

2005015268

1 CLINCH-TYPE BLIND NUT

2 FIELD OF THE INVENTION

3 The present invention relates to inserts of the blind nut type which are
4 permanently installed in a panel with access to the panel from one side only. More
5 specifically, it applies to a blind nut which provides flush clinch-type attachment by
6 receiving the cold flow of metal from the panel.

7 BACKGROUND OF THE INVENTION

8 Blind nuts are a class of inserts well known in the insert industry which
9 provide a threaded element to a thin panel such as a sheet of metal which is of
10 insufficient depth and/or hardness to support threads directly in the sheet. This type
11 of a nut is called "blind" because it can be applied in situations where there is access
12 to only one side of the panel. Typically the nut is gripped to the panel between a
13 flanged head which lies against one side of the panel and collapsed bulges or bulbs
14 which abut the opposite side of the panel. The bulbs are created by deforming an
15 intermediate tubular portion of the nut shank of reduced diameter (hereinafter
16 "deformable portion") adjacent to an internally threaded end by a compression tool
17 mandrel threaded into the nut. After the nut is installed, the mandrel is unthreaded
18 from the nut leaving the nut/panel assembly ready to receive a threaded screw or bolt
19 for attachment of other parts to the panel. There are also externally threaded blind
20 inserts in which a permanently attached stud replaces the function of the mandrel as
21 the means for applying the compression load to the end of the insert.

22 The performance of a blind nut/panel assembly may be described by two
23 distinct axial strength considerations of attaching a mating threaded insert. The first is
24 the clamp load capacity, which is a measure of the amount of axial load that can be



1 applied when the mating threaded fastener is tightened. Clamp load capacity is a
2 function of the thread-stripping strength and the support strength of the threaded
3 area. Considering the shape of the cross section of the installed insert, this support
4 strength is a combination of the bulb shear strength and the compressive strength of
5 the deformable portion within the panel. The second strength consideration is the
6 working load capacity which is a measure of the load required to separate the
7 attached part from the panel containing the blind insert. Considering the shape of the
8 cross section of the installed insert, the bulb is the only element preventing the insert
9 from pulling out of the panel and hence the working load capacity is simply the bulb
10 shear strength. Because the additive effect of the deformable portion compressive
11 strength is not present for the working load, the working load capacity will always be
12 less than the clamp load capacity.

13 Another consideration is the type of installation tool that may be used. Tools
14 to install blind nuts are of two basic types: spin-pull tools and spin-spin tools. Spin-
15 spin tools create compressive load in the collapsible region of the insert by rotation of
16 a mating threaded member. Spin-spin tools are inexpensive, light-weight and simple
17 to set up and use and are therefore generally preferred. Because the upset force they
18 can develop is limited, they generally cannot be used to install parts with thicker walls.
19 Spin-pull tools spin the mating threaded member into position and then apply an axial
20 pulling force before spinning in the opposite direction to remove the threaded member
21 from the nut. Spin-pull tools are more complex and consequently more expensive and
22 heavier than spin-spin tools. They are also more difficult to set up and require more
23 maintenance. The upset load or the force required to form the panel gripping bulb
24 therefore often determines which of these two common types of installation tools can

1 be used. It is therefore desirable to provide a blind nut insert with the greatest
2 working load capacity and with an upset load that can be achieved by the limited
3 upset force provided by a spin-spin type installation tool.

4 A desired performance characteristic of blind nuts is a large grip range. That
5 is, the ability for the same part to attach to panels of various thickness. Hereinafter,
6 the term "grip" will be used to mean the portion of the shank deformable portion that
7 lies within the panel hole between the primary bulb and the insert head.

8 In certain applications, there is a need for a blind nut which can be installed
9 flush with the access side of the panel. This may require countersinking the panel to
10 receive the head of the nut so that the face of the head is flush with the front of the
11 panel, however this is undesirable since countersinking the panel requires an
12 additional manufacturing operation. To overcome this problem, a broaching-type
13 blind nut has been devised which provides flush attachment in which the nut does not
14 have a head but instead has a serrated end portion with teeth that secure the blind nut
15 to the workpiece in a non-rotating relationship without the need for a countersink in
16 the panel. Such an insert is disclosed for example in U.S. Patent 3,948,142 issued to
17 McKay et al. In order to accommodate the broaching attachment, a cavity in the
18 interior of the nut receives the inward collapsing deformable wall of material into the
19 body of the nut. One of the problems with this type of attachment, however, is that
20 there is no positive structure on the insert to prevent the insert from pushing out of
21 the sheet. A push-out load equal to the broaching load will cause it to broach all the
22 way through the panel and become dislodged.

23 It is also known in the art to utilize a self-clinching type attachment for flush-
24 mounted blind nuts. A self-clinching type blind nut is shown, for example, in U.S.

1 Patent 3,215,026 issued to Davis. Clinch-type attachment requires a much higher
2 installation clamp load than broaching attachment since it depends on the cold flow of
3 the deformed metal panel. Therefore, within the range of the shear strength of the
4 known blind nut materials and construction, this insert is limited to metal panels of
5 relatively soft material. Attempts to increase shear strength of the nut by increasing
6 the strength of the nut material works against the nut's ability to properly collapse
7 against the backside of the attached sheet given the limited working force of
8 installation tools. Also, attempts to structurally increase the strength of the clamp
9 load of the blind nut without increasing the material strength are shown, for example,
10 in U.S. Patent 2,324,142 issued to Eklund in which the collapsible section of a blind
11 rivet is provided with a second reinforcing bulb. However, as disclosed, this structure
12 requires applying pairs of grooves to the outer surface of the collapsible portion of the
13 nut shank which does not provide the necessary bulb shear strength for the higher
14 working loads required by clinch-type attachment into harder metal sheets.

15 It is further known to create an area of weakness in the region of a blind nut
16 deformable portion by annealing to create a zone of reduced hardness along the length
17 of the deformable portion. When the insert is compressed, a bulb forms in the
18 annealed area. This method of altering a blind nut metallurgy for bulb production is
19 shown, for example, in U.S. Patent 4,826,372 issued to Kendall.

20 Despite the efforts in the art, a blind nut which can be installed flush with the
21 access side of the panel and which displays a wide grip range that can be installed by a
22 spin-spin tool has not yet been achieved. There is therefore a need in the art to
23 provide a blind nut with a clinch-type flush attachment capable of use in sheets of
24 harder metal. There is a further need to provide a clinch-type blind nut for harder

1 metal panels which can be installed with a spin-spin type tool and which provides a
2 wide grip range for installation into panels of varying thickness.

3 SUMMARY OF THE INVENTION

4 To meet the needs in the art described above, the present blind nut has been
5 devised. It provides a blind nut with a relatively thin wall and an increased
6 deformable shank length with multiple bulb producing capability. The bulbs may be
7 formed by providing the inside or outside surface of the insert with additional material
8 in the area of the deformable portion of the shank. Alternatively, selectively hardened
9 collars may be formed in the material in the deformable region by heat treatment such
10 as selective annealing.

11 Because the wall thickness is relatively thin, the present insert can be installed
12 with a spin-spin tool and provides a wide grip range. When the present insert is
13 installed, two bulbs will form. By design, the primary bulb in contact with the sheet
14 will always be the same or larger in diameter than the secondary supporting bulb that
15 forms adjacent to the threaded end region. Because two bulbs are formed, the bulb
16 shear strength will be proportional to four times the wall thickness rather than being
17 proportional to two times the wall thickness when only one bulb is formed.

18 By controlling the axial position of the multiple bulb producing feature of the
19 invention, the order in which the multiple bulbs form can be controlled. In most
20 designs, the bulb adjacent the panel will be formed first. In one embodiment, the
21 compressive strength of the part inside the panel mounting hole is reduced by
22 increasing the clearance between the outside diameter and the mounting hole. This
23 clearance results in bending of this area when the bulb forms adjacent to the panel.
24 The presence of this initial bending facilitates additional bending as the head is

1 embedded.

2 In another embodiment, the multiple bulb producing capability of the insert
3 can be provided by changing the metallurgical properties of selected localized areas of
4 the insert by either selective hardening or selective annealing. Alternatively, a
5 reinforcing rib may be added to the outside diameter of the part to create a localized
6 area of increased strength, on either side of which bulbs are formed as will be further
7 described herein.

8 More specifically, the invention comprises a threaded blind insert having a
9 shank with an axial bore therethrough having a head at one end and a threaded region
10 of the bore at the opposite end, the shank having a wall line between an outer surface
11 thereof and the bore. A deformable portion of the shank is created by an area of
12 reduced diameter located axially along the outer surface of the shank. A
13 reinforcement collar integral with the shank is located at approximately the middle of
14 the area of reduced diameter and provides a greater wall thickness at that point to
15 create bulges on either side of the collar as the insert is compressed when it is
16 clamped to a panel. The insert further includes a flange located adjacent the underside
17 of the head. The flange has an outer diameter greater than the diameter of the shank
18 but less than the diameter of the head. The head includes a knurl or other non-round
19 feature such as a polygonal shape. The insert attaches to a panel having a circular
20 aperture with a diameter slightly less than the diameter of the flange which is fitted
21 within the aperture. By these dimensions, a substantial annular gap is provided which
22 lies between the shank and the sidewall of the aperture. As the insert is compressed,
23 bulges form on either side of the collar and provide a reactive force against a backside
24 of the panel which clamp the panel between the bulges and the head of the insert. The

1 reaction forces of the bulges is sufficient to embed the head and the knurl into the
2 panel such that the final installation provides a flush attachment with the front surface
3 of the panel. Alternatively, the reinforcement collar can be replaced by a band of
4 greater hardness of the deformable wall which is created by heat treating the insert.
5 This can be achieved by annealing portions of the deformable portion on either side of
6 the band or heat treating the area of the band to create an area of greater hardness or
7 annealing the material on opposite sides of the band to soften the material in those
8 regions.

9 Thus, the present invention provides the following advantages. First, it
10 provides increased bulge strength relative to wall thickness and upset load. Secondly,
11 it allows a flush installation on the side from which the insert is installed without
12 special hole preparation. Thirdly, as further explained herein, it provides increased
13 torsional holding strength in a round mounting hole. And finally, the invention
14 provides increased grip range compared to blind inserts using heavier wall thickness
15 to increase bulb shear strength. Other objects and advantages will be apparent to
16 those of skill in the art from the following drawings and detailed description of the
17 preferred embodiment.

18 BRIEF DESCRIPTION OF THE DRAWINGS

19 Figure 1 is a bottom front isometric view.

20 Figure 2 is a top front isometric view.

21 Figures 3-6 are a series of partial cut-away side sectional views depicting the
22 sequence of insert installation according to the invention.

23 Figures 7-10 are a series of partial cut-away side sectional views depicting the
24 sequence of insert installation according to an alternate embodiment of the invention.

1 **DESCRIPTION OF THE PREFERRED EMBODIMENT**

2 Referring now to Figures 1 and 2, the first embodiment of the insert 10 of the
3 invention includes an axial bore 9 therethrough. An integral radial collar 11 lies along
4 the shank in approximately the center of deformable area 12, which is an area of
5 reduced outer diameter compared to the flange 17. The collar 11 is located slightly
6 closer to the threaded portion 13 of the insert than to the head 15. The head 15
7 includes a knurl 16 that is commonly used on certain types of self-clinching inserts
8 which is known to provide a high level of torsional resistance when pressed into a
9 workpiece. The knurl is hardened so that it is greater than the hardness of the
10 workpiece. Flange 17 on the underside of head 15 centers the insert in a mounting
11 hole of the workpiece and provides an annular gap between the shank and the sidewall
12 of the hole. The axial length of the flange must be somewhat less than the minimum
13 panel thickness into which the insert can be installed.

14 Figures 3-6 depict an installation sequence which shows the buckling of the
15 wall of the insert in the deformable area and the embedding of the knurl portion of the
16 head. Referring first to Figure 3, the embodiment of Figure 1 is shown assembled
17 onto an installation tool 21 which is shown in phantom. The tool includes a threaded
18 mandrel 23 which extends into the insert. The tool further includes a nosepiece 21
19 with an endface that abuts the head of the insert at all times during installation. As
20 shown in this figure, the flange 17 adjacent the head of the insert is set into the
21 mounting hole of the workpiece or panel 20 to properly center the insert in the hole.
22 Reinforcement collar 11 lies approximately in the center of shank deformable portion
23 12. The installation process begins with the installation tool applying a pulling force

1 to the mandrel which is engaged with the threads 18 of the insert.

2 Referring now to Figure 4, the pulling force of the tool loads the deformable
3 portion of the insert in compression. In this figure, a first bulb 25 directly adjacent the
4 backside of the panel has been completely formed and a second bulb 26 is beginning
5 to form. For a deformable portion of uniform wall thickness divided into two
6 segments by a collar 11 of external material along its outside diameter, the longer
7 segment will have a lower compressive strength and will be the area to buckle first.
8 In this manner, the order in which the bulbs form can be controlled by the axial
9 placement of the collar of material. At this point in the process, the first bulb 25 is
10 not yet symmetric about the radial axis.

11 Referring now to Figure 5, the installation tool continues the pulling force and
12 a second bulb 26 is almost completely formed. The deformable portion between the
13 flange and the backside of the panel has now assumed a generally radial shape. At
14 this point in the process, the knurled head 16 has not yet started to embed into the
15 panel 20.

16 Referring now to Figure 6, the final stage of the installation of this
17 embodiment is depicted. The increasing force applied by the tool 21 has now caused
18 both bulbs 25 and 26 to fully close, that is, the two surfaces which were formerly
19 located on the inside diameter of the deformable portion have moved axially to a point
20 of intimate contact with each other. After each bulb has closed on itself and the two
21 bulbs have closed against each other, the bulbs suddenly develop significant resistance
22 to further deformation. As the tool applies increasing force, the reaction force of the
23 tool nosepiece against the head of the fastener exceeds the force required to embed
24 the knurl head into the workpiece, plus the force required to deform the shank within

1 the grip by an amount equal to the head thickness. Therefore, the head embeds fully
2 and the deformable portion of the shank within the grip deforms resulting in a tighter
3 radius of curvature of the shank against the backside of the panel than as shown in
4 Figure 5. Sufficient clearance between the outside diameter of the shank and the
5 panel hole is necessary for this to occur. This clearance is provided by the difference
6 in diameters between the shank and the flange which provides an annular gap that lies
7 between a sidewall of the hole and the shank. The tool which has a nosepiece of
8 larger diameter than the knurled head 15 serves as a positive stop preventing the head
9 from embedding farther than flush with the front surface of the panel.

10 Both bulbs are now essentially symmetric about a radial plane and are fully
11 formed. The knurling 16 has fully embedded into the panel 20 and the installation
12 process is complete. Formation of the bulbs as above describe a critical feature of the
13 invention which permits an insert soft enough to be deformable yet provides sufficient
14 resistance to cause the knurl to fully embed into the panel. Although the preferred
15 embodiment utilizes knurling to provide torsional securement means, other means
16 such as a non-circular head shape or radial protrusions may also be employed.

17 Figures 7-11 depict an alternate embodiment of the invention. In this
18 embodiment, multiple bulb formation is not aided by a collar of extra material along
19 the outside diameter of the shank as in the previous embodiment but rather by a band
20 of greater hardness of the shank material. The band of greater hardness 31 may be
21 created by selectively hardening the area of the band or by hardening the entire insert
22 and then selectively annealing the remainder of the shank around the area of the band
23 to reduce its hardness. Otherwise, this embodiment is similar in other physical
24 respects to the previous embodiment shown in Figures 1-6 except that the area of

1 reduced outer diameter compared to the flange extends the full length of the shank.
2 The thinner walled area of the shank which provides the deformable portion lies
3 between the flange and the threaded region being achieved by the difference in
4 internal diameters of the deformable region and the threaded region. The sequence of
5 deformation is similar to the embodiment shown in Figure 1-6. As shown in Figure 7,
6 the first step in the installation process is to thread the insert onto the mandrel 23 of
7 the tool until the head of the insert abuts the tool nosepiece 21 and then to place the
8 flange of the insert into the hole in the panel 20.

9 Referring now to Figure 8, the installation tool applies increasing pulling force
10 to the insert, thus compression loading the wall in the area of reduced diameter. In
11 this embodiment, as in the previous embodiment, the first bulb 35 closer to the panel
12 20 forms first and at this point the second bulb 36 is beginning to form. And likewise,
13 placement of the relatively harder band of material 31 along the length of the
14 deformable portion determines on which side of the band 31 the bulb is formed first.

15 Referring now to Figure 9, the second bulb 36 created in the formation
16 process of the second embodiment is now almost completely formed. Configuration
17 of the portion of the shank wall in the area of reduced diameter located between the
18 centering flange and the backside of the panel 20 has assumed a generally radial
19 shape. At this point it will be noted that the knurled head 16 has not yet started to
20 embed into the panel 20.

21 Figure 10 depicts the final step in the installation process. When increased
22 pulling force of the installation tool has caused both bulbs to fully form and the
23 knurled head 16 to fully embed into the panel 20, ever increasing force applied by the
24 tool has caused both bulbs to fully close and become substantially symmetric about a

1 radial plane. As in the previous embodiment, the wall of the insert within the panel
2 hole deforms resulting in a tighter radius against the backside of the panel 20 than is
3 depicted in Figure 9. This is achieved in part by the spacing between the panel hole
4 diameter and the outside diameter of the shank provided by the flange. As in the
5 previous embodiment, the nosepiece 21 of the tool provides flush attachment with the
6 knurled head 16 into the front side of the panel 20.

7 From the foregoing description of the preferred embodiment, it will be
8 understood that the object of the invention has been achieved. The blind insert of the
9 invention provides a controlled sequential deformation of the fastener that allows for
10 flush attachment of a knurled head into relatively hard workpieces or panels. It
11 should be understood that there may be other modifications and changes to the
12 present invention that will be obvious to those of skill in the art from the foregoing
13 description, however, the present invention should be limited only by the following
14 claims and their legal equivalents.

CLAIMS

- 1
2 1. A threaded blind insert, comprising:
3 a shank having an axial bore therethrough with a head at one end and a
4 threaded region of the bore at an opposite end, said shank having a wall lying between
5 an outer surface thereof and said bore;
6 a deformable portion of said shank being an area of reduced diameter
7 located axially along said outer surface of said shank; and
8 a reinforcement collar integral with said shank and extending radially
9 therefrom, said collar being axially located substantially in the middle of said
10 deformable portion wherein the thickness of said wall in the area of said deformable
11 portion is less than other areas of said wall except in the area of said collar where it is
12 substantially greater.
- 13 2. The insert of claim 1 further including a flange located adjacent an
14 underside of said head, said flange having an outer diameter greater than the diameter
15 of said shank but less than the diameter of said head.
- 16 3. The insert of claim 2 wherein the head has an outer periphery which
17 includes torsional securement means.
- 18 4. An assembly of parts comprising:
19 a shank having an axial bore therethrough with the head at one end and
20 a threaded region of the bore at an opposite end;
21 a flange located adjacent an underside of said head, said flange having
22 an outer diameter greater than the diameter of said shank directly adjacent said flange
23 but less than the diameter of said head, said head further including a knurl around its
24 periphery;

1 a panel having a circular aperture with a diameter slightly less than the
2 diameter of said flange, said flange fitted within said aperture such that a substantial
3 annular gap lies between a sidewall of said aperture and said shank, and wherein said
4 head and said knurl are embedded into said panel such that said head is flush with a
5 front surface of said panel; and

6 a first bulge of said shank having an outer surface forceably abutting a
7 backside of said panel in the area around said aperture.

8 5. The assembly of parts of claim 4 further including a second bulge of
9 said shank having a front surface which forceably abuts a back surface of said first
10 bulge.

11 6. The method of fastening a blind threaded insert to a panel comprising
12 the steps of:

13 providing a panel having a circular aperture therein;

14 placing an insert into said aperture, said insert comprising:

15 a shank having an axial bore therethrough with the head at one
16 end and a threaded region of the bore at an opposite end; and

17 a flange located directly adjacent an underside of said head,
18 said flange having an outer diameter greater than the diameter of said shank directly
19 adjacent said flange but less than the diameter of said head, such that a substantial
20 annular gap lies between said shank and a sidewall of said aperture, said head further
21 including a knurl around its periphery;

22 applying a first compressive force to opposite ends of said insert
23 thereby deforming a first region of the shank of said insert creating a first bulb which
24 abuts a backside of the panel;

1 applying a greater force which creates a second bulge by deforming a
2 second region of the shank of the insert whereby a front surface of the second bulge
3 abuts a rear surface of the first bulge; and
4 applying a final and greatest compressive force to opposite ends of the
5 insert whereby said head embeds into said panel by a reaction force supplied by said
6 first and second bulbs against the backside of the panel such that said head is
7 embedded to a depth flush with the front surface of said panel.

8 7. The method of claim 6 wherein said means for applying said increased
9 force, said greater force, and said maximum force is a tool having a pull-stud which is
10 threadably engaged with said threaded region of the bore of said shank.

11 8. A threaded blind insert, comprising:

12 a shank having an axial bore therethrough with a head at one end and a
13 threaded region of the bore at an opposite end, said shank having a wall lying between
14 an outer surface thereof and said bore;

15 a deformable portion located axially along said shank being an area of
16 reduced diameter; and

17 an area of greater hardness of the material of said shank, said area
18 being axially located at approximately the middle of said area of reduced diameter
19 wherein said area of greater hardness is an area of reduced deformability compared to
20 other regions of said shank.

21 9. The threaded blind insert of claim 8 wherein said area of greater
22 hardness is formed by heat treatment of said insert.

23 10. The threaded blind insert of claim 9 wherein said area of greater
24 hardness is a band of hardened material created by heating.

- 1 11. The threaded blind insert of claim 10 wherein said area of greater
2 hardness is formed by annealing an area of said shank that lies immediately beyond
3 either side of said area of greater hardness.
- 4 12. The threaded blind insert of claim 11 wherein said area of greater
5 hardness is a band of material of said insert bounded on opposite sides by material of
6 the insert which is softened by annealing.
- 7 13. The insert of claim 3 wherein said torsional securement means is a
8 knurl.