The use of two nuts to prevent self loosening

By Bill Eccles, Bolt Science

Many types of old machinery have two nuts on the bolts. A thin nut is frequently used in these applications. Sometimes the thin nut can be observed on top of a standard thickness nut **(figure 1)** and on other installations, it's next to the joint, under the thick nut **(figure 2)**.

Although it may seem counter-intuitive, the thin nut should go next to the joint and not be put on last. In other applications, for example on column attachments, two standard thickness nuts are frequently used. In this article I investigate the effectiveness of this locking method and discuss the tightening procedure that should be used if effective locking is to be achieved.

Figure 1 - Thin nut on top of a thick nut.

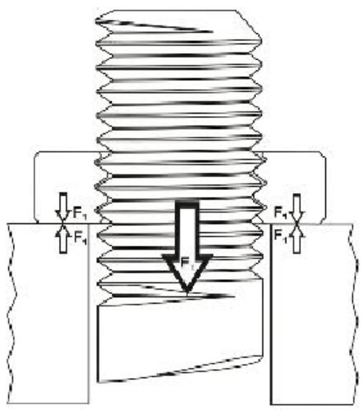
Figure 2 - Thin nut placed next to the joint.

The use of two plain nuts goes back at least 150 years based upon observation of historic machinery. Tightening one nut down and then simply tightening another nut on top of it achieves little locking effect. A specific procedure needs to be followed if locking is to be achieved. When a thin and thick nut are used, it may be thought that the thick nut should go next to the joint since this would take the entire load. However, by placing the thin nut on first, when the thick nut is tightened on top of it, the load on the threads of the thin nut are relieved of their load. What follows is an explanation as to why such a procedure is effective in resisting self-loosening, whereas just tightening a thin nut on top of a thick nut is not effective.

The thin nut should be placed on the bolt first. This nut is typically tightened to between 25% to 50% of the overall tightening torque. The second (thick) nut is then placed on the bolt and the thin nut held to prevent rotation by a spanner whilst the thick nut is tightened to the full torque value. A series of diagrams, **figures 3 to 5** show the effect that the procedure has on forces present between the nuts and in the bolt.

When the thick nut is tightened onto the thin nut, as the load increases, the load is lifted from the pressure flanks of the thin nut. As tightening continues a point is reached when the bolt thread touches the top flanks of the thin nut. At this point F3 = F2. Continuing to tighten the top nut results in the jamming of the threads leading to F3 > F2. This is shown in **figure 4**. If tightening is continued, the force between the two nuts will continue to increase. If the thick nut is overtightened, there is the risk of thread stripping or the tensile fracture of the bolt between the two nuts.

Figure 3 - Small nut is placed on the bolt - The first stage involves tightening the small nut onto the bolt. The small nut is typically tightened to between 25% to 50% of the overall torque value. This torque generates a force of F1 in the bolt that the nut reacts onto the joint.



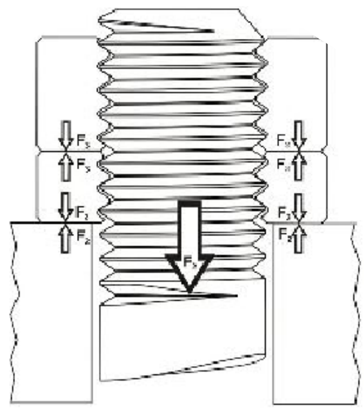
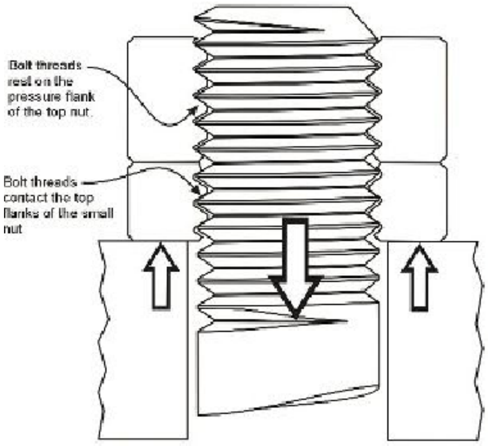


Figure 4 - Thick nut is placed over the thin nut - The next stage involves holding the small nut with a spanner to prevent its rotation whilst tightening the thick nut on top of it to the full torque value. This generates a force F2 in the bolt that is reacted through the small nut and into the joint.

The reason why the two nut system is effective in resisting self loosening is due to the way the threads are jammed together (hence the term jam nut being frequently used for the thin nut). Since the bolt thread is in contact with the top flank of the small nut and the bottom flank of the top nut, relative thread movement is not possible. This is illustrated in **figure 5**. For self-loosening to occur, relative movement between the bolt and nut threads must occur. It is this jamming action that is the secret of the two-nut method.

In order to achieve the appropriate bolt preload prior to the threads jamming it is necessary to tighten the smaller nut. The greater the grip length of the joint, the greater is the extension needed to achieve a given preload and hence the higher the initial load that must be sustained by the small nut. Although the axial backlash can be calculated for given tolerance conditions of the nut and bolt threads, there can be a factor of 10 difference between the minimum and maximum values. Such variation makes it difficult to establish the correct preloading of the small nut. As a result, the bottom nut is tightened to a simple percentage (i.e. 25% to 50% of the overall torque value). Two full height nuts can be used if the principles that have been outlined above are followed. Small (jam nuts) are frequently used since there is no need to have a full height nut on the

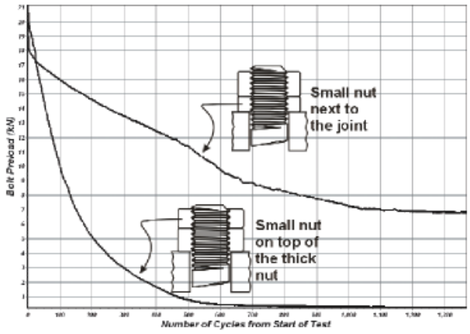
Figure 5 -
The two nuts jammed together



bottom since the threads do not carry the load. An advantage of a thin nut in this application is that a greater amount of axial backlash will be provided for a given tolerance class.

A series of tests were conducted to investigate the effectiveness of the two-nut method in terms of resistance to self-loosening. A Junker transverse vibration test machine was used with M10 nuts and bolts. The results are illustrated in **figure 6**. With the small nut on top, both nuts can be observed to rotate together and can subsequently come completely loose. The results are slightly better than is normally observed with a single plain nut. With the small nut next to the joint, some relaxation occurs but not a significant amount of self-loosening. The performance of the two-nut method, when properly applied, provides a superior locking capability when compared to many so-called lock nuts. The proper application of the two-nut method is time intensive and requires a degree of skill and is hence unlikely to make a major comeback on new machinery any time soon.

Figure 6 -
Results of a Junker Transverse Vibration Test



Bill Eccles is a Chartered Engineer and formed his company Bolt Science some 16 years ago to specialise in bolting technology. The company writes and markets bolted joint analysis software together with completing consultancy assignments and training courses.

Further information is available from Bill via email **(bill.eccles@boltscience.com)** or from the website **www.boltscience.com**