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GB 1463496
GB 1208171
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(54) Torque limiting tamper resistant fastener

(57) A torque-limited one piece tamper resistant nut (12) has a driving portion (26) spaced radially from and extending circumferentially about a threaded body portion, and a plurality of spokes (38) interconnecting the two portions, which shear at a predetermined level of torque to enable the driving portion to separate from the body portion. The body portion has a smoothly contoured outer surface which renders the fastener-bolt assembly tamper-resistant. A driving tool (14) has projections (54) to engage in notches (29) in the driving portion (26) and a locating portion (56) to engage a guide portion (24) of the body portion (16).

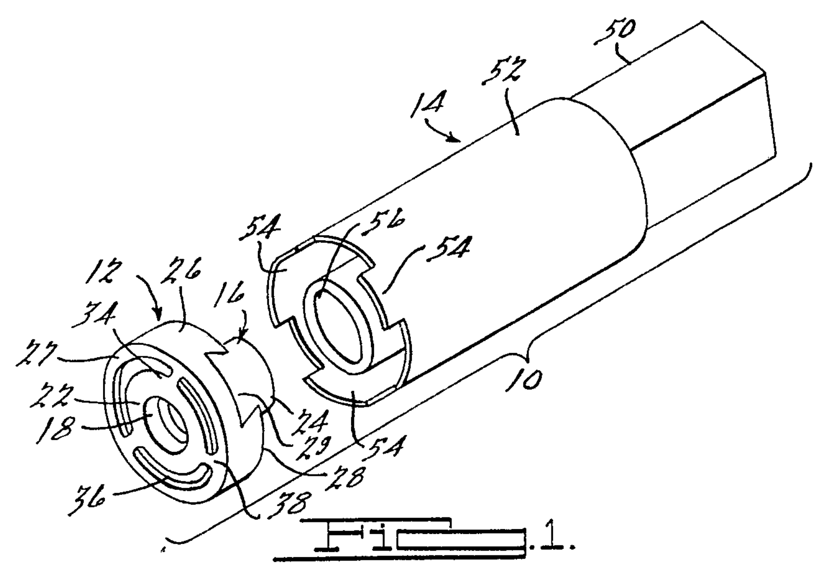

FIG.1.

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FIG. 3.

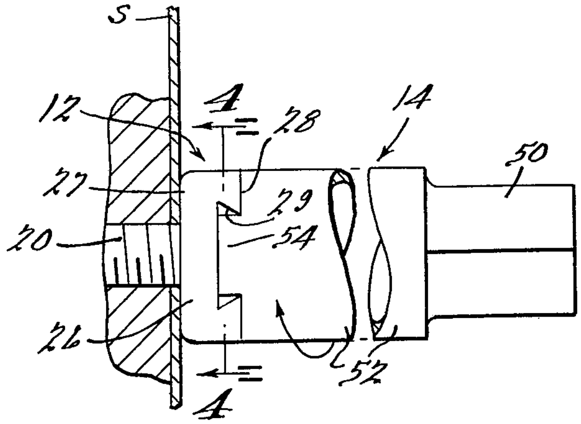


FIG. 5.

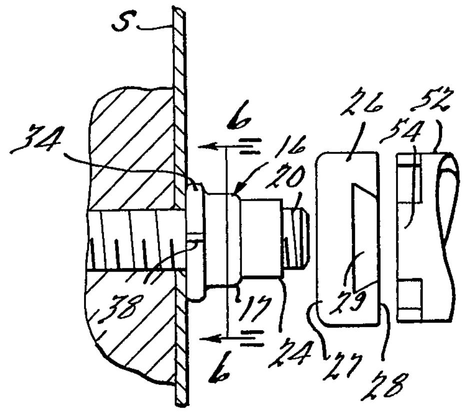


FIG. 4.

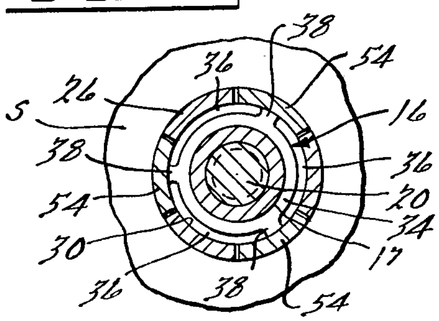


FIG. 6.

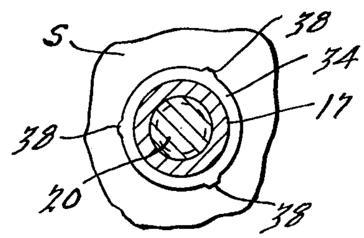
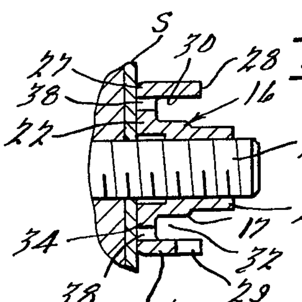


FIG. 2.



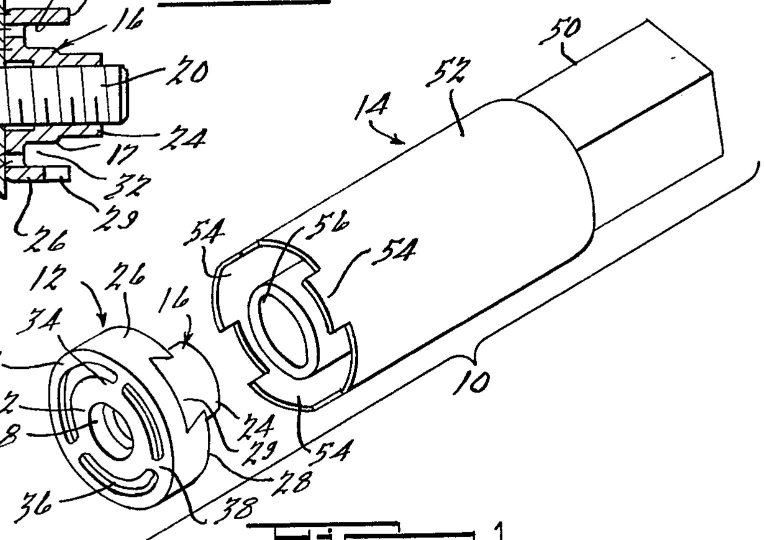


FIG. 1.

SPECIFICATION

Torque limiting tamper resistant fastener

The present invention relates to fasteners and more particularly to an inherently torque-limited one piece fastener having a threaded body portion surrounded by a driving portion which separates from the body portion upon the application of a predetermined torque. Removal of the driving portion leaves a threaded nut-bolt combination which cannot easily be tampered with thereafter.

Several approaches have been taken in providing inherently torque-limited fasteners, as well as fasteners which achieve a relatively tamper resistant assembly. However, prior known devices possess certain deficiencies and disadvantages which limit their utility. One known approach has been to provide a shear pin extending between a driving portion and a separate threaded driven portion and which shears under a given torque to enable the driving portion to thereafter move relative to the driven portion. However, fasteners of this type present cost and tolerance problems, since they require several separate pieces, including shear pins, as well as alignable pilot holes through which such pins must be inserted.

Another known type of torque-limited fastener includes a driving portion which is axially spaced from a threaded bolt engaging portion by an area of reduced wall thickness. This area defines either an internal or external circumferential groove which forms a shear plane. This plane will fail upon the application of a torque exceeding a predetermined level to enable the driving portion to separate from the threaded bolt engaging portion. However, fasteners of this type are generally fairly expensive to manufacture since they require careful control over machining operations due to the fact that their groove shapes must be machined to very close tolerances.

Another known torque-limited fastener includes an internally threaded driven body and a circumferentially extending driving ring. The driving ring and the body are connected by a full radially extending shear web which is designed to shear and separate the driving ring from the driven body upon the application of a predetermined torque. However, fasteners of this type possess the disadvantage of having a continuous uninterrupted shear web, which limits the choice of fastener materials when the fastener is designed to shear at low torque levels. More particularly, the physical properties of strong materials such as steel require a shear web which is too thin to be practicably formed if the fastener is designed to shear at a relatively low torque level.

A fastener which attempts to solve this problem is illustrated in U.S. Patent No. 3,449,998, wherein the material comprising the shear area is grouped at several spaced apart locations, each location being thicker than a continuously annular web designed to shear at the same torque level. This approach results in a fastener which can be made from strong materials, yet which can fail at low torque levels. However, fasteners of this type must be formed by several machining operations, and are therefore relatively expensive to manufacture.

It is, therefore, desirable to provide a one piece inherently torque-limited tamper resistant fastener which is relatively easy and inexpensive to manufacture. It is moreover desirable to provide such a fastener which can be made from relatively strong material, yet provide a low torque tamper-proof connection.

According to the present invention there is provided a nut or fastener adapted to be driven to an inherently limited predetermined level of torque, said fastener comprising a body portion having an axially extending bore provided with threads at least partially therealong to enable said body portion to engage a threaded bolt, a coaxial driving portion radially spaced from said body portion and having a driving surface thereon through which a torque may be applied to said fastener, and an annular flange extending radially between said body portion and said driving portion and having one or more circumferentially spaced apertures formed therethrough which define one or more circumferentially spaced radially extending shear sections therebetween, said shear sections being the weakest region of said fastener when under a torque condition, whereby said shear sections will fail upon the application of said predetermined level of torque to said fastener through said driving surface and said driving portion will separate from said body portion to prevent the transmission of a torque exceeding said predetermined level of torque to said body portion.

The preferred form of nut or fastener of the present invention includes an internally threaded body portion and a hollow cylindrical driving portion surrounding the body portion. The driving portion has a plurality of notches formed thereon which engage generally complementary shaped projections on a driving tool to enable the tool to apply a torque to the fastener through the driving portion. A plurality of shear spokes extend radially between the driving portion and the body portion to interconnect these two portions. The shear spokes transmit a torque from the driving portion to the body portion below a predetermined level of torque, which level is determined by the fastener material, as well as the thickness and number of the shear spokes. The spokes will fail in shear upon the application of a torque exceeding the predetermined level to enable the driving portion to move relative to the body portion and separate therefrom to prevent the transmission of a torque above the predetermined level to the threaded body portion. The driving portion may thereafter be removed, leaving the body portion assembled with a threaded bolt at the predetermined torque level. The body portion is of a generally smooth contour so that the resulting assembly is generally tamper proof. The fastener may be made as one piece in an easy and inexpensive stamping-punching operation. By suitable design and configuration of the shear spokes, a fastener wherein the driving portion will separate from the body portion at a relatively low torque level may be made from relatively strong materials.

The invention will become further apparent from a reading of the following description of a preferred embodiment which is given by way of example in the accompanying drawings, in which:

Figure 1 is an exploded perspective view of a fastener designed to effect a threaded connection set to a predetermined torque level, and a driving tool, in accordance with the present invention;

Figure 2 is a sectional view of the fastener as assembled with a workpiece and bolt prior to the imposition of the predetermined level of torque;

Figure 3 is an elevational view of the fastener and driving tool in a driving relationship;

Figure 4 is a sectional view along Line 4—4 of Figure 3;

Figure 5 is an elevational view of the fastener as installed at the predetermined level of torque with a workpiece and a bolt; and

Figure 6 is a sectional view of the fastener taken along Line 6—6 of Figure 5.

Referring now to the drawings, an inherently torque-limiting fastener incorporating the teachings of the present invention, as well as an accompanying driving tool, are shown in combination at 10. The fastener-tool combination 10 includes an inherently torque-limiting threaded fastener 12 and a driving tool 14, whose function and features will be described more fully hereinafter.

The fastener 12 includes an axially extending body portion 16 having a generally smoothly contoured outer surface 17 and an axial bore 18 extending therethrough. Bore 18 is provided with internal threads at least partially therealong to enable body portion 16 to threadably engage a threaded bolt or stud 20. One end of body portion 16 defines a base 22 which is adapted to engage the surface of a workpiece S upon assembly of the fastener 12 with bolt 20. The opposite end of body portion 16 defines a reduced diameter guide portion 24 which assists in properly locating tool 14 relative to the fastener 12, as described more fully hereinafter.

The fastener 12 also includes a hollow cylindrical driving portion 26 which is coaxial with and is spaced radially outwardly from body portion 16. As shown in Figures 1 and 2, driving portion 26 defines an annular workpiece engaging end 27 which is axially aligned with base 22. The opposite end 28 of driving portion 26 is provided with three circumferentially spaced driving notches 29, whose purpose and function are set forth below. The inner peripheral surface of driving portion 26 between ends 27 and 28 defines an inner wall 30 which cooperates with outer surface 17 of body portion 16 to define an axially extending well 32 therebetween. Disposed within well 32 is a flange 34 which extends radially thereacross between base 22 and inner wall 30 adjacent end 27 of driving portion 26. As shown in Figures 1 and 4, flange 34 has three circumferentially extending apertures 36 formed therein. These apertures 36 effectively define three circumferentially spaced shear spokes 38 which extend radially outwardly from base 22 across well 32 to inner wall 30 for connecting driving portion 26 with body portion 16.

The driving tool 14 utilized to drive the fastener 12 is shown in Figures 1 and 3. The tool 14 includes a gripping portion 50 adapted to be received and turned by a powered rotary driver (not shown). Formed integrally with gripping portion 50 is an elongated hollow cylindrical driver 52 having a mean diameter and radial thickness substantially equal to that of driving portion 26. Driver 52 includes three integral circumferentially extending projections 54 formed at one end and which extend axially therefrom. These projections 54 are suitably shaped and spaced circumferentially above driver 52 to enable them to matingly engage driving notches 29 and create an operative connection between driver 52 and driving portion 26 for applying a torque to the fastener 12. Disposed within the driver 52 is a coaxial hollow cylindrical locating portion 56 having an internal diameter which enables it to receivably engage guide portion 24 of body portion 16 to insure that the tool 14 is properly located relative to the fastener 12 and retained against slippage during powered operation of the tool 14. In the preferred embodiment of the invention, the possibility of tool slippage is further reduced by forming each driving notch 29 in driving portion 26 in the shape of a dove-tail recess. This configuration results in an improved wrenching characteristic which enhances retention of projections 54 with driving notches 29.

To utilize the fastener-tool combination 10, the fastener 12 is threaded onto a bolt 20 which has been preassembled with a workpiece S. The tool 14 is thereafter operatively connected with the fastener 12 by rotating the tool 14 to effect a proper angular alignment of the driver 52 for enabling axial advancement of the tool 14 for insertion of the projections 54 into driving notches 29, as well as engagement of locating portion 56 with guide portion 24. The tool 14 and the fastener 12 may thereafter be turned by a powered rotary driver.

As is readily apparent, the operative engagement of projections 54 with driving notches 29 enables the torque generated by the rotary driver to be transmitted through driving portion 26 and shear spokes 38 to the body portion 16-bolt 20 assembly. However, when the value of torque to which the fastener-bolt combination is subjected reaches a predetermined level, determined by the material properties and dimensions of shear spokes 38, the shear spokes 38 will fail, thereby breaking the connection between driving portion 26 and body portion 16. Driving portion 26 will thereupon separate from body portion 16 and move relative thereto to prevent a torque exceeding the predetermined level from being transmitted to the fastener-bolt combination. As shown in Figures 5 and 6, driving portion 26 may thereafter be removed, leaving a resulting assembly as shown. As can be seen, this assembly provides a visual indication that the assembly has been torqued to the predetermined level. Moreover, the smoothly contoured outer surface 17 of body portion 16 provides an assembly which is virtually tamper proof.

The advantages of the present invention include the fact that it provides a fastener wherein the torque applied to the resulting fastener-bolt combination can be readily controlled in a simple and efficient manner. The amount of torque applied to the assembly can be controlled by the selection of fastener material, the size of apertures 36, and the dimensions and number of shear spokes 38 disposed within well 32. While the preferred embodiment of the invention is provided with three such shear spokes 38, it is readily apparent that the number of spokes may be varied in accordance with desired torque limits and properties of the material selected for fastener 12.

The design of the fastener 12 also makes it possible to concentrate shear material within shear spokes 38 to provide a shear area with a thickness adequate to accommodate relatively strong fastener materials in a fastener having a relatively low predetermined torque limit. As previously noted, this advantage is unavailable when using strong materials in a fastener having an uninterrupted reduced section which fails in shear, since an uninterrupted shear area would require a section thickness too thin to be feasibly manufactured to meaningful tolerances.

The design of the fastener 12 further results in an improved one piece inherently torque-limiting fastener which can be made with simple and economical manufacturing methods. Specifically, the basic fastener profile, including the body portion 16, driving portion 26 and flange 34, can be formed in a simple stamping operation. Moreover, the apertures 36, and resulting shear spokes 38, can be formed in a punching operation by axially advancing a suitably shaped punch through well 32 and into engagement with flange 34. As is readily apparent, this method of forming a shear structure wherein the shear material is grouped in a plurality of circumferentially spaced locations possesses distinct cost advantages over previous more intricate machining operations.

CLAIMS

1. A fastener adapted to be driven to an inherently limited predetermined level of torque, said fastener comprising a body portion having an axially extending bore provided with threads at least partially therealong to enable said body portion to engage a threaded bolt, a coaxial driving portion radially spaced from said body portion and having a driving surface thereon through which a torque may be applied to said fastener, and an annular flange extending radially between said body portion and said driving portion and having one or more circumferentially spaced apertures formed therethrough which define one or more circumferentially spaced radially extending shear sections therebetween, said shear sections being the weakest region of said fastener when under a torque condition, whereby said shear sections will fail upon the application of said predetermined level of torque to said fastener through said driving surface and said driving portion will separate from said body portion to prevent the transmission of a torque exceeding said predetermined level of torque to said body portion.

2. A fastener as claimed in claim 1, wherein said driving portion is spaced radially outward from said body portion.

3. A fastener as claimed in claim 2, wherein said driving portion comprises a hollow cylindrical member with said driving surface being disposed at one end thereof.

4. A fastener as claimed in claim 2 or 3, wherein said body portion has a workpiece engaging base portion at one end thereof, said driving portion comprises an axially extending hollow cylindrical member, and said flange extends radially between said base portion and one end of said cylindrical member.

5. A fastener as claimed in claim 4, wherein said driving surface is disposed at the end of said cylindrical member opposite said one end.

6. A fastener as claimed in claim 5, wherein said driving surface comprises one or more notches in said cylindrical member which are adapted receivably to engage a like number of complementary shaped projections on a driving tool to turn and apply a torque to said fastener in use thereof.

7. A nut comprising a body portion having an internally threaded axial bore for receivably engaging a threaded bolt, a coaxial hollow cylindrical driving portion spaced radially outward from said body portion and having an inner wall which cooperates with the outer surface of said body portion to define an axially extending well therebetween, and a plurality of elongated connecting members disposed within and extending radially across said well for interconnecting said body portion and said driving portion and transmitting a torque below a predetermined torque level from said driving portion to said body portion, each of said plurality of connecting members being adapted to fracture at said predetermined torque level to enable said driving portion to separate from said body portion in order to prevent the transmission of a torque above said predetermined torque level to said body portion.

8. An inherently torque limiting tamper resistant fastener having a smoothly contoured body portion which includes a threaded axial bore for engaging a threaded bolt and a driving portion through which a torque is applied to the fastener and which is interconnected with the body portion by a shear section which is the weakest region of the fastener when under a torque condition and which yields upon the application of a predetermined level of torque to enable relative

movement between the driving portion and the body portion, said driving portion comprising a hollow cylindrical member spaced radially outward from said body portion and said shear section comprising a plurality of shear members extending radially between said body portion and the inner wall of said cylindrical member and cooperating to interconnect said cylindrical member with said body portion below said predetermined level of torque, but which yield at said predetermined level of torque to enable said relative movement.

9. A fastener as claimed in claim 8, wherein each of said plurality of shear members fails at said predetermined level of torque to enable said cylindrical member to separate from said body portion.

10. A fastener or nut as claimed in any preceding claim, in combination with a driving tool for applying a torque thereto and comprising a working portion having one or more projections thereon engageable with the nut or fastener and a mating portion which cooperates with said body portion properly to house said working portion for proper engagement of the or each projection with the nut or fastener for application of a driving torque thereto.

11. A device for applying a predetermined level of torque to a nut-bolt combination, said device comprising an inherently torque limiting nut, said nut including an axially extending shank having a guide portion at one end thereof and an axial bore which is at least partially threaded for engaging a threaded bolt, a coaxial hollow cylindrical driving portion spaced radially from said shank and including one or more circumferentially spaced driving notches at one end thereof, said shank and said driving portion being interconnected by a plurality of shear members extending radially between said shank and said driving portion and which fail upon the application of said predetermined level of torque to enable relative movement between said shank and said driving portion to prevent the transmission of a torque exceeding said predetermined level to said nut-bolt combination, said device further comprising a driving tool for applying a torque to said nut, said tool including a working portion having one or more projections thereon which are engageable with said driving notches on said driving portion and through which a torque may be applied to said driving portion, and a mating portion which cooperates with said guide portion of said shank to properly locate said working portion for engagement of said projections with said driving notches.

12. A device as claimed in claim 11, wherein said working portion comprises an elongated hollow cylindrical driver having a mean diameter and a radial thickness substantially equal to said driving portion with said projections being disposed circumferentially about one end thereof and extending axially therefrom, and each of said driving notches comprises a circumferentially extending recess formed at said one end of said driving portion and adapted to receivably engage one of said projections upon axial advancement of said tool toward said fastener.

13. A device as claimed in claim 12, wherein each of said driving notches is formed in the shape of a dove-tail recess.

14. A device as claimed in claim 12 or 13, wherein said guide portion comprises a generally cylindrical outer surface and said mating portion of said tool comprises an elongated hollow cylindrical tube disposed within and coaxial with said cylindrical driver and which receivably engages said outer surface of said guide portion for properly locating said cylindrical driver with respect to said driving portion for engagement of said projections with said driving notches as said tool is advanced axially toward said fastener.

15. A fastener or nut constructed and arranged to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

16. A fastener or nut as claimed in claim 15, in combination with a driving tool substantially as herein described with reference to and as illustrated in Figures 1, 3 and 4 of the accompanying drawings.

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