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(54) SELF-LOCKING FASTENERS

(71) We, BAUER & SCHAURTE GmbH & Co. KG., a German Company of, Further Strasse 24/26, D–4040 Neuss/Rhein, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

The invention relates to self-locking fasteners, for example nuts, bolts, screws, and the like which have a part for engagement with a tool and which have a surface which in use lies adjacent to the work-piece on or in which the fastener is engaged, on which surface is a plurality of projections which, when the fastener is used, engage with the work-piece.

Many types of self-locking fasteners are known. The projections in these known types are generally in the form of a sawtooth corrugation, so that aftere tightening any tendency to turning loose in hindered by the sharp edges of these saw teeth engaging with the material of the work-piece in such a way that a "hooking together" takes place between the edges of the teeth and the material of the work-piece. Expressed in another way, the edges of the teeth engage with or cut into the material of the work-piece. By way of example attention is directed to German Auslegeschrift 1,090,468, particularly Figure 4, in which the condition described is clearly illustrated.

If such teeth in practice "hook in" to the material of the work-piece, there automatically results damage to the work-piece which is undesired for several reasons. For example, the strength of the work-piece can be decreased in indeterminate fashion and additionally swarf arises which can come to be in places at which it is undesired and which can even be a danger, for example in a gear housing of automobiles or the like.

It is also known (German Lay Open Print 2,306,087) so to construct ridges on the teeth that the depth of penetration of the teeth into the material of the work-piece is limited. According to German Lay Open Print 2,306,087 for this purpose the ridges of the teeth are slightly flattened, though the above-mentioned sharp edge is still present. This means that also in the fasteners disclosed in this literature citation, the previous principle of "hooking together" between the teeth and the material of the work-piece is maintained. The same goes for another known type (German Lay Open Print 2,308,557) according to which the shape of the teeth is either flattened as according to the previously noted citation or can be gradually rounded. Also here, the normal principle is maintained of creating the locking against self-generated loosening of the fastener by "hooking" between the teeth and the material of the work-piece.

It is an object of the present invention to provide a self-locking fastener which avoids the disadvantages of known types just described.

We have found that for guaranteeing sufficient locking against working loosening of a fastener it is not necessary to provide the aforementioned "hooking together". Rather it has been found that a sufficient locking against working loose, even after many times of tightening and untightening can be achieved if the part of the projections coming into engagement with the work-piece is rounded off in such a way that on turning the fastener even under any necessary preload, the projections slide over the surface of the work-piece without penetrating the work-piece. Expressed in another way, the invention provides a self-locking fastener such as a bolt, screw, or nut comprising a threaded part and a part capable of being engaged by a tool and a surface which, in use, faces towards a work-piece on which the fastener engages, said surface being substantially at right angles to the axis of the threaded part and having a plurality of rounded locking ribs having on their part engaging with work-piece at least one rounded portion, the arrangement being such that, on turning the fastener relative to the work-piece, the or a rounded portion of each rib slides over the surface of the work-piece, whereby, on tightening the fastener an essentially even strain hardening of the bearing surface of the work-piece adjoining the fastener is effected.

When the part of the projections which comes into engagement with the work-piece is shaped in the fashion according to the present invention, there arises on tightening the fastener an essentially even strain hardening of the total bearing surface of the work-piece adjoining the fastener. In contrast thereto, with the use of known self-locking fasteners, an irregular strain hardening arises, wherein at the places at which after tightening the teeth come to lie, a strain hardening is achieved, which is substantially greater than that of the places between the teeth. If such a known self-locking fastener is subjected to an exterior force in addition to the tightening force then the teeth are pressed deeper into the work-piece since the regions of the work-piece in the gap between adjacent teeth are up till then only slightly strain hardened and, on application of the additional force are brought to bear a load; the fastener "settles" into the work-piece. The fastener according to the present invention has the advantage in contrast thereto that the whole bearing surface of the work-piece is substantially evenly strain hardened, so that as a result, correspondingly higher loads are necessary in order to generate a settlement. The danger of settlement is accordingly correspondingly smaller when using the fastener according to the invention.

By "settlement" here is to be understood a loss of preload arising after the end of the tightening process as a result of flowing of the material of the work-piece subsequent to the initial tightening of the fastener.

A further advantage of the fastener according to the invention is that, on tightening, substantially less swarf is generated than with the known fasteners, since a hooking in and accordingly a penetration of projections on the fastener into the material of the work-piece, which would generate damage to the work-piece material, does not in practice take place.

The locking action of the fasteners according to the invention arise from the elastic-plastic deformations arising on tightening cause the arching of the work piece between the projections after the ending of the tightening process which archings give sufficient resistance against self-generated loosening.

Preferably the noted projections according to the invention are constructed as ribs. Various forms of these ribs are described in the following description.

A further important advantage which arises from the invention consists in the fact that a sufficient locking action is achieved even after many times of tightening and untightening particularly if the hardness of the ribs is substantially greater than the hardness of the work-piece to be fixed, for example if the work-piece consists of comparatively soft material.

The invention is illustrated by way of example with reference to the accompanying in which:

Figure 1 is a perspective part view of a fastener according to the invention in the form of a bolt,

Figures 2 to 8 show various embodiments of ribs on fasteners according to the invention.

In Figure 1 is a fastener in the form of a bolt is illustrated as an embodiment of the invention. This bolt has a head 1 with which a tool (not shown) can be engaged. On the underneath surface of the head i.e. on that surface which engages a work-piece, there are a plurality of ribs 2 which in the embodiment illustrated extend radially and in straight lines over the whole underneath surface or contacting surface of the head 1.

In Figures 2 to 6 various cross-sectional shapes of the ribs 2 are set out. These ribs are represented in partly developed form.

The ribs 2*a* according to Figure 2 have a substantially rectangular shape, in which the free edges are however rounded off to such a degree that on tightening a bolt, screw, nut or the like having such ribs on to a work-piece without penetrating into it, but thereby, with increasing preload generating an increasing and evenly resulting strain hardening of the material of the work-piece. Despite the ribs not penetrating the surface of the work-piece, the use of ribs 2*a* with the cross-sectional shape according to Figure 2 gives rise to sufficient locking against self-generated loosening.

In the embodiment according to Figure 3, the ribs 2*b* have a substantially semicircular cross-section, and the region of the head of the bolt between the ribs are curved and have a comparatively large radius with respect to the radius of the ribs.

In the embodiment according to Figure 4 the ribs 2*c* have an essentially trapezium shaped cross-section, wherein the free edges are rounded off to a sufficient extent that the above mentioned sliding action arises.

In the embodiment according to Figure 5 the ribs 2*d* have a cross-section in the form of an asymmetrical trapezium, the corners of which that are remote from the surface being rounded.

In the embodiment according to Figure 6 the ribs 2*e* have a cross-section which is defined by an asymmetric curve whose radius of curvature varies along its length.

The ribs illustrated in Figures 2 to 6 can project out from a flat plane 1 Alternatively, they can be connected with the surface and/or with one another by a curved surface.

In Figures 7 and 8 ribs 2*f* and 2*g* are illustrated which have a symmetrical shape in the form of an isosceles triangle whose apex is rounded off.

In practical tests it has been found that the

desired sliding action is obtained, for example with rib shapes according to Figures 7 and 8, if the rounding off radius at the part of the ribs coming into engagement with the work-piece is in the region of 0·15 to 0·17mm. The radius of the rib shown in Fig. 7 is 0·15 mm and of the rib shown in Fig. 8 is 0·17 mm. In this respect, various edge angles can be used in the range of from 50 to 120; and a rib height of, for example, 0·17 mm. By the term "edge angle" is the angle between two planes defining the rib.

It is to be stated that the rounding off radius of the parts of the ribs coming into contact with the work-piece is only critical insofar as it must be guaranteed that on turning the fastener relative to the work-piece the above mentioned sliding is obtained. Accordingly the values for the rounding off radius can be different from those given above, so long as the desired action is obtained. The same goes for the values given for the edge angles and for the height of the ribs. Also here, the values given are only examples used in practical tests.

It is further to be stated that the number of ribs used in any particular case depends on particular applications, particular requirements and the like. Generally it can be said that the number of ribs provided lies in the customarily used range. The ribs can further be present in an even distribution and arrangement. They can however in certain cases also be present in irregular distribution and arrangement.

WHAT WE CLAIM IS:—

1. A self-locking fastener such as a bolt, screw, or nut comprising a threaded part and a part capable of being engaged by a tool and a surface which, in use, faces towards a work-piece on which the fastener engages, said surface being substantially at right angles to the axis of the threaded part and having a plurality of rounded locking ribs having on their part engaging with the work-piece at least one rounded portion, the arrangement being such that, on turning the fastener relative to the work-piece, the or a rounded portion of each rib slides over the surface of the work-piece, whereby, on tightening the fastener, an essentially even strain hardening of the bearing surface of the workpiece adjoining the fastener is effected.

2. The fastener of claim 1, wherein the ribs formed on said surface facing a work-piece extend radially and in straight lines over at least part of the said surface.

3. The fastener of claim 1, wherein the ribs extend towards the outside of the surface along a curved path and extend over at least part of the said surface.

4. The fastener of any one of claim 1 to 3, wherein the cross-section of the ribs is generally rectangular, the corners of which that are furthest from the said surface being rounded off.

5. The fastener of any one of claim 1 to 3, wherein the cross-section of the ribs is essentially semicircular.

6. The fastener of any one of claim 1 to 3, wherein the cross-section of the ribs is in the form of a symmetric trapezium, the corners of which that are remote from the said surface being rounded off.

7. The fastener of any one of claims 1 to 3, wherein the cross-section of the ribs in the form of an asymmetric trapezium, the corners of which that are remote from the said surface being rounded off.

8. The fastener of any one of claim 1 to 3, wherein the ribs have a cross-section that is bounded by a curve whose radius of curvature changes along its length.

9. The fastener of any one of claims 1 to 3, wherein the cross-section of the ribs has the general shape of an isosceles triangle with a rounded apex.

10. The fastener of any one of claim 1 to 9, wherein the rounded parts of the ribs that come into engagement with the work-piece have a radius of curvature in the range of from 0·15 to 0·17 mm.

11. The fastener of any one of claims 1 to 10, wherein the ribs are each joined to the surface from which they project by curved surfaces.

12. The fastener of any one of claims 1 to 10, wherein the surface between adjacent ribs is curved.

13. A self-locking fastener substantially as hereinbefore described with reference to, and as shown in any of the accompanying drawings.

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3 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 1

Fig. 1

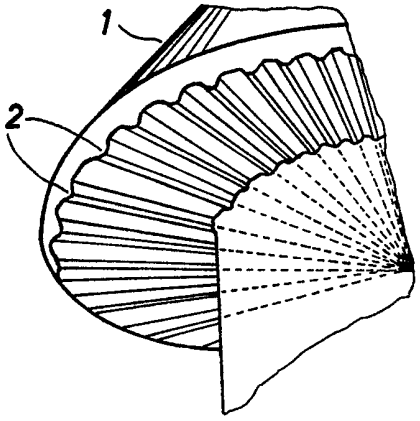

Fig. 2

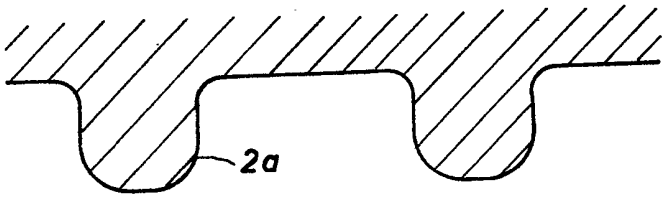

Fig. 3

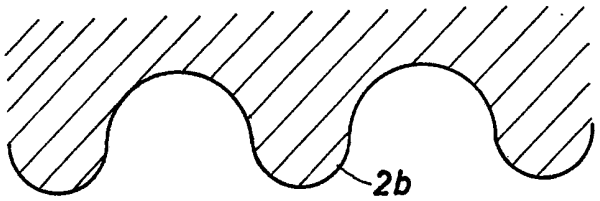

Fig. 4

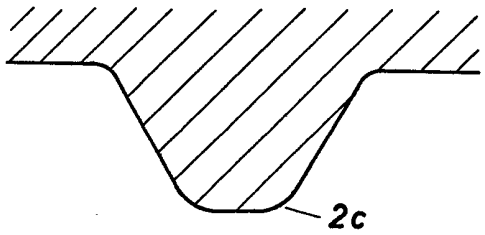

Fig. 5

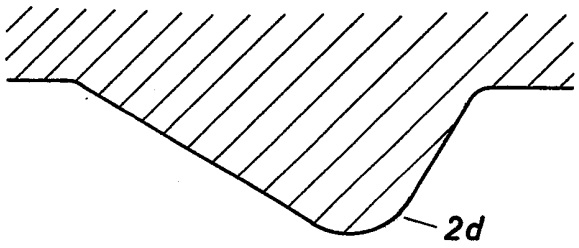

Fig. 6

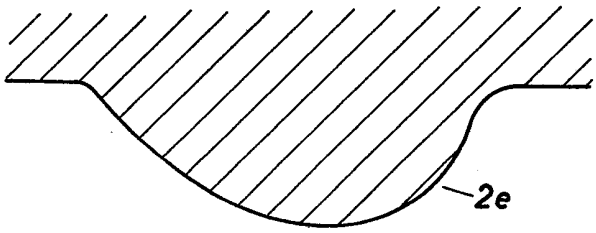

Fig.7

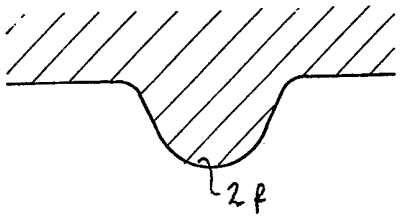

Fig. 8