(12) UK Patent Application (19) GB (11) 2 416 575 (13) A

(43) Date of A Publication 01.02.2006

(21) Application No: 0415961.2

(22) Date of Filing: 16.07.2004

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(51) INT CL:
F16B 19/10 (2006.01) **B21J 15/04** (2006.01)
B21K 1/58 (2006.01) **F16B 13/04** (2006.01)

(52) UK CL (Edition X):
F2H HAEF

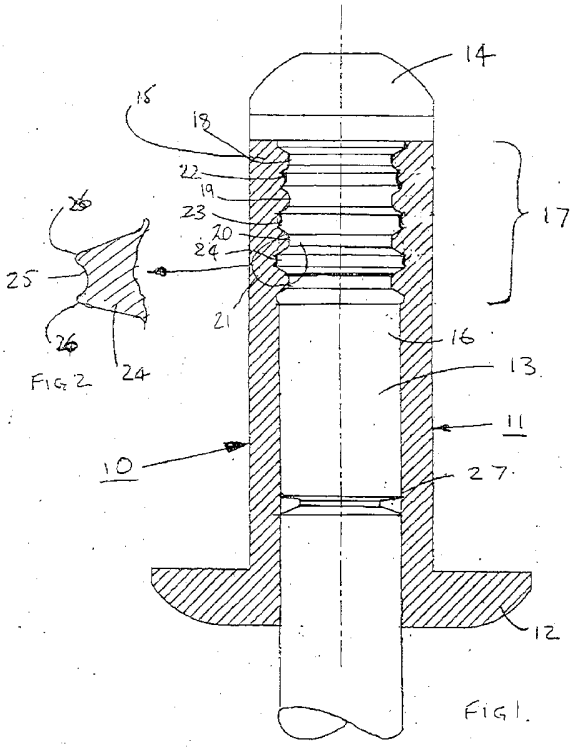
(56) Documents Cited:
FR 001241123 A **US 6004086 A**
US 3286580 A **US 3149530 A**

(58) Field of Search:
INT CL[7] **B21J, B21K, F16B**
Other: **Online: WPI, EPODOC, JAPIO**

(54) Abstract Title: **A blind rivet**

(57) A blind rivet (10) comprising an elongate hollow rivet body (11) having a head end (12) and a tail end (15) and an elongate mandrel (13) having a head end (14) located adjacent the tail end (15) of the body (11). The mandrel (13) has a stem (16) extending through the hollow body (11) and the stem (16) has a tapered portion (17) adjacent the head (14) of the mandrel (13) that tapers towards the head (14). The stem (16) has a distal end that projects beyond the head end (12) of the body (11). The tapered portion (17) of the stem (16) is provided with a plurality of axially spaced grooves (18 to 20) that define between them ribs (21 to 23) that have a profile comprising two axially spaced ridges (25,26) subtending a concave circumferential surface (24) between the ridges (25, 26) , The body (11) is of substantially uniform outer diameter and has a thicker wall thickness over the region (17) corresponding to the tapered section (17) of the mandrel (13).

The hollow body is cold formed on to the stem to cause the material of the body to flow into the grooves, around the ribs and tapered portion.



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

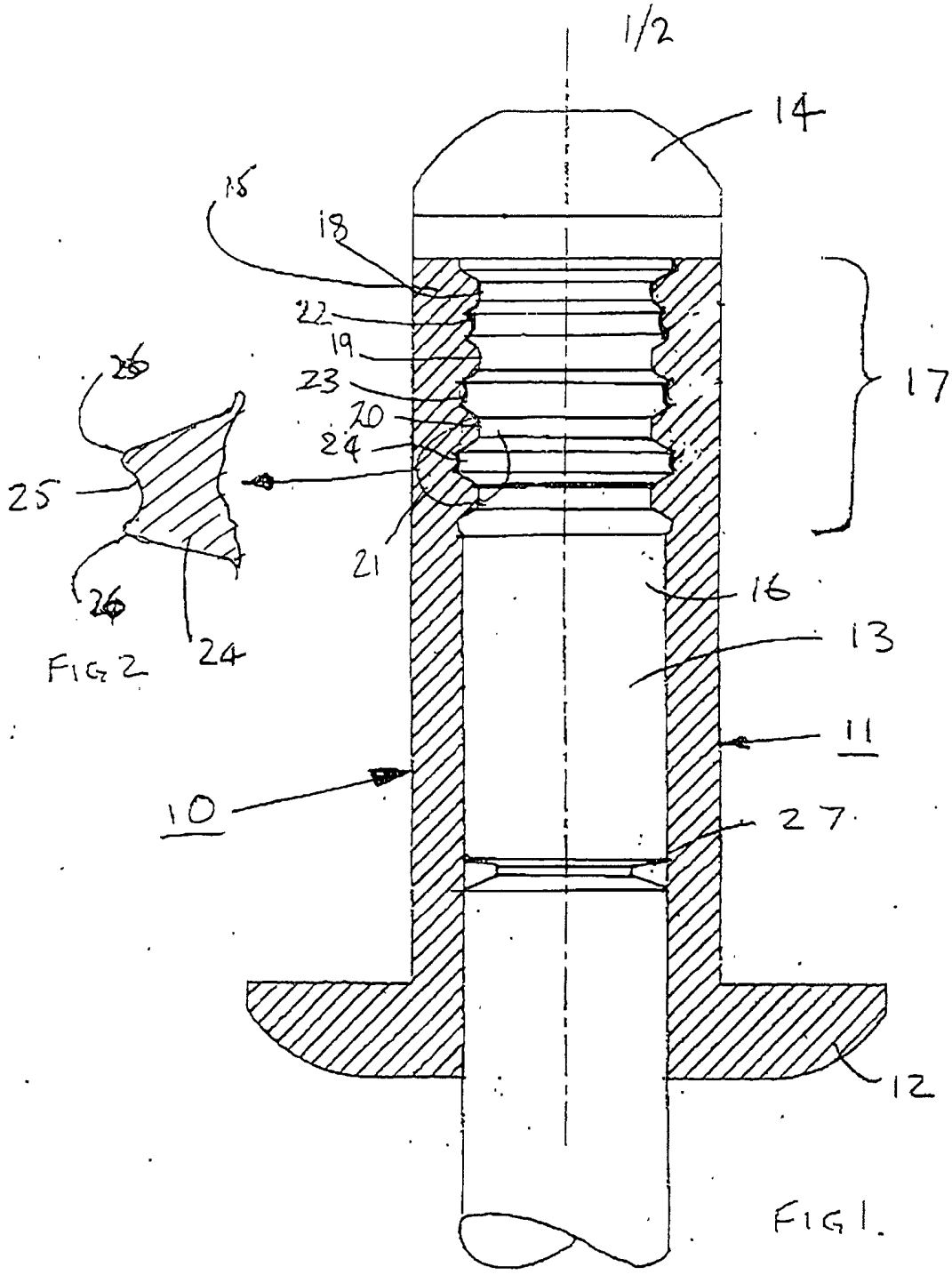

FIG 1.

FIG 2

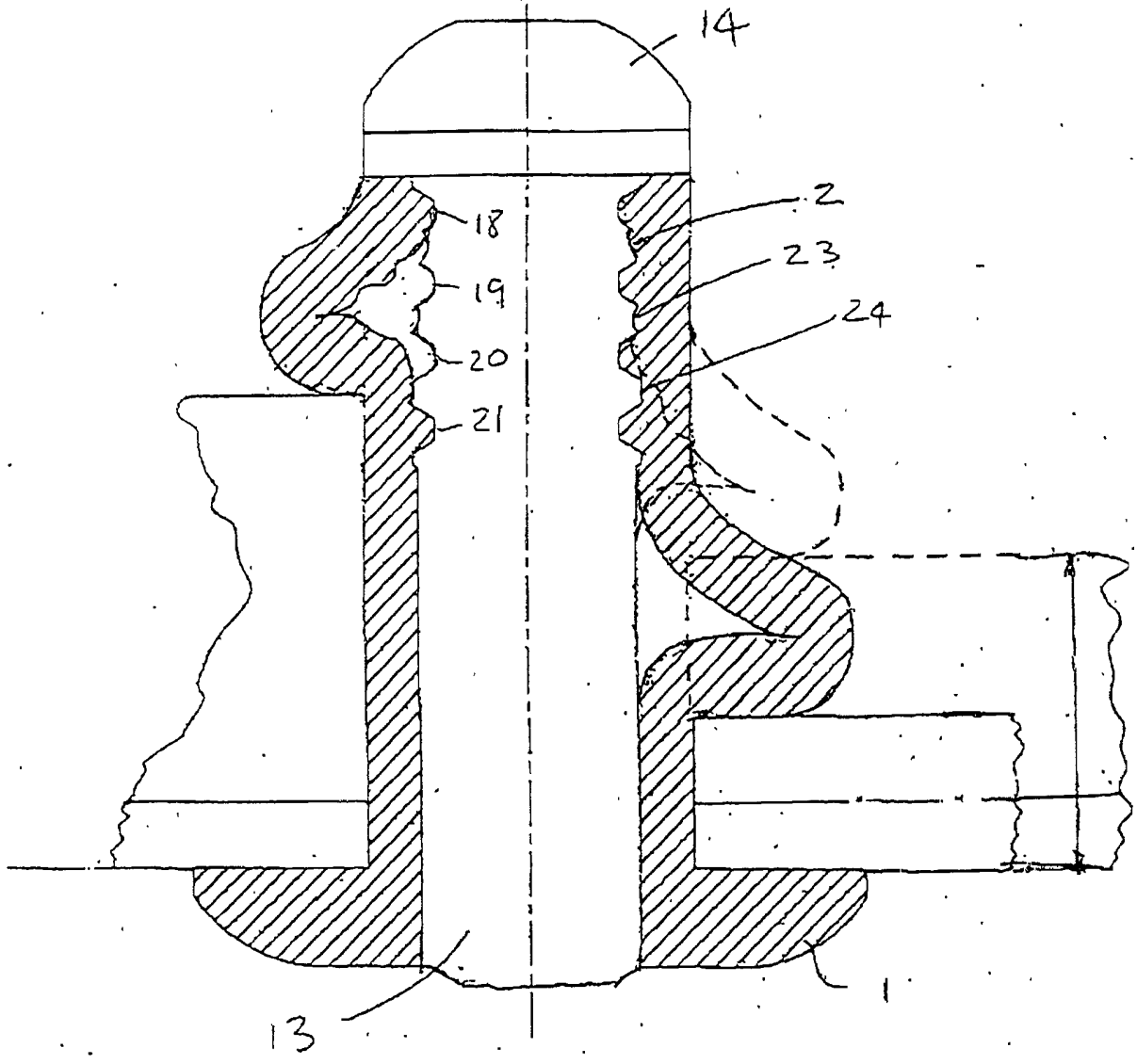

FIG 3.

A BLIND RIVET

This invention relates to blind rivets and is particularly concerned with improving the head retention and setting characteristics of a blind rivet.

Blind rivets are used for a variety of applications from the securing of thin sheets to the securing of relatively thick components to a variety of types and thickness of sheet materials. It is recognised that the blind rivet makes a considerable contribution to the strength and integrity of the resulting joint or fixing.

For instance if the workpiece sheets are slightly bowed the rivet is required to claim the sheets together. As well as high shear strength the rivet is expected to fill any clearance between the rivet body and the hole in the application, which will prevent the workpiece sheets from fretting under applied vibration, or oscillating applied loads. Also, it is commonly expected that rivets should have a roll-type bulged setting on the blind side of the workpiece giving increased tensile resistance.

Ideally the mandrel should also be break flush with the surface of the rivet flange on setting thus contributing to an increase in the shear resistance of the joint.

In order to achieve all these requirements especially with higher strength blind rivets the mandrel head should be fixed to the tail-end of the rivet body on assembly and remain during and after setting. Currently it is not possible to identify any prior known rivets that will give high joint integrity as well as providing a relatively wide grip capability especially with the more intractable rivet body materials such as steel.

There are many prior known means of attaching the tail-end of the rivet body to beneath the mandrel head during rivet assembly such that it remains attached even after setting, but each known solution has limitations when applied to high strength steel rivets.

Referring to US Patent 5,054,977 – (Automatic Fastener Corporation) there is shown a 'T-rivet' with a heavily grooved mandrel. Although this is a 'Peel-type' rivet there is no reason why the retaining mechanism should not be used with plain-

headed mandrels, for example in "non-Peel" versions. During setting of the rivet the mandrel shank with its various grooves is pulled into the nosepiece of the setting tool. As the mandrel head reaches the vicinity of the blind-side face of the workpiece, the rivet body is compressed between the head of the mandrel and the nosepiece of the setting tool. The setting load increases and rivet body material is displaced into a groove beneath the head of the mandrel and also into grooves adjacent to the breaker groove in the mandrel.

Since the mandrel head is not secured to the rivet body during manufacture, problems can occur with its anticipated retention. As the mandrel progresses down the rivet body, the rivet body material starts to be displaced inwardly against the raised edges adjacent to the grooves on the mandrel. Since the mandrel is still moving these edges on the mandrel act as a broach and cut progressively the rivet body material that is being pushed in towards the grooves in the mandrel. This broaching action prevents the displaced rivet body material from being remaining as a homogeneous material with the rest of the rivet body. Consequently the mandrel is not adequately secured.

Further, it can also be seen that the inward displacement of rivet body material is dependent upon workpiece hole size. If the hole is large or oversize compared with the diameter of the rivet body there is insufficient resistance to prevent the rivet body from expanding outwardly thus giving, at best, inadequate inwards material displacement of the rivet body material into the grooves of the mandrel resulting in increased broaching and debris in the grooves.

A further example of a retained mandrel is shown in British Patent 2,231,932 – (Milladale Ltd.). This shows a mandrel with grooves beneath its head. On assembly, the tail of the rivet body is swaged into these grooves and retains the mandrel in-place during manufacture. The patent describes how, as the mandrel stem is pulled to set the rivet, that part of the rivet body swaged to the mandrel beneath the mandrel head bulges, and begins to be forced outwards and out of engagement with the grooves in the mandrel stem. As the rivet body bulge process proceeds with setting, and the mandrel continues to move through the rivet body and the mandrel grooves

and the head of the mandrel then moves into engagement with the internal bulge bore diameter and is held in place.

Unfortunately, as in the previous mentioned prior art, the inwards movement of the rivet body material is completed before forwards movement of the mandrel ceases, and the rivet body bore is "broached" by the grooves on the mandrel and, therefore, will not be locked in-place. This is particularly so if the rivet body is made of steel and bulging is less pronounced than compared with, for example, aluminium. The subsequent release of strain energy, especially when setting steel rivets, is such that the mandrel head will tend to move away from the flange of the rivet body as there is insufficient engagement of mandrel with the body to prevent movement. The mandrel is, therefore, not retained in the rivet body shell.

Another type of grooving beneath the mandrel head is shown in US Patent 6,004,086 – (Avdel) that shows a "Christmas tree" type of grooving into which the tail end of the rivet body is swaged on assembly. The patent describes the mandrel as being retained in the rivet body after setting by virtue of the grooves, but fails to identify how this is achieved. As the rivet body is being set, the tail of the rivet bulges away from the mandrel and out of engagement with the grooves, except that the extreme tail portion which is held in the recess immediately beneath the mandrel head. This may be successful if the rivet body were of a soft material such as aluminium. Difficulties will arise, however, if the body of the rivet were made of steel since the higher setting loads employed will not be supported by the tail of the rivet and the mandrel head will pull-into the rivet body before setting is complete. Again the release of strain energy will promote backward movement of the mandrel head-shaft and leave a gap between the underside of the mandrel head and the tail of the rivet body.

A further prior known method of retaining the mandrel within the tail of the rivet body is shown in the now familiar "F" Series rivet manufactured and sold by Emhart Teknologies GmbH and described in European Patent 1,106,845. This patent shows a single but four-facetted recess beneath the mandrel head that has tapering sides inclined away from the head of the mandrel. It is into this recess that the rivet body tail end is formed in such a way that the tail end of the rivet body fills the recess and

results in a thickened wall section. The combination of the thickened wall and the work hardening of the rivet material at the tail end is designed to retain the mandrel in place during setting. In practice, however, the setting load for steel rivets is relatively high and as the maximum load is approached the end of the rivet body deforms and the internal bore (which is a four-facet shape) moves away from the tapered four-facet shape of the mandrel shank. Thus a gap appears between the tapering recess and the rivet body. As the mandrel breaks there is a release of strain energy and the head shaft of the mandrel is able to move backwards, closing the gap and causing the underside of the mandrel head to separate slightly from the tail of the rivet.

A further technique for retaining mandrels in rivet bodies is shown in European Patent 0,677,666 – (Avdel) which is representative of a rivet sold under their trademark "Stavex". The tail end of the rivet body is crimped into an elliptically shaped recess beneath the mandrel head. For rivet bodies made from carbon steel there has to be a compromise between the length of the crimped portion of the rivet body and the breaking load of the mandrel. Even taking into account the effect of work hardening of the crimped portion of the rivet shell that will increase the resistance to being displaced under the action of the setting load the length of the crimped portion is still relatively long. Thus the rivet body is longer for a given grip capability compared with conventional rivet construction as can be seen from the protruding portion of the rivet body that extends beyond the roll-type setting on the blind-side of the workpiece.

An object of the present invention to provide a rivet that incorporates a means for improving the retention of the mandrel head in the tail end of a high strength rivet body.

A further object of the present invention to provide a rivet that incorporates means for improving the retention of the mandrel head in the tail-end of a high strength rivet body over a wide grip range.

A further object is to provide a rivet with a substantially constant reduction in length during setting thus providing a flush break mandrel capability with high shear strength of the set rivet.

According to one aspect of the present invention as set out in the attached claims there is provided a rivet having a unique form of grooves and ribs beneath the mandrel head.

Preferably these ribs are so designed to be of different heights.

Since the external diameter of the rivet body is constant, it follows that the wall section at the tail of the rivet body will be progressively thicker along the body length towards its tail-end. Since this thickness is achieved during mandrel assembly, a beneficial increased hardness and, thus, increased resistance to compressive loading at the tail-end of he rivet body is achieved.

According to a further aspect of the present invention there is provided a method of manufacturing a blind rivet according to the attached method claims.

The unique shape of the ribs is achieved by rotary swaging, pressure forming, forging or rolling the grooves in accordance with the method claimed in the attached claims, and the unique shape of the ribs is due to the fact that the flow of displaced material from the mandrel stem during forming is greater along the flanks of the ribs than at the centre of the rib. This forms the ridges on each rib.

Using the claimed method the grooves are produced in blank mandrels by rotary swaging, pressure forming or rolling the stem of the mandrel This is particularly important when rivet body materials are from more the intractable materials such as steel because in order to set such rivets, the setting loads are high. These loads, however, must be supported by the end of the rivet and the resulting compressive stresses must be below the ultimate compressive stress of the rivet body material otherwise the rivet body material in engagement with the mandrel will rupture prematurely before the rivet is set correctly. This would lead to an undesirable situation where the mandrel would be loose and the formation of the blind-side roll-type setting incomplete. . This ensures that increased resistance to mandrel movement in the rivet body as the rivet is being set, particularly at the maximum setting load.

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which :-

Figure 1 is a cross-sectional side elevation of a rivet constructed in accordance with the present invention;

Figure 2 is an enlarged view of the grooves of the mandrel of the rivet of Figure 1; and

Figure 3 shows the rivet of Figure 1 in three different set positions.

Referring to Figure 1, the rivet 10 comprises a hollow generally tubular body 11, a head 12 and a central mandrel 13 extending through the centre of the body 11. The mandrel 13 has a head 14 at one end that abuts the tail end 15 of the rivet 10 and extends beyond the head 12 of the rivet 10 so as to be capable of being gripped in the jaws of a riveting tool (not shown).

The diameter of the stem 16 of the mandrel, over at least a region 17 adjacent the mandrel head 14, tapers towards the head 14 of the mandrel. This tapered region 17 is provided with a plurality of concentric grooves 18 to 20 spaced along its length. In accordance with the present invention, the grooves 18, 19, 20 define ribs 21, 22, 23 between the respective grooves 18, 19, 20 that have a special profile that is shown in greater detail in Figure 2.

Referring to Figure 2 each of the ribs 19, 20, and 21 have a concave shaped circumferential surface 24 subtended between two axially spaced ridges 25, 26. The outside diameter of the ridges 25, 26 decrease slightly due to the taper of the stem 16 but the diameter of the valleys of the grooves 18, 19, 20 are the same. It should be noted that there are three ribs 21 to 23, but there could be more or less grooves and ribs. It will be seen that the ribs 21 to 23 are of differing heights tapering from full height at rib 21 to the lower height at rib 23 with an intermediate height at rib 22. There is in effect an inward taper of the crests of the ribs 21 to 23 towards the head 14 of the stem 16.

The ribs 21 to 23 are formed as a result of rotary swaging, pressure forming, forging or rolling a mandrel blank in order to form the taper region 17 and the grooves 18 to 20, and this gives a unique shape to the crest of the ribs 121 to 23. The unique

shape of the ribs 121 to 23 is due to the fact that the flow of displaced material from the mandrel stem 16 during forming, is greater along the flanks of each of the ribs 12 to 23 than at the centre of each of the ribs 21 to 23. This forms the ridges 25, 26 whilst leaving the concave depression 24 on the outer diameter of each rib 21 to 23.

This is particularly important when rivet body materials are made from more the intractable materials such as steel because, in order to set such rivets, the setting loads are high. These loads, however, must be supported by the end of the rivet and the resulting compressive stresses must be below the ultimate compressive stress of the rivet body material otherwise the rivet body material in engagement with the mandrel 13 will rupture prematurely before the rivet is set correctly. This would lead to an undesirable situation where the mandrel 13 11would be loose and the formation of the blind-side roll-type setting incomplete. . This ensures that increased resistance to mandrel movement in the rivet body as the rivet 10 is being set, particularly at the maximum setting load.

The mandrel 13 is inserted into the bore of a hollow rivet body 11 with the head 14 of the mandrel at the tail end of the body 11 and the rivet body 11 is swaged down onto the mandrel 13 to a uniform outer diameter. This causes the rivet body 11 to have a greater wall thickness at the tail end15 than the rest of the body 11and therefore gives a greater resistance to compression loading when the mandrel 13 is pulled towards the head 12 of the rivet 10 during setting of the rivet 10. Also, by virtue of the rivet manufacturing process, the cold work done to achieve the thickened end will give a greater material hardness at that end thus further increasing resistance to compression loads. It can be seen that unlike conventionally grooved mandrels, the crests of the ribs 21 to 23 result in greater area of contact with the rivet body 11 and, therefore, gives a greater setting load carrying capability.

As the rivet 10 is being set in the conventional manner with the mandrel 13 being pulled and the flange 12 of the rivet being supported by the nosepiece of the setting tool (not shown), the setting load is applied via the mandrel head 14, the grooves 18 to 20 and the ribs 21 to 23 on the mandrel stem 16. This is shown in Figure 3 that also shows the distribution of the pulling load and the way the shape of the grooves 18 to 29 and the shape of the crest of the ribs 21 to 23 contribute to this

distribution. Figure 3 shows the rivet 10 set in maximum, minimum and intermediate grip thickness positions. In the maximum grip position, the rivet body 11 bulges in the region 17 of the grooved part of the mandrel 13. On commencement of setting, the rivet body 11will shorten in length to give good hole filling followed by the characteristic collapse to give a blind-side bulge. Since the end of the rivet body 11 is thicker in section than the rest of the body 11, the bulging or collapse of the rivet body 11 occurs nearer to the tail end 15 of the body 11 than other types of prior known rivets. Thus an increase of grip thickness can be obtained. It is also a benefit to have the mandrel head 14 and stem 16 retained after setting 11 by ensuring that the groove 21 nearest to the distal end of the rivet body 11 has rivet body material retained in that groove 21.

The intermediate and minimum grip thickness settings (shown dotted) show the mandrel head 14 and stem 16 remaining substantially in place after setting of the rivet by virtue of the rivet body 11 being substantially held in place in the grooves 21 to 23 adjacent the mandrel head 14.

It is due to the unique shape of the ribs 21 to 23 resulting from forming the grooves 18 to 20 that provides an increased resistance to the mandrel 13 being pulled into the rivet body 11 during setting of the rivet 10. Thus for rivet bodies 11 of higher strength materials such as steel, the interface between the mandrel 13 and rivet 11 will give good rivet hole filling and a wide blind-side roll-type setting. There is no disturbance of this locking mechanism subsequent from it's the original attachment of the mandrel 13 to the body 11 at the end 15 of the rivet body 11. It is this mandrel retention in the rivet body 11 that provides an enhanced shear resistance of the rivet over a wide grip range.

The mandrel 13 is provided with a recess 27 at a location along the length of the stem 15 corresponding to a position adjacent to where the head 12 of the rivet 10 would be after setting the rivet. The groove 27 provides a line of weakness that causes the mandrel stem 16 to snap off flush with the rivet head 12 when the rivet is set.

CLAIMS

1. A blind rivet comprising an elongate hollow rivet body having a head end and a tail end and an elongate mandrel having a head end located adjacent the tail end of the body, the mandrel having a stem extending through the hollow body and the stem having a tapered portion adjacent the head of the mandrel that tapers towards the head of the mandrel, and a distal end that projects beyond the head end of the body, the tapered portion of the stem being provided with a plurality of axially spaced grooves that define between them ribs that have a profile comprising two axially spaced ridges subtending a concave circumferential surface between the ridges, and said body being of substantially uniform outer diameter and having a thicker wall thickness over the region corresponding to the tapered section of the mandrel.

2. A rivet according to claim 1 wherein the grooves have valleys of a common diameter.

3. A rivet according to claim 1 or claim 2 wherein the thickness of a wall section at the tail end of the body is progressively thicker along the body length towards its tail-end.

4. A rivet according to any one of the preceding claims wherein the wall section of the tail end of the body is of increased hardness compared with that of the rest of the body thereby to provide increased resistance to compressive loading at the tail-end of he rivet body compared to the remainder of the body.

5. A method of manufacturing a blind rivet comprising the steps of :-

(a) providing an elongate hollow rivet body having a head and a tail end;

(b) providing a blank elongate mandrel having a head and a stem that has a tail end that, when attached to the body, extends beyond the head end of the body;

(c) providing the stem with a tapered region adjacent the head that tapers towards the head of the mandrel;

(d) working the mandrel at least in the tapered region to form grooves and thereby displace material of the stem radially outwards to form ribs between the

grooves that have two axially spaced ridges subtending a concave outer circumferential surface;

(e) inserting the mandrel through the hollow body so as to locate the head of the mandrel adjacent the tail end of the body and a distal end of the stem beyond the head of the body; and,

(f) cold forming the hollow body on to the stem to cause the material of the body to flow into the grooves, around the ribs and tapered portion, and form a region of substantially uniform outer diameter that has a thicker wall thickness over the region corresponding to the tapered section of the mandrel than the remainder of the mandrel.

Application No:	GB 0415961.2	11	**Examiner:**	Carsten Nielsen
Claims searched:	1-5		**Date of search:**	6 December 2004

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
A	-	US 3286580 A	(HARVEY PHILIP JEAL) See whole document, especially figures 4b, 4c
A	-	FR 1241123 A	(ROGER-HENRI GACHOT) See whole document and especially figure 9
A	-	US 3149530 A	(ROBERT F. KOLEC) See figures
A	-	US 6004086 A	(ANDREAS GAND ET AL) Cited in application

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[W]:

Worldwide search of patent documents classified in the following areas of the IPC[7]:

F16B, B21J, B21K

The following online and other databases have been used in the preparation of this search report:

WPI, EPODOC, JAPIO