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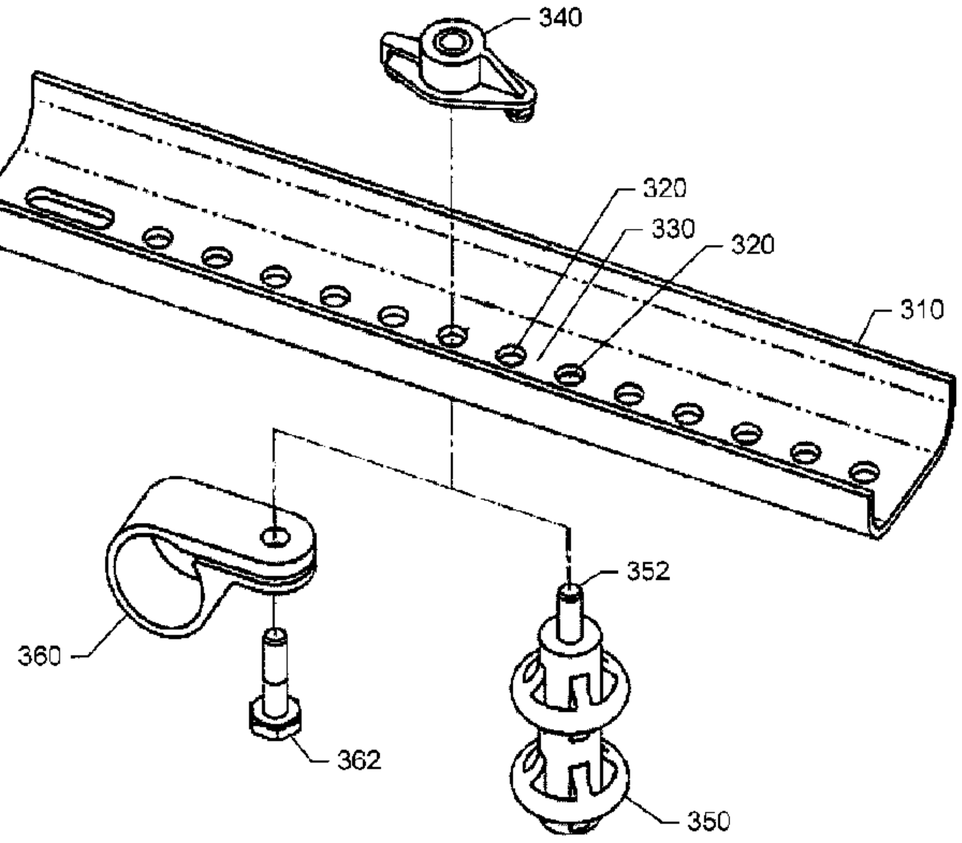


(57) Abrégé/Abstract:
An aircraft having a fuselage, at least one wing assembly, at least one secondary support structure defining at least one mounting hole, and at least one propulsion engine. The aircraft includes a spanner bar having a mounting surface and return flanges, and a nut plate engaging the secondary support structure, the nut plate including a body having an internally threaded bore, at least one locator protrusion engaging a mounting hole in the secondary support structure to constrain motion of the nut plate along the secondary support structure, and means for additionally constraining motion of the nut plate away from the secondary support structure. The means for additionally constraining motion includes first and second resilient finger tabs cantilevered to the body and extending outward from the body and the first and second resilient finger tabs releasably engaging the return flanges.

ABSTRACT

An aircraft having a fuselage, at least one wing assembly, at least one secondary support structure defining at least one mounting hole, and at least one propulsion engine. The aircraft includes a spanner bar having a mounting surface and return flanges, and a nut plate engaging the secondary support structure, the nut plate including a body having an internally threaded bore, at least one locator protrusion engaging a mounting hole in the secondary support structure to constrain motion of the nut plate along the secondary support structure, and means for additionally constraining motion of the nut plate away from the secondary support structure. The means for additionally constraining motion includes first and second resilient finger tabs cantilevered to the body and extending outward from the body and the first and second resilient finger tabs releasably engaging the return flanges.

SELF-INDEXING NUT PLATE

BACKGROUND

Spanner bars and other secondary support structures are commonly used in commercial aircraft for wire bundle management. A typical spanner bar includes a thin gauge member having a repeating pattern of mounting holes separated by lands.

The spanner bars may be secured to primary aircraft structures. Wire support hardware such as p-clamps and ring posts are fastened to the spanner bars, and wire bundles are secured to the wire support hardware.

A ring post may be fastened to a spanner bar as follows. The ring post is positioned on a front side of the spanner bar. A threaded end of the ring post is aligned with a select open hole of the spanner bar. The threaded end of the ring post is maneuvered through the select hole until threads are exposed on a back side of the spanner bar. A loose washer and nut are placed over and threaded onto the threaded end of the ring post. The nut is tightened with a hand tool until firmly clamped against the spanner bar. This process is repeated for each ring post.

It would be desirable to reduce part count and installation time of attaching wire support hardware to a spanner bar. Even a seemingly trivial reduction for a single nut and washer can be significant due to the large number of fastening operations on secondary support structures in a commercial aircraft.

SUMMARY

In accordance with one disclosed aspect there is provided an aircraft including a spanner bar having a mounting surface and return flanges, and a nut plate engaging the spanner bar. The nut plate includes a body having an internally threaded bore, at least one locator protrusion engaging a mounting hole in the spanner bar to constrain motion of the nut plate along the spanner bar, and provisions for additionally constraining motion of the nut plate away from the spanner bar. The provisions for additionally constraining motion includes first and second resilient finger tabs cantilevered to the body and extending outward from the body and the first and second resilient finger tabs releasably engaging the return flanges. The provisions for

additionally constraining motion further include a bar having opposing ends. Tthe bar is attached to the body generally opposite from the first and second resilient finger tabs, extends across the mounting surface, and the opposing ends of the bar are located beneath the return flanges.

The nut plate may be constrained without use of mounting hardware.

The aircraft may include mounting hardware that may be fastened onto the nut plate.

The aircraft may include a wire bundle carried by the mounting hardware.

The aircraft may include tubing carried by the mounting hardware.

The provisions further may include third and fourth resilient finger tabs cantilevered to the body and extending outward from generally opposite sides of the body, the third and fourth tabs releasably engaging the return flanges.

The internally threaded bore may have a threaded portion, and the threaded portion may be a full thread metallic insert.

The first and second resilient finger tabs may be laterally offset from the internally threaded bore with respect to a longitudinal axis of the spanner bar.

The internally threaded bore may be positioned laterally between the first resilient finger tab and the bar with respect to a longitudinal axis of the spanner bar.

In accordance with another disclosed aspect there is provided an apparatus including a spanner bar having a surface with an alternating pattern of mounting holes and lands, the spanner bar having return flanges. The apparatus also includes a nut plate engaging the spanner bar, the nut plate including a body having a mounting surface and an internally threaded bore accessible from the mounting surface, the mounting surface being in contact with the spanner bar. The nut plate also includes at least one protrusion extending from the mounting surface, each protrusion engaging one of the mounting holes to constrain motion of the nut plate along the spanner bar, and provisions for engaging the spanner bar to constrain motion of the nut plate away from the spanner bar without cooperation of mounting hardware. The provisions for engaging the spanner bar to constrain motion include first and second resilient finger tabs cantilevered to the body and extending outward from the body, the first and second resilient finger tabs being configured to releasably engage the return flanges,

and a bar having opposing ends, and the bar being attached to the body generally opposite from the first and second resilient finger tabs, the bar extending across the mounting surface, and the opposing ends of the bar being located beneath the return flanges.

The first and second resilient finger tabs and the bar may be laterally offset from the internally threaded bore with respect to a longitudinal axis of the spanner bar.

The internally threaded bore may be positioned laterally between the first resilient finger tab and the bar with respect to a longitudinal axis of the spanner bar.

The nut plate may be constrained without use of mounting hardware.

The apparatus may include mounting hardware that may be fastened onto the nut plate.

In accordance with another disclosed aspect there is provided a nut plate configured to engage a thin gauge member having a base and return flanges, the base having an alternating pattern of holes and lands. The nut plate includes a body having a mounting surface and an internally threaded bore accessible from the mounting surface, a locator protrusion configured to extend from the mounting surface and into one of the holes, and first and second resilient finger tabs cantilevered to the body and extending outward from the body. The first and second resilient finger tabs are configured to releasably engage the return flanges to constrain motion of the nut plate away from the base. The nut plate further includes a bar having opposing ends, the bar being attached to the body generally opposite from the first and second resilient finger tabs, the bar extending across the mounting surface, and the opposing ends of the bar being located beneath the return flanges.

The nut plate may include third and fourth resilient finger tabs cantilevered to the body and extending outward from generally opposite side of the body, the third and fourth tabs being configured to releasably engage the return flanges.

The first and second resilient finger tabs may be laterally offset from the internally threaded bore with respect to a longitudinal axis of the thin gauge member.

The internally threaded bore may be positioned laterally between the first resilient finger tab and the bar with respect to a longitudinal axis of the thin gauge member.

The nut plate may include mounting hardware that may be fastened onto the nut plate, and a wire bundle, carried by the mounting hardware.

The nut plate may include mounting hardware that may be fastened onto the nut plate, and tubing, carried by the mounting hardware.

These features and functions may be achieved independently in various embodiments or may be combined in other embodiments. Further details of the embodiments can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an illustration of an aircraft.

FIGS. **2**A and **2**B are illustrations of raceway wire bundles in a fuselage of an aircraft.

FIG. **3** is an illustration of a spanner bar and a first embodiment of a self-indexing nut plate.

FIGS. **4**A to **4**D are illustrations of the first embodiment of the self-indexing nut plate.

FIG. **5** is an illustration of a method of installing and using the first embodiment of the self-indexing nut plate.

FIGS. **6**A-**6**E are illustrations of the first embodiment of the self-indexing nut plate during various stages of installation.

FIG. **7**A is an illustration of an assembly including two sidewalls, a sidewall gap cover, a self-indexing nut plate, and a bracket having a slotted hole pattern for mounting the sidewall gap cover.

FIG. **7**B is an illustration of the self-indexing nut plate and the bracket of FIG. **7**A.

FIG. **7**C is a cross-sectional view of the nut plate of FIG. **7**B.

FIGS. **8**A and **8**B are illustrations of a second embodiment of a self-indexing nut plate.

FIG. **9**A is an illustration of a method of installing the second embodiment of the self-indexing nut plate on a spanner bar having return flanges.

FIGS. **9**B-**9**D are illustrations of the second embodiment of the self indexing nut plate engaged with the spanner bar having return flanges.

FIG. **10** is an illustration of various types of mounting hardware that may be fastened to the second embodiment of the self-indexing nut plate.

FIGS. **11**A and **11**B are illustrations of a third embodiment of a self-indexing nut plate.

FIGS. **12**A and **12**B are illustrations of an assembly including a bracket, a self-indexing nut plate, and a push-in fastener.

FIG. **13** is an illustration of a generic self-indexing nut plate.

DETAILED DESCRIPTION

Reference is made to FIG. **1**, which illustrates an aircraft **100** including a fuselage **110**, wing assemblies **120**, empennage **130**, and landing gear assemblies **140**. Propulsion engines **150** are mounted to the wing assemblies **120**.

The aircraft **100** further includes wiring assemblies and tubing assemblies. The wiring assemblies include wire bundles that are attached to secondary support structures such as spanner bars. The tubing assemblies include tubing that is attached to secondary support structures such as combination tube and spanner bars. These secondary support structures may be located inside the fuselage **110** and wing assemblies **120**.

Reference is now made to FIG. **2**A, which illustrates some raceway wire bundles **210**, **220** and **230** inside the aircraft fuselage **110**. A frame bay raceway wire bundle **210** is located between frames **112** of the fuselage **110**. A crown raceway wire bundle **220** extends across frames **112** of the fuselage **110**. A floor raceway wire bundle **230** is located beneath a floor **114** of the fuselage **110**, and extends across several floor beams **116**. The floor raceway wire bundle **230** supports a small tube **232**.

Additional reference is made to FIG. **2**B, which shows a portion of the crown raceway wire bundle **220** in greater detail. Wires **222** in the bundle **220** are clamped to a spanner bar **240**. The spanner bar **240**, in turn, is secured to a frame **112** by a bracket **250**.

The spanner bar **240** may be a thin gauge member having a repeating pattern of mounting holes separated by lands. For instance, the spanner bar **240** may have an equally spaced, predrilled open-hole pattern of mounting holes separated by lands.

Reference is made to FIG. **13**, which illustrates a generic self-indexing nut plate **1310** for fastening wire support hardware to a secondary support structure such as the spanner bar **240**. Each nut plate **1310** includes at least one locator protrusion **1312**. Each protrusion **1312** engages one of the mounting holes in the secondary support structure to constrain motion of the nut plate **1310** along the secondary support structure. The nut plate **1310** further includes means **1314** for additionally constraining motion of the nut plate **1310** away from the secondary support structure.

FIG. **3** illustrates a first embodiment of a self-indexing nut plate **340**. The nut plate **340** is engaged with a spanner bar **310** and locked in place, whereby an internally threaded bore in the nut plate **340** is aligned with a mounting hole **320** in the spanner bar **310**. The nut plate **340** is engaged with the spanner bar **310** prior to installing fastener hardware such as a ring post **350** or p-clamp **360** (which holds a wire bundle or tubing). Thereafter, a threaded stud **352** of the ring post **350** or a p-clamp bolt **362** may be inserted through the mounting hole **320** of the spanner bar **310** and threaded into the bore of the nut plate **340**. A wire bundle (not shown) may be attached to the ring post **350** after the ring post **350** has been threaded into the nut

plate **340**. A wire bundle or tubing (not shown) may be held by the p-clamp **360** as the p-clamp bolt **362** is being threaded into the nut plate **340**.

Reference is made to FIGS. **4**A and **4**B, which illustrate the first embodiment of the self-indexing nut plate **340** in greater detail. The nut plate **340** includes a body **410** having a flat mounting surface **420** and an internal bore **450** that extends to the mounting surface **420**. The bore **450** may have an internally threaded portion **460** for engaging fastener hardware (e.g., the ring post **350**). In some embodiments, the threaded portion **460** may be a full thread metallic insert.

The nut plate **340** further includes first and second mounting posts (locator protrusions) **430** and **440** extending from the mounting surface **420**. The mounting posts **430** and **440** may be orthogonal to the mounting surface **420**. Each mounting post **430** and **440** has an undercut portion U. In some embodiments, both posts **430** and **440** terminate in circular caps **435** and **445** (restraining means), which have larger cross-sections than the posts **430** and **440**. In those embodiments, each undercut portion U is defined by a cap **435** or **445**, post **430** or **440**, and mounting surface **420**.

The posts **430** and **440** are located on opposite sides of the bore **450**. The bore **450** is offset from the posts **430** and **440** (that is, the bore **450** is closer to one of the posts **440** than the other post **430**) by an offset distance. The offset distance is such that the bore **450** is aligned with a hole **320** in the spanner bar **310** when the undercut portions U of the posts **430** and **440** engage the lands of the spanner bar **310** (that is, when the nut plate **340** engages the spanner bar **310**).

The nut plate **340** further includes a locking member **470** that is hinged from the body **410** by a spring lever **480**. The lever **480** can move the locking member **470** between a locked position and an unlocked position. The locking member **470** may be retracted by pulling up on a release grip ledge **482** of the spring lever **480**. This retraction feature is desirable because it allows a mislocated nut plate **340** to be relocated, and it allows a nut plate **340** to be released from the spanner bar **310** and reused.

In some embodiments, the body **410**, the posts **430** and **440**, the caps **435** and **445**, the locking member **470** and the spring lever **480** are made of plastic. The body **410** may include a boss molded around the full thread metallic insert.

Reference is now made to FIG. **4**C, which illustrates the nut plate **340** locked to the spanner bar **310**. FIG. **4**C shows the following features of the spanner bar **310**: a first land **311**, first hole **312**, second land **313**, second hole **314**, third land **315**, third hole **316**, and fourth land **317**.

The nut plate **340** engages the spanner bar **310** when the posts **430** and **440** are abutted against the first and third lands **311** and **315** of the spanner bar **310**. The nut plate **340** is locked to the spanner bar **310** by inserting the locking member **470** into the third hole **316** to occupy the space between the post **440** and the fourth land **317**. With the nut plate **340** locked as such, the bore **450** of the nut plate **340** is aligned with the second hole **314** in the spanner bar **310**.

Reference is now made to FIG. **4**D, which is a cross-sectional view of FIG. **4**B along lines **4**D-**4**D. In some embodiments, the posts **430** and **440** may have an elliptical shape in cross section. Moreover, the posts **430** and **440** are preferably solid. This geometry allows the posts **430** and **440** to withstand shear forces that are generated when a fastener (e.g., a ring post stud **352**) is torqued onto the nut plate **340**.

The posts **430** and **440** are superior to conventional pin barbs. The posts **430** and **440** have greater cross-sectional area than conventional pin barbs and are better suited to handle greater torque loads (which can occur when a fastener is threaded into the nut plate **340**). The posts **430** and **440** also have greater ledge surface area and can counter larger axial loads. Therefore, the posts **430** and **440** are less likely to disengage and release the nut plate **340** from the spanner bar **310**. Pin barbs, in contrast, tend to collapse inward and disengage.

Reference is now made to FIG. **5** and FIGS. **6**A-**6**E, which illustrate a method of installing a nut plate **340** onto a secondary support structure **610**. Three holes of the support structure **610** will be used by the nut plate **340**.

Referring to block **510** of FIG. **5** and also to FIG. **6**A, the nut plate **340** is held in one hand and positioned above the surface of the support structure **610**. The posts **430** and **440** of the nut plate **340** are aligned with first and second holes **620** and **630** of the support structure **610**.

Referring to block **520** of FIG. **5** and also to FIG. **6**B, the first and second mounting posts **430** and **440** are firmly pressed (in the direction of the arrow) through the first and second holes **620** and **630** until the mounting surface of the nut plate **340** makes contact with the support structure **610**. At this point, the center axis of the internal bore **450** is not in alignment with a center (third) hole **640**. In addition, the spring lever **480** is flexed upward. The undercut portions of the mounting posts **430** and **440** have not yet engaged the support structure **610** (see also FIG. **6**C).

Referring to block **530** of FIG. **5** and also to FIG. **6**D, the nut plate **340** is slid forward in the direction of the arrow until each mounting post **430** and **440** abuts against a land **615** and **625**. At this point, the bore **450** in the nut plate **340** is aligned with the center hole **640**. Thus, the nut plate **340** is self-indexing.

The undercut portions in the mounting posts **430** and **440** may be slightly wider or narrower than the gauge of the support structure **610**. In some embodiments, the gap may be slightly narrower, whereby the cap **445** is deflected outward by the land **625** and snap onto the land **625** as the nut plate **340** is being pushed into engagement (FIG. **6**E).

At block **540** of FIG. **5**, the nut plate **340** is locked in position. The spring lever **480** is depressed to push the locking member **470** into the space between the second mounting post **430** and the trailing land **635**. An audible sound such as a "click" may occur as the locking member **470** is snapped onto the hole **630**. The audible sound provides additional input to the installer that the nut plate **340** has properly engaged the support member **610**.

A trailing surface **442** of the second mounting post **440** may be flattened to mate with the locking member **470** (FIG. **6**E). The locking member **470** prevents the nut plate **340** from moving along the support structure **610**. The caps **435** and **445** prevent the engaged nut plate **340** from being pulled away from the support structure **610**.

At block **550** of FIG. **5**, a fastener is installed into the nut plate **340**. This may be done immediately after the nut plate is installed, or some time later.

The nut plate **340** is not limited to spanner bars and similar secondary support structures. For example, the nut plate **340** may be used to mount a sidewall gap cover to sidewall panels via a secondary support structure such as a bracket.

Reference is now made to FIG. **7**A, which illustrates two adjacent sidewall panels **710** and **712** and a gap **714** there between. FIG. **7**A also illustrates a cover **720** for covering the gap **714**, cover mounting fastener **740**, and related bracket **730**.

Additional reference is made to FIG. **7**B. The sidewall gap cover **720** is mounted to the bracket **730**, which has a custom slot pattern consisting of first and second rectangular slots **732** and **734**, and an opening (e.g., a hole or parallel slot) **736** in between. A nut plate **700** includes first and second posts **702** and **704** having rectangular cross-sections (FIG. **7**C). The nut plate **700** may be attached to the bracket **730** by inserting the posts **702** and **704** into the rectangular slots **732** and **734** and moving the nut plate **700** in the direction of the arrow. A locking member **706** is then inserted in the space between the second post **704** and the trailing land. In this locked position, the nut plate's bore **708** is aligned with the opening **736** in the mounting bracket **730**. After the nut plate **700** has been locked to the mounting bracket **730**, a conventional threaded fastener **740** or ring post may be threaded onto the nut plate **700**.

Reference is now made to FIGS **8**A and **8**B, which illustrate a second embodiment of a self-indexing nut plate **810**. The second embodiment of the nut plate **810** is configured to engage a spanner bar having return flanges. The nut plate **810** includes a body **820** having a flat mounting surface **830** and an internal bore **840** that extends to the mounting surface **830**. The bore **840** may have an internally threaded portion for engaging fastener hardware.

The nut plate **810** further includes a boss (locator protrusion) **850** extending outward from the mounting surface **830**. The boss **850** is coaxially aligned with the internal bore **840**. As described below, the boss is configured to constrain motion of the nut plate along a surface of a spanner bar.

The nut plate **810** further includes first and second resilient finger tabs **860** and a cross bar **870** for constraining motion of the nut plate **810** away from the spanner bar. The first and second resilient finger tabs **860** are cantilevered to the body **820** and

extend outward from one end of the body **820**. The tabs **860** are configured to releasibly engage the return flanges of the spanner bar. The cross bar **870** is located at an opposite end of the body **820** and extends transversely across the body **820**.

Additional reference is made to FIG. **9**A, which illustrates a method of installing the nut plate **810** on a spanner bar **900** having return flanges **902**. At step **950**, the nut plate **810** is positioned sideways on a surface **904** of the spanner bar **900**, with the cross bar **870** touching the surface **904** and oriented lengthwise along the spanner bar **900**. At step **960**, the nut plate **810** is rotated **90** degrees counter-clockwise until the cross bar **870** extends across the width of the spanner bar **900**.

At step **970**, the resilient finger tabs **860** are pressed inward as the nut plate **810** is rotated downward towards the spanner bar surface **904**. The position of the nut plate **810** along the spanner bar **900** is adjusted until the boss **850** engages a spanner bar mounting hole (the mounting hole is best seen in FIG. **10**). The boss **850** is configured to fit snuggly in the mounting hole. After step **970** has been completed, the mounting surface **830** of the nut plate body **820** is flush against the spanner bar surface **904**.

At step **980**, the resilient tabs are released, whereby the tabs **860** engage the return flanges **902**. The boss **850** constrains the motion of the nut plate **810** along the spanner bar **900**, and the tabs **860** and the cross bar **870** constrain the motion of the nut plate **810** away from the spanner bar **900**. In this manner, the nut plate **810** is engaged with the spanner bar **900** prior to being engaged with fastener hardware.

FIG. **9**B is another illustration of the nut plate **810** engaged with the spanner bar **900**. FIG. **9**C, which is an illustration of the nut plate **810** and spanner bar **900** taken along lines **9**C-**9**C of FIG. **9**B, shows the resilient finger tabs **860** engaging the return flanges **902** of the spanner bar **900**. Vertical stop blocks and multi-step indentations **865** accommodate the tolerance range of the inner height of the return flanges **902**.

FIG. **9**D is an illustration of the nut plate **810** and spanner bar **900** taken along lines **9**D-**9**D of FIG. **9**B. The cross bar **870** is abutted against the return flanges **902** of the spanner bar **900**.

FIG. **10** illustrates various types of mounting hardware that may be secured to the spanner bar **900** by fastening to the nut plates **810**. The mounting hardware includes, but is not limited to, p-clamps **1010**, ring posts **1020**, and saddles **1030**.

Reference is now made to FIGS **11**A and **11**B, which illustrate a third embodiment of a self-indexing nut plate **1110**. Similar to the second embodiment, the third embodiment of the self-indexing nut plate **1110** includes a body **1120** having a flat mounting surface **1130** and an internal bore **1140**. The nut plate **1110** further includes first and second resilient finger tabs **1150** that are cantilevered to the body **1120** and extend outward from the body **1120** in a first direction. The first and second tabs **1150** are configured to releasibly engage the return flanges of a spanner bar.

Unlike the second embodiment, the third embodiment of the nut plate **1110** includes first and second locator pins **1170** instead of the boss. The locator pins **1170** are configured to engage two mounting holes of the spanner bar and thereby constrain the nut plate **1110** from moving along a surface of the spanner bar. When the locator pins **1170** engage the mounting holes, the internal bore **1140** is aligned with another mounting hole in the spanner bar (between the two engaged holes).

Unlike the second embodiment, the third embodiment of the nut plate **1110** includes third and fourth resilient tabs **1160** in place of the cross bar. These additional resilient tabs **1160** are cantilevered to the body **1120** and extend outward from the body **1120** in a second direction, which is opposite the first direction. The third and fourth tabs **1160** are also configured to releasibly engage the return flanges of a spanner bar.

Each tab **1150** and **1160** includes vertical stop blocks and a multi-step indentation. These accommodate the tolerance range of the inner height of the return flanges.

To install the third embodiment of the nut plate **1110**, the first and second tabs **1150** are depressed inwards, and the third and fourth tabs **1160** are depressed inwards. The nut plate **1110** is positioned above an open slot of the spanner bar and then lowered into the slot. The locator pins **1170** are seated into mounting holes, and then the tabs **1150** and **1160** are released. The nut plate **1110** is now engaged with the spanner bar prior to being engaged with fastener hardware.

A nut plate herein is not limited to ring posts and other wire support hardware, nor is it limited to threaded fasteners. For example, a nut plate herein may be used with push-in fasteners.

Reference is made to FIGS. **12**A and **12**B, which illustrate an assembly **1210** including a bracket **1220**, a self-indexing nut plate **1230**, and a push-in fastener **1240**. The bracket **1220** may have a slotted hole pattern for mounting the nut plate **1230**. The push-in fastener **1240** may be used, for example, to fasten a p-clamp **1250** to the bracket **1220**. The internal bore **1235** of the nut plate **1230** may be smooth and may have a non-threaded provision for engaging a push-in barb, as shown in FIG. **12**B. In other embodiments, the internal bore may be threaded for a push-in fastener.

Certain embodiments of a nut plate may offer advantages over a conventional nut and washer. For example, a nut plate may be installed in some embodiments without having to also install fastener hardware such as a ring post. The independent installation may reduce production flow and allow modularization. As but one example, a plurality of nut plates may be pre-installed on a spanner bar to form a raceway wire bundle module. Preassembling raceway wire bundles into modules may reduce the touch time of the installers during the installation of the wire bundles in an aircraft. Installing a wire bundle module may be more efficient than installing individual wires. Further, certain embodiments of a nut plate may be self indexing. When the nut plate engages a secondary support member, its bore may be aligned with a hole in the support structure such that time of installation is reduced. No tooling may be required to install various embodiments of a nut plate. No manual dexterity may be needed to slip a washer over a fastener, and then turn a nut onto the fastener. A visual sightline to the back side of the secondary support structure may not be needed. Some embodiments are simply pushed into a secondary support structure, snapped into position, and locked in place. Embodiments may have a lower part count than a conventional nut and washer. In addition to terminating a fastener, the nut plate may eliminate the need for a washer in some embodiments. The savings in time and cost afforded by a single nut plate as described herein might seem trivial. However, given the total number of fastening operations in a commercial aircraft, the savings in the aggregate may be substantial.

One aspect of the present disclosure relates to an aircraft **100** comprising a secondary support structure **240**, **310**, **610**, **820**, **900**, **1220** and a nut plate **340**, **700**, **810**, **1110**, **1230**, **1310** engaging the secondary support structure **240**, **310**, **610**, **820**, **900**, **1220** having a gauge. The nut plate **340**, **700**, **810**, **1110**, **1230**, **1310** includes at least one locator protrusion **430**, **440**, **470**, **702**, **704**, **706**, **850**, **1170**, **1312** engaging a mounting hole **310**, **314**, **316**, **320**, **620**, **630**, **732**, **734** in the secondary support structure **240**, **310**, **610**, **820**, **900**, **1220** to constrain motion of the nut plate **340**, **700**, **810**, **1110**, **1230**, **1310** along the secondary support structure **240**, **310**, **610**, **820**, **900**, **1220**. The nut plate **340**, **700**, **810**, **1110**, **1230**, **1310** also includes means U, **860**, **1150**, **1160**, **1314** for additionally constraining motion of the nut plate **340**, **700**, **810**, **1110**, **1230**, **1310** away from the secondary support structure **240**, **310**, **610**, **820**, **900**, **1220**.

In one example of the aircraft **100**, the secondary support structure **240**, **310**, **610**, **820**, **900**, **1220** includes a spanner bar **240**, **310**, **900** and the nut plate **340**, **700**, **810**, **1110**, **1230**, **1310** is constrained without the use of mounting hardware.

In one variant, the aircraft **100** also includes mounting hardware **740**, **840**, **850**, **1010**, **1020**, **1030**, **1240**, **1250** that is fastened onto the nut plate **340**, **700**, **810**, **1110**, **1230**, **1310**.

In one alternative, the aircraft **100** also includes a wire bundle **210**, **220**, **230** carried by the mounting hardware **740**, **840**, **850**, **1010**, **1020**, **1030**, **1240**, **1250**.

In another example, the aircraft **100** also includes tubing **232** carried by the mounting hardware **740**, **840**, **850**, **1010**, **1020**, **1030**, **1240**, **1250**.

In another variant of the aircraft **100**, the nut plate **340**, **700**, **810**, **1110**, **1230**, **1310** includes a body **410**, **820**, **1120** having an internally threaded bore **450**, **460**, **708**, **840**, **1140**, **1235**.

In another alternative of the aircraft **100**, the body **410**, **820** has a mounting surface **420**, **830** against the secondary support structure **240**, **310**, **610**, **820**, **1220**. The at least one locator protrusion **430**, **440**, **470**, **702**, **704**, **706**, **850**, **1170**, **1312** includes first and second posts **430**, **440**, **702**, **704** and a locking member **470**, **706**. The first and second posts **430**, **440**, **702**, **704** extend from the mounting surface **420**, **830** and through respective mounting holes **310**, **314**, **316**, **320**, **620**, **630**, **732**, **734** in

the secondary support structure **240**, **310**, **610**, **820**, **1220** comprising a spanner bar **240**, **310**. The locking member **470**, **706** occupies a space between one of the posts **430**, **440**, **702**, **704** and a land **310**, **313**, **315**, **317**, **330**, **615**, **625**, **635**. The means U, **1314** includes an undercut portion U in each post **430**, **440**, **702**, **704**.

In yet another example of the aircraft **100**, the bore **450**, **460**, **708** is offset from the first and second posts **430**, **440**, **702**, **704** by a distance such that the bore **450**, **460**, **708** is aligned with one of the mounting holes **310**, **314**, **316**, **320**, **620**, **630**, **732**, **734** in the secondary support structure **240**, **310**, **610**, **820**, **1220**.

In yet another variant of the aircraft **100**, the portions of the first and second posts **430**, **440**, **702**, **704** abutting against the lands **310**, **313**, **315**, **317**, **330**, **615**, **625**, **635** are solid and elliptical in cross section.

In yet another alternative of the aircraft **100**, the locking member **470**, **706** is resilient and is hinged to the body **410**, **820**, whereby the locking member **470**, **706** is retractable.

In still another example of the aircraft **100**, each of the first and second posts **430**, **440**, **702**, **704** terminates in an enlarged cap **435**, **445**. The cap and the mounting surface **420**, **830** form the undercut portion U, which is narrower than the gauge of the secondary support structure **240**, **310**, **610**, **820**, **1220**, wherein the enlarged cap **435**, **445** snaps onto one of the lands **310**, **313**, **315**, **317**, **330**, **615**, **625**, **635** as the nut plate **340**, **700**, **1230**, **1310** is pushed into engagement with the secondary support structure **240**, **310**, **610**, **820**, **1220**.

In still another variant of the aircraft **100**, the spanner bar **900** has return flanges **902**, and the means U, **860**, **870**, **1150**, **1160**, **1314** includes first and second resilient finger tabs **860**, **1150** cantilevered to the body **820**, **1120** and extending outward from the body **820**, **1120**, the tabs releasably engaging the return flanges **902**.

In still another alternative of the aircraft **100**, the means U, **860**, **870**, **1150**, **1160**, **1314** further includes a bar **870** attached to the body **820** opposite from the resilient finger tabs **860**. The bar **870** extends across the mounting surface **830**, opposite ends of the bar **870** located beneath the return flanges **902**.

In still yet another example of the aircraft **100**, the means U, **860**, **870**, **1150**, **1160**, **1314** further includes third and fourth resilient finger tabs **1160** cantilevered to the body **1120** and extending outward from an opposite side of the body **1120**, the third and fourth resilient finger tabs **1160** releasably engaging the return flanges **902**.

Another aspect of the present disclosure relates to an apparatus which includes a spanner bar **240**, **310**, **900** having a surface **904** with an alternating pattern of mounting holes **320** and lands **330** and a nut plate **340**, **700**, **810**, **1110**, **1230**, **1310**, engaging the spanner bar **240**, **310**, **900**. The nut plate **340**, **700**, **810**, **1110**, **1230**, **1310** includes a body **410**, **820**, **1120**, having a mounting surface **420**, **830**, **1130** and an internally threaded bore **450**, **460**, **708**, **840**, **1140**, **1235** accessible from the mounting surface **420**, **830**, **1130**. The mounting surface is in contact with the spanner bar **240**, **310**, **900**. The nut plate also includes at least one protrusion **430**, **440**, **702**, **704**, **850**, **1170**, extending from the mounting surface **420**, **830**, **1130**. Each protrusion **430**, **440**, **702**, **704**, **850**, **1170** engages one of the mounting holes **320** to constrain motion of the nut plate **340**, **700**, **810**, **1110**, **1230**, **1310** along the spanner bar **240**, **310**, **900**. The nut plate further includes means U, **860**, **870**, **1150**, **1160**, **1314** for engaging the spanner bar **240**, **310**, **900** to constrain motion of the nut plate **340**, **700**, **810**, **1110**, **1230**, **1310** away from the spanner bar **240**, **310**, **900** without cooperation of mounting hardware.

In one example of the apparatus, the spanner bar **900** has return flanges **902**, and the means U, **860**, **870**, **1150**, **1160**, **1314** includes first and second resilient finger tabs **860**, **1150** cantilevered to the body **820**, **1120** and extending outward from the body **820**, **1120**. The first and second resilient finger tabs **860**, **1150** are configured to releasably engage the return flanges **902**.

Yet another aspect of the present disclosure relates to a nut plate **810**, **1110**, **1230**, **1310** configured to engage a thin gauge member **900**, having a base and return flanges **902**. The base has an alternating pattern of holes and lands. The nut plate **810**, **1110**, **1230**, **1310** includes a body **820**, **1120** having a mounting surface **830**, **1130** and an internally threaded bore **840**, **1140** accessible from the mounting surface **830**, **1130**; a locator protrusion **850**, **1170**, configured to extend from the mounting surface **830**, **1130** and into one of the mounting holes; and first and second resilient

finger tabs **860**, **1150** cantilevered to the body **820**, **1120** and extending outward from the body **820**, **1120**. The first and second resilient finger tabs **860**, **1150** are configured to releasably engage the return flanges **902** to constrain motion of the nut plate **810**, **1110**, **1230**, **1310** away from the base.

In one example, the nut plate **810** also includes a bar **870** attached to the body **820** opposite from finger tabs **860**. The bar **870** extends across the mounting surface **830** and the opposite ends of the bar **870** are located beneath the return flanges **902**.

In one variant, the nut plate **1110** also includes third and fourth resilient finger tabs **1160** cantilevered to the body **1120** and extending outward from an opposite side of the body **1120**. The third and fourth resilient finger tabs **1160** are configured to releasably engage the return flanges **902**.

The terms “example”, “variant”, and “alternative” hereinabove are used interchangeably.

A nut plate herein is not limited to aircraft. Other applications include, but are not limited to, marine, automotive and electronic products.

EMBODIMENTS IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An aircraft comprising:

a spanner bar having a mounting surface and return flanges; and

a nut plate engaging the spanner bar, the nut plate including a body having an internally threaded bore, at least one locator protrusion engaging a mounting hole in the spanner bar to constrain motion of the nut plate along the spanner bar, and means for additionally constraining motion of the nut plate away from the spanner bar,

wherein the means for additionally constraining motion includes:

first and second resilient finger tabs cantilevered to the body and extending outward from the body and the first and second resilient finger tabs releasably engaging the return flanges; and

a bar having opposing ends, and wherein:

the bar is attached to the body generally opposite from the first and second resilient finger tabs;

the bar extends across the mounting surface; and

the opposing ends of the bar are located beneath the return flanges.

2. The aircraft of claim **1**, wherein the nut plate is constrained without use of mounting hardware.

3. The aircraft of claim **1**, further comprising mounting hardware that is fastened onto the nut plate.

4. The aircraft of claim **3**, further comprising a wire bundle carried by the mounting hardware.

5. The aircraft of claim **3**, further comprising tubing carried by the mounting hardware.

6. The aircraft of claim **1**, wherein the means further includes third and fourth resilient finger tabs cantilevered to the body and extending outward from generally opposite sides of the body, the third and fourth tabs releasably engaging the return flanges.

7. The aircraft of claim **1**, wherein the internally threaded bore has a threaded portion; and wherein the threaded portion is a full thread metallic insert.

8. The aircraft of claim **1**, wherein the first and second resilient finger tabs are laterally offset from the internally threaded bore with respect to a longitudinal axis of the spanner bar.

9. The aircraft of claim **1**, wherein the internally threaded bore is positioned laterally between the first resilient finger tab and the bar with respect to a longitudinal axis of the spanner bar.

10. An apparatus, comprising:

a spanner bar having a surface with an alternating pattern of mounting holes and lands, wherein the spanner bar has return flanges; and

a nut plate engaging the spanner bar, the nut plate including:

a body having a mounting surface and an internally threaded bore accessible from the mounting surface, the mounting surface being in contact with the spanner bar;

at least one protrusion extending from the mounting surface, each protrusion engaging one of the mounting holes to constrain motion of the nut plate along the spanner bar; and

means for engaging the spanner bar to constrain motion of the nut plate away from the spanner bar without cooperation of mounting hardware, wherein the means for engaging the spanner bar to constrain motion includes:

first and second resilient finger tabs cantilevered to the body and extending outward from the body, the first and second resilient finger tabs being configured to releasably engage the return flanges; and

a bar having opposing ends, and wherein:

the bar is attached to the body generally opposite from the first and second resilient finger tabs;

the bar extends across the mounting surface; and

the opposing ends of the bar are located beneath the return flanges.

11. The apparatus of claim **10**, wherein the first and second resilient finger tabs and the bar are laterally offset from the internally threaded bore with respect to a longitudinal axis of the spanner bar.

12. The apparatus of claim **10**, wherein the internally threaded bore is positioned laterally between the first resilient finger tab and the bar with respect to a longitudinal axis of the spanner bar.

13. The apparatus of claim **10**, wherein the nut plate is constrained without use of mounting hardware.

14. The apparatus of claim **10**, further comprising mounting hardware that is fastened onto the nut plate.

15. A nut plate configured to engage a thin gauge member having a base and return flanges, the base having an alternating pattern of holes and lands, the nut plate comprising:

a body having a mounting surface and an internally threaded bore accessible from the mounting surface;

a locator protrusion configured to extend from the mounting surface and into one of the holes; and

first and second resilient finger tabs cantilevered to the body and extending outward from the body, the first and second resilient finger

tabs being configured to releasably engage the return flanges to constrain motion of the nut plate away from the base; and

a bar having opposing ends, and wherein:

the bar is attached to the body generally opposite from the first and second resilient finger tabs;

the bar extends across the mounting surface; and

the opposing ends of the bar are located beneath the return flanges.

16. The nut plate of claim **15**, further comprising third and fourth resilient finger tabs cantilevered to the body and extending outward from generally opposite side of the body, the third and fourth tabs being configured to releasably engage the return flanges.

17. The nut plate of claim **15**, wherein the first and second resilient finger tabs are laterally offset from the internally threaded bore with respect to a longitudinal axis of the thin gauge member.

18. The nut plate of claim **15**, wherein the internally threaded bore is positioned laterally between the first resilient finger tab and the bar with respect to a longitudinal axis of the thin gauge member.

19. The nut plate of claim **15**, further comprising:

mounting hardware that is fastened onto the nut plate; and

a wire bundle, carried by the mounting hardware.

20. The nut plate of claim **15**, further comprising:

mounting hardware that is fastened onto the nut plate; and

tubing, carried by the mounting hardware.

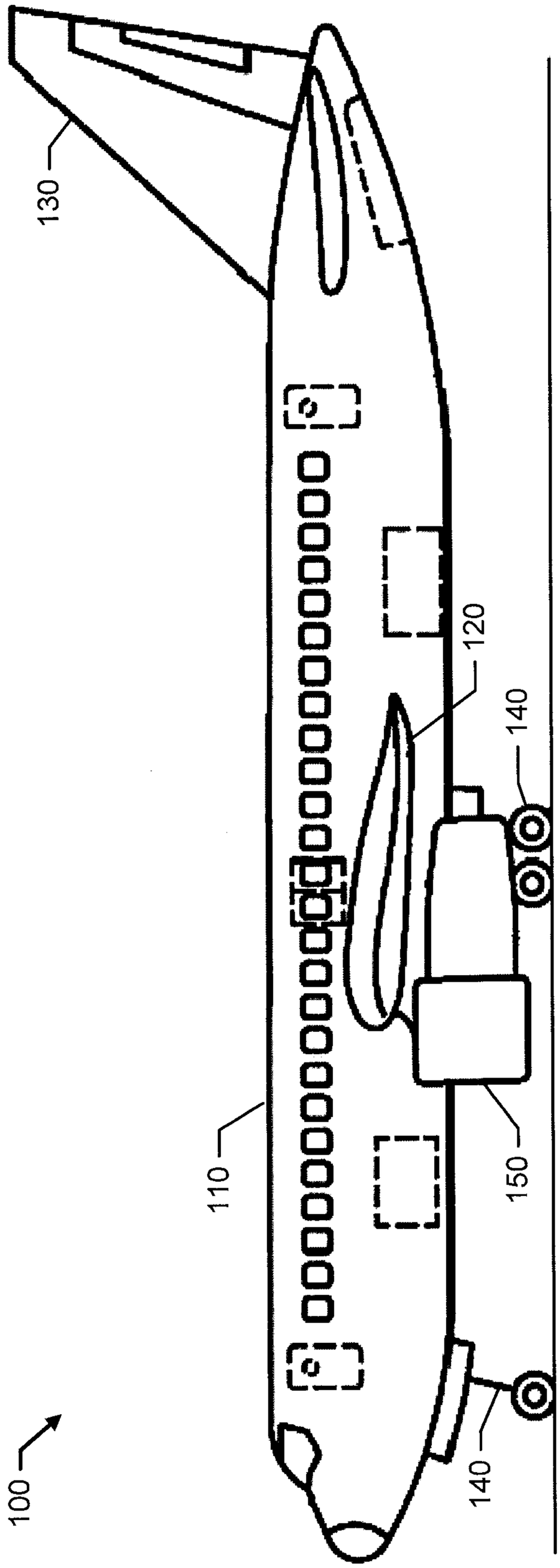


FIG. 1

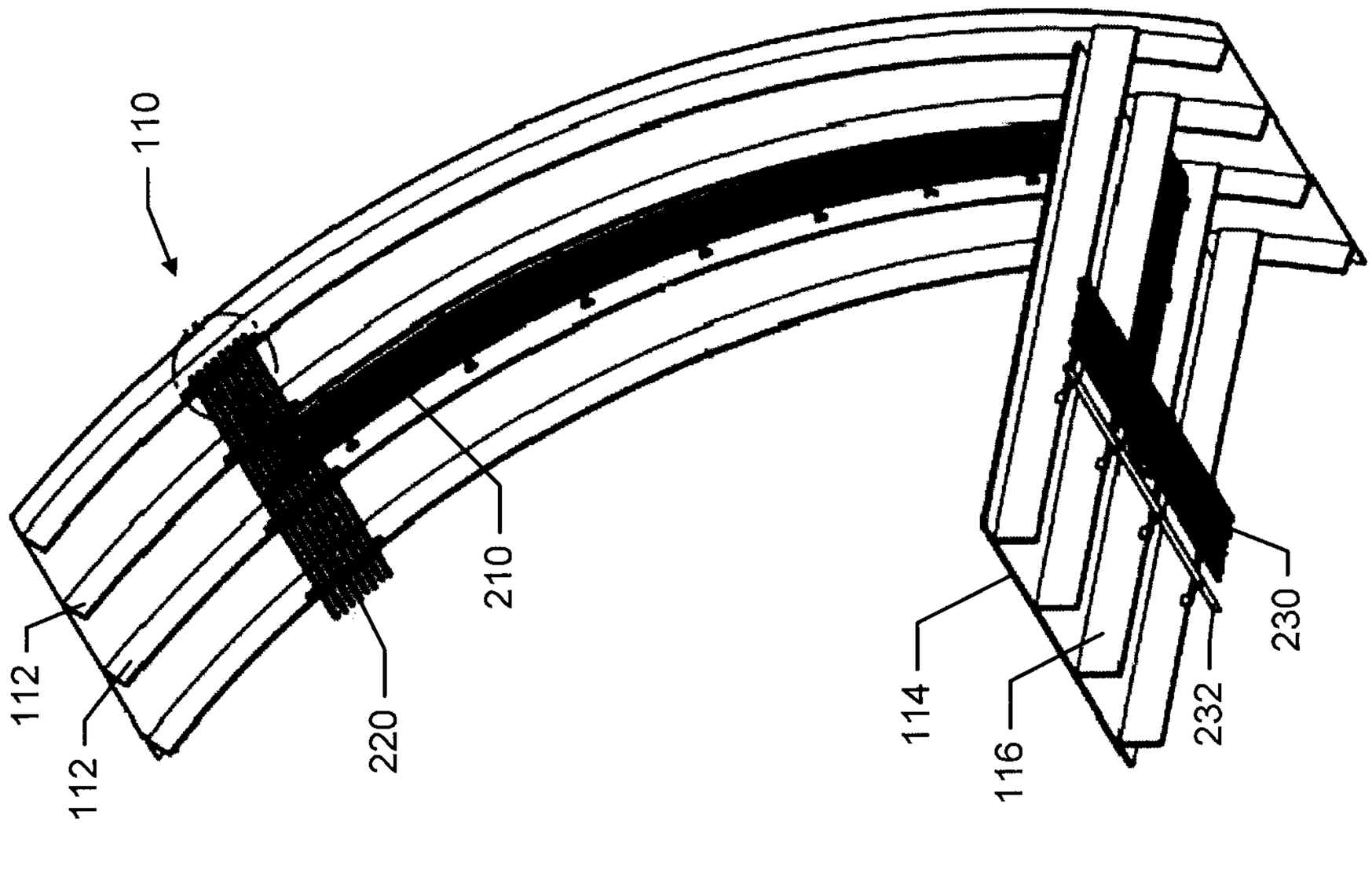


FIG. 2A

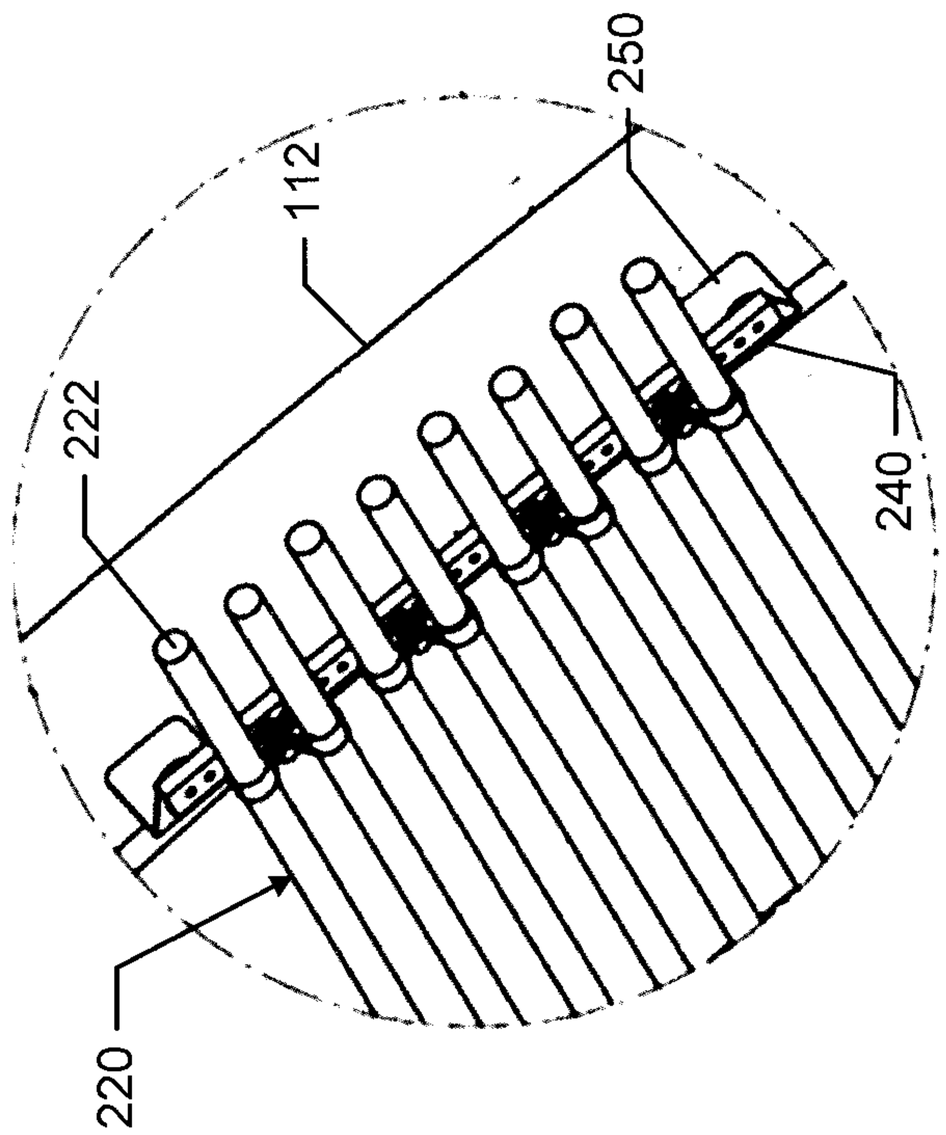


FIG. 2B

FIG. 3

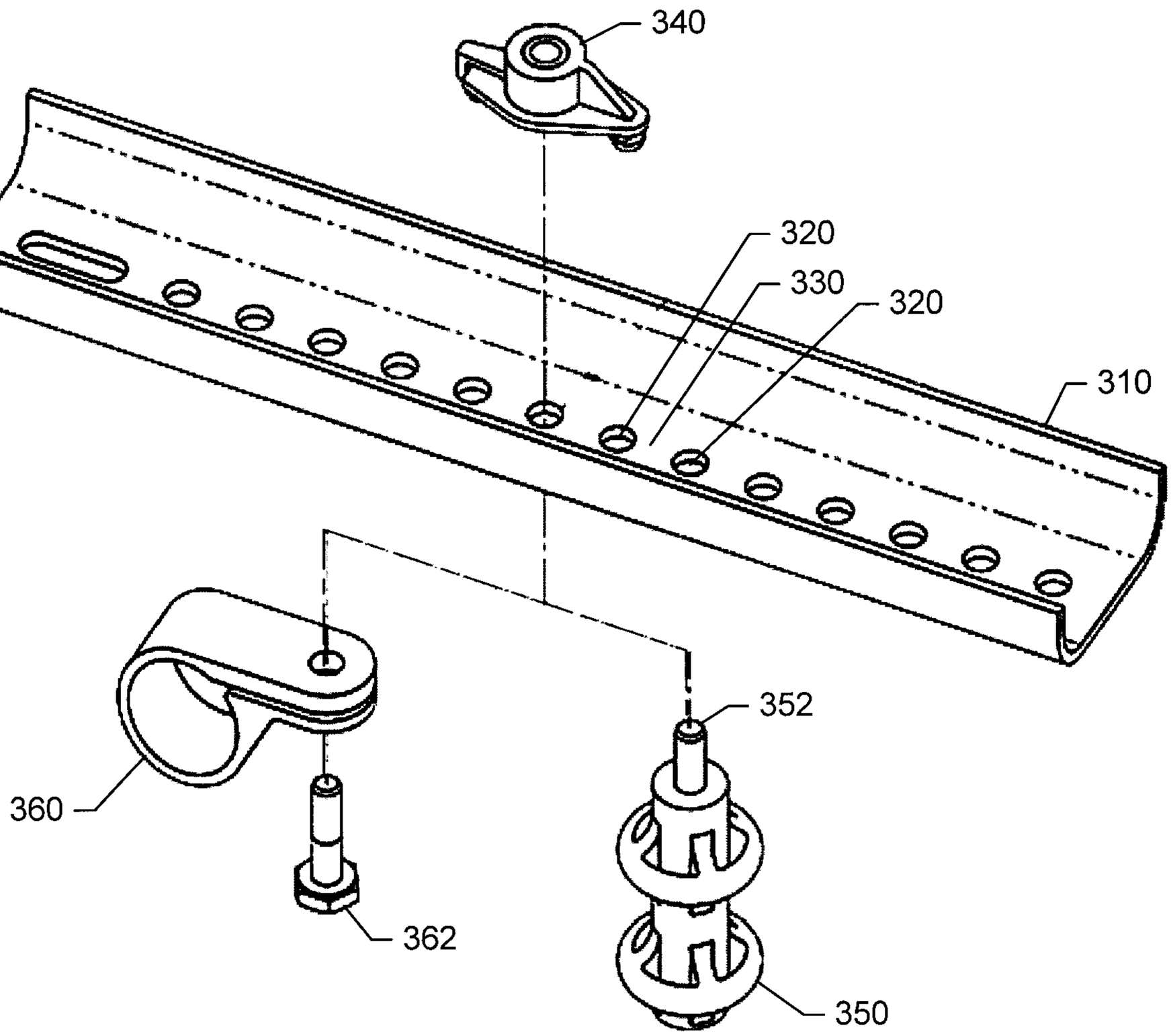


FIG. 4A

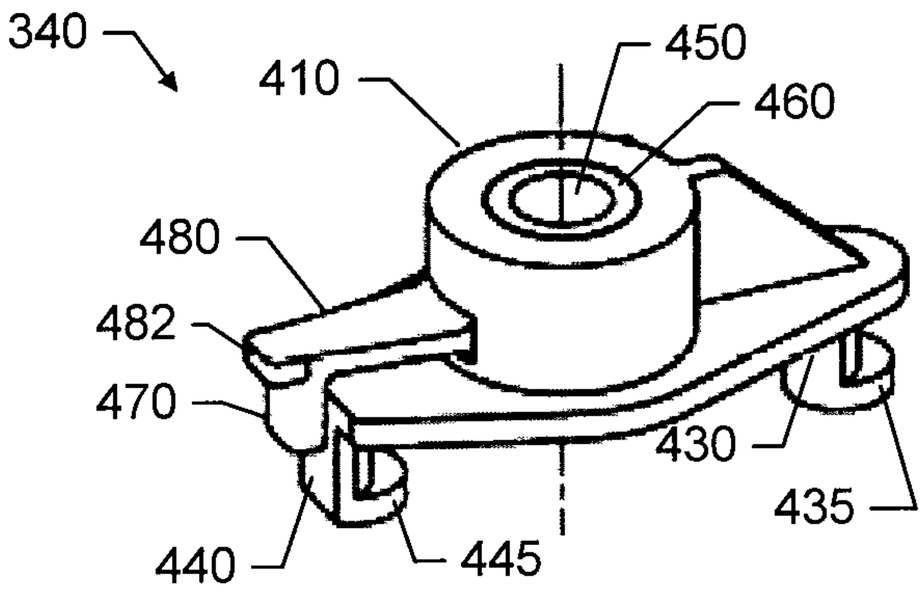


FIG. 4B

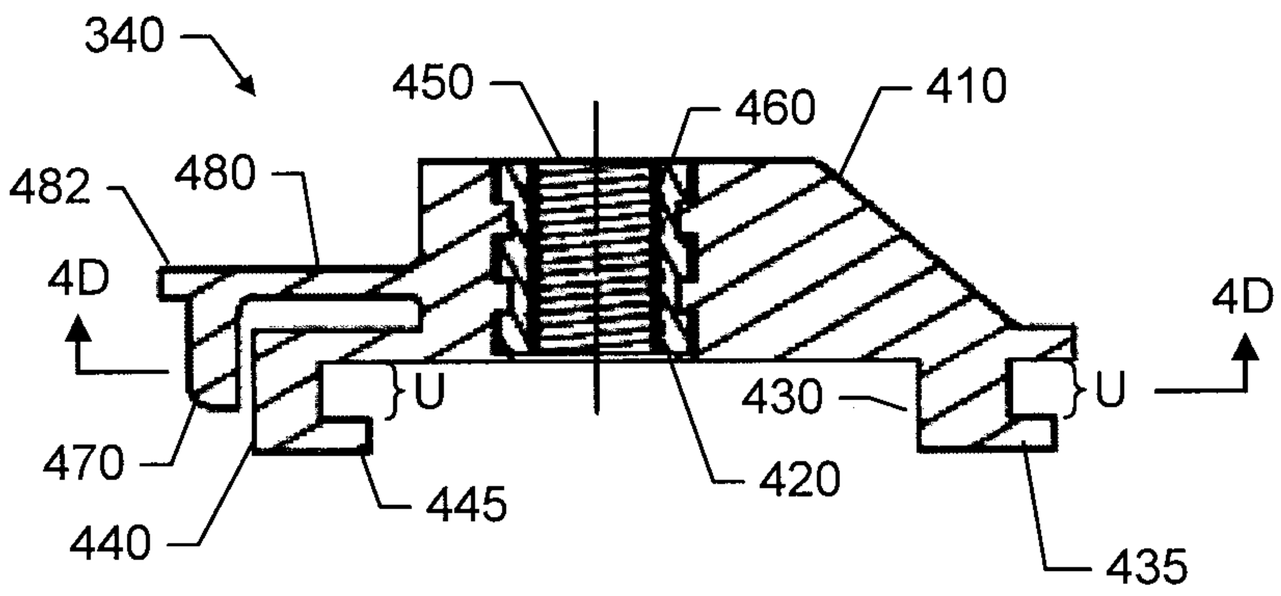


FIG. 4C

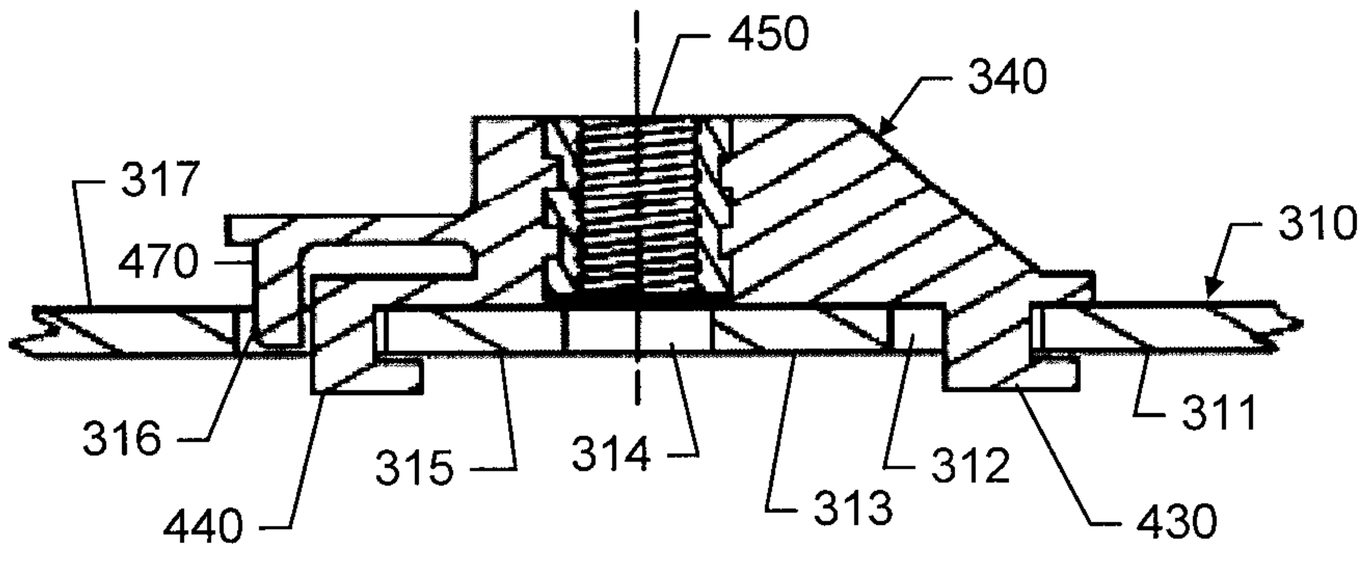


FIG. 4D

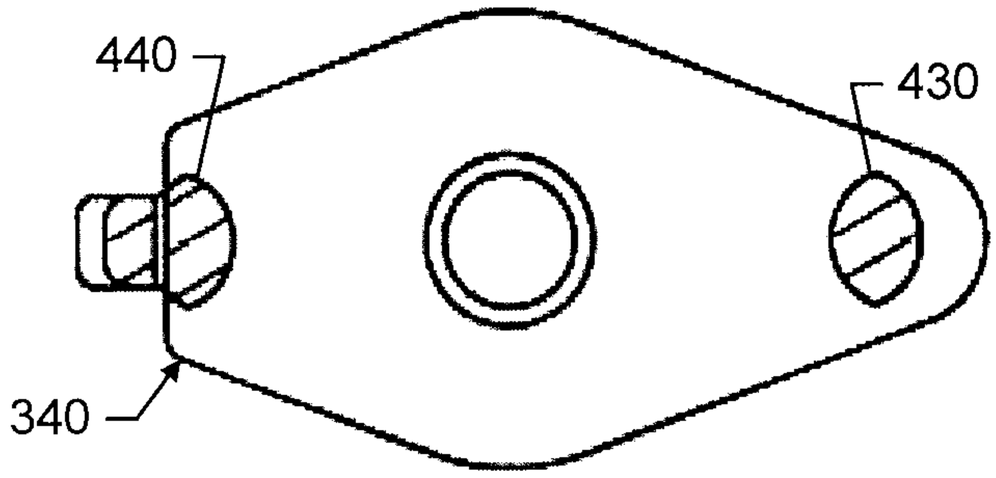


FIG. 5

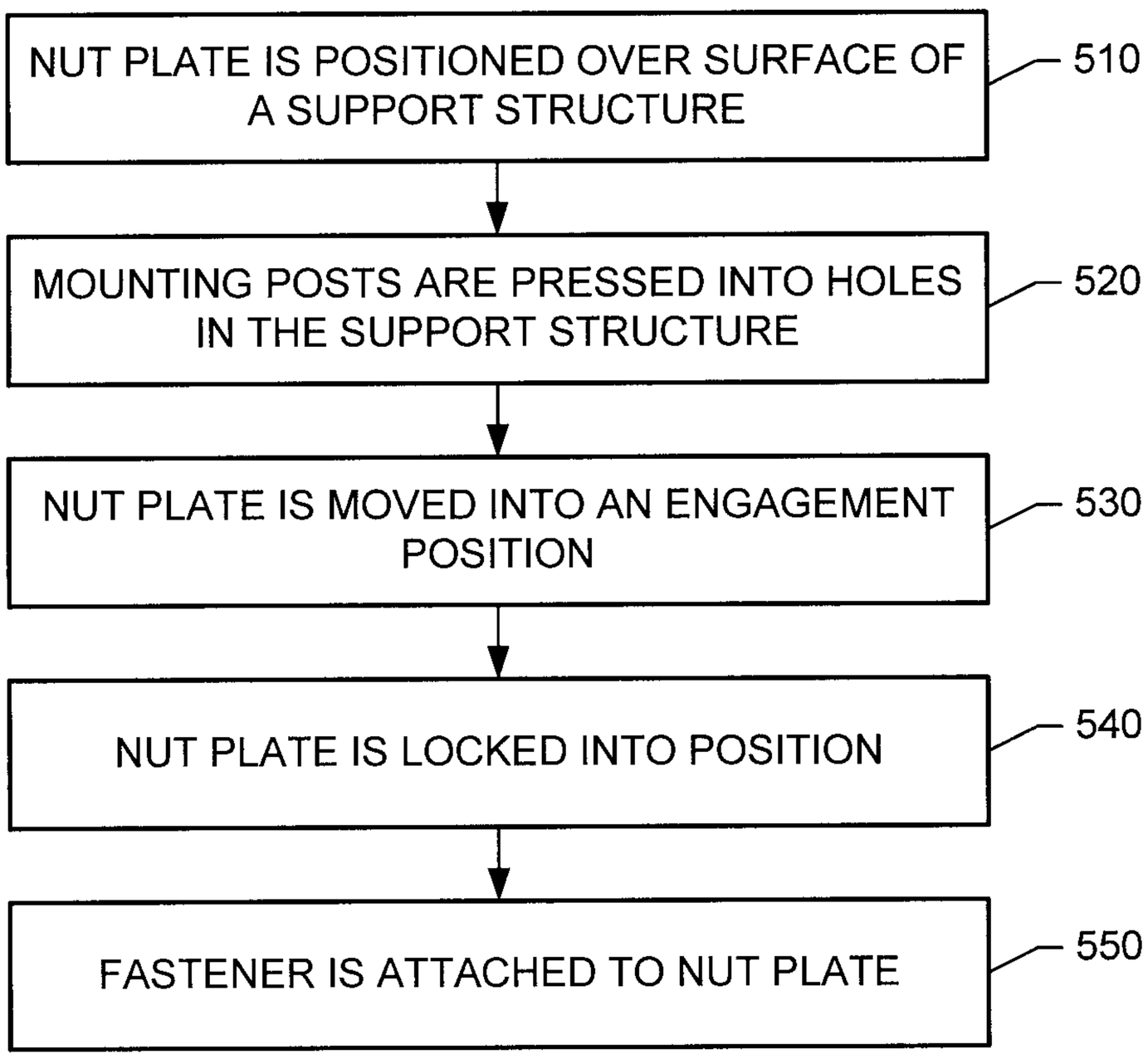

NUT PLATE IS POSITIONED OVER SURFACE OF A SUPPORT STRUCTURE
510
MOUNTING POSTS ARE PRESSED INTO HOLES IN THE SUPPORT STRUCTURE
520
NUT PLATE IS MOVED INTO AN ENGAGEMENT POSITION
530
NUT PLATE IS LOCKED INTO POSITION
540
FASTENER IS ATTACHED TO NUT PLATE
550

FIG. 6A

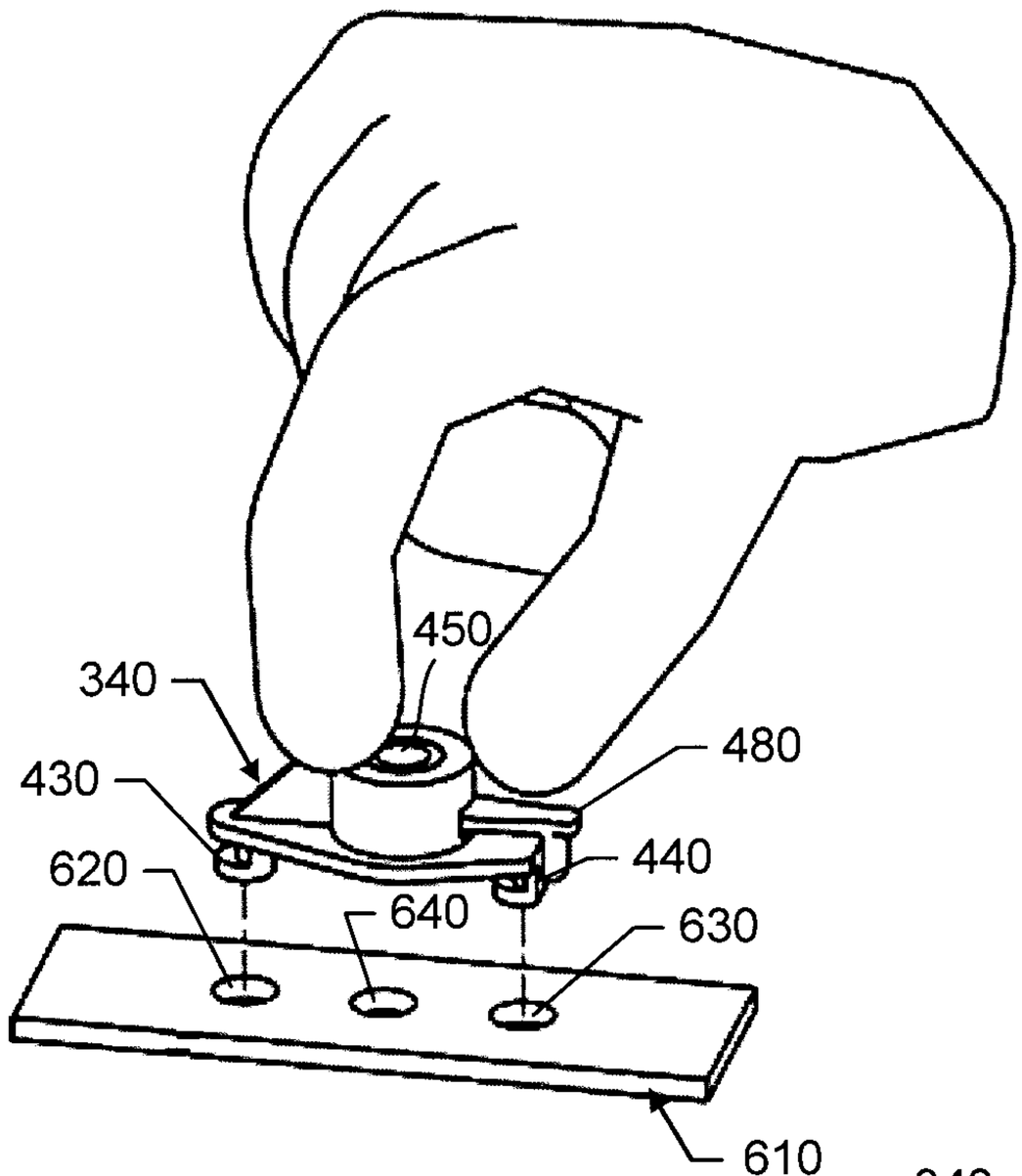


FIG. 6B

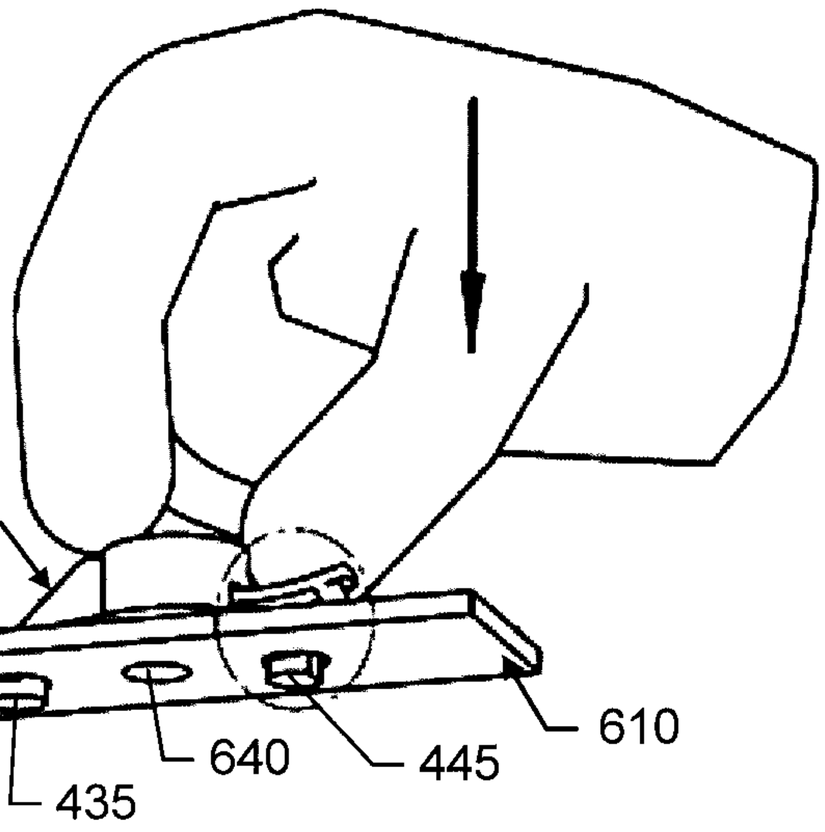
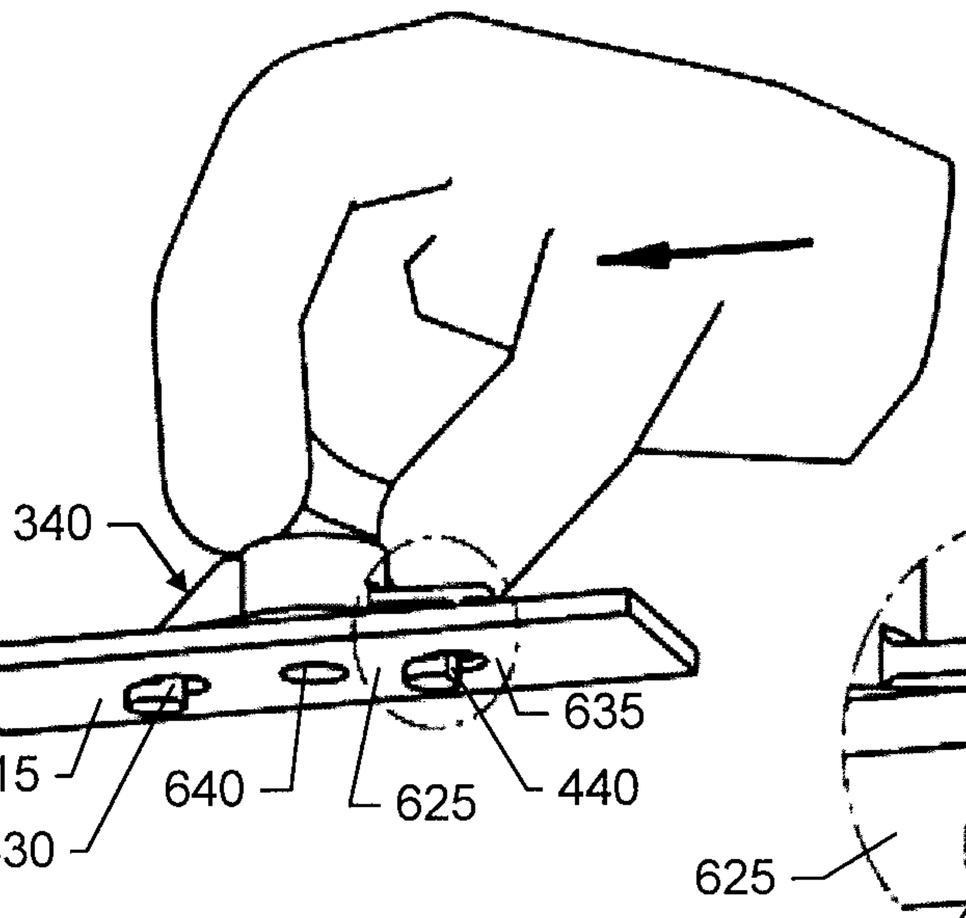


FIG. 6D



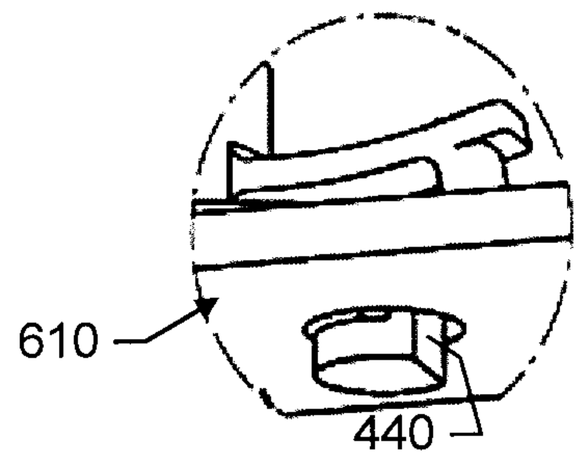


FIG. 6C

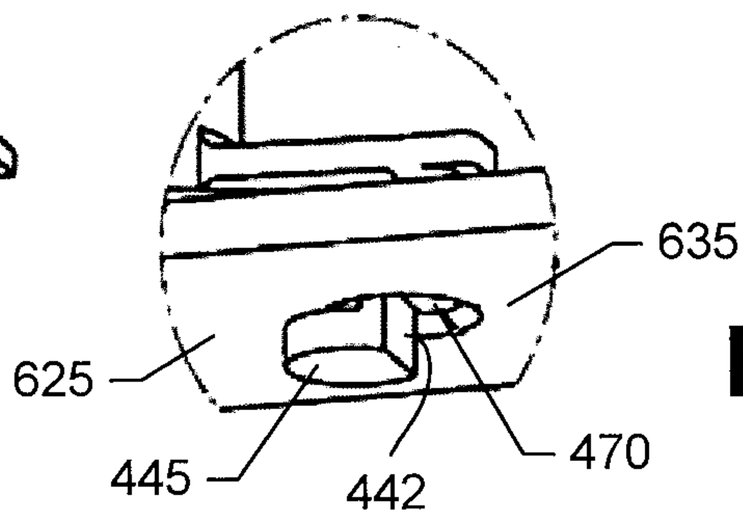


FIG. 6E

FIG. 7A

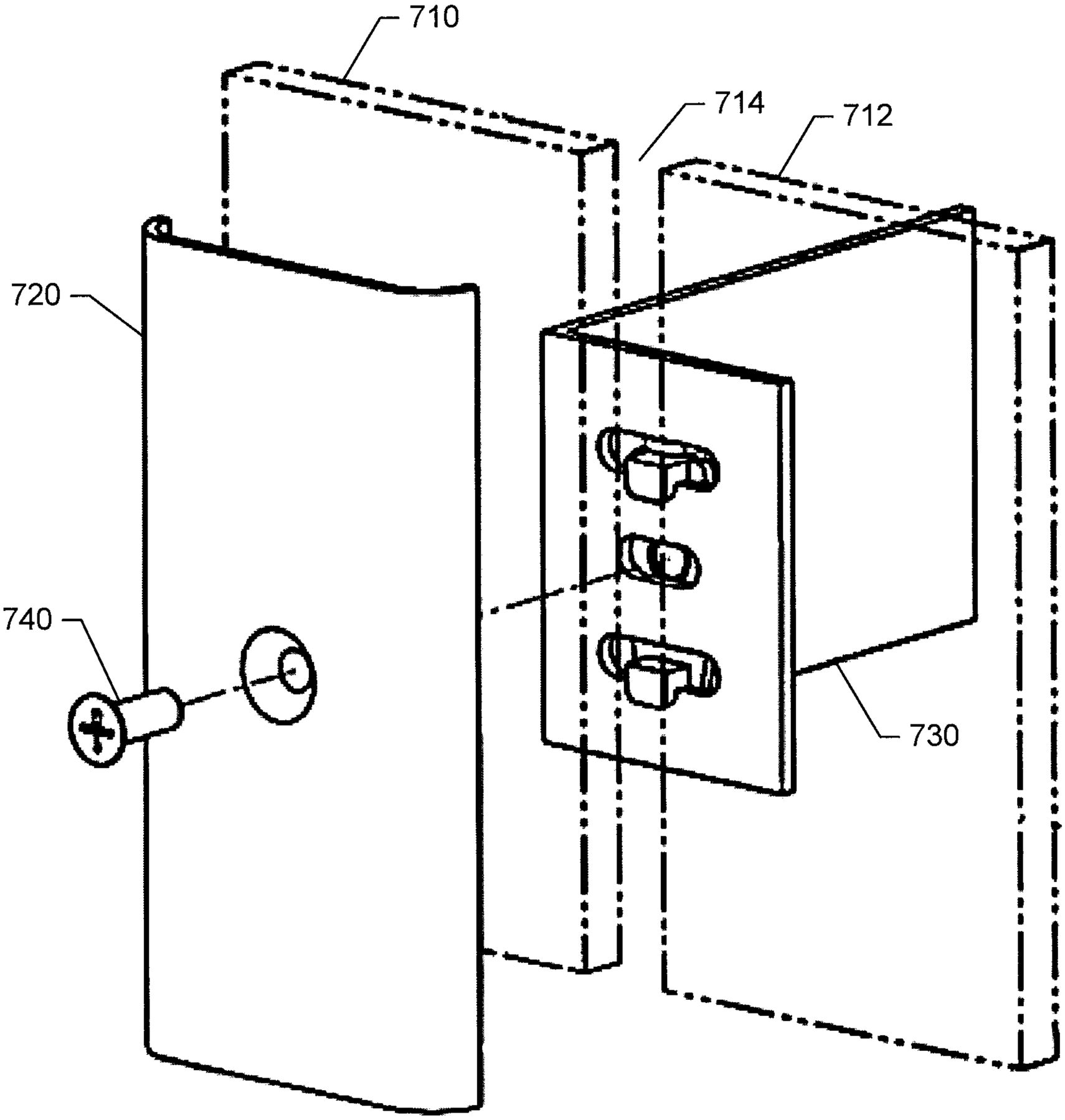


FIG. 7B

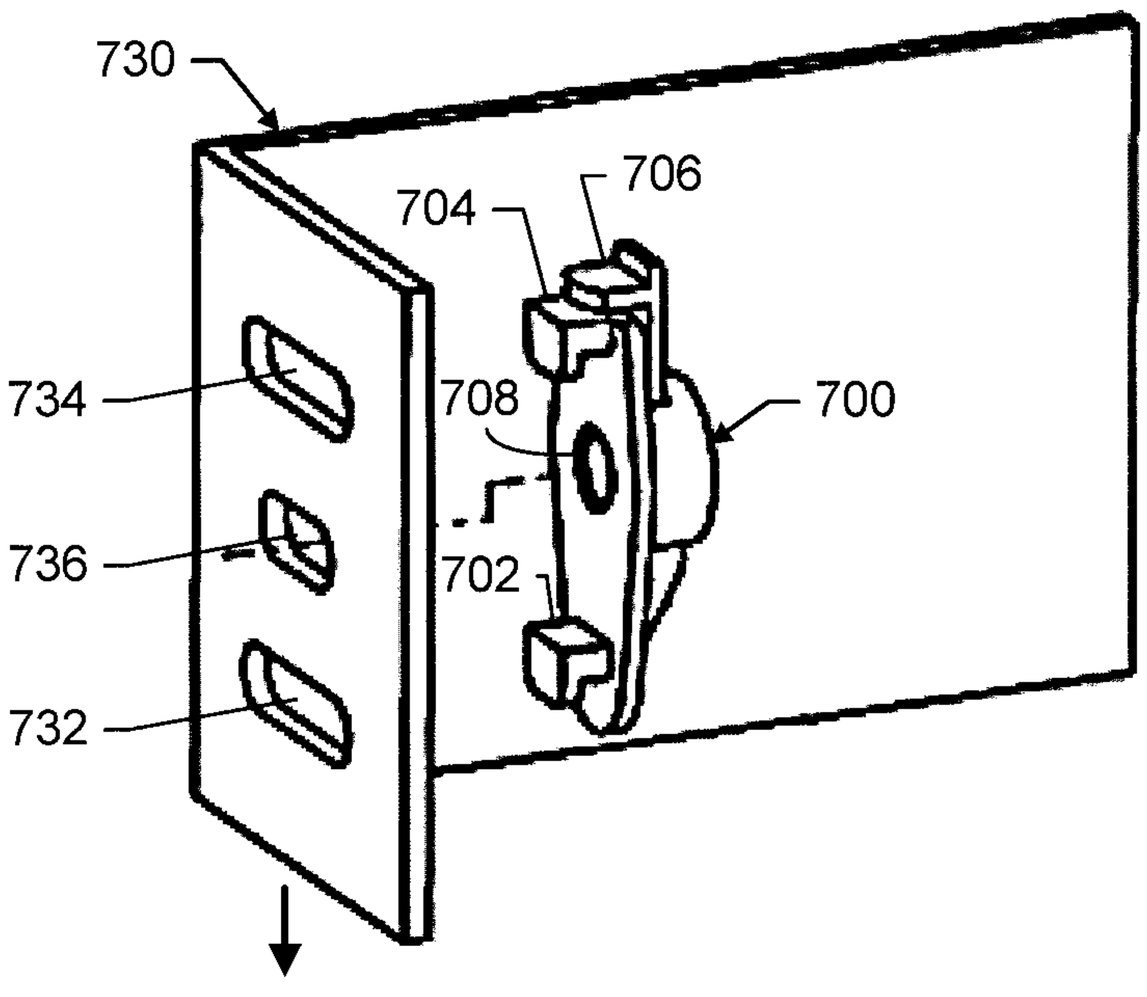


FIG. 7C

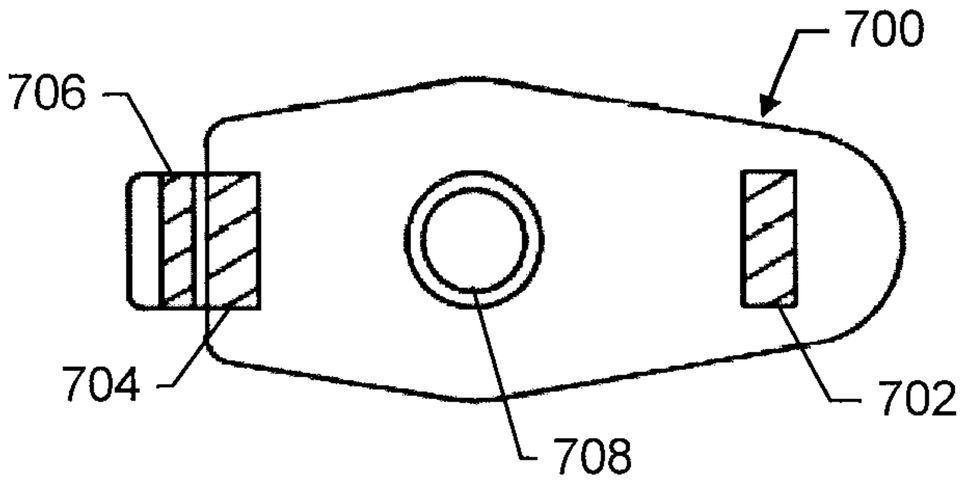


FIG. 8A

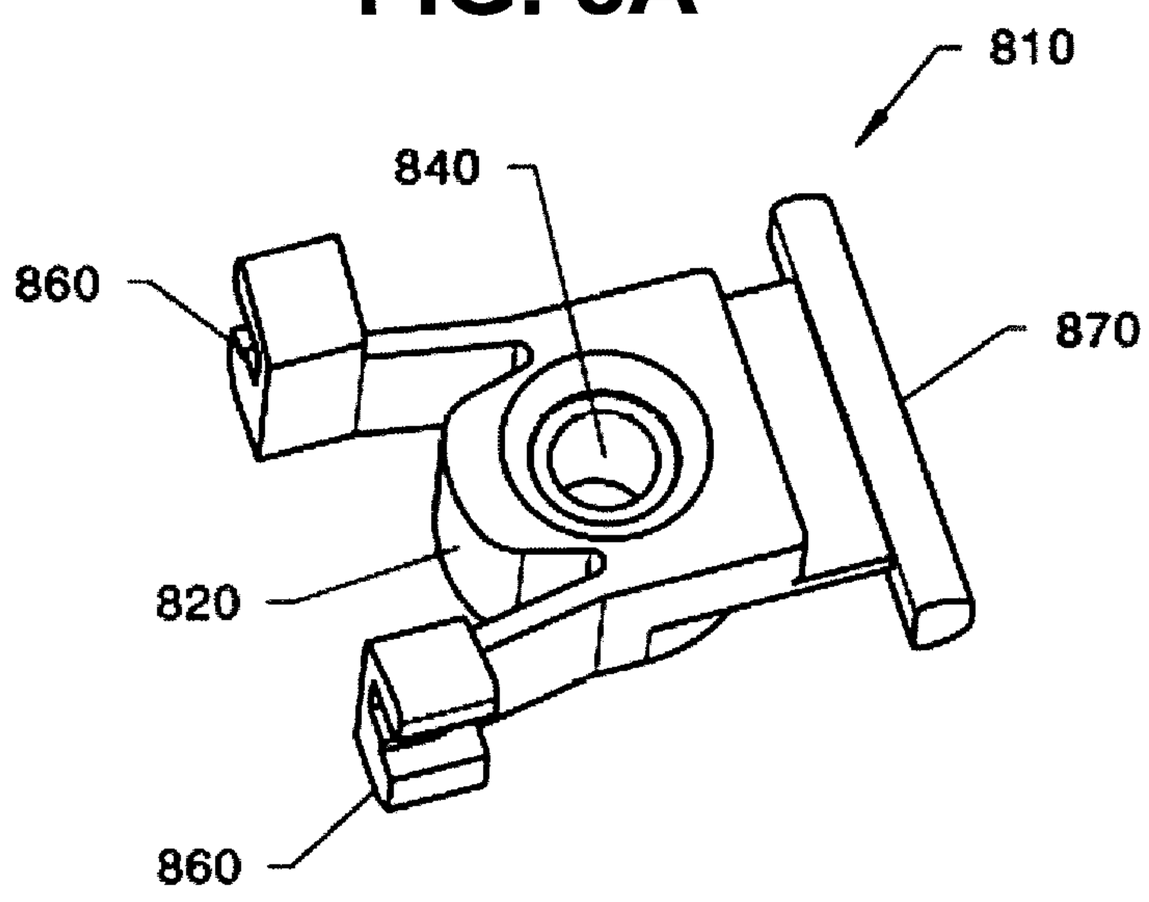
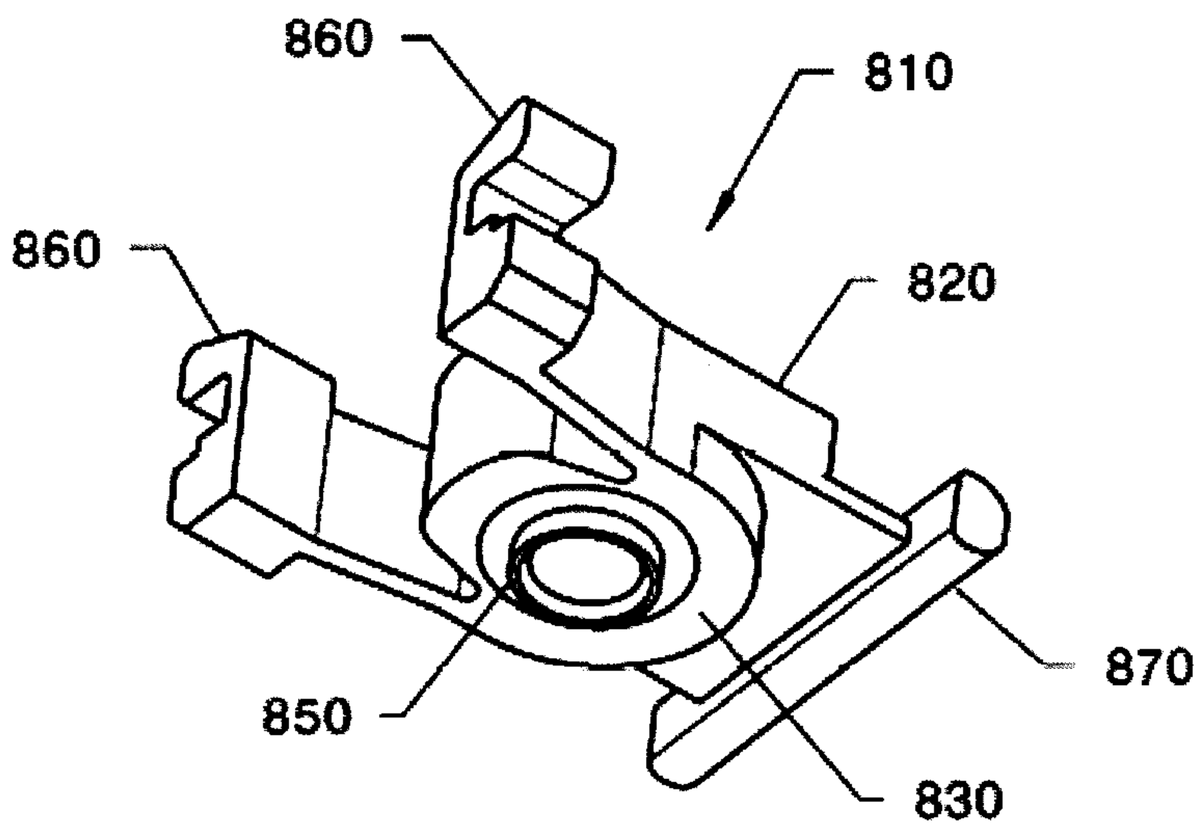


FIG. 8B



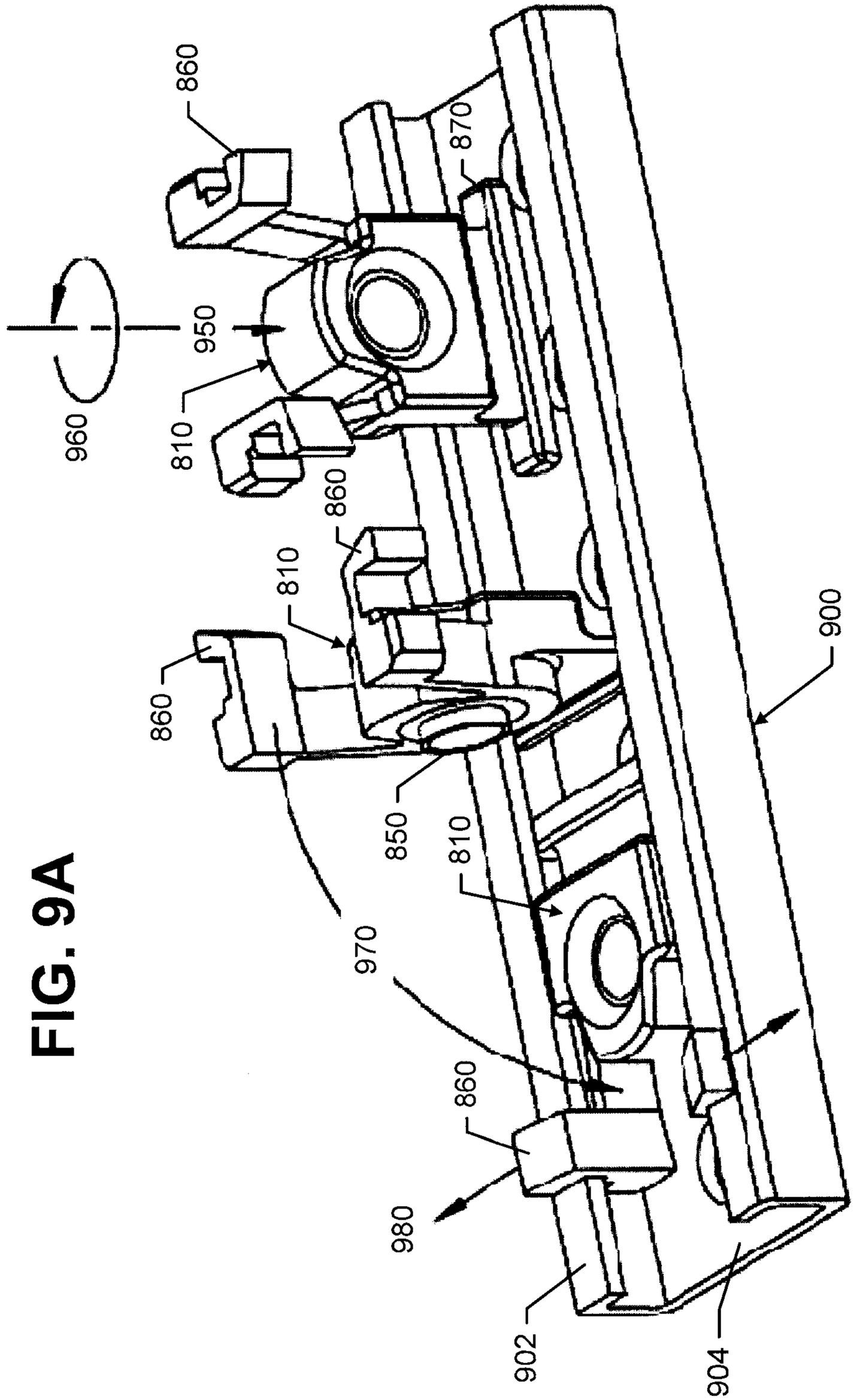


FIG. 9A

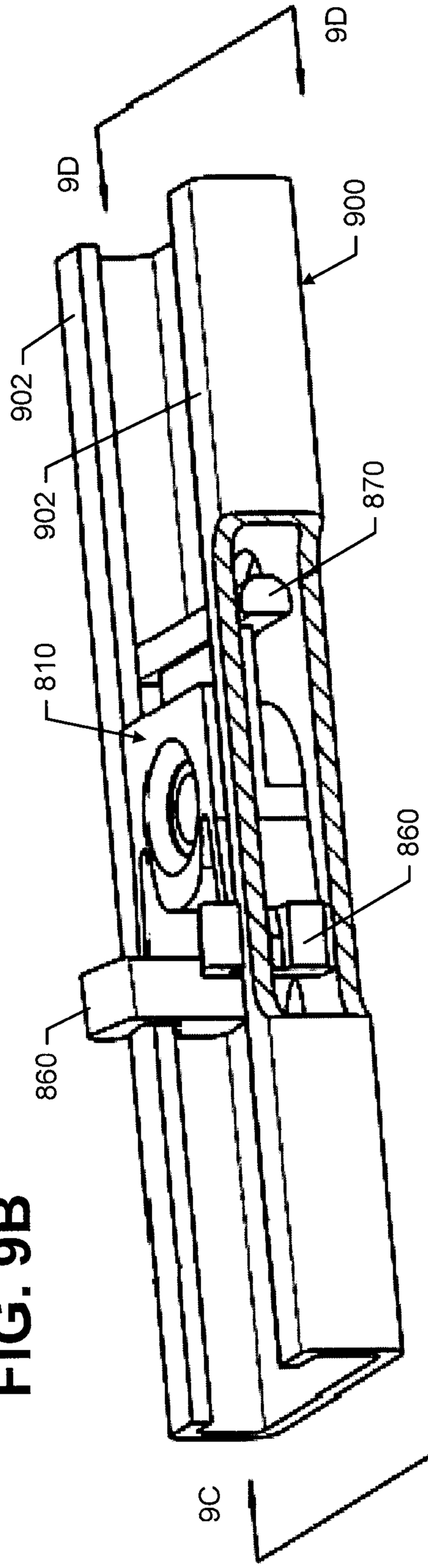


FIG. 9B

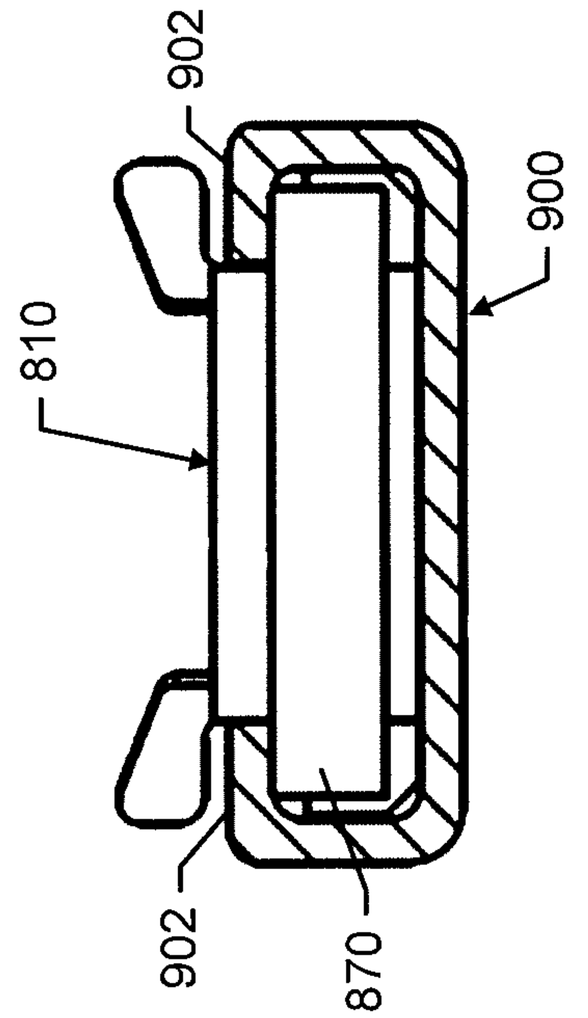


FIG. 9D

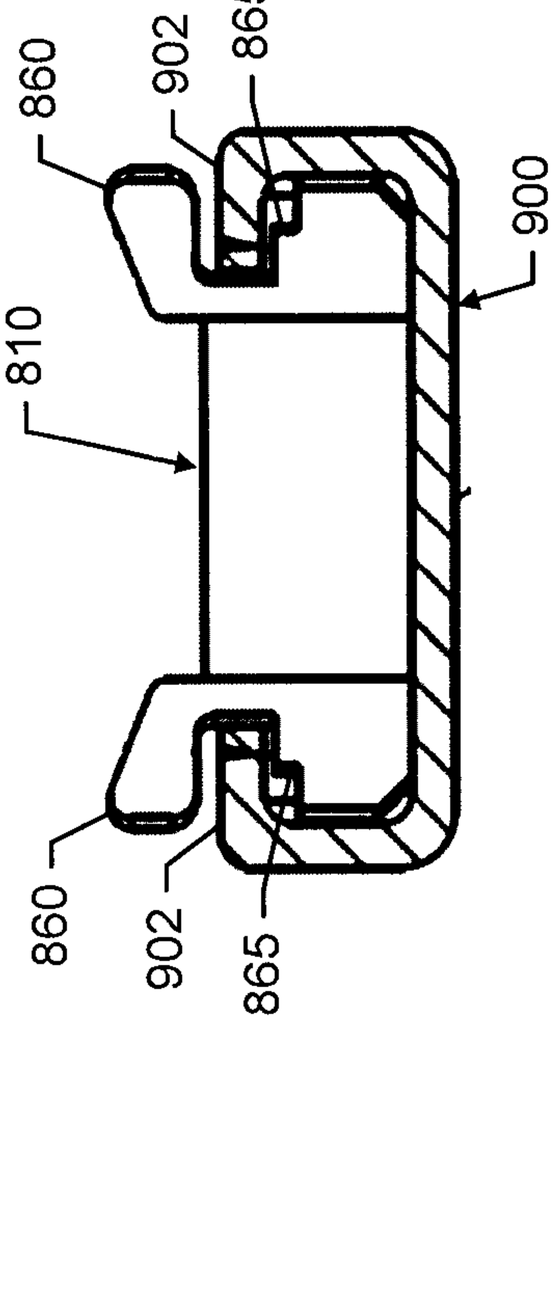


FIG. 9C

FIG. 10

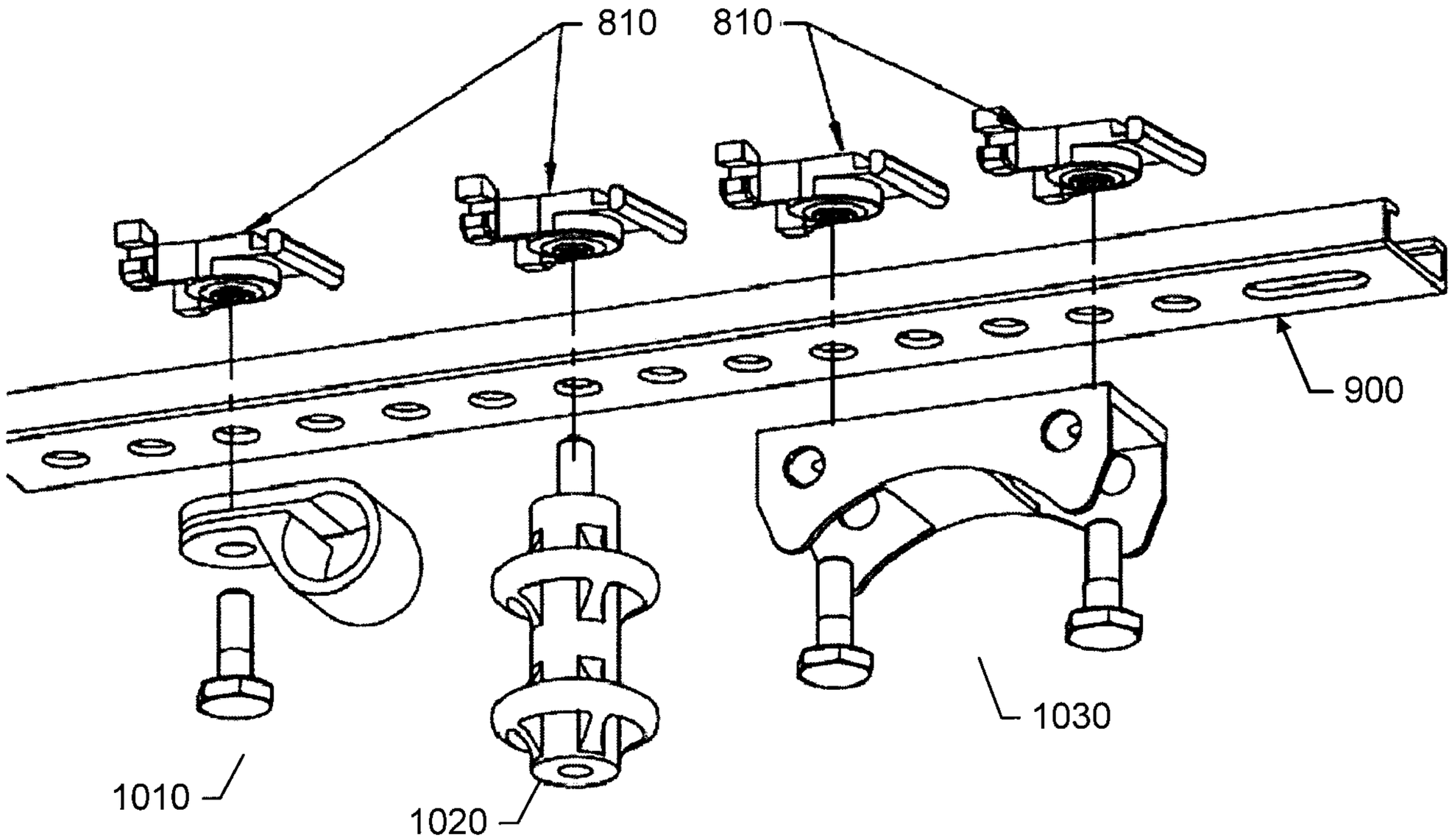


FIG. 11A

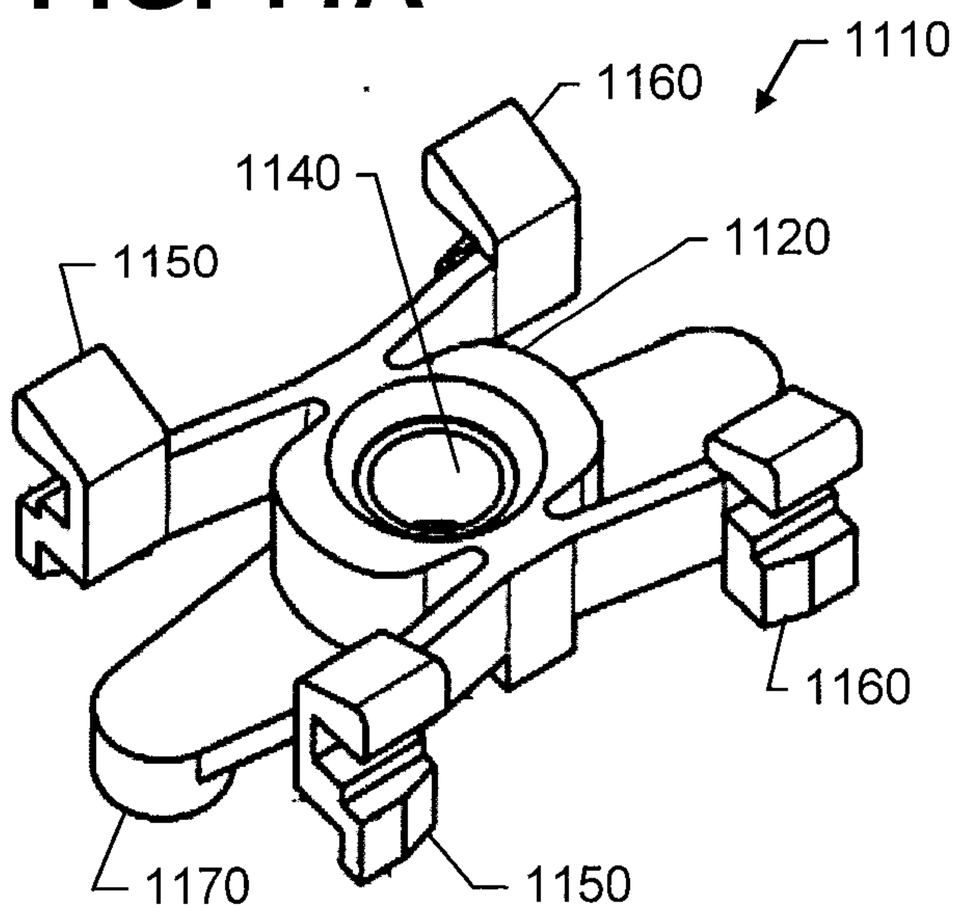


FIG. 11B

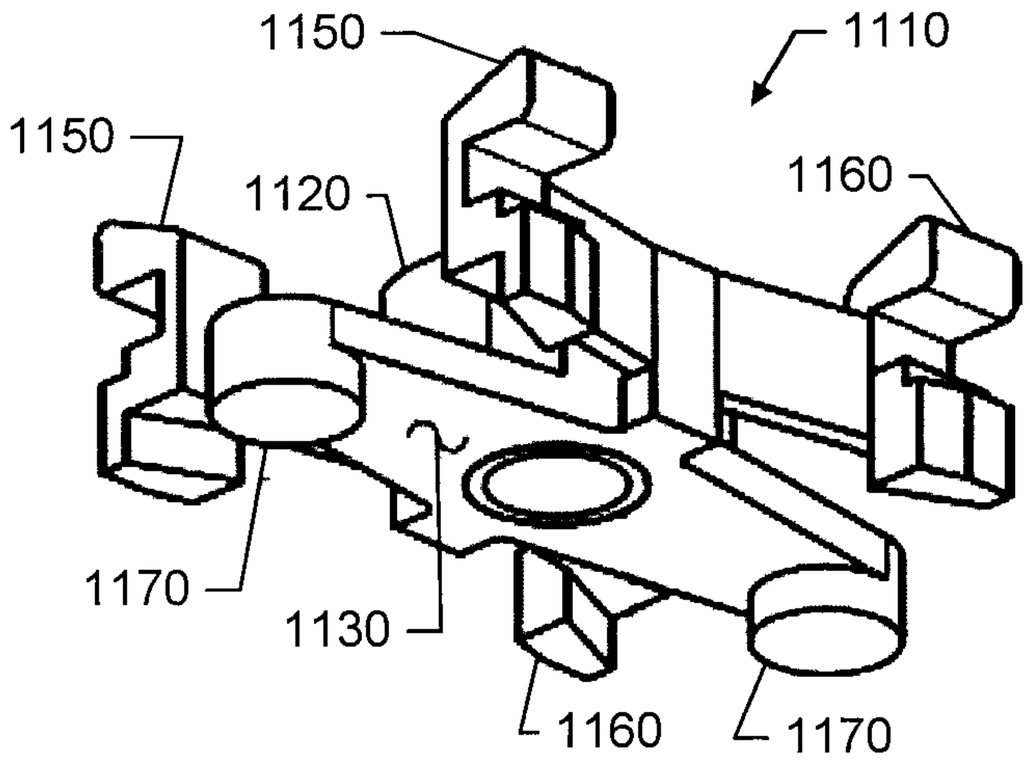


FIG. 12A

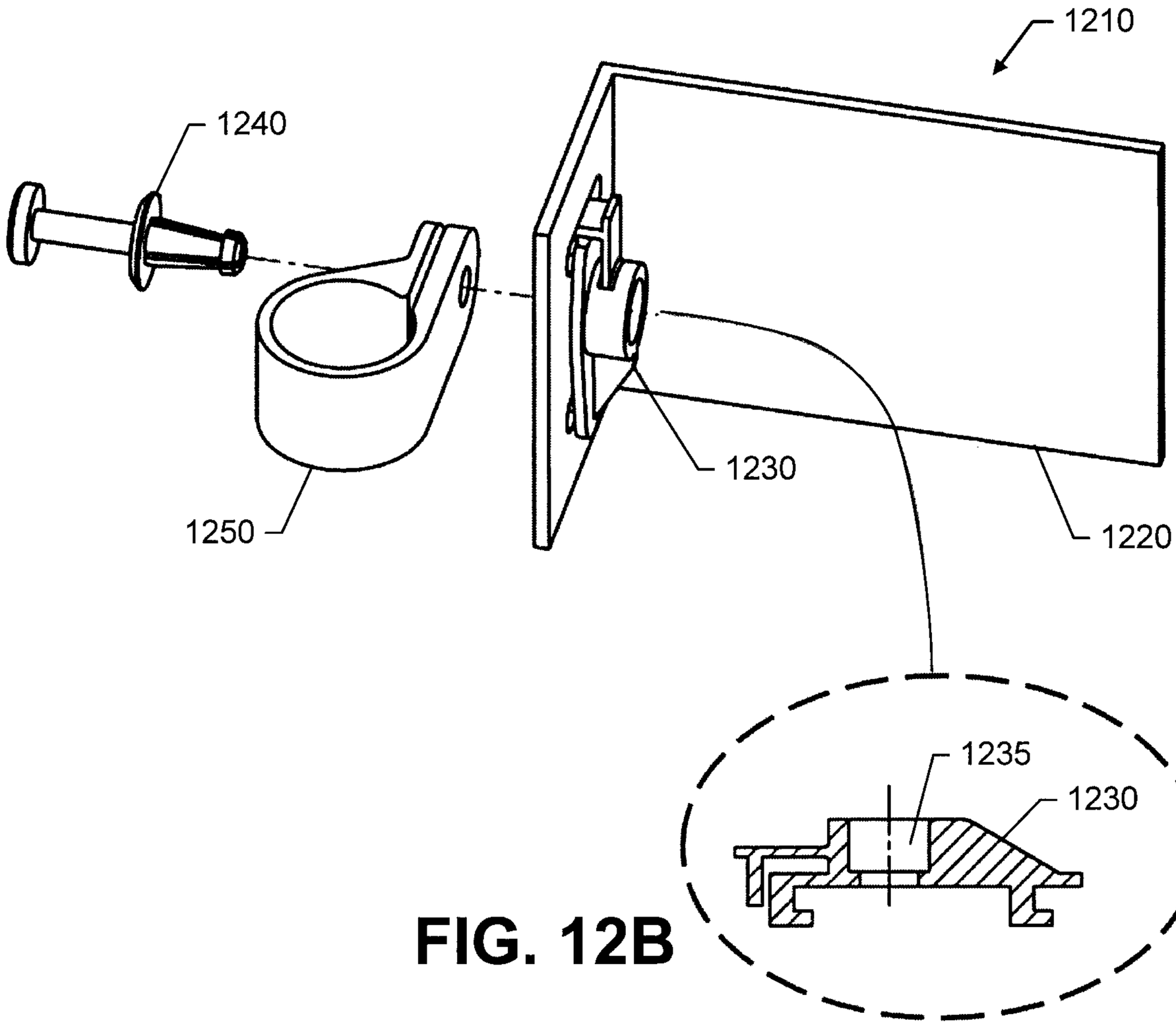
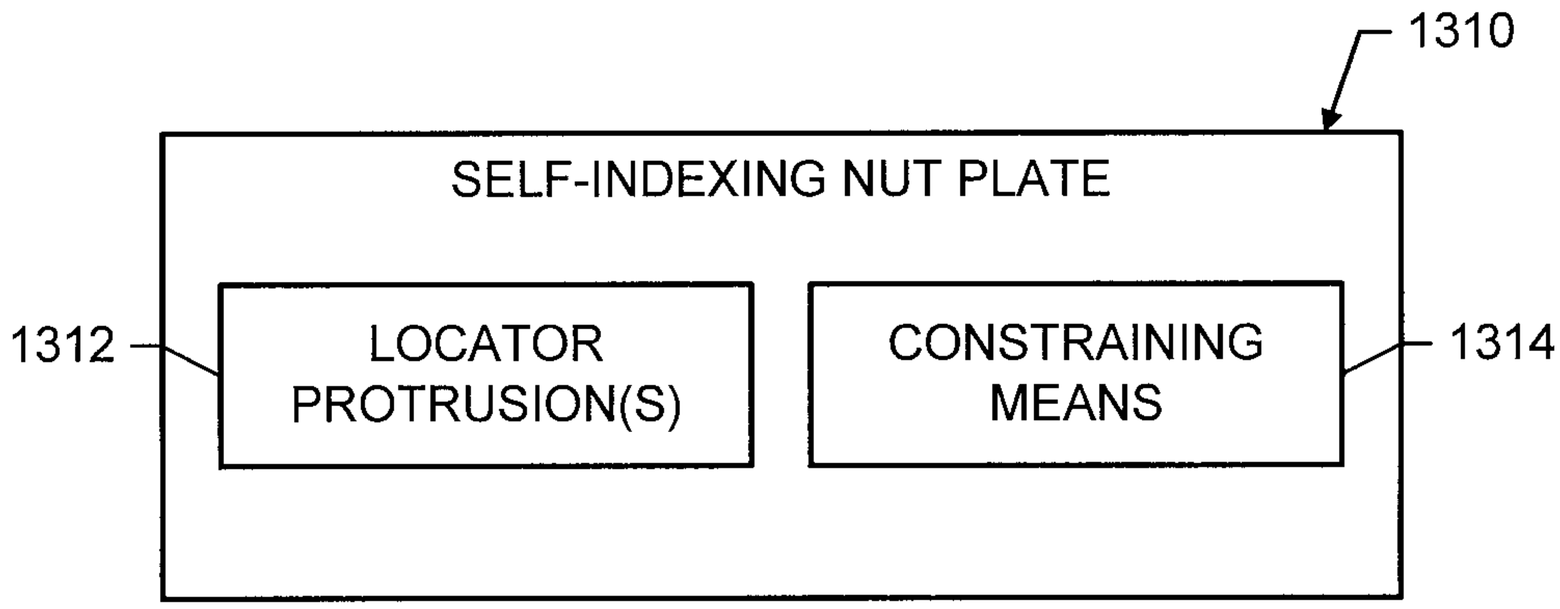
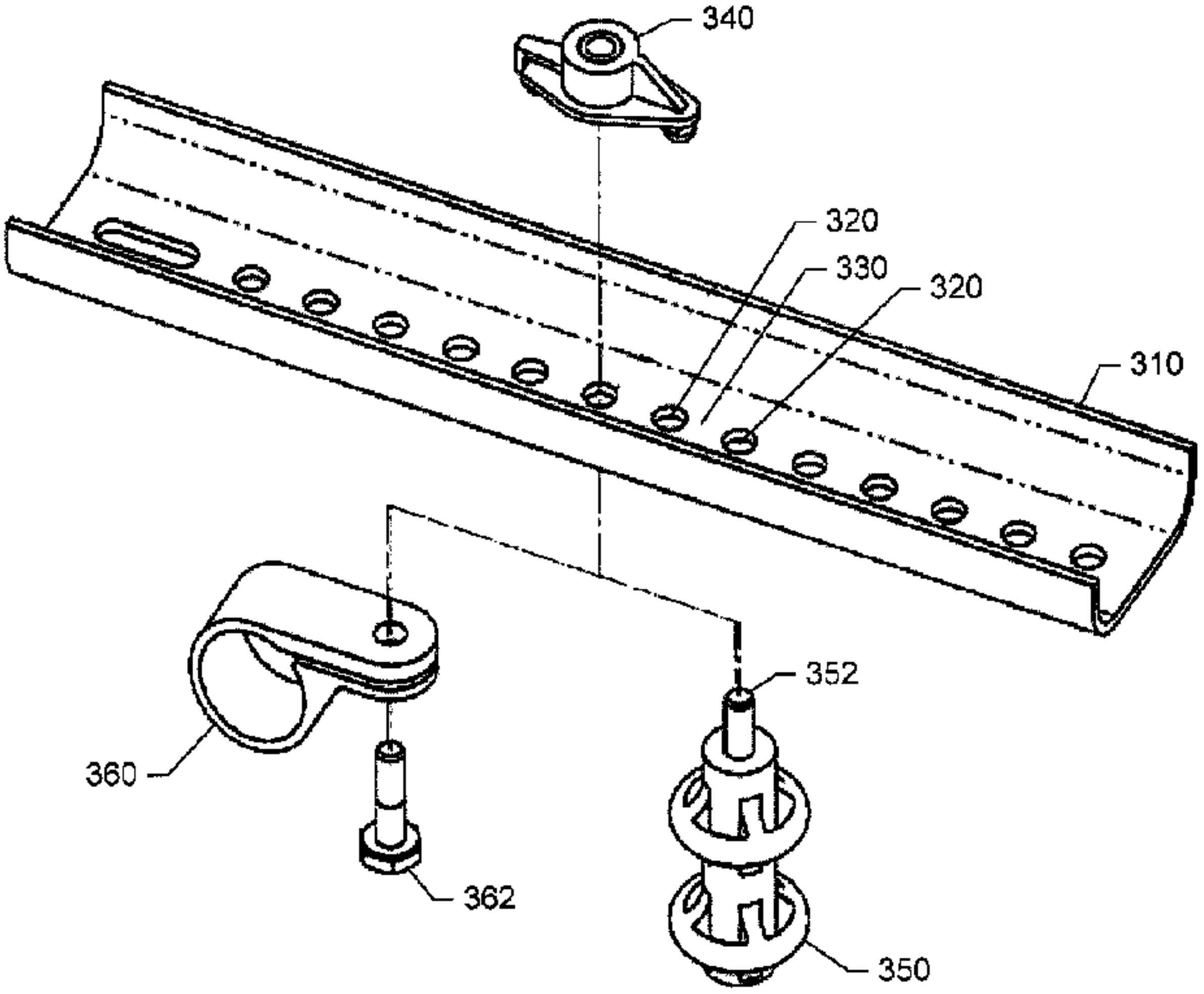


FIG. 12B

FIG. 13

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