

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
9 November 2006 (09.11.2006)

PCT

(10) International Publication Number
WO 2006/119401 A2

(51) International Patent Classification:
B23P 11/00 (2006.01)

(21) International Application Number:
PCT/US2006/017086

(22) International Filing Date: 3 May 2006 (03.05.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/677,390 3 May 2005 (03.05.2005) US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished upon receipt of that report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SPLINED FASTENER

(57) Abstract: A splined pierce fastener of the present invention engages a plastically deformable panel having an aperture formed therein. A pilot portion of the splined pierce fastener defines an annular outer wall and includes a distal end and a proximal end. A flange portion of the splined pierce fastener surrounds the distal end of the pilot portion and defines an annular groove generally surrounding the pilot portion. An annular outer wall of the pilot portion defines a splined surface with abutting ribs each defining an apex spaced from the annular outer wall. A lead in wall forms a transitional surface from the apex of each spline to the distal end of the pilot portion for directing the pilot portion into the aperture disposed in the plastically deformable panel.



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SPLINED FASTENER

RELATED APPLICATIONS

5 **[00001]** This application claims priority to a provisional patent application serial number 60/677,390 filed on May 3, 2005.

FIELD OF THE INVENTION

[00002] This invention relates to self-attaching female fasteners,
10 particularly including pierce and clinch nuts, which may be formed by conventional cold header techniques.

BACKGROUND OF THE INVENTION

[00003] Self-clinching and piercing fasteners generally include a pilot portion that is used sometimes to pierce through a metallic panel and sometimes to
15 guide the fastener into a pre-pierced aperture in the metallic panel. In addition to the pilot portion, the self-clinching fastener also includes a flange portion that extends radially outwardly from one end of the pilot portion and provides a panel engaging surface preventing the pilot portion from passing entirely through the aperture disposed in the panel to which the fastener is being affixed. Generally, the panel is
20 deformed into an annular groove formed in the panel engagement surface of the flange portion to prevent the fastener from being removed from the panel during further assembly. However, for the benefit of various maintenance and manufacturing operations, it is sometimes desirable to affix the fastener to the panel merely by engagement of the pilot portion with an annular wall defining the aperture
25 in the panel.

[00004] Known processing variation with forming an aperture through a panel has made this objective technically difficult to perform, and requires additional processing causing adverse economical effects. When forming a pre-pierced aperture in a panel, a die forces a punch through the panel ejecting a slug from the panel. The
30 punch generally defines a diameter associated with the desired diameter of the pre-pierced aperture being formed in the panel. While the initial engagement side of the panel defines an aperture of desired diameter, a phenomenon known as "blow out" results in an aperture having different diameters at each side of the panel.

Specifically, the exit side of the panel defines an aperture diameter that is greater than the aperture diameter defined on the side of the panel initially engaged by the punch. The transition between entry diameter and exit diameter of the panel is inconsistently located somewhere between two sides of the panel due to manufacturing variability.

5 **[00005]** One method to obtain a consistent aperture that has been pierced in a panel is to perform a secondary machinery operation on the pierce aperture, which is not cost effective. It has been difficult to retain a fastener onto sheet metal with, primarily, the interference between the pilot portion and the inner wall of the aperture defined by the panel. Furthermore, when it is desirable to have
10 the fastener releasably retained to the panel, it has been difficult to achieve a consistent retention force due to the blow-out discussed above. Therefore, it would be desirable to provide a fastener, and a fastener panel assembly, where a consistent retention of the fastener due to the interaction between the pilot portion and the inner wall of the aperture in a panel is achieved.

15 SUMMARY OF THE INVENTION

[00006] A fastener and panel assembly includes a fastener having a pilot portion and a flange portion. The pilot portion includes an outer wall defining a plurality of splines disposed radially around the outer wall. The outer wall includes a major diameter associated with an apex of each spline and a minor diameter
20 associated with the base of each spline. The flange portion includes a flange diameter that is greater than the major diameter of the outer wall. The panel includes a preformed aperture with an inner wall defining an aperture diameter. The aperture diameter is generally less than the major diameter and greater than the minor diameter so that the inner wall engages the plurality of splines disposed radially around the
25 outer wall of the pilot portion for affixing the fastener to the panel.

[00007] The aperture blow-out is accounted for by deforming the aperture radially inwardly to achieve a consistent interaction between the splines disposed radially around the outer wall of the pilot portion and the inner wall of the aperture once the pilot portion has been inserted into the aperture disposed in the
30 panel. By dimensionally forming an aperture having a diameter that is generally less than the major diameter of the splines disposed on the pilot portion, a secure and consistent interference retention is achieved between the fastener and the panel.

[00008] By consistently deforming the blow-out portion of the radially inwardly so that the blow-out side of the aperture also has a consistent diameter that is generally less than the major diameter of the splines of the pilot portion, a consistent retention force is achieved has not been heretofore considered or practiced.
5 Furthermore, deforming the panel radially inwardly once the pilot portion of the fastener has been inserted into the aperture defined by the panel, an additional machining operation to achieve a consistent aperture diameter is eliminated. Therefore, an economical panel and fastener assembly is obtained enabling the releasable affixation of the fastener to the panel for maintenance or further
10 manufacturing processing.

BRIEF DESCRIPTION OF THE DRAWINGS

[00010] Figure 1 is a top plan or perspective view of a splined fastener
15 or nut of this invention;

[00011] Figure 2 is a partially cross sectional and exploded view of a splined nut and panel assembly;

[00012] Figure 3 is a fragmental and cross-sectional view of the splined nut shown in Figures 1 and 2 taken through one of the splines;

20 [00013] Figure 4 is a cross sectional view of the splined nut and panel assembly illustrating a die button forcing the splined nut into the aperture defined in the panel;

[00014] Figure 5 is partial and cross sectional view of the affixed engagement defined between splines of the splined nut and an inner wall of the panel
25 before the splined nut is fixedly engaged with the panel;

[00015] Figure 6 is a cross sectional view of the splined nut and panel assembly of Figure 4 further illustrating the splined nut disposed in the panel with a second die button or slug deforming the panel into the splined nut thereby forcing the panel between the splines of the splined nut to minimize the clearance between the
30 splines and the panel;

[00016] Figure 7 is partial and cross sectional view of the affixed engagement defined between the splines of the splined nut and the inner wall of the panel after the splined nut is fixedly engaged within the panel;

[00017] Figure 8 a fragmental and cross-sectional view of the pilot portion and the flange of the splined nut and a groove defined therebetween;

[00018] Figure 9 a fragmental and cross-sectional view of the pilot portion and the flange of the splined nut of Figure 8 and the panel deformed into the
5 groove;

[00019] Figure 10 a fragmental and cross-sectional view of the alternative embodiment of the pilot portion and the flange of the splined nut and a dove-tailed groove or undercut defined therebetween; and

[00020] Figure 11 a fragmental cross-sectional view of the pilot portion
10 and the flange of the splined nut of Figure 10 and the panel deformed in to the dove-tailed groove or undercut.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[00021] This application discloses two alternative embodiments of a splined nut or fastener of the present invention. However, as will be understood by
15 those skilled in this art, the disclosed embodiments are illustrative only and do not limit further embodiments based upon this disclosure, except as set forth in the appended claims. Figures 1 through 9 illustrate one preferred embodiment of the splined fastener, generally shown at 20, which, as described above, may be formed by conventional cold forming or cold heading techniques, possibly including
20 supplemental or secondary operations. While the fastener is shown as a female fastener, it should be understood that the inventive concept also apply to a male fastener.

[00022] Referring to Figure 1, the splined fastener 20 may be utilized as either a pierce fastener or a clinch fastener as described above. The disclosed
25 embodiment of the splined fastener 20 includes a central pilot portion, generally indicated at 22, a bore 24 defining a central axis A extending through the pilot portion 22 and an annular end face or upper surface 26 surrounding the bore 24. The bore 24 may be threaded as shown or unthreaded for receipt of a self-tapping or thread rolling male fastener (not shown). The bore 24 includes a counter sink 27 at opposite ends of
30 the bore 24. An annular flange portion 28 extends radially outwardly from, preferably, one end of the pilot portion 22 disposed in the flange portion 28. The flange portion 28 has a pilot portion 26 and an annular groove 32 defined in a panel engaging surface 30 surrounding the pilot portion 22. The panel engaging surface 30

is generally perpendicular to the central axis A. As best shown in Figures 8 and 9, the annular groove 32 includes an inner side wall 34 adjacent the pilot portion 22, a bottom wall 36 and an outer side wall 38. The outer side wall 38 of the annular groove 32 slopes radially outwardly from the pilot portion 22. In this embodiment, the bottom wall 36 of the annular groove 32 includes a radius to permit removal of the splined fastener 20 from the die member (not shown) used to form the bottom wall 36 of the annular groove 32 and to allow release of the splined fastener 20 from a panel 40, as will be explained further below.

[00023] As best shown in Figure 1, the pilot portion 22 includes an outer annular wall 41 presenting plurality of splines 42. Each spline 42 includes an apex 44 defining a major diameter D1 of the pilot portion 22 and a base 46 defining a minor diameter D2 of the pilot portion 22. The base 46 of each spline 42 is disposed in an abutting relationship with respect to the base 46 of the adjacent splines 42. Each spline 42 further includes a transitional surface 48 intersecting the upper surface 30 of the pilot portion 22 and the apex 44 of the spline 42 spaced from the upper surface 30 of the pilot portion 22. As illustrated in Figures 2, 8, and 9, for example, the transitional surface 48 of each of the plurality of splines 42 defines a leading surface, generally indicated at 50, of the pilot portion 22 in aggregate.

[00024] The splined fastener 20 and the panel 40 are combined to form an inventive assembly. As such, the panel 40 includes an aperture 50 with an inner wall 52 defining an aperture diameter D3. The aperture diameter D3 is generally less than the major diameter, i.e. D1 and is greater than the minor diameter, i.e. D2 so that the inner wall 52 engages the plurality of splines 42 disposed radially around the outer wall 41 of the pilot portion 22 for affixing the splined fastener 20 to the panel 40. The inventive engagement of the splines 42 and the inner wall 52 of the aperture 50 provides benefits for various maintenance and manufacturing operations, wherein the splined fastener 20 is required to be affixed to the panel 40 merely by engagement of the pilot portion 22 with the inner wall 52 defining the aperture 50 in the panel 40. The inventive design of the splined fastener 20 and the method of attaching the splined fastener 20 to the panel 40 provide a consistent retention of the splined fastener 20 relative the panel 40 due to the interaction between the pilot portion 22 and the inner wall 52 of the aperture 50.

[00016] Figures 10 and 11 illustrate an alternative embodiment of the splined fastener generally shown at 120, wherein the splined fastener 120 is numbered in the same sequence as the splined fastener 20 illustrated in Figures 1 through 9, but in the 100 series. The splined fastener 120 includes a central pilot portion 122
5 defining a bore 124 and an annular end face 126 surrounding the bore 124. The splined fastener 120 further includes a flange portion 128 having an annular end face 130 and an annular groove 132 defined in the end face 130 of the flange portion 128. The annular groove 132 includes an inner side wall 134 adjacent the pilot portion 122, a bottom wall 136, which extends radially generally perpendicular to the axis A of the
10 bore 124, and an outer side wall 138 inclined radially inwardly from the bottom wall 136 forming a “dovetail” or undercut, generally indicated at 150. This embodiment of the splined fastener 120 provides greater pull out force. It is contemplated by the invention that this embodiment would be used in application wherein the fastener 120 will not be removed from the panel 140.

15 [00017] Alluding to the above, the pilot portion 122 presents plurality of splines 142. Each spline 142 includes the apex 144 defining the major diameter D1 of the pilot portion 122 and the base 146 defining the minor diameter D2 of the pilot portion 122. The base 146 of each spline 142 is disposed in an abutting relationship to the base 146 of the other splines 142. Each spline 142 further includes a
20 transitional surface 148 intersecting the upper surface 130 of the pilot portion 122 and the apex 144 of the spline 142 spaced from the upper surface 130 of the pilot portion 122. As illustrated in Figures 10 and 11, the transitional surface 148 of each of the plurality of splines 142 defines the leading surface, generally indicated at 160, of the pilot portion 122 in aggregate.

25 [00018] The panel 140 includes the aperture 150 with the inner wall 152 defining the aperture diameter D3. The aperture diameter D3 is generally less than the major diameter, i.e. D1 and is greater than the minor diameter, i.e. D2 so that the inner wall 152 engages the plurality of splines 142 disposed radially around the outer wall of the pilot portion 122 for affixing the fastener to the panel 40. The inventive
30 engagement of the splines 142 and the inner wall 152 of the preformed aperture 150 provides benefit for various maintenance and manufacturing operations, wherein the splined fastener 120 is required to be affixed to the panel 140 merely by engagement of the pilot portion 122 with the inner wall 152 defining the aperture 150 in the panel

140. The inventive design of the splined fastener 120 and the method of attaching the splined fastener 120 to the panel 140 provide a consistent retention of the splined fastener 120 relative the panel 140 due to the interaction between the pilot portion 122 and the inner wall 152 of the aperture 150.

5 **[00019]** Alluding to the above, various prior art methods and designs tried to come up with a solution of how to releasably affix the fastener to the panel for maintenance or further manufacturing processing. However, these methods proved to be not cost effective for various reasons. First of all, it has been difficult to retain a fastener onto sheet metal with, primarily, the interference between the pilot portion
10 and the inner wall of the aperture defined by the panel. Furthermore, when it is desirable to have the fastener releasably retained to the panel, it has been difficult to achieve a consistent retention force due to the aforementioned blow-out. The inventive method, discussed furtherbelow, provides a consistent retention of the splined fastener 20 relative the panel 40 due to the interaction between the pilot
15 portion 22 and the inner wall 52 of the aperture 50 thereby providing an economical panel and fastener assembly.

[00020] As is known to those of skill in the art, piercing the aperture 50 through the panel 40 results in a “blow out” of the exit end of the slug being pierced from the panel 40. This generally results in the aperture diameter D3, adjacent the
20 side of the panel 40 as the die punch enters and a second aperture diameter D4 adjacent the side of the panel 40 the slug is ejected. The second aperture diameter D4 is generally greater than the aperture diameter D3 due to the “blow out” phenomena. This is best represented in Figure 2.

[00021] As stated above, the outer diameter D1 of the splined outer
25 wall 22 interferes with the inner wall 52 of the aperture 50 at the first aperture diameter D3. However, at the second aperture diameter D4 the interference with the splined outer wall 22 is inconstant, or a gap exists as best shown in Figure 4. A die button 57 includes an annular lip 59 that is driven into the opposite side of the panel 40 from the fastener 20 which receives opposing force from a die 61. The annular
30 lip 59 defines a trapezoidal shape and forms an inverse trapezoidal groove 55 in the panel as best shown in Figures 6, 9, and 11. The annular lip 59 deforms the inner wall 52 of the panel 40 at, but not exclusively at the second aperture diameter D4 driving the inner wall 52 radially inwardly into the splines 42 of the pilot portion 22 so that

the second aperture diameter D4 is substantially the same as the first aperture diameter D3. This provides a more consistent interface between the along the entire width of the aperture 24 between the splines 42, 142 and the inner wall 52, 152.

[00022] By practicing the method set forth above, the splined fastener
5 20 is adaptable for the applications that require maintenance and/or further manufacturing processing, wherein the fastener provides retention force of between generally three and five KiloNewtons. This allows the splined fastener 20, 120 to be releasably affixing to the panel 40, 140 thereby allowing the splined fastener 20, 120 to be removed from the panel 40, 140.

CLAIMS

1. A method of attaching a fastener to a panel, said fastener having a pilot portion defining a splined outer wall with a major diameter and a minor diameter, and
5 a flange portion having a diameter greater than said major diameter of said pilot portion to a panel, comprising the steps of:

piercing an aperture having an inner wall through the panel with said inner wall defining a first aperture diameter adjacent a first side of the panel and a second aperture diameter adjacent a second side of the panel, said second aperture diameter
10 being greater than said first aperture diameter;

forcing said pilot portion of said fastener into said aperture so that said major diameter of said splined outer wall interferes with said inner wall at said first aperture diameter; and

deforming the panel radially inwardly into said splined outer wall of said pilot
15 portion by reducing the second aperture diameter to interlock with said splined outer wall of said pilot portion thereby affixing said fastener to the panel.

2. The method as set forth in claim 1, wherein said step of affixing said fastener to the panel is further defined by releasably affixing said fastener to the
20 panel.

3. The method as set forth in claim 2, wherein said step of affixing said fastener to the panel is further defined by affixing said fastener to the panel with release force of between generally three and five kilo Newtons.

25

4. The method as set forth in claim 1, wherein said step of affixing said fastener to the panel is further defined by unremovably affixing said fastener to the panel.

5. The method as set forth in claim 4, wherein said step of unremovably affixing said fastener to the panel is further defined by forming a groove in said flange of said fastener having an undercut and deforming the panel into said undercut thereby interlocking said fastener with the panel.

6. The method as set forth in claim 1, further including the step of forming a groove in the panel axially aligned with said pilot portion of said fastener thereby deforming the panel radially inwardly into said splined outer wall of said pilot portion.

7. The method as set forth in claim 6, wherein said step of forming a groove in the panel is further defined by deforming the panel into a groove defined by said flange of said fastener.

8. The method as set forth in claim 6, wherein said step of forming a groove in the panel is further defined by forming an inverse trapezoidal groove in the panel.

9. The method as set forth in claim 1, wherein said step of forcing said pilot portion of said fastener into said aperture is further defined by spacing said pilot portion below the second side of the panel.

10. A fastener and panel assembly, comprising

a fastener having a pilot portion and a flange portion, said pilot portion having an outer wall defining a plurality of splines disposed radially around said outer wall, said outer wall having a major diameter and a minor diameter associated with said plurality of splines with said flange portion having a flange diameter greater than said major diameter of said outer wall; and

a panel having a preformed aperture with an inner wall defining an aperture diameter; and

said aperture diameter being generally less than said major diameter and greater than said minor diameter so that said inner wall engages said plurality of splines disposed radially around said outer wall of said pilot portion thereby affixing said fastener to said panel.

11. A fastener and panel assembly as set forth in claim 10, wherein said flange portion of said fastener defines a panel engagement surface being in an abutting relationship with said panel.

12. A fastener and panel assembly as set forth in claim 10, wherein said flange portion of said fastener defines a panel engagement surface having a radial groove disposed therein.

13. A fastener and panel assembly as set forth in claim 12, wherein said radial groove includes an inner wall generally aligned with said major diameter of said pilot portion and an outer wall spaced radially outwardly from said inner wall.

14. A fastener and panel assembly as set forth in claim 13, wherein said outer wall of said radial groove is inclined radially inwardly defining an undercut.

15. A fastener and panel assembly as set forth in claim 14, said panel is deformed radially outwardly into said undercut thereby fixedly attaching said panel to said fastener.

16. A fastener and panel assembly as set forth in claim 10, wherein said fastener is releasably affixed to said panel.

10

17. A fastener and panel assembly as set forth in claim 10, wherein said fastener is releasably affixed to said panel by a push out force of between about three and five kilo Newtons.

15 18. A fastener and panel assembly as set forth in claim 12, wherein said panel defines a panel groove having an inverse trapezoidal shape circumscribing said aperture.

19. A fastener and panel assembly as set forth in claim 10, wherein said pilot portion includes a distal end and said distal end is located between said first and said second side of said panel.

20. A clinching fastener, comprising:

a pilot portion with a bore disposed therethrough defining a central axis and having an outer annular wall defining a plurality of splines generally parallel with said central axis;

a flange portion extending radially outwardly from said pilot portion and
5 having a panel engagement surface spaced from said pilot portion by a groove circumscribing said pilot portion and being disposed in said flange portion; and

said pilot portion having an upper surface being generally perpendicular to said central axis and being generally parallel to said panel engagement surface.

10 21. A clinching fastener defined in claim 20, wherein said plurality of splines each include an apex defining a major diameter of said pilot portion.

22. A clinching fastener defined in claim 20, wherein each of said plurality of splines includes a base defining a minor diameter of said pilot portion.

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23. A clinching fastener defined in claim 21, wherein said base of adjacent splines are disposed in an abutting relationship.

24. A clinching fastener defined in claim 20, wherein each of said plurality
20 of splines include a transitional surface intersecting said upper surface of said pilot portion and said apex of said spline spaced from said upper surface of said pilot portion.

25. A clinching fastener defined in claim 24, wherein said transitional surface of each said plurality of splines defines a lead in of said pilot portion in aggregate.

5 26. A clinching fastener defined in claim 21, wherein said groove circumscribing said pilot portion defines an inner wall and an outer wall.

27. A clinching fastener defined in claim 26, wherein said outer wall of said groove slopes radially inwardly toward said pilot portion defining an undercut.

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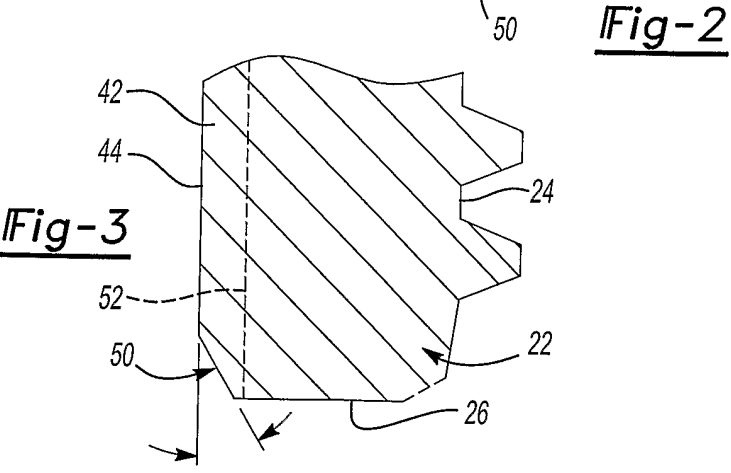
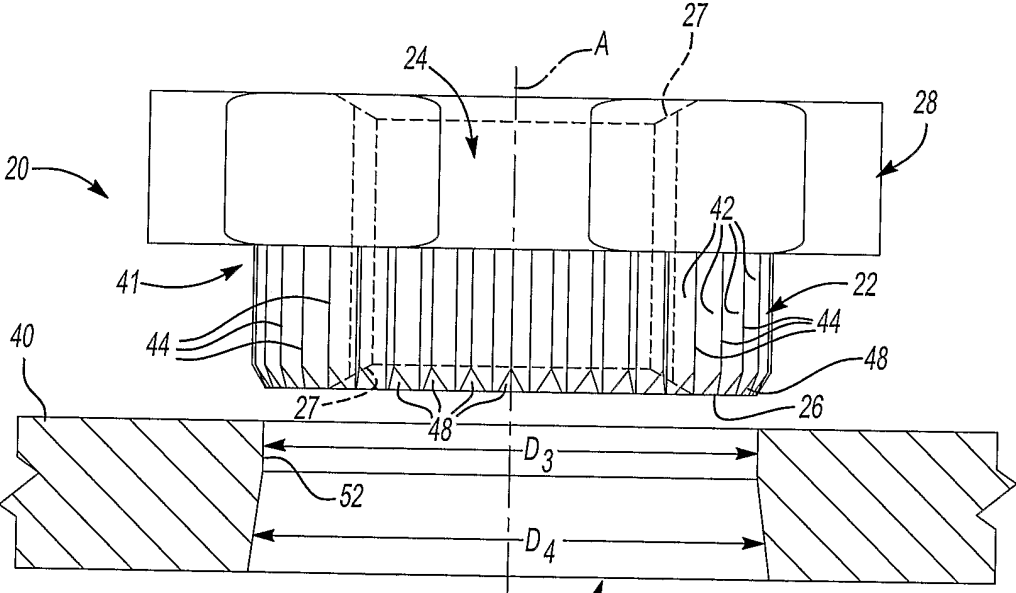
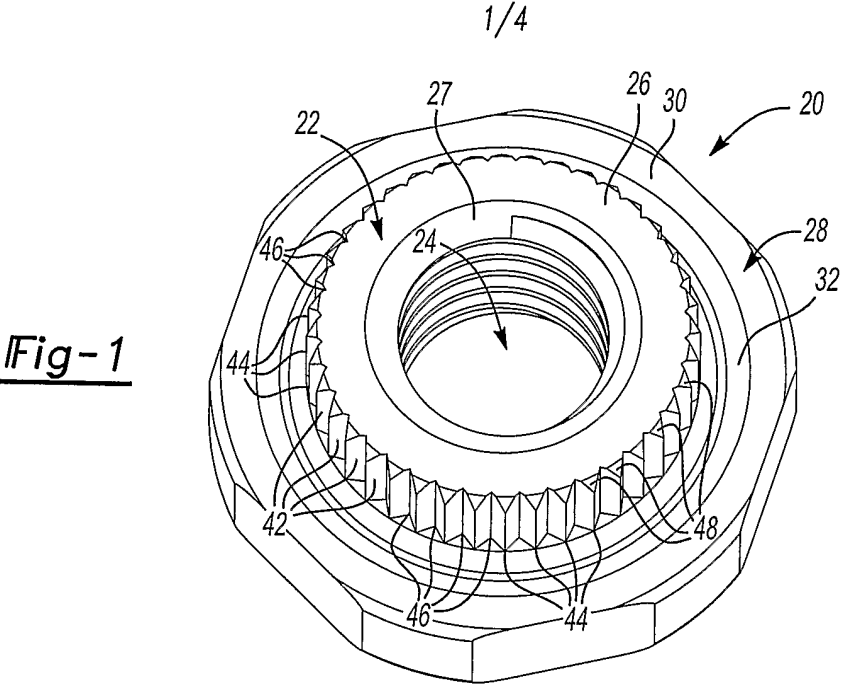
28. A clinching fastener defined in claim 26, wherein said outer wall of said groove slopes radially outwardly toward said panel engaging surface of said flange portion.

15 29. A clinching fastener defined in claim 20, wherein said flange portion includes an outer wall having planar surfaces spaced by radial surfaces.

30. A clinching fastener defined in claim 20, wherein said bore includes a counter sink at opposite ends of said bore.

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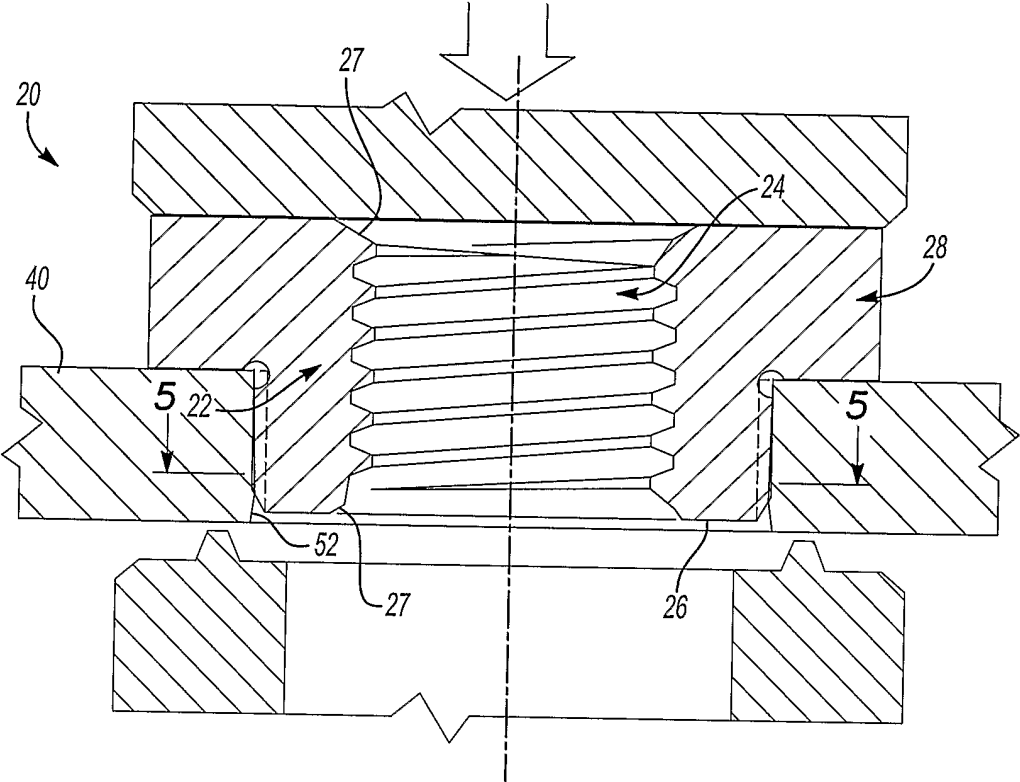


Fig-4

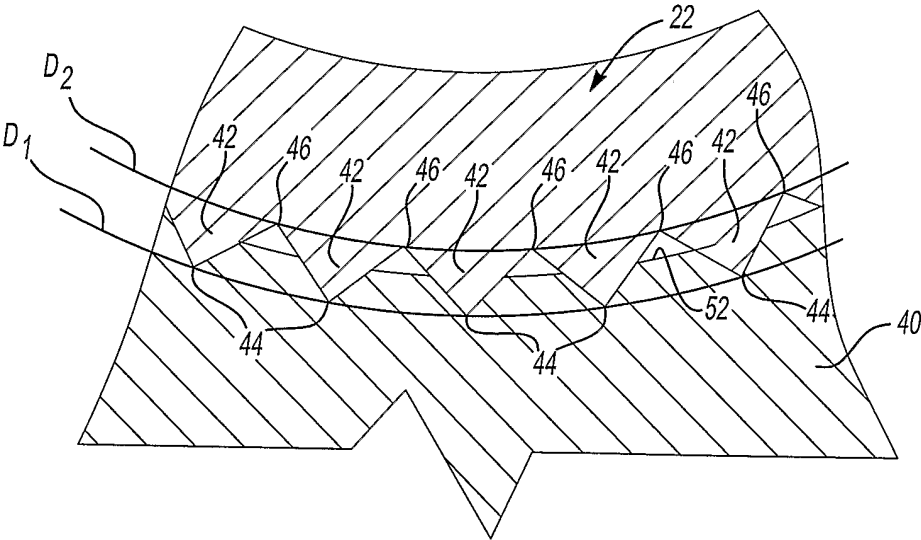


Fig-5

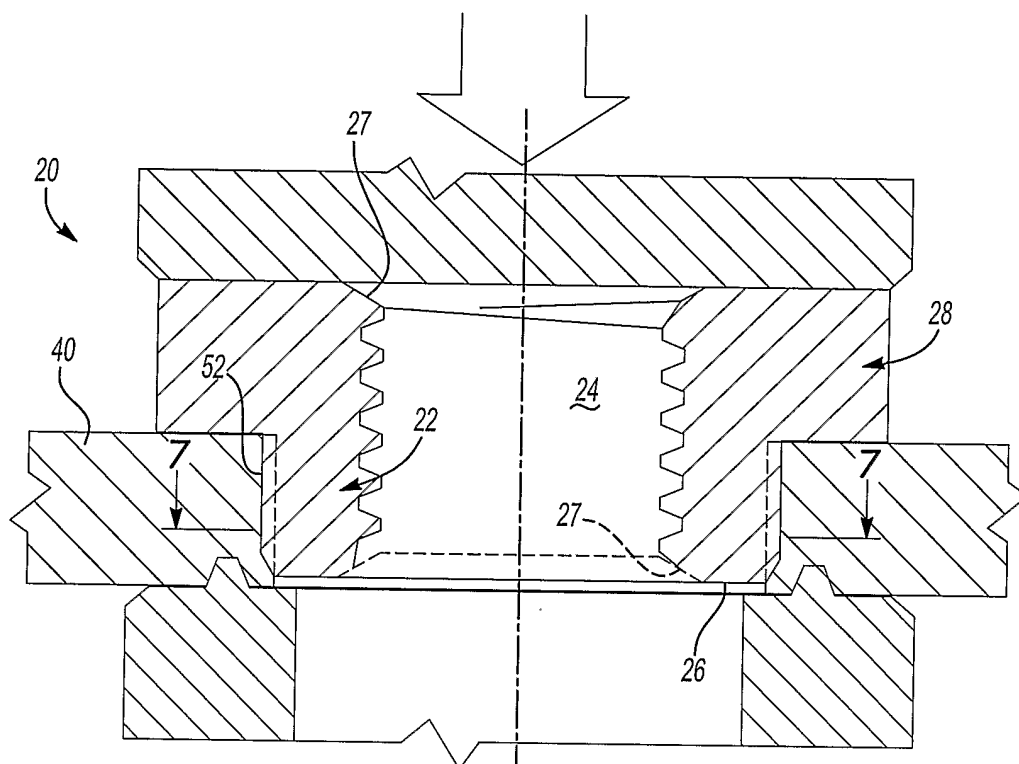
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Fig-6

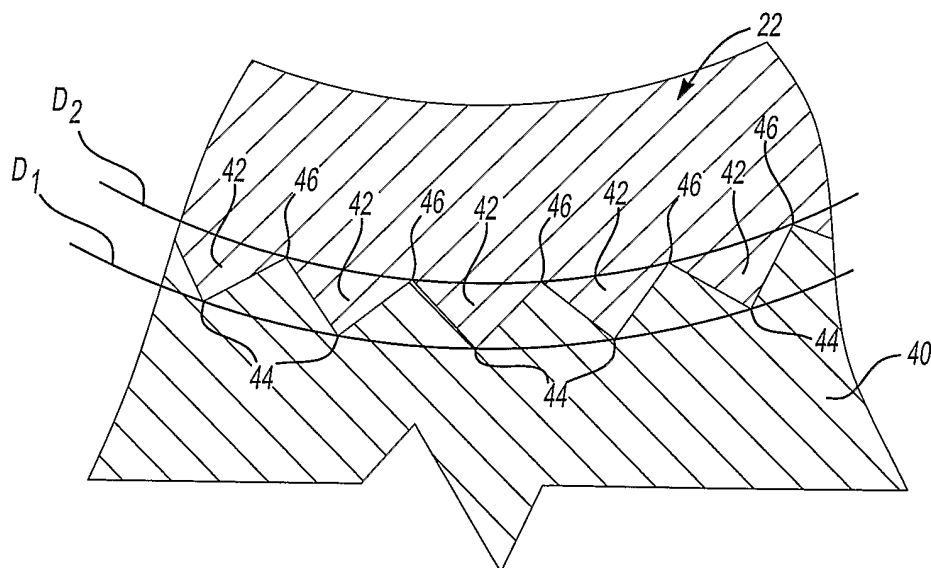


Fig-7

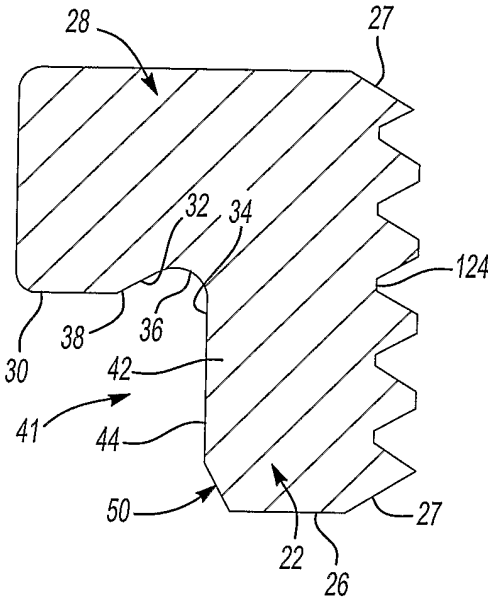


Fig-8

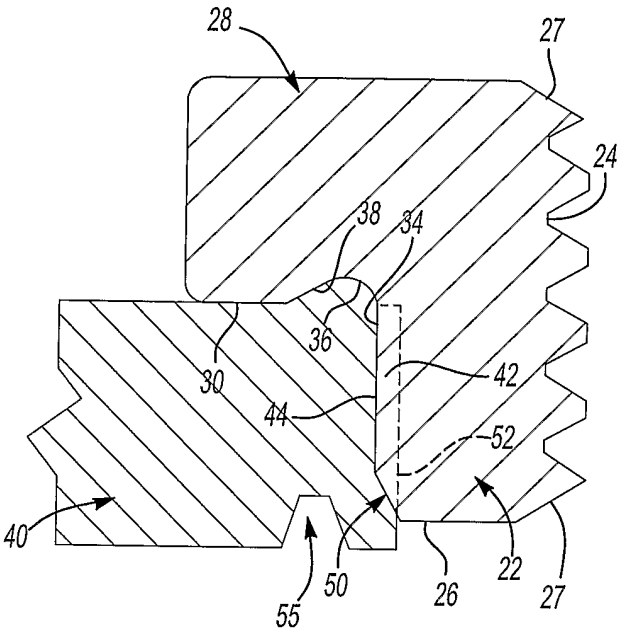


Fig-9

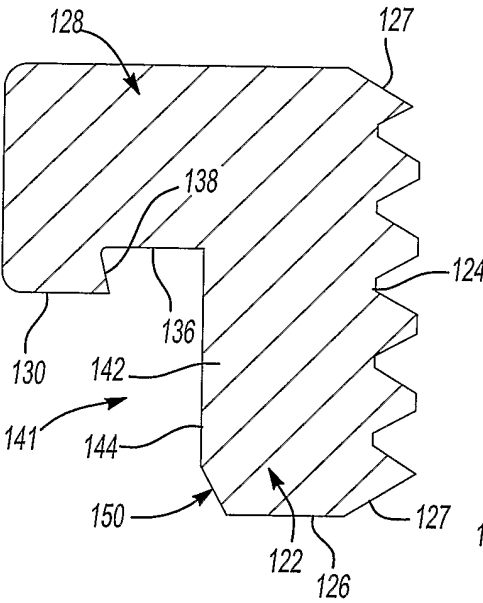


Fig-10

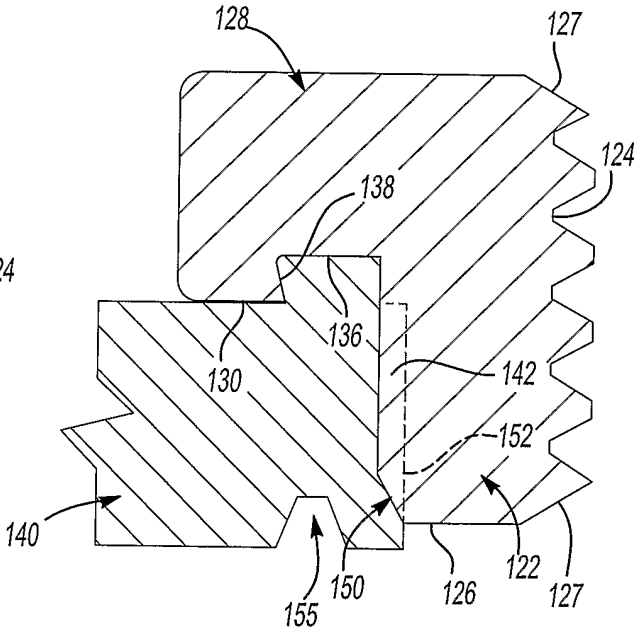


Fig-11