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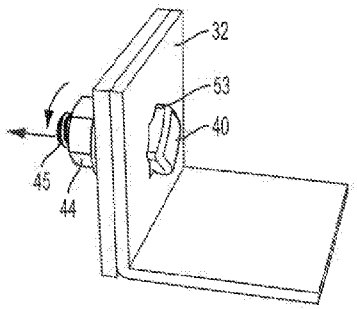

FIG. 22

(57) Abstract: A system includes panels and a fastener for fastening the panels together. The fastener includes a threaded shaft and a head having proximal, intermediate, and distal portions. The proximal portion has a non-circular perimeter such that a maximum dimension of the proximal portion in a direction transverse to the axial direction is larger than a minimum dimension across a non-circular opening of one of the panels. The intermediate portion has an intermediate perimeter surface positioned to limit rotation of the fastener within the non-circular opening when the intermediate surface extends into the non-circular opening. The distal portion has a distal perimeter surface permitting rotation of the fastener within the non-circular opening when the distal surface extends into the non-circular opening. A proximal shoulder extends in a radial direction between the intermediate surface of the intermediate portion of the head and the proximal portion of the head.

QUICK ACCESS BLIND FASTENER

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to U.S. Patent Application No. 62/425,351, filed November 22, 2016, which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

The present invention relates generally to fasteners, and particularly, to blind fasteners that can be used for securing two panels together.

BACKGROUND OF THE INVENTION

Fasteners are sometimes needed to secure two panels together even when it is difficult or impossible to access the underside (blind side) surface of one of the panels. For example, in installation, it may be desired to insert a fastener into aligned apertures of panels that are being secured together, and after installation is complete the fastener and a nut may be used to clamp the panels together.

Blind fasteners have been proposed, for example, in U.S. Patent Nos. 6,547,500, 4,772,167 and 4,747,202, each of which is incorporated by reference in its entirety and for all purposes. Nevertheless, there remains a need for improvements in fasteners in terms of performance, ease of use, and/or reliability.

SUMMARY OF THE INVENTION

Aspects of the present invention are related to blind fasteners.

According to one aspect, a fastener for fastening panels together is provided. The fastener comprises a threaded shaft extending in an axial direction. A head is positioned such that the threaded shaft extends distally from the head in the axial direction. The head has a proximal portion, an intermediate portion, and a distal portion. The proximal portion of the head has a non-circular perimeter. The intermediate portion and distal portion of the head each have a perimeter surface extending distally from the non-circular perimeter of the proximal portion of the head. The intermediate portion has an anti-rotation surface extending distally from the non-circular perimeter of the proximal portion of the head. A proximal shoulder extends in a radial direction between the intermediate portion of the head and the proximal portion of the head. A distal shoulder optionally extends in a radial direction between the distal portion of the head and the intermediate portion of the head.

According to another aspect, a system for fastening panels together is provided. The system comprises panels each defining openings extending through the panel, the opening of at least one of the panels being a non-circular opening. The system further comprises a fastener for fastening the panels to one another. The

fastener has a threaded shaft extending in an axial direction; and a head positioned such that the threaded shaft extends distally from the head in the axial direction. The head has a proximal portion, an intermediate portion, and a distal portion, the proximal portion of the head having a non-circular perimeter such that a maximum dimension of the proximal portion of the head in a direction transverse to the axial direction is larger than a minimum dimension across the non-circular opening. The intermediate portion has an intermediate perimeter surface positioned to limit rotation of the fastener within the non-circular opening when the intermediate surface of the intermediate portion extends into the non-circular opening. The distal portion of the head has a distal perimeter surface permitting rotation of the fastener within the non-circular opening when the distal surface of the distal portion extends into the non-circular opening. A proximal shoulder extends in a radial direction between the intermediate surface of the intermediate portion of the head and the proximal portion of the head. The proximal shoulder is positioned to prevent passage of the proximal portion of the head through the non-circular opening in at least one rotational position.

According to yet another aspect, a fastener for fastening two panels together is provided. The fastener comprises a threaded shaft extending in an axial direction. A non-circular head is disposed on one end of the threaded shaft and having a plurality of flat sides disposed along a perimeter of the non-circular head, the plurality of flat sides including a first flat side that intersects a second flat side at a corner. A flat relief surface is disposed along the perimeter of the non-circular head that intersects the first flat side at a first edge and intersects the second flat side at a second edge. A shoulder extends in a radial direction from the corner to the flat relief surface and extending along the perimeter of the non-circular head between the first edge and the second edge.

According to still another aspect, a system for fastening panels together is provided. The system comprises at least one panel defining a non-circular opening extending through the panel. A fastener having a non-circular head is sized to at least partially pass through the non-circular opening of the panel in a first rotational orientation of the fastener. The non-circular head includes (i) a plurality of flat sides disposed along a perimeter of the non-circular head, the plurality of flat sides including a first flat side that intersects a second flat side at a corner, (ii) a flat relief surface disposed along the perimeter that intersects the first flat side at a first edge and intersects the second flat side at a second edge, the flat relief surface being configured to engage a surface of the non-circular opening of the panel in a second rotational orientation of the bolt, and (iii) a shoulder extending in a radial direction from the corner to the flat relief surface and extending along the perimeter of the non-circular

head between the first edge and the second edge. The shoulder is positioned to bear on the surface of the panel in a fastened configuration of the fastener. The non-circular head is not limited to having flat sides and flat relief surfaces, and may have other control features or geometries to accomplish the same or similar result.

According to yet another aspect, a method for fastening at least two panels together is provided. The method comprises the steps of: inserting a non-circular head of a fastener in an axial direction at least partially through a non-circular opening disposed through a surface of a panel of the at least two panels, rotating the fastener until a flat relief surface of the non-circular head positively engages a surface of the non-circular opening of the panel, the flat relief surface extending between two flat sides of the non-circular head that intersect at a corner along the perimeter of the non-circular head, and fastening a nut onto a shaft of the fastener until the surface of the panel bears on a shoulder of the non-circular head that extends in a radial direction from the corner to the flat relief surface.

According to yet another aspect, a fastener system is provided for fastening to at least one panel. The fastener system includes a first fastener component having a shaft extending in an axial direction for extending through an aperture defined in the at least one panel The first fastener component also has a head positioned such that the shaft extends distally from the head in the axial direction, the head having a proximal portion, an intermediate portion, and a distal portion, the proximal portion of the head having a non-circular perimeter, the intermediate portion and distal portion of the head each having a perimeter surface extending distally from the non-circular perimeter of the proximal portion of the head, and the intermediate portion having an anti-rotation surface extending distally from the non-circular perimeter of the proximal portion of the head, wherein a proximal shoulder extends in a radial direction between the intermediate portion of the head and the proximal portion of the head, the head being shaped such that it can pass through the aperture defined in the at least one panel in one rotational orientation about the axial direction and cannot pass through the aperture defined in the at least one panel in another rotational orientation about the axial direction. The fastener system also includes a second fastener component configured to be coupled to the shaft of the first fastener component, the second fastener being shaped such that it cannot pass through the aperture defined in the at least one panel when it is coupled to the shaft of the first fastener component in at least one rotational orientation about the axial direction.

In the fastener system, threads are optionally applied to the shaft of the first fastener component and threads are optionally applied to the second fastener

component for releasable engagement with threads applied to the shaft of the first fastener component.

In the fastener system, the first fastener component and/or the second fastener component is optionally configured to resist or prevent separation of the second fastener component from the shaft of the first fastener component.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is best understood from the following detailed description when read in connection with the accompanying drawings. It is emphasized that, according to common practice, the various features of the drawings are not to scale. On the contrary, the dimensions of the various features may be arbitrarily expanded or reduced for clarity. Included in the drawings are the following figures:

FIG. 1 depicts a side elevation view of an exemplary fastener and nut assembly in accordance with aspects of the present invention.

FIG. 2 depicts a front elevation view of the fastener and nut assembly of FIG. 1.

FIG. 3 depicts a rear elevation view of the fastener and nut assembly of FIG. 1.

FIG. 4 depicts an exploded view of the fastener and nut assembly of FIG. 1.

FIG. 5A depicts the fastener and nut assembly of FIG. 1 clamping inner and outer panels.

FIG. 5B depicts the fastener and nut assembly of FIG. 1 clamping inner and outer panels and an earth strap.

FIG. 6 depicts a front elevation view of the inner panel of FIGs. 5A and 5B.

FIG. 7 depicts a front elevation view of the outer panel of FIGs. 5A and 5B.

FIG. 8 depicts a front elevation view of the earth strap of FIG. 5B.

FIGs. 9 and 10 depict perspective views of the fastener of FIG. 1.

FIG. 11 depicts a side elevation view of the fastener of FIG. 9.

FIG. 12 depicts a cross-sectional view of the fastener of FIG. 11 taken along the lines 12-12.

FIG. 13 depicts a cross-sectional view of the fastener of FIG. 11 taken along the lines 13-13.

FIG. 14 depicts a cross-sectional view of the fastener of FIG. 11 taken along the lines 14-14.

FIG. 15 depicts a rear elevation view of the fastener of FIG. 9.

FIG. 16 depicts a perspective view of the nut of FIG. 1.

FIG. 17 depicts a side elevation view of the nut of FIG. 16.

FIG. 18 depicts a cross-sectional view of the nut of FIG. 17 taken along the lines 18-18.

FIGs. 19, 20, 21 and 22 depict an exemplary process for mounting the fastener and nut assembly of FIG. 1 onto inner and outer panels.

FIG. 23 depicts a rear elevation view of the assembly of FIG. 22.

FIG. 24 depicts a cross-sectional view of the assembly of FIG. 23 taken along the lines 24-24.

DETAILED DESCRIPTION OF THE INVENTION

Although the invention is illustrated and described herein with reference to specific embodiments, the invention is not intended to be limited to the details shown. Rather, various modifications may be made in the details within the scope and range of equivalents of the claims and without departing from the invention.

Referring generally to the figures, a system 30 is provided for fastening panels 32, 34 together. The system 30 includes panels 32, 34 each defining openings 80, 84 extending through the panels 32, 34, respectively. The opening 84 of at least one of the panels 34 being a non-circular opening. The system 30 also includes a fastener 40 for fastening the panels 32, 34 to one another. The fastener 40 has a threaded shaft 45 extending in an axial direction along axis A. Although the mechanical threads are described herein as right-hand threads, it should be understood that the threads may be left-hand threads. Also, in lieu of mechanical threads, system 30 may include other means for fastening, such as ¼ turn cams and tabs, for example, or any other connection means known to those skilled in the art.

The fastener 40 also has a head 42 positioned such that the threaded shaft 45 extends distally from the head 42 in the axial direction along axis A. The head 42 has a proximal portion 46, an intermediate portion 50, and a distal portion 48. The proximal portion 46 of the head 42 has a non-circular perimeter such that a maximum dimension of the proximal portion 46 of the head 42 in a direction transverse to the axial direction of axis A is larger than a minimum dimension W5 across the non-circular opening 84, the intermediate portion 50 having an intermediate perimeter surface 58 positioned to limit rotation of the fastener 40 within the non-circular opening 84 when the intermediate perimeter surface 58 of the intermediate portion 50 extends into the non-circular opening 84, and the distal portion 48 of the head 42 having a distal perimeter surface 65 permitting rotation of the fastener 40 within the non-circular opening 84 when the distal surface 65 of the distal portion 48 extends into the non-circular opening 84, wherein a proximal shoulder 56 extends in a radial direction

between the intermediate surface 54 of the intermediate portion 50 of the head 42 and the proximal portion 46 of the head 42, the proximal shoulder 56 being positioned to prevent passage of the proximal portion 46 of the head 42 through the non-circular opening 84 in at least one rotational position.

Referring now to the specific embodiments illustrated in the drawings, FIGS. 1-4 illustrate an exemplary fastener and nut assembly 30 (which may be referred to hereinafter as assembly 30) in accordance with aspects of the present invention. Assembly 30 is configured to secure two panels 32 and 34 (and, optionally, an earth strap 36) together, as shown in FIGS. 5A and 5B. As a general overview, assembly 30 includes a threaded fastener 40 and a nut 44 that is threadedly mated to the fastener 40. Additional details of assembly 30 are described below.

FIGs. 9-15 depict fastener 40. Fastener 40 generally comprises a solid body having a substantially square head 42 at a proximal end thereof and a threaded shaft 45 at a distal end thereof. Threaded shaft 45 extends distally and in an axial direction from head 42.

Head 42 has a substantially cubic shape including a flat proximal surface 51, a flat distal surface 59, and four flat side surfaces 52 extending between surfaces 51 and 59. A corner 53, which may be either round (as shown) or sharp, is defined at the intersection of adjacent side surfaces 52. A formation 55, comprising a flat relief surface 54 (referred to hereinafter as relief 54) and a rounded surface 65, is formed at each corner 53 of head 42. Although only one formation 55 will be described hereinafter, it should be understood that all of formations 55 are structurally and functionally equivalent.

As best shown in FIG. 11, head 42 generally includes a proximal portion 46, a distal portion 48 and an intermediate portion 50 located between proximal portion 46 and distal portion 48. As will be described hereinafter, proximal portion 46 of head 42 comprises the axial length of corner 53, intermediate portion 50 comprises the axial length of trailing edge 61, and distal portion 48 comprises the axial length of rounded surface 65. The different portions of head 42 will be described hereinafter.

FIGs. 10, 11, 12 and 15 depict proximal portion 46 of head 42. Proximal portion 46 includes proximal surface 51 and a portion of four side surfaces 52 that intersect proximal surface 51 at a rounded edge and extend in a distal direction. As shown in FIG. 12, proximal portion 46 of head 42 has a square shape in cross-section, which is taken in a direction perpendicular to a longitudinal axis A of fastener 40. Proximal portion 46 has a square, or an otherwise non-circular, perimeter, having equal width and length dimensions W1. Width and length dimensions W1 are measured in a plane perpendicular to axis A.

FIGs. 10, 11 and 13 depict intermediate portion 50 of head 42. Intermediate portion 50 extends distally and in an axial direction from proximal portion 46. Each one of side surfaces 52 extends into intermediate portion 50. Relief 54 is defined at every corner 53 of head 42, and each relief 54 intersects two adjacent side surfaces 52 of head 42. Each relief 54 has the same geometry and extends at an angle of approximately 45 degrees with respect to side surfaces 52 that it intersects.

The portion of relief 54 that resides in intermediate portion 50 forms an anti-rotation surface 58 on head 42, the purpose of which will be explained later. Anti-rotation surface 58 extends along the side of head 42 between a trailing edge 61 and a leading edge 62. The axial length of trailing edge 61 is less than that of leading edge 62 due to a rounded surface 65 formed in each side surface 52, which will be explained with reference to distal portion 48 of head 42.

Anti-rotation surface 58 is a flat surface having a length L1 that is measured in a plane perpendicular to axis A. Additionally, as best shown in FIG. 13, a distance W2, as measured in a plane perpendicular to axis A, exists between opposing reliefs 54. The distance W2 is substantially equal to the distance W1.

A proximal shoulder 56 extends radially (i.e., perpendicular to longitudinal axis A) outward from the proximal end of anti-rotation surface 58 and intersects corner 53 and side surfaces 52 that form corner 53.

FIGs. 10, 11 and 14 depict distal portion 48 of head 42. Distal portion 48 extends distally and in an axial direction from intermediate portion 50 of head 42. Each one of side surfaces 52 extends into distal portion 48. In distal portion 48, a convex rounded surface 65 is formed in each side surface of head 42 and extends between a leading surface 71 and a trailing surface 72. Leading surface 71 is rotationally aligned with a corner 53 of head 42, and trailing surface 72 is rotationally aligned with the midpoint of an adjacent side surface 52. Rounded surface 65 also extends in an axial direction between anti-rotation surface 58 and distal surface 59 of head 42.

The portion 66 of relief 54 that resides in distal portion 48 does not form a rotation surface on head 42. Portion 66 of relief 54 that resides in distal portion 48 extends in an axial direction from anti-rotation surface 58 to distal surface 59 of head 42. Portion 66 extends in a rotational direction between a leading edge 62 and leading edge 71 of an adjacent rounded surface 65. Each portion 66 is a flat surface having a length L2 that is measured in a plane perpendicular to axis A. Length L2 is less than length L1.

A distal shoulder 67 extends radially (i.e., perpendicular to longitudinal axis A) outward from the proximal end of rounded surface 65 and intersects an adjacent side surface 52 and anti-rotation surface 58.

An imaginary circle surrounding the perimeter of the radial cross-section of intermediate portion 50 shown in FIG. 13 is larger than an imaginary circle surrounding the perimeter of the radial cross-section of distal portion 48 shown in FIG. 14. This is due to the inclusion of rounded surfaces 65 in distal portion 48. Accordingly, distal portion 48 is capable of rotating within an opening having a pre-determined size whereas intermediate portion 50 is not capable of rotating within the same opening.

Referring still to the features of fastener 40, threaded shaft 45 of fastener 40 includes male threads. A thread patch (not shown) may be applied to the very distal end 47 of the threaded shaft 45 in order to captivate nut 44 onto threaded shaft 45. It should be understood that the thread patch can only be applied after nut 44 is connected to shaft 45. It should also be understood that nut 44 is capable of rotating about the portion of threaded shaft 45 to which the thread patch is not applied. Alternatively, the threads at the very distal end of threaded shaft 45 may be permanently deformed so as to prevent removal of nut 44 once it is connected to shaft 45.

FIG. 5A depicts the fastener and nut assembly 30 of FIG. 1 clamping inner and outer panels 32 and 34, respectively. FIG. 5B depicts the fastener and nut assembly 30 of FIG. 1 clamping inner and outer panels 32 and 34, respectively, in addition to an earth strap 35. Fastener and nut assembly 30 is configured to accommodate and exhibit sufficient compressive force over a wide range of panel thicknesses.

FIG. 6 depicts inner panel 32, which is shown as square but may have any desired shape. Inner panel 32 includes a square opening 80 having four equal sides each having a length dimension W4. Dimension W4 is slightly larger than dimensions W1 and W2 of head 42 such that fastener 40 may be inserted at least partially through opening 80. Opening 80 is sized generally to (i) permit limited rotation of fastener 40 therewithin when opening 80 is axially aligned with distal portion 48, and (ii) prevent rotation of intermediate portion 50 when opening 80 is axially aligned with intermediate portion 50, as will be described in greater detail with reference to FIGs. 19-24.

Each side of opening 80 is defined by a flat surface 93. The number of flat surfaces 93 of opening 80 generally corresponds to the number of side surfaces 52 of head 42. The shape of opening 80, the corresponding number of flat surfaces 93,

and the corresponding number of side surfaces 52 of head 42 may vary from that which is shown and described.

FIG. 7 depicts outer panel 34, which is shown as square but may have any desired shape. Outer panel 34 includes an opening 84 in the shape of an oval or elongated circle having a width dimension W5 and a length dimension W6. Dimension W5 is substantially equal to dimension W4 of inner panel 32, whereas dimension W6 is greater than dimension W5. Opening 84 is sized generally to permit free rotation of fastener 40 therewithin.

FIG. 8 depicts earth strap 35, which is shown as rectangular but may have any desired shape. Earth strap 35 includes one or more openings 86 (two shown) in the shape of an oval or elongated circle. A plurality of openings 86 are provided for establishing ground contact between a plurality of fastener and nut assemblies 30 that are positioned adjacent to each other. The dimensions of each opening 86 are substantially equal to that of opening 84. Opening 86 is also sized to permit free rotation of fastener 40 therewithin. Earth strap 35 is an optional component and may be omitted if so desired.

The shape of openings 80, 84 and 86 may vary from that which is shown and described.

FIGs. 16-18 depict nut 44. Nut 44 generally includes a hollow cylindrical body. A distal end of nut 44 includes a hexagonal shaped exterior 88 surrounding a hollow interior 90 including female threads. Exterior 88 may have any shape that is configured to receive a tool, such as a wrench, for rotating nut 44 on threaded shaft 45 of fastener 40. A proximal end of nut 44 includes a hollow cylindrical sleeve 92. The interior diameter of sleeve 92 is sufficiently large to permit rotation of distal portion 48 of fastener head 42 within sleeve 92. The outer diameter of sleeve 92 is large enough such that it cannot pass through the openings in one or more panels 32, 34 and/or 35, thereby preventing the entire nut and fastener assembly 30 from inadvertently passing through the openings in the panels.

The female threads of nut 44 and/or the male threads of threaded shaft 45 are designed such that, under the application of low torque, there exists sufficient friction at the threaded interface so that the shaft 45 will rotate along with the nut 44. The application of a greater torque will cause the nut 44 to rotate on threaded shaft 45. The advantage of this feature will be described with reference to FIG. 21. Although not shown, a coating may be applied to the threads of nut 44 and/or threaded shaft 45 to increase the friction therebetween. Additionally or alternatively, a compression spring (or other compliance member) could be positioned between nut 44 and head 42 to provide friction at the threaded interface.

The nut 44 is a flanged hex nut, as shown, however, the nut 44 can vary from that which is shown and described. By way of example, the nut may be a standard hex nut, a wing nut, a cap nut, an acorn nut, a T-nut, a slotted nut, a castle nut, a flange nut, a well nut, or any type of nut that is known to those skilled in the art.

According to another exemplary embodiment of the invention, the nut may be a nut (hex or otherwise) that is overmolded with a plastic wing, such as those sold and distributed by Southco, Inc. of Concordville, Pennsylvania, U.S.A. Certain features of the overmolded nut, including its outer contours, are selected for ornamental design and are not dictated by practical function. Accordingly, design elements of the overmolded nut can be varied and selected while maintaining functionality, such that a variety of ornamental configurations are available with substantially the same function or performance. For example, the contours, colors and configurations of the overmolded nut can be varied to provide a different ornamental appearance while maintaining substantially the same functionality. The ornamental design of a nut that is overmolded with a plastic wing is protected separately in U.S. Design Patent Application No. 29/550,091, which is incorporated by reference herein in its entirety.

The aforementioned overmolded nut, as well as the other nuts described herein, are useful for securing electronics equipment (servers, computers, modules, etc.) in a 19 inch (482.6 millimeters) electronics rack. This is so because 19 inch electronics racks have mounting areas/strips with square holes. The square holes can accommodate the square head of the fastener 40. An example of a server mounted in a 19 inch rack is shown in U.S. Patent No. 8,528,872, for example, which is incorporated by reference herein in its entirety.

FIGs. 19-22 depict an exemplary process for mounting fastener and nut assembly 30 of FIG. 1 onto inner and outer panels 32 and 34, respectively. Fastener and nut assembly 30 is a blind fastening system in that fastener and nut assembly 30 can be assembled and dissembled onto panels 32 and 34 at the side of the outer panel 34. In other words, it is not necessary to gain access to the inner panel 32 for assembling and dissembling fastener and nut assembly 30 onto panels 32 and 34.

Starting from the disassembled position depicted in FIG. 19, nut 44 is shown mounted to fastener 40. The square head 42 of fastener 40 is first rotated about axis A such that the orientation of the square head 42 matches that of opening 80 in inner panel 32 (as shown). This step may be performed manually by hand and without a tool.

Turning now to FIG. 20, head 42 of fastener 40 is then inserted through openings 84 and 80 in outer and inner panels 34 and 32, respectively, as depicted by

the arrow in FIG. 20. At this stage, distal portion 48 is aligned within opening 80 in inner panel 34. Also, each side surface 52 of fastener 40 faces a flat surface 93 of opening 80 in inner panel 32. Head 42 may not be user accessible at this stage.

Turning now to FIG. 21, nut 44 is then rotated by forty five degrees in a clockwise tightening direction about axis A, as indicated by the rotational arrow in FIG. 21, until edges 62 of fastener 40 bear on flat surfaces 93 of opening 80, thereby preventing any further clockwise tightening of fastener 40. This step may be performed manually by hand and without a tool. Rotating nut 44 also rotates fastener 40 due to the friction between the threads of nut 44 and fastener 40, as explained above, and this is particularly convenient because it may not be possible to rotate fastener 40 at this stage since head 42 may not be user accessible and nut 44 is covering threaded shaft 45. The geometry of relief 54 and rounded surface 65 of distal portion 48 make rotation in the clockwise tightening direction possible. It is noted that rotation in the counterclockwise direction from the position shown in FIG. 20 is not possible due to the geometry of flat side surface 52 and rounded surface 65 (of an adjacent formation 55) which side surface 52 intersects. At this stage, distal portion 48 is still axially aligned with opening 80 in inner panel 34. Each relief 54 of fastener 40 now faces a flat surface 93 of opening 80 in inner panel 34.

Turning now to FIG. 22, nut 44 is continued to be rotated in a clockwise tightening direction about axis A by one or more turns (using a tool) as indicated by the rotational arrow in FIG. 22. Rotation of nut 44 in the fastening direction causes fastener 40 to translate rearwardly (and without rotation) in the direction of the arrow shown in FIG. 22, until (i) intermediate portion 50 of head 42 is axially aligned with opening 80 in inner panel 34, (ii) surfaces 93 of opening 80 are positioned to face anti-rotation surfaces 58, and (iii) inner panel 34 is seated on proximal shoulders 56. At this stage, fastener 40 is prevented from rotating about axis A in either rotational direction due to the engagement between anti-rotation surfaces 58 and surfaces 93 of opening 80.

Rotating nut 44 in the clockwise tightening direction causes nut 44 and head 42 to translate toward each other, thereby compressing panels 32 and 34. Once panels 32 and 34 are compressed between nut 44 and head 42, the interaction between anti-rotation surfaces 58 and their respective surfaces 93 of opening 80 prevent head 42 from rotating in either rotational direction about axis A without first loosening nut 44.

To disassemble fastener and nut assembly 30 from panels 32 and 34, nut 44 is first loosened by rotating nut 44 in a counterclockwise direction about axis A

using a tool. Nut 44, which may be captivated to fastener 40, cannot be removed from the threaded shaft 45 of fastener 40.

Turning back to FIG. 21, rotation of nut 44 in the counter clockwise direction (using a tool or by hand) causes fastener 40 to translate (without rotation) away from nut 44 in a forward axial direction toward panel 32 such that (i) anti-rotation surfaces 58 of intermediate portion 50 become axially separated from surfaces 93 of opening 80, (ii) distal portion 48 becomes axially aligned with opening 80 in inner panel 34, and (3) each relief 54 of distal portion 48 faces a flat surface 93 of opening 80 in inner panel 34. Once distal portion 48 of fastener 40 becomes axially aligned with opening 80 in inner panel 34, fastener 40 is free to rotate in the counter clockwise direction.

Turning back to FIG. 20, nut 44 and fastener 40 are continued to be rotated by tool or hand in the counter clockwise direction by forty five degrees until each side surface 52 of fastener 40 faces a flat surface 93 of opening 80 in inner panel 32. At this stage, fastener 40 rotates along with nut 44 due to the friction between their threads.

Turning back to FIG. 19, nut 44 is then translated away from panels 32 and 34 until fastener and nut assembly 30 is disassembled from panels 32 and 34.

It should be understood that any references herein to clockwise and counterclockwise rotational directions would be reversed if fastener and nut assembly 30 included left-hand threads instead of right-hand threads.

While preferred embodiments of the invention have been shown and described herein, it will be understood that such embodiments are provided by way of example only. Numerous variations, changes and substitutions will occur to those skilled in the art without departing from the spirit of the invention. For example, the material of each component described herein and the process for forming these components may vary from that which is shown and described. Accordingly, it is intended that the appended claims cover all such variations as fall within the spirit and scope of the invention.

What is Claimed:

1. A fastener for fastening panels together, the fastener comprising:

a threaded shaft extending in an axial direction; and

a head positioned such that the threaded shaft extends distally from the head in the axial direction, the head having a proximal portion, an intermediate portion, and a distal portion, the proximal portion of the head having a non-circular perimeter, the intermediate portion and distal portion of the head each having a perimeter surface extending distally from the non-circular perimeter of the proximal portion of the head, and the intermediate portion having an anti-rotation surface extending distally from the non-circular perimeter of the proximal portion of the head, wherein a proximal shoulder extends in a radial direction between the intermediate portion of the head and the proximal portion of the head.

2. A system for fastening panels together, the system comprising:

panels each defining openings extending through the panel, the opening of at least one of the panels being a non-circular opening; and

a fastener for fastening the panels to one another, the fastener having

a threaded shaft extending in an axial direction; and

a head positioned such that the threaded shaft extends distally from the head in the axial direction, the head having a proximal portion, an intermediate portion, and a distal portion, the proximal portion of the head having a non-circular perimeter such that a maximum dimension of the proximal portion of the head in a direction transverse to the axial direction is larger than a minimum dimension across the non-circular opening, the intermediate portion having an intermediate perimeter surface positioned to limit rotation of the fastener within the non-circular opening when the intermediate surface of the intermediate portion extends into the non-circular opening, and the distal portion of the head having a distal perimeter surface permitting rotation of the fastener within the non-circular opening when the distal surface of the distal portion extends into the non-circular opening, wherein a proximal shoulder extends in a radial direction between the intermediate surface of the intermediate portion of the head and the proximal portion of the head, the proximal shoulder being positioned to prevent passage of the proximal portion of the head through the non-circular opening in at least one rotational position.

3. A fastener for fastening two panels together, the fastener comprising:

a threaded shaft extending in an axial direction,

a non-circular head disposed on one end of the threaded shaft and having a plurality of flat sides disposed along a perimeter of the non-circular head, the plurality of flat sides including a first flat side that intersects a second flat side at a corner,

a flat relief surface disposed along the perimeter of the non-circular head that intersects the first flat side at a first edge and intersects the second flat side at a second edge, and

a shoulder extending in a radial direction from the corner to the flat relief surface and extending along the perimeter of the non-circular head between the first edge and the second edge.

4. A system for fastening panels together comprising:

at least one panel defining a non-circular opening extending through the panel, and

a fastener having a non-circular head that is sized to at least partially pass through the non-circular opening of the panel in a first rotational orientation of the fastener, the non-circular head including (i) a plurality of flat sides disposed along a perimeter of the non-circular head, the plurality of flat sides including a first flat side that intersects a second flat side at a corner, (ii) a flat relief surface disposed along the perimeter that intersects the first flat side at a first edge and intersects the second flat side at a second edge, the flat relief surface being configured to engage a surface of the non-circular opening of the panel in a second rotational orientation of the bolt, and (iii) a shoulder extending in a radial direction from the corner to the flat relief surface and extending along the perimeter of the non-circular head between the first edge and the second edge, the shoulder being positioned to bear on the surface of the panel in a fastened configuration of the fastener.

5. A method for fastening at least two panels together comprising:

inserting a non-circular head of a fastener in an axial direction at least partially through a non-circular opening disposed through a surface of a panel of the at least two panels,

rotating the fastener until a flat relief surface of the non-circular head positively engages a surface of the non-circular opening of the panel, the flat relief surface extending between two flat sides of the non-circular head that intersect at a corner along the perimeter of the non-circular head, and

fastening a nut onto a shaft of the fastener until the surface of the panel bears on a shoulder of the non-circular head that extends in a radial direction from the corner to the flat relief surface.

6. The fastener of claim 1, wherein the head comprises a plurality of flat sides disposed along a perimeter of the non-circular head, the plurality of flat sides including a first flat side that intersects a second flat side at a corner.

7. The fastener of claim 6 further comprising a flat relief surface disposed along the perimeter of the intermediate portion of the non-circular head that intersects the first flat side at a first edge and intersects the second flat side at a second edge.

8. The fastener of claim 7, wherein the proximal shoulder extends in a radial direction from the corner to the flat relief surface and extends along the perimeter of the non-circular head between the first edge and the second edge.

9. The fastener of claim 7 further comprising a rounded surface formed on the distal portion of the head that extends between the flat relief surface and the first flat side.

10. The fastener of claim 9, wherein the distal shoulder extends in the radial direction between the rounded surface and the first flat side, and between the rounded surface and the flat relief surface.

11. The system of claim 2 further comprising a nut that is threadedly connected to the threaded shaft of the fastener.

12. The system of claim 11, wherein the nut is captivated to the threaded shaft of the fastener.

13. The system of claim 11, wherein the nut and threaded shaft are configured such that the nut rotates along with the threaded shaft at a first torque applied to the nut, and the nut rotates on the threaded shaft at a second torque applied to the nut that is higher than the first torque.

14. The system of claim 11, wherein the fastener further comprises a distal shoulder that extends in a radial direction between the distal portion of the head and the intermediate portion of the head.

15. The system of claim 2, wherein the head comprises a plurality of flat sides disposed along a perimeter of the head, the plurality of flat sides including a first flat side that intersects a second flat side at a corner.

16. The system of claim 15 further comprising a flat relief surface disposed along the perimeter of the intermediate portion of the head that intersects the first flat side at a first edge and intersects the second flat side at a second edge, the flat relief surface of the intermediate portion of the head being sized to prevent rotation of the fastener when the flat relief surface of the intermediate portion of the head is axially aligned with the non-circular opening of the panel.

17. The system of claim 16, wherein the proximal shoulder extends in a radial direction from the corner to the flat relief surface and extends along the perimeter of the non-circular head between the first edge and the second edge.

18. The system of claim 16 further comprising a rounded surface formed on the distal portion of the head that extends between the flat relief surface and the first flat side, the rounded surface of the distal portion of the head being sized to permit rotation of the fastener when the rounded surface of the distal portion of the head is axially aligned with the non-circular opening of the panel.

19. The system of claim 18, wherein a distal shoulder extends in the radial direction between the rounded surface and the first flat side.

20. The system of claim 2, wherein in one rotational orientation of the fastener, the head is configured to pass through the non-circular opening of the panel, and in another rotational orientation of the fastener, the head is not configured to pass through the non-circular opening of the panel.

21. A fastener system for fastening to at least one panel, the fastener system comprising:

a first fastener component having

a shaft extending in an axial direction for extending through an aperture defined in the at least one panel; and

a head positioned such that the shaft extends distally from the head in the axial direction, the head having a proximal portion, an intermediate portion, and a distal portion, the proximal portion of the head having a non-circular perimeter, the intermediate portion and distal portion of the head each having a perimeter surface extending distally from the non-circular perimeter of the proximal portion of the head, and the intermediate portion having an anti-rotation surface extending distally from the non-circular perimeter of the proximal portion of the head, wherein a proximal shoulder extends in a radial direction between the intermediate portion of the head and the proximal portion of the head, the head being shaped such that it can pass through the aperture defined in the at least one panel in one rotational orientation about the axial direction and cannot pass through the aperture defined in the at least one panel in another rotational orientation about the axial direction; and

a second fastener component configured to be coupled to the shaft of the first fastener component, the second fastener being shaped such that it cannot pass through the aperture defined in the at least one panel when it is coupled to the shaft of the first fastener component in at least one rotational orientation about the axial direction.

22. The fastener system of claim 21, wherein threads are applied to the shaft of the first fastener component.

23. The fastener system of claim 22, wherein threads are applied to the second fastener component for releasable engagement with the threads applied to the shaft of the first fastener component.

24. The fastener system of claim 21, wherein the second fastener component is coupled to the shaft of the first fastener component.

25. The fastener system of claim 24, wherein the first fastener component and/or the second fastener component is configured to resist or prevent separation of the second fastener component from the shaft of the first fastener component.

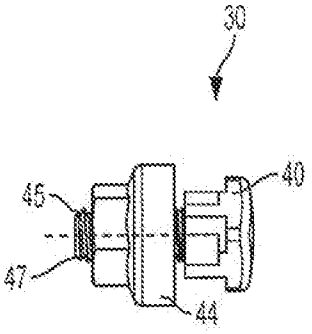

FIG. 1

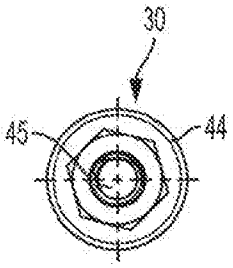

FIG. 2

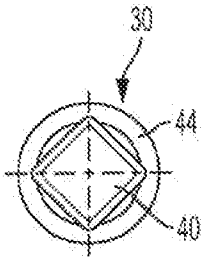

FIG. 3

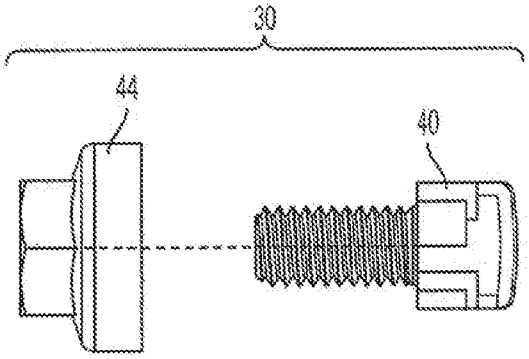

FIG. 4

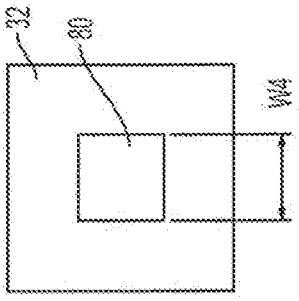

FIG. 6

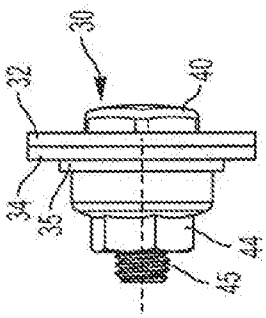

FIG. 5B

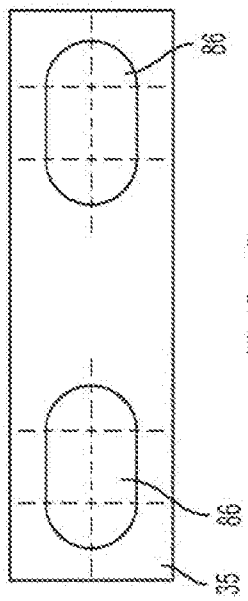

FIG. 8

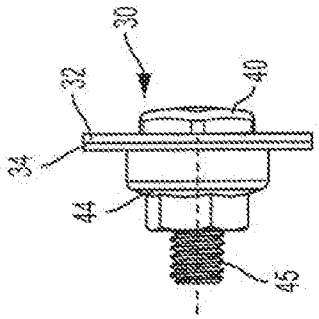

FIG. 5A

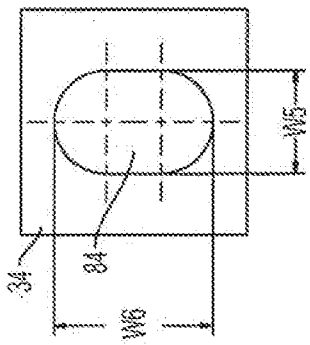

FIG. 7

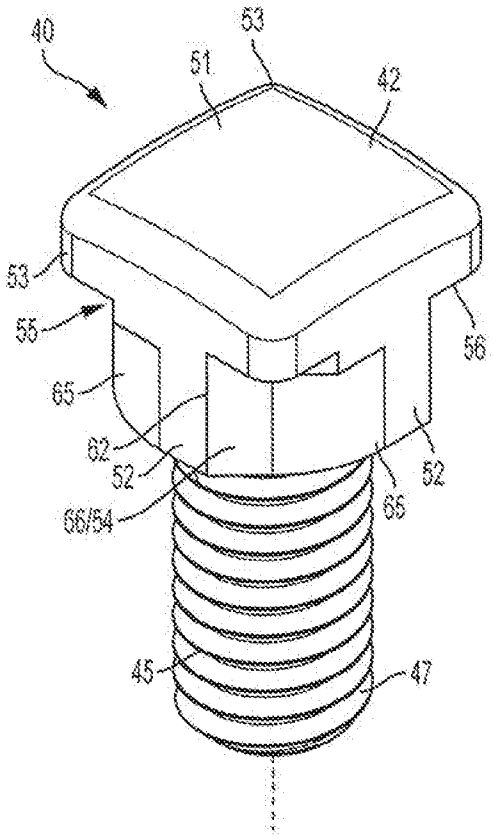
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FIG. 9

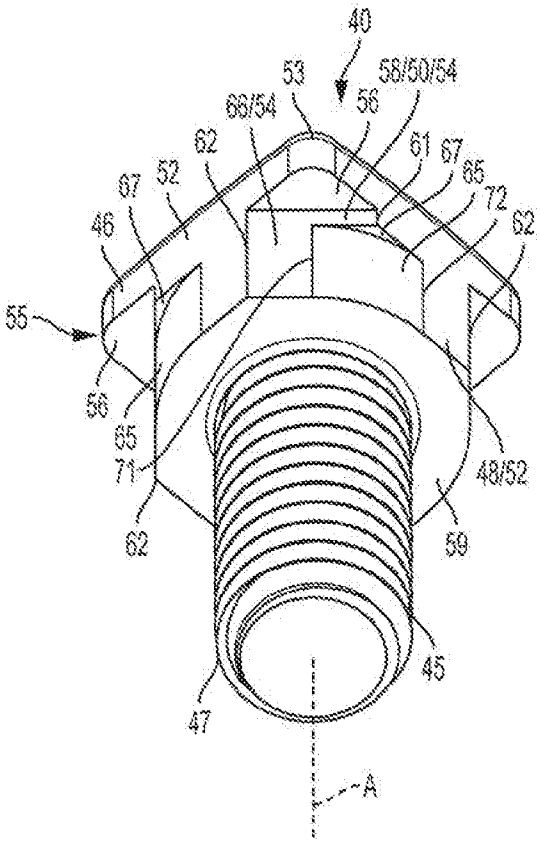
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FIG. 10

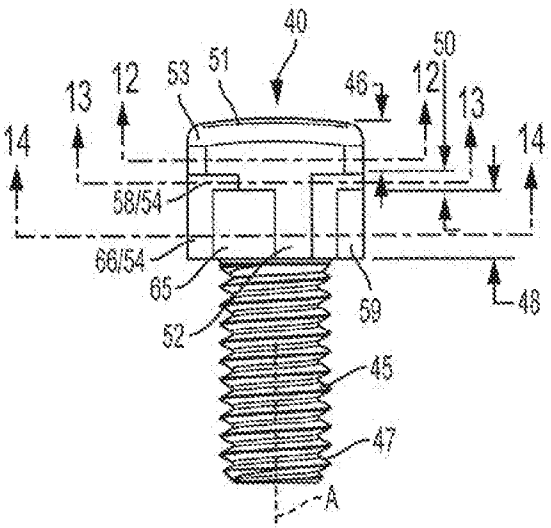

FIG. 11

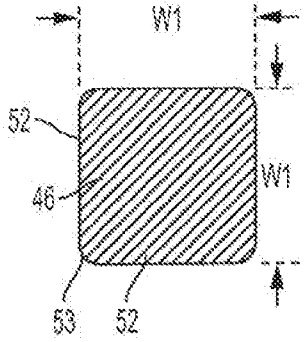

FIG. 12

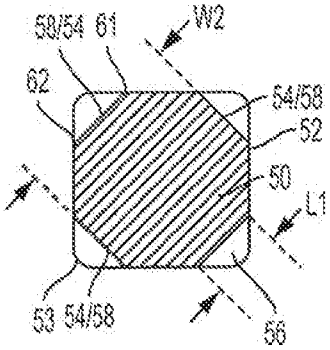

FIG. 13

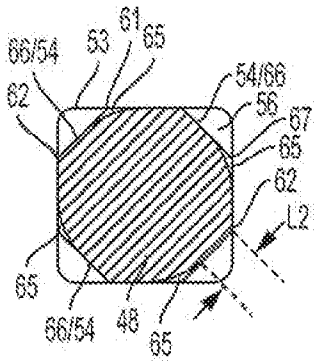

FIG. 14

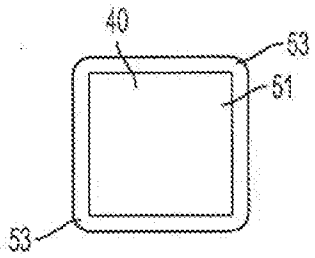

FIG. 15

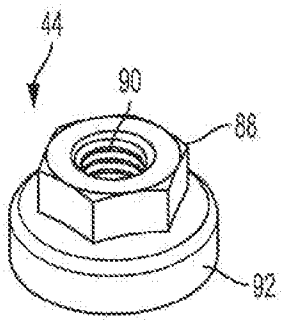

FIG. 16

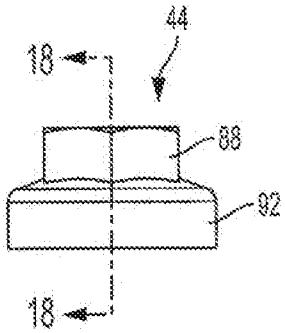

FIG. 17

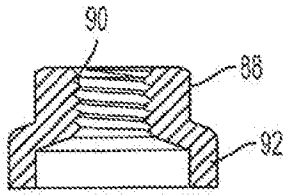

FIG. 18

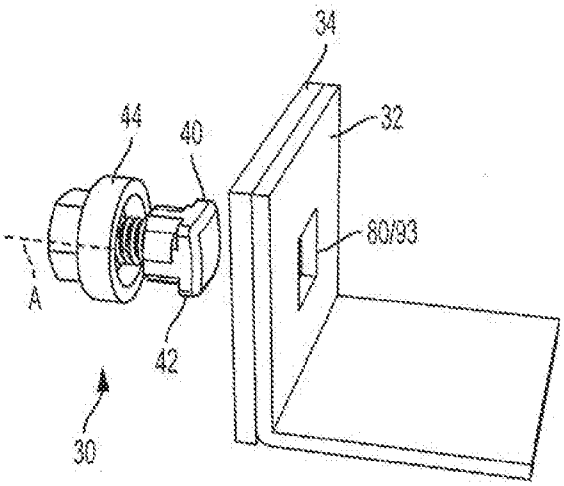

FIG. 19

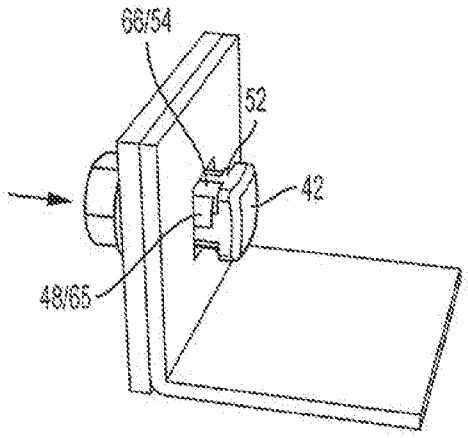

FIG. 20

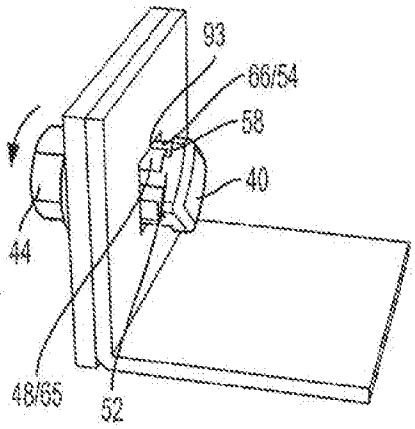

FIG. 21

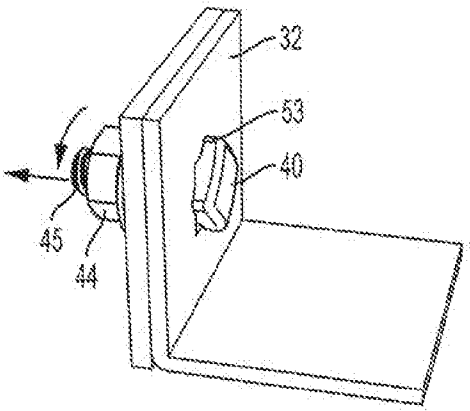

FIG. 22

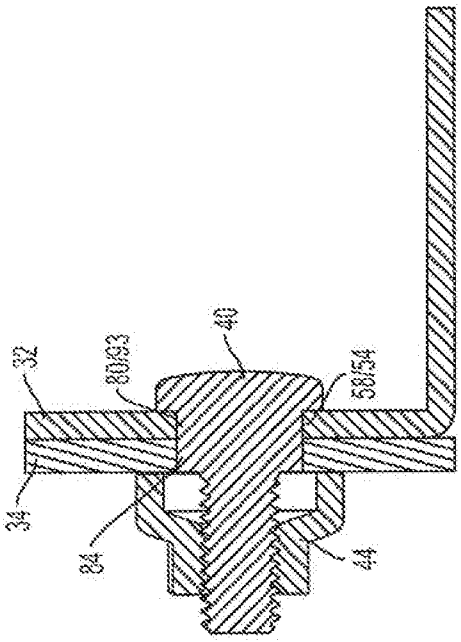

FIG. 24

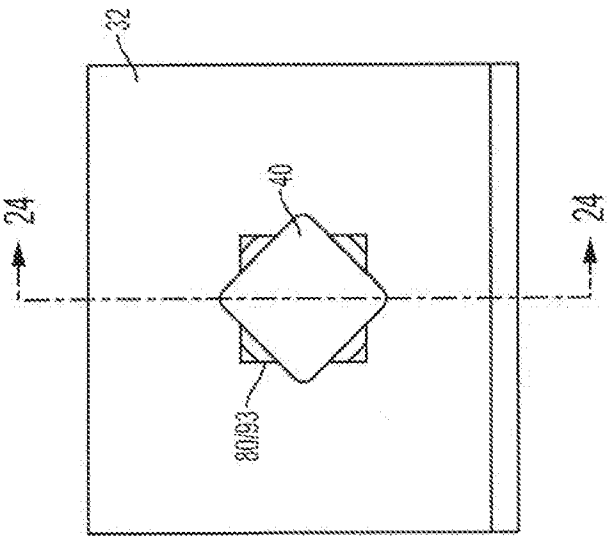

FIG. 23

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2017/062139

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16B37/04
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16B

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2015/155019 A1 (BROSE FAHRZEUGTEILE [DE]) 15 October 2015 (2015-10-15) figures 1, 2A-B, 3A-B, 4A, 4C, 5A, 5B page 10, line 27 - page 11, line 18 page 12, line 6 - page 13, line 25 page 14, line 19 - line 25	1-25
X	US 2014/334896 A1 (YANG KEVIN [US]) 13 November 2014 (2014-11-13) figures 1-3 paragraphs [0038] - [0040], [0042], [0043]	1
A	US 2008/014014 A1 (NEHLS CHARLES [US]) 17 January 2008 (2008-01-17) figures 2A-C	1-25

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

☒ See patent family annex.

* 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
24 January 2018	02/02/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Sisinni, Giovanni

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2017/062139

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		DE 102014206862 A1	15-10-2015
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