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(54) Hydraulic tensioning nut

(57) A hydraulic tensioning nut includes a stack of compressible Belville washers 12, on which a piston 2 acts and which fits freely about an externally screw-threaded part 19 of an article 21 to which the nut is applied for use. The washers 12 are compressible to a limited extent under hydraulic pressure applied between a body 1 and piston 2, but resist further compression when the applied pressure exceeds a predetermined value. The initial effect of applied hydraulic pressure, while the compressible means compresses, is for equal and opposite reaction to the force at the screw-threaded part. As the predetermined value is exceeded and the washers 12 resist further compression loading, tensioning of the screw-threaded part 19 increases. Retention means, e.g. shims 17 or a collar 18, is then applied to hold the screw-threaded part 19 tensioned when the hydraulic pressure is removed. The arrangement reduces load loss on the screw-threaded part when the hydraulic pressure is removed, enhancing security of the nut. Screws (35, Fig 4) in tapped holes (34) extending through the body to the piston 2 can be tightened onto the piston 2 to urge the body 1 and piston 2 apart mechanically if hydraulic pressure cannot be supplied between them.

FIG. 1.

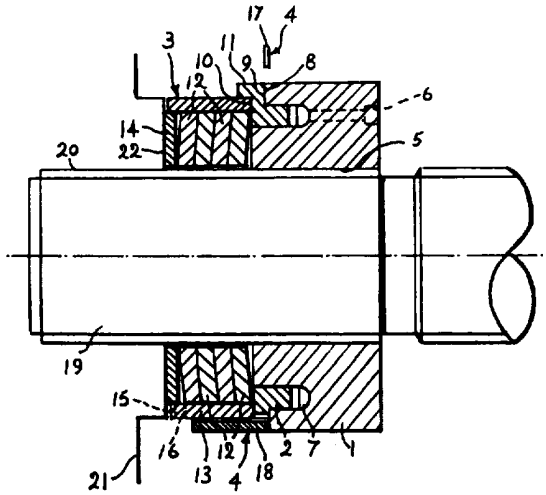

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FIG. 1.

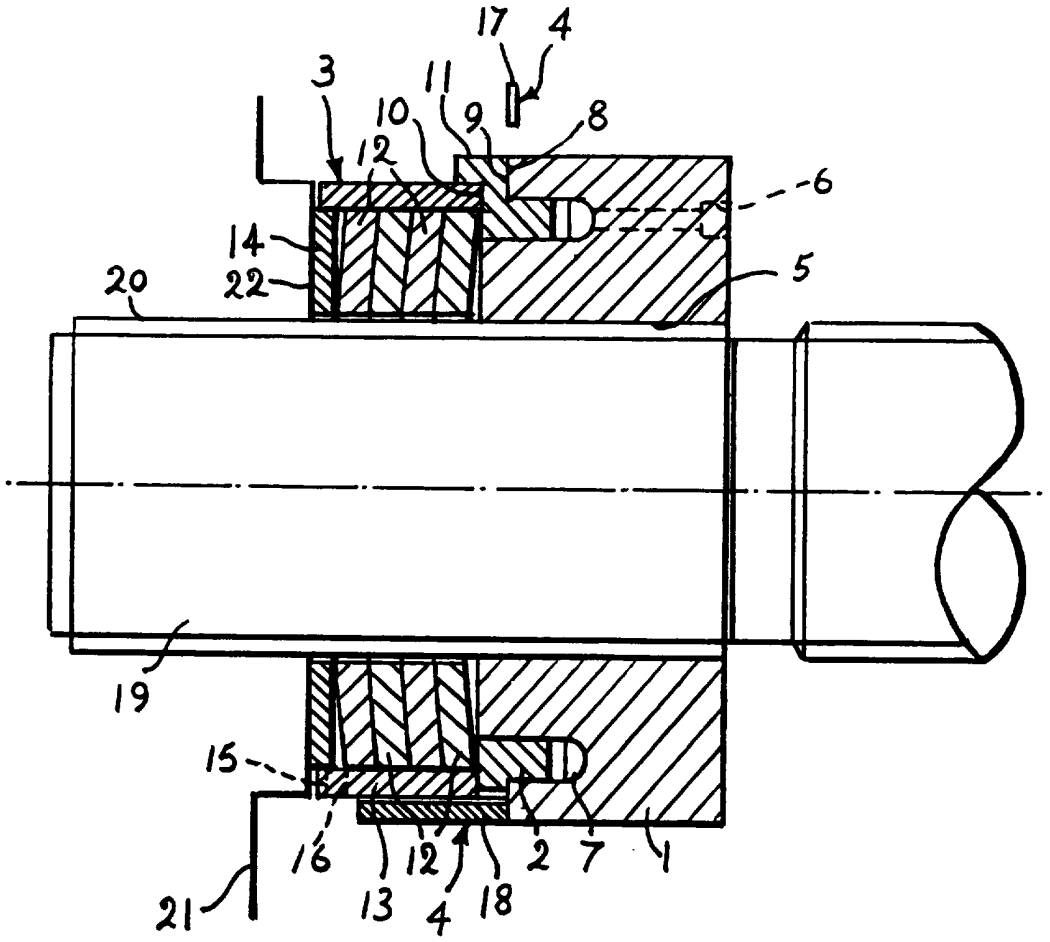


FIG. 2.

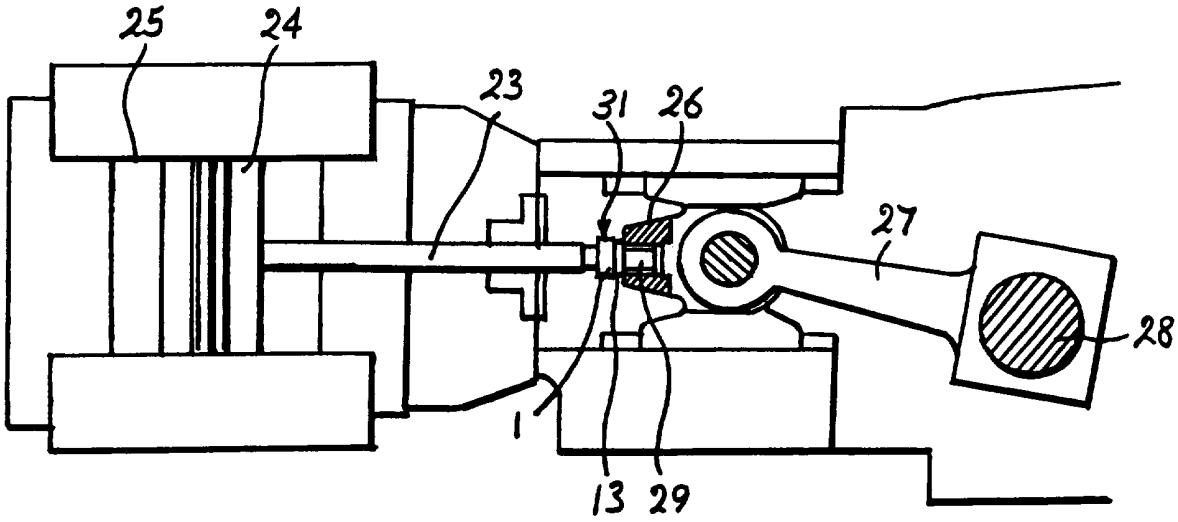


FIG. 3.

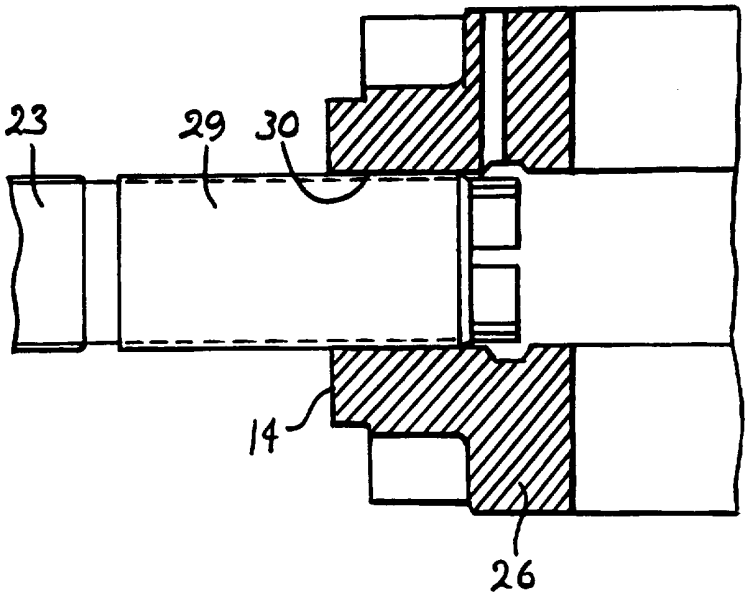
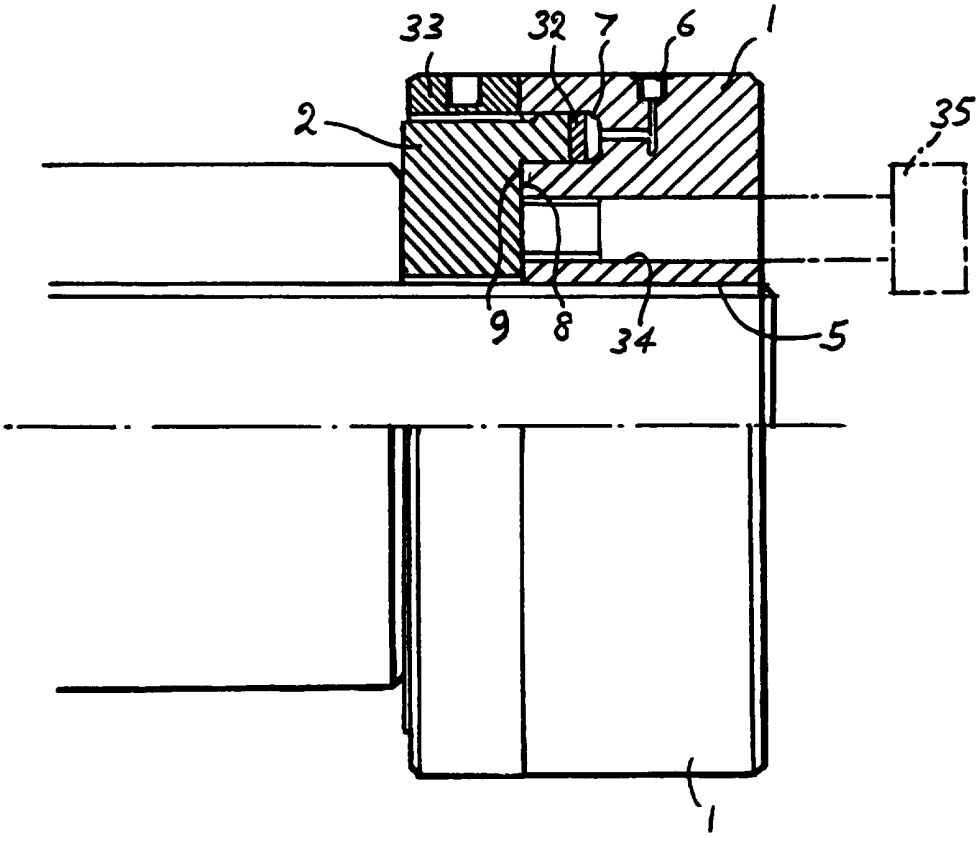


FIG. 4.



HYDRAULIC TENSIONING NUT

This invention relates to a hydraulic tensioning nut for application to an externally screw threaded part of an article, such as a bolt or stud, to enhance the security of a joint made with the article.

More particularly the invention relates to a hydraulic tensioning nut of the kind comprising an internally screw-threaded body which screws onto a complementary externally screw-threaded part of an article, an annular piston co-axial with the body which is adapted to fit freely around the screw-threaded part, is connected to the body for relative axial movement therebetween and between which and the body hydraulic pressure is arranged to be applied to urge the body and piston apart, and retention means operable to retain the body and piston in the relative positions to which they have been urged when the hydraulic pressure is removed, the arrangement being such that in use of the nut to secure the article to another item in which the screw-threaded part of the article is engaged, the body is screwed onto the screw-threaded part adjacent to the item, with the piston towards the item, until the piston acts on the item, hydraulic pressure is then applied between the body and piston which urges the body away from the item and thereby tensions the screw-threaded part, and the retention means is operated to hold the screw-threaded part so tensioned when the hydraulic pressure is subsequently removed. Such a hydraulic tensioning nut is hereinafter referred to as "of the kind described".

The hydraulic pressure applied is controlled to cause the screw-threaded part of the article to be tensioned to a pre-determined extent by the nut. There

may be some elongation of the tensioned screw-threaded part and/or deformation of one or both of the engaged threads of the screw-threaded part and the body of the nut. Usually some load loss (or load transfer) in the tensioning of the screw-threaded part occurs when the hydraulic pressure is removed and the nut, or other bearing pad or the washer on which the piston acts, beds onto an adjacent surface of the item. The extent of the load loss is a function of the diameter of the screw-threaded part and the grip length between the body of the nut and the screw-threaded part.

A problem experienced with known hydraulic tensioning nuts of the kind described has been the extent of the load loss when there is only a short grip length. The present invention seeks to overcome, or at least reduce, this problem.

According to the present invention a hydraulic tensioning nut is provided of the kind described including compressible means on which the piston acts and which is adapted to fit freely about an externally screw-threaded part of an article to which the nut is applied for use, the compressible means being compressible to a limited extent under hydraulic pressure applied between the body and piston but resisting further compression when the applied pressure exceeds a predetermined value.

When the nut is applied to a complementary externally screw-threaded part of an article engaged in an item so that the compressible means bears on the item, and the hydraulic pressure is applied, the initial effect is for the load to be exerted on the compressible means which compresses, and there is an equal and opposite reaction to the force at the

screw-threaded part. As the hydraulic pressure increases and exceeds the predetermined value further compression is resisted at the compressible means and the loading and tensioning of the screw-threaded part increases until the maximum hydraulic pressure has been applied. The retention means is then applied to retain the screw-threaded part tensioned when the hydraulic pressure is subsequently removed.

In consequence load loss on the screw-threaded part is reduced when the hydraulic pressure is removed from the nut and enhanced security of the nut on the screw-threaded part achieved. It has found that improved security can be obtained even when there is a short grip length between the body of the nut and the screw-threaded part.

The compressible means may take various forms. In a preferred form it comprises one or more disc springs, for example of the conical kind known as Belville washers, which deflect under applied compressive loads. Usually two or more such disc springs will be provided in a stack. The stack of disc springs may be contained, with at least one bearer pad, washer or the like, if provided, in a rigid sleeve of shorter length than the stack of disc springs in their unloaded state, or than the disc springs and bearer element. As load from the hydraulic pressure is exerted on the stack of disc springs they become compressed until the stack, or stack and bearer element, is or are fully received into the sleeve. The load is then taken by the sleeve which is incompressible under the range of hydraulic pressures under which the nut is designed to operate. Once the sleeve takes the load the body also transfers load to the screw-threaded part to which the nut is fitted for use so that the screw-threaded part is

tensioned. In another form the compressible means may comprise one or more elements of a compressible material, such as a suitable rubber or synthetic rubber material, which may be suitably contained in a rigid sleeve, or contain one or more rigid components, by which the load is taken when a given extent of compression of the compressible element or elements has occurred. Yet another possibility is for the compressible means to comprise a helical compression spring which resists further compression when it has been subjected to a given level of loading.

The retention means of the nut may comprise one or more shims which insert between the body and the piston. An alternative is for the retention means to comprise a collar on the piston which is movable relative to the piston to engage with the body and is held securely in any position to which it is moved for engagement with the body.

A hydraulic tensioning nut in accordance with the present invention may be used with a stud or bolt for various applications. It may be used with other articles having an externally screw-threaded part which is to be secured to an item, or to have an item secured to it such as, for example, tie or connecting rods. The nut may be used to provide added security of connections of, or associated with, moving parts of mechanisms so as to resist loosening of the connections under the loads and stresses of the movement. The invention is particularly advantageous when applied to a relatively short screw-threaded part of an article.

A further problem which may be encountered in the use of hydraulic tensioning nuts of the kind described, whether or not the nuts include compressible

means in accordance with the present invention, is separation of the body and piston in the event that hydraulic pressure cannot be supplied to urge them apart.

According to a further aspect the present invention consists in a hydraulic tensioning nut of the kind described including means mechanically operable between the body and piston to urge the body and piston apart in the event that hydraulic pressure cannot be supplied between the body and piston.

The mechanically operable means may comprise screw-threaded means threadedly engaged with the body and operable to bear on the piston to urge the body and piston apart. Preferably the screw-threaded means comprises a plurality of screws threadedly engaged in a ring of tapped holes extending through the body parallel to the central longitudinal axis of the body, the screws being tightenable in the tapped holes to bear on the piston to urge the body and piston apart. The diameter of the body may be increased to accommodate the tapped holes.

The mechanically operable means can be provided in addition to the compressible means.

When the retention means of the nut is formed by one or more shims which insert between the body and the piston, the plurality of screws in the preferred form of the screw-threaded means may bear on an annular face of the piston, and the or each shim may have slots or recesses through which the screws pass to the annular face. Alternatively, if a collar forms the retention means, the piston may have an internal annular shoulder presenting an annular face on which the screws can be

engaged without interfering with the collar. The piston may similarly have an internal shoulder for the screws to engage with when a shim or shims form the retention means.

Typically, in either arrangement, there will be 8 - 16 screws but there may be fewer or more, depending upon the load required to be applied to separate the body.

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

Figure 1 is a diagrammatic axial section through a hydraulic tensioning nut in accordance with the present invention, showing alternative forms of retention means;

Figure 2 shows the nut in use connecting a piston rod to a cross-head in a compressor,

Figure 3 is an enlarged section through connected parts of the piston rod and cross-head of Figure 2, and

Figure 4 is a partly sectioned side view of a hydraulic tensioning nut including mechanically operable means for urging the body and piston apart.

Referring to Figure 1, the hydraulic tensioning nut comprises a cylindrical body 1, an annular piston 2 co-axially retained, and sealingly connected, to the body for relative axial movement between the two, a

compressible unit 3 retained to the piston, and retention means 4.

The body 1 and piston 2 are of a substantially known form, the body having an internally screw-threaded axial bore 5 and being adapted for connection at an inlet 6 to a hydraulic fluid supply for admission of hydraulic fluid into a chamber 7, defined between the body and piston, to urge the body and piston apart. When there is no fluid pressure in the chamber 7 opposed annular faces 8, 9 of the body and piston abut. A radial, outer, face 10 of the piston 2 has a short peripheral skirt 11.

The compressible unit 3 comprises a stack of nested Belville washers 12 held inside a sleeve 13, and a flat annular bearing pad 14 which seats on one end of the stack of Belville washers and is a free fit inside the sleeve. At their radially inner edges the Belville washer 12 are of a diameter larger then the screw-threaded bore 5 of the body. The sleeve abuts at one end against the radial face 10 of the piston 2 inside the skirt 11 to which it is rigidly secured. In the free conical state of the Belville washers 12 the stack is slightly shorter then the sleeve so that with the washer at one end of the stack abutting at its radially outer edge against the radial face 10 of the piston, the bearing pad 14, seated on the radially inner edge of the washer at the opposite end of the stack, projects a short distance out of the sleeve, as shown. The bearing pad 14 is positively retained to the sleeve by angularly spaced pins 15 anchored to the bearing pad engaged in slots 16 in the sleeve which allow the bearing pad to move axially relative to the sleeve sufficiently to be withdrawn fully into the sleeve.

It will be understood that the body 1, piston and compressible unit are retained together as one in the nut.

Under axial compressive loading, the Belville washers 12, which present a high reactive force against the loading, flatten from the free conical form so that the stack shortens in length and the bearing pad moves into the sleeve, thereby compressing the compressible unit 3 as a whole. The washers can flatten sufficiently for the bearing pad to be fully received into the sleeve, at which point the compressible unit becomes solid and resists further compression.

As illustrated there are four Belville washers in the stack. There may be more, or fewer. Preferably there are at least two of the washers in the compressible unit 3.

Two forms of the retention means 4 are shown in Figure 1. One form, shown at the upper part of Figure 1, comprises two or more arcuate shims 17 which are arranged to fit between the annular faces 8, 9 of the body and piston when they are separated. The shims 17 are of a thickness slightly greater than the distance by which the bearing pad projects from the sleeve when the Belville washers 12 are in their free conical state. The second form of the retention means 4, shown at the lower part of Figure 1, comprises an internally screw-threaded collar 18 which is threadedly engaged with an external screw thread on the skirt 11 of the piston and is a free sliding fit over the sleeve 13 of the compressible unit. Rotation of the collar 18 moves it axially relative to the piston and sleeve.

For use on an externally screw-threaded part 19 of an article which is threadedly engaged in an internally screw-threaded bore 20 of an item 21, the nut is fitted to the screw-threaded part 19 adjacent a bearing surface 22 of the item 21, the compressible unit 3 towards the bearing surface. The body 1 screws onto the screw-threaded part 19. Initially the body 1 is screwed along the screw-threaded part 19, which may be done by hand, until the bearing pad 14 abuts against the bearing surface 22. Hydraulic pressure is then applied in the chamber 7 which urges the piston away from the body, causing the Belville washers 11 to be compressed in the sleeve 13 and separating the annular faces 8, 9 of the body and piston. This compression continues until the bearing pad 14 is fully withdrawn into the sleeve. When that point is reached the sleeve bears on the bearing surface 22 and, because the compressible unit 3 compresses no further, the hydraulic pressure then acts more forcefully on the body 1 which is urged away from the piston and compressible unit, and hence away from the bearing surface 22 so as to tension the screw-threaded part 19.

The hydraulic pressure induced in the chamber 7 is regulated as required according to the tensioning of the screw-threaded part desired. Suitable indicator means associated with the hydraulic fluid supply shows tensioning readings.

When a desired level of tensioning is achieved the shims 17 of the retention means 4 are inserted into the gaps between the separated annular faces 8, 9, or the collar 18 is tightened on the piston to abut against the annular face 8 of the body to close the gap, as the case may be. This locks the piston and body in the relative axial positions they have attained under the

applied hydraulic pressure. The hydraulic pressure is then released. There is elongation of the tensioned screw-threaded parts 19 and/or distortion of the engaged threads of the internally threaded bore 5 of the body 1 and the screw-threaded part.

Some load loss on the screw-threaded part occurs as the hydraulic pressure is released and the sleeve 13 of the compressible unit 3 beds on the bearing surface 22. The screw-threaded part is held tensioned, however, to a substantial extent so that the screw-threaded part is very securely retained to the item 21 to which it is connected. Typically 60-70% of the applied load is retained even with a short grip length between the nut and the screw-threaded part 19.

Reference will now be made to Figures 2 and 3 of the accompanying drawings. Here a piston rod 23 of a piston 24 operating in a cylinder 25, of a high capacity gas compressor, is connected to a cross-head 26 coupled to a connecting rod 27 on a crank shaft 28. The piston rod 23 has a short externally screw-threaded end portion 29 which is screwed into an externally screw-threaded bore 30 of the cross-head 26 to join the piston rod to the cross-head. This joint is made secure against untightening under the loads exerted on it by the relative operating movements of the piston rod and connecting rod, by a hydraulic tensioning nut 31 of the form just described. The body 1 of the nut 31 is tensioned on the end portion 29 of the piston rod 23 in the manner described, the bearing pad 14 and sleeve 13 bearing on a bearing surface 14 of the cross-head 26.

For such an application the nut will typically be designed to offer a load of up to 2260kN. Under this

load the piston of the hydraulic tensioning nut 31 may move relative to the body of the nut by up to 3.5mm, however the true extension of the screw-threaded end portion 29 of the piston rod may only be about 0.2mm and because load loss from compression (typically approximately 0.1 - 0.15mm) of the shims or collar, as the case may be, of the retention means of the nut is small compared to the movement of the nut's piston the load loss on the piston rod is reduced to a minimum.

In Figure 4 a hydraulic tensioning nut is shown which comprises a cylindrical body 1 and an annular piston 2. The body 1 has an internally screw-threaded axial bore 5 and is adapted for connection at an inlet 6 to a hydraulic fluid supply for admission of the fluid into an annular chamber 7 defined between the body and piston and sealed at the piston by a seal 32. Opposed faces 8, 9 of the body and piston abut when there is no fluid pressure in the chamber. A locking collar 33 circumferentially carried by the piston 2 is screw-threadedly connected to the piston to be tightened into abutting engagement with the body 1 to lock the body and piston in relative axial positions.

The nut is modified to enable the body 1 and piston 2 to be urged apart in the event that hydraulic pressure cannot be supplied to the chamber 7. The body 1 is formed with a ring of angularly spaced, tapped holes 34 which extend through the body, around the bore 5, parallel to its central longitudinal axis. Cap screws 35 are threadedly engaged in the holes 34. Normally the cap screws are located in the holes 34 so that their ends adjacent to the piston are within the holes out of, or in loose, contact with the piston. They may be detached from the holes when not required for use. The cap screws are tightenable

in the holes to bear on the piston and urge the body and piston apart mechanically.

The nut of Figure 1 may be similarly modified to include a ring of tapped holes in the body 1 and cap screws engaged in the holes for mechanically urging the body and piston apart if hydraulic pressure cannot be supplied to the chamber 7.

Claims

1. A hydraulic tensioning nut of the kind described including compressible means on which the piston acts and which is adapted to fit freely about an externally screw-threaded part of an article to which the nut is applied for use, the compressible means being compressible to a limited extent under hydraulic pressure applied between the body and piston but resisting further compression when the applied pressure exceeds a predetermined value.

2. A hydraulic tensioning nut according to claim 1 wherein the compressible means comprises one or more disc springs which deflect under applied pressure loads.

3. A hydraulic tensioning nut according to claim 2 wherein the or each disc spring is a Belville washer.

4. A hydraulic tensioning nut according to claim 2 or claim 3 wherein there are two or more of the disc springs in a stack.

5. A hydraulic tensioning nut according to claim 4 wherein the stack of disc springs is contained in a rigid sleeve of shorter length than the stack of disc springs in their unloaded state and incompressible in the range of hydraulic pressure under which the nut is designed to operate, the stack being compressible to be fully received into the sleeve under applied pressure of the pre-determined value, and the sleeve then taking the load of pressure applied between the body and piston in excess of the predetermined value for that pressure to be transferred by the body

to the screw-threaded part to which the nut is fitted for use, thereby to tension the screw-threaded part.

6. A hydraulic tensioning nut according to claim 4 wherein at least one bearer element is provided seated on the stack of disc springs.

7. A hydraulic tensioning nut according to claim 6 wherein the stack of disc springs and the bearer element or elements are contained in a rigid sleeve of shorter length than the combined length of the stack of disc springs in their unloaded stack and the bearer element or elements seated on the stack, and incompressible in the range of hydraulic pressure under which the nut is designed to operate, the stack being compressible for it and the bearer element or elements to be fully received into the sleeve under applied pressure of the pre-determined value, and the sleeve then taking the load of pressure applied between the body and piston in excess of the predetermined value for that pressure to be transferred by the body to the screw-threaded part to which the nut is fitted for use, thereby to tension the screw-threaded part.

8. A hydraulic tensioning nut according to claim 1 wherein the compressible means comprises one or more elements of a compressible material and one or more rigid components in combination with the compressible element or elements, the compressible element or elements being compressible under applied pressure up to the pre-determined value and the rigid component or components taking the load of pressure applied between the body and piston in excess of the predetermined value for that pressure to be transferred by the body to the screw-threaded part to which the nut

is fitted for use, thereby to tension the screw-threaded part.

9. A hydraulic tensioning nut according to claim 1 wherein the compressible means comprises a helical compression spring.

10. A hydraulic tensioning nut according to any preceding claim wherein the retention means comprises one or more shims which insert between the body and the piston.

11. A hydraulic tensioning nut according to any of claims 1 to 9 wherein the retention means comprises a collar on the piston which is movable relative to the piston to engage with the body and is held securely in any position to which it is moved for engagement with the body.

12. A hydraulic tensioning nut of the kind described including means mechanically operable between the body and piston to urge the body and piston apart in the event that hydraulic pressure cannot be supplied between the body and piston.

13. A hydraulic tensioning nut according to any of claims 1 to 11 including means mechanically operable between the body and piston to urge the body and piston apart in the event that hydraulic pressure cannot be supplied between the body and piston.

14. A hydraulic tensioning nut according to claim 12 or claim 13 wherein the mechanically operable means comprises screw-threaded means threadedly engaged with the body and operable to bear on the piston to urge the body and piston apart.

15. A hydraulic tensioning nut according to claim 14 wherein the screw-threaded means comprises a plurality of screws threadedly engaged in a ring of tapped holes extending through the body parallel to the central longitudinal axis of the body, the screws being tightenable in the tapped holes to bear on the piston to urge the body and piston apart.

16. A hydraulic tensioning nut according to claim 15 as dependent from claims 10 and 13 wherein the screws bear on an annular face of the piston, and the or each shim has slots or recesses through which the screws pass to the annular face.

17. A hydraulic tensioning nut according to claim 15 as dependant from claim 13 and either one of claims 10 and 11 wherein the piston has an internal annular shoulder on which the screws bear.

18. A hydraulic tensioning nut substantially as described herein with reference to Figure 1 of the accompanying drawings.

19. A hydraulic tensioning nut substantially as described herein with reference to Figure 4 of the accompanying drawings.

The Patent Office

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Application No: GB 9607349.9 **Examiner:** Robert H Games
Claims searched: 1-11 **Date of search:** 25 June 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F2H

Int Cl (Ed.6): B25B 29/02; F16B 31/04

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 2274893 A (HYDRA-TIGHT) see Fig 2	1

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.