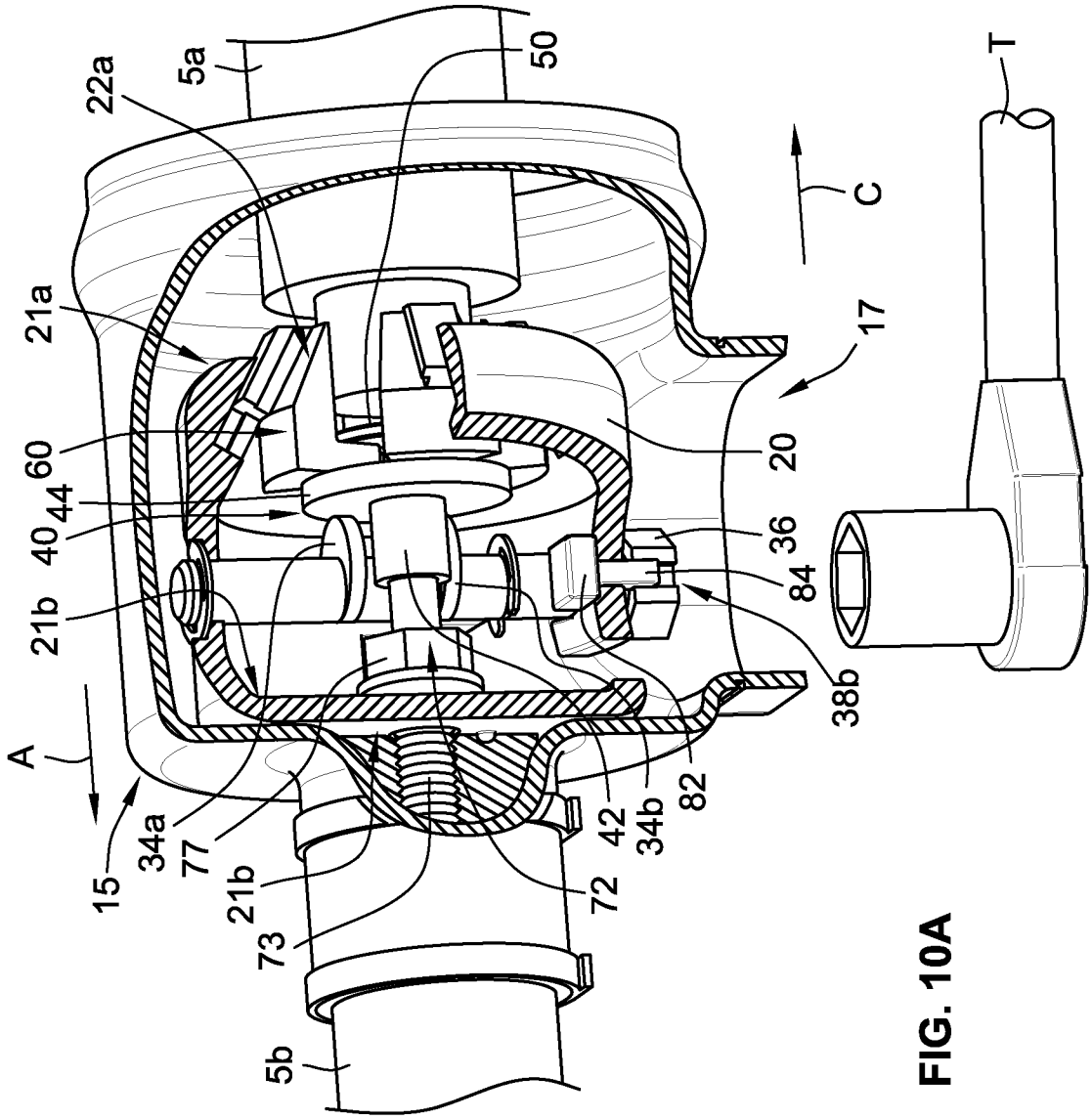

FIG. 10A

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 13/30968

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H02G 5/00, 5/08; H01R 4/50 (2013.01)
USPC - 439/811
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)
IPC(8): H02G 5/00, 5/08; H01R 4/50 (2013.01)
USPC: 439/811

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC(8): H02G 5/00, 5/08; H01R 4/50 (2013.01) (keyword limited, see terms below)
USPC: 174/68.2, 70B, 72B, 88B, 99B; 361/611, 624, 637; 439/212, 213, 251, 611, 811, 812, 949 (keyword limited, see terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase, Google Scholar, Google Patents, Google. Search terms used: busbar, cam, collar, connect, fasten, secur, hold, clamp, jaw, check, rod, shaft, press, plate, two, sleeve, Schneider Electric, Matthew Williford

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2012/0118605 A1 (WILLIFORD et al.) 17 May 2012 (17.05.2012) Fig 1-3, 5-8, para [0005],[0024]-[0031]	1-3, 7-9
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Y		6, 10-12, 16, 19, 22-24
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A		4-5, 13-15, 17, 18, 20, 21
Y	US 2,549,725 A (Uline et al.) 17 April 1951 (17.04.1951) Fig 1, 2, col 2, ln 20-27, col 3, ln 46 to col 4, ln 36	6, 10-12, 16, 19, 22-24
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A		13-15, 17, 18, 20, 21
Y	US 5,344,330 A (Hoffman) 06 September 1994 (06.09.1994) (col 11, ln 59-64, col 12, ln 5-19)	16
---		---
A		17, 18
Y	US 2004/0058567 A1 (MA) 25 March 2004 (25.03.2004) para [0009], [0019]	19
Y	GB 824,260 A (FARISH et al.) 18 December 1956 (18.12.1956), Fig 4 and 5, page 2, ln 111 to page 3, ln 17	22, 23

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"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
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 May 2013 (08.05.2013)	05 JUN 2013
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)