A fastening device for cooperating with a shaft, wherein the fastening device includes: a deformable sleeve, and a locking collar, the deformable sleeve is configured to have a perimeter relative to the shaft such that the deformable sleeve can be pushed over the shaft, and the locking collar is configured to push over the sleeve so as to bear against a surface of the sleeve and to cause the fastening device to engage with the shaft.
BOLT WITH COLLAR AND FLEXIBLE SLEEVE INSERT

TECHNICAL FIELD

[0001] This invention relates to a friction mechanism.

[0002] More specifically, the present invention relates to friction mechanisms which are variations on fastener mechanisms.

BACKGROUND ART

[0003] Shafts of one form or another are commonly used to hold one or more articles in place as part of an assembly. The shaft is passed through the article and a fastener used to hold the article in place on the shaft.

[0004] A very common example is a shaft in the form of a threaded bolt. The articles to be assembled are loaded onto the bolt, and a fastener, in the form of a threaded nut, is wound onto the shaft and tightened against the article such that the article is secured between a bearing surface on the head of the bolt and a bearing surface on the nut.

[0005] There are, however, a number of well known problems with the use of nuts as fasteners on bolts. These include:

[0006] The need to align the threads of the nut and bolt in order to engage the nut onto the bolt. This is time consuming and if not done properly may lead to cross-threading which essentially destroys and integrity of the threads on either the nut or the bolt (or both), resulting in both having to be discarded.

[0007] Typically a large number of rotations of the nut (or bolt) are required to move the bolt along the shaft of the bolt prior to tightening. This is time consuming, particularly in situations where the bolt extends a significant amount from where the nut is to be engaged with the article to be fastened.

[0008] There may be limited access available to the nut and bolt making it difficult to engage a tool to turn the nut or bolt.

[0009] Typically only a small fraction of the available thread on the nut is used to hold the nut in position when tightened. As a consequence there may be little resistance to the nut loosening as may occur for example due to vibration. Loosening of nuts as a result of vibration may constitute a critical safety factor in many assemblies.

[0010] In all cases there is a limit to the torque that may be applied to tighten a nut before damage occurs to the threads. If this limit is exceeded the result generally is deformation of the threads to a point where the thread is stripped, either from the nut or bolt. In such cases the nut and bolt must be replaced which may be costly and time consuming.

[0011] These problems have created a high demand for a fastener that can be quickly located onto a shaft and securely held thereto.

[0012] Rooopmarine, in U.S. Pat. No. 6,712,574 discloses a quick insertion fastener comprising a casing in which a plurality of inserts is held by a variety of springs and retainers. The inserts are arranged such that they are spaced away from the shaft of a bolt when inserted, and engage with the threads of the bolt on rotation of the casing.

[0013] This device, and the many other similar ones, for example Fiorell et al in U.S. Pat. No. 5,988,965, all require a complex arrangement of many pieces, each of which must be configured to fit into the casing and to cooperate with each other both when retained and when engaged. These devices may therefore not only be costly to manufacture but the pieces must also be carefully assembled prior to use, adding further to the cost of the fastener.

[0014] Furthermore, there is always the possibility of jamming of the parts, or of foreign matter entering the mechanism, either of which may lead to failure of the fastener to operate.

[0015] A common feature among these prior art fasteners (and similar ones) is that they are adapted to engage with a threaded shaft. The threaded components of the devices are required in order to tighten the device against a bearing surface (such as an object on the shaft or the head of a bolt) on the shaft. These fasteners still depend on rotation to engage complementary screw threads in the same manner as a nut and bolt, and therefore may suffer from the problems outlined above when tightened.

[0016] It is an object of the present invention to address the foregoing problems or at least to provide the public with a useful choice.

[0017] All references, including any patents or patent applications cited in this specification are hereby incorporated by reference. No admission is made that any reference constitutes prior art. The discussion of the references states what their authors assert, and the applicants reserve the right to challenge the accuracy and pertinency of the cited documents. It will be clearly understood that, although a number of prior art publications are referred to herein, this reference does not constitute an admission that any of these documents form part of the common general knowledge in the art, in New Zealand or in any other country.

[0018] It is acknowledged that the term ‘comprise’ may, under varying jurisdictions, be attributed with either an exclusive or an inclusive meaning. For the purpose of this specification, and unless otherwise noted, the term ‘comprise’ shall have an inclusive meaning—i.e. that it will be taken to mean an inclusion of not only the listed components it directly references, but also other non-specified components or elements. This rationale will also be used when the term ‘comprised’ or ‘comprising’ is used in relation to one or more steps in a method or process.

[0019] Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

DISCLOSURE OF INVENTION

[0020] According to one aspect of the invention there is provided a fastening device for cooperating with a shaft, wherein the fastening device includes a deformable sleeve, and a locking collar, characterised in that the deformable sleeve is configured to have a perimeter relative to the shaft such that the deformable sleeve can be pushed over the shaft, and the locking collar is configured to push over the sleeve so as to bear against a surface of the sleeve and to cause the fastening device to engage with the shaft.

[0021] According to another aspect of the invention there is provided a kit set including a deformable sleeve, a locking collar, and a shaft.
wherein the deformable sleeve is configured to have a perimeter relative to the shaft such that the deformable sleeve can be pushed over the shaft, and the locking nut is configured to push over the sleeve so as to bear against a surface of the sleeve and to cause the fastening device to engage with the shaft.

According to another aspect of the invention there is provided a method of using a fastening device in relation to a shaft, the fastening device including a deformable sleeve and a locking collar, characterized by the steps of:

a) pushing the deformable sleeve into position along the shaft, and
b) pushing the locking collar along the shaft and over the deformable sleeve, so that a surface of the locking collar bears against a surface of the deformable sleeve, and
c) pushing the locking collar further over the deformable sleeve until a surface of the deformable sleeve fastens to the shaft.

According to another aspect of the invention there is provided a method of using a fastening device in relation to a shaft, the fastening device including a deformable sleeve and a locking collar, characterized by the steps of:

a) forming a fastening device by pushing the deformable sleeve partially into the locking collar until the sleeve is held by the collar, and
b) pushing the fastening device into position along the shaft, and
c) pushing the locking collar further over the deformable sleeve until a surface of the deformable sleeve fastens to the shaft.

It is envisaged that the principles behind the fastening device of the present invention can be applied to fastening devices in a wide variety of shapes and sizes and for use in a variety of situations. For ease of reference the fastening device shall be referred to as a sleeve clamp. It should be appreciated however that this is not intended to be limiting.

A sleeve clamp according to the current invention is a device that may be pushed onto a shaft and fastened to the shaft at some position.

In all embodiments the initial movement to locate and secure a sleeve clamp to a shaft is a push.

However, it should be appreciated that in some embodiments the sleeve clamp, or a component of it, may be rotated after it has been pushed onto and fastened to the shaft. This may be done, for example, to provide additional grip between the sleeve clamp and the shaft.

In some embodiments the sleeve clamp may include a collar configured to push and rotate over a sleeve in order for the collar to bear against a surface of a sleeve. For example, a push and turn motion (e.g., helical) may be required for engagement of cooperating details of the sleeve clamp, as outlined in more detail below.

In some embodiments, to be discussed in more detail below, a sleeve clamp may include internally threaded components, or be configured to engage with a threaded shaft, in which case some rotation of the clamp, or a component of it, may be required.

Reference to a shaft throughout this specification should be understood to refer to a rigid elongate solid or hollow rod. Commonly a shaft may be a straight rod of circular cross-section, such as a uniform solid or hollow cylinder.

However, it will be apparent that a shaft for use with the present invention may have any suitable cross-section and indeed the cross-section may vary along the length of the shaft.

In some embodiments the sleeve clamp may be configured to cooperate with a shaft having a non-circular cross section.

An advantage of using a sleeve clamp with a shaft having a non-circular cross section is that the non-circularity hinders rotation of the fastener with respect to the shaft. This may be particularly important for uses in which the shaft and fastener are subject to vibration, a common cause of failure of fasteners involving threaded nuts and bolts which by necessity must have a circular cross section.

The outer surface of the shaft may be adapted in many ways to suit different embodiments of the present invention. For example the outer surface may in some cases be smooth, roughened, or may be threaded or modified in some other way to enhance the action of the sleeve clamp.

Reference to a sleeve throughout this specification should be understood to refer to an object configured such that it at least partially encloses a shaft inserted into it.

A sleeve according to the present invention has a perimeter that enables the sleeve fit around a shaft with sufficient clearance to pass freely along the shaft.

In all embodiments a sleeve has an outer surface and a hollow core bounded by an inner surface.

In a preferred embodiment the sleeve clamp includes a single sleeve only.

Use of a single sleeve only overcomes many of the problems of prior art devices that are formed from a plurality of parts.

A single sleeve may be configured to be self-supporting when pushed onto a shaft. This obviates the need for the complex arrangements of springs and other forms of retainers used in prior art devices in order to hold the multiple components in place and clear of the shaft prior to engagement.

Use of a single sleeve may significantly reduce the amount of machining required as only one piece is formed. In prior art fasteners several pieces are formed each of which must be configured to cooperate with other components in order to fit into a fastener.

These advantages may lead to substantial savings in the cost of manufacture of the fastener, as fewer components are required and there is no need for pre-assembly.

Use of a single sleeve also reduces the possibility of failure due to misalignment or jamming of multiple components.

Reference will be made throughout the specification to a sleeve clamp including a single deformable sleeve only. However, it will be appreciated that any number of deformable sleeves may be used with the current invention and that reference to a single sleeve only should not be considered limiting.

A deformable sleeve should be understood to mean a sleeve that is capable of changing shape when subjected to an applied force.

A deformable sleeve may be configured such that when an appropriate force is applied to the sleeve its shape...
changes so that the inner surface of the sleeve contacts an outer surface of a shaft to which the sleeve is fitted.

[0053] In preferred embodiments the sleeve may deform such that substantially the entire inner surface of the sleeve contacts a surface of a shaft to which it is fitted.

[0054] This is an important feature as the grip between a sleeve clamp and a shaft is dependent (among other factors) on the extent of contact between the sleeve and the shaft.

[0055] It is envisaged that the material from which the sleeve may be made is preferably of a type and construction that possesses a material "memory". This means that if the sleeve is deformed through forces placed on it, there is a natural tendency for the material "memory" to bias the sleeve back towards its original shape.

[0056] Deformation in which the body returns to its original shape following removal of the external forces causing the deformation is commonly referred to as elastic deformation.

[0057] An advantage of using a sleeve that may be elastically deformed is that following use (deformation) the sleeve returns to its original shape, allowing it to be reused as required without degradation.

[0058] A deformable sleeve may be formed from a material that readily compresses elastically when subjected to an applied force. Examples of such materials include various rubbers and foam plastics.

[0059] In other embodiments a deformable sleeve may be formed from a relatively incompressible material that has been configured to allow deformation to occur. Examples of such materials include metals and rigid plastics. A sleeve made from such materials may be formed in a manner that allows all or part of the sleeve to move when a force is applied.

[0060] In some embodiments a combination of materials may be used. For example a composite sleeve may be formed having a relatively incompressible outer layer and a relatively compressible inner layer. The outer layer may be configured to deform under an applied force, thus compressing the inner layer.

[0061] Such a sleeve may be of advantage in situations where there is a requirement to limit damage to a shaft. An example may be a sleeve clamp used as a splint or as a way of holding a bandage in place, or in other situations where the "shaft" is a body part.

[0062] Other forms of composite sleeves may be formed from materials having different properties. For example an insert of a relatively compressible material may be included in a sleeve formed primarily from a relatively incompressible material. The inserts may be placed in a location where the required deformation may be greater than can be readily achieved by the relatively incompressible material.

[0063] Alternatively, an insert of relatively incompressible material may be included in a sleeve in order to stiffen a region of a relatively compressible sleeve.

[0064] In a preferred embodiment the sleeve includes a slit extending at least partially along the length of the sleeve.

[0065] A slit in the current specification may be of any shape and size as required, a slit generally referring to a region where material has been removed from an otherwise continuous sheet or surface. A slit may be in the form of an opening extending through a sheet of material, or may be in the form of a groove in a surface.

[0066] In some embodiments a slit may be a straight. However in other embodiments a slit may be curved, for example into a helical or spiral form.

[0067] Inclusion of a slit in a sleeve is one way in which the ability of the sleeve to deform may be enhanced. A slit provides space for the material of the sleeve to move into when the sleeve is squeezed by an applied force, generally causing the sleeve to deform inwards.

[0068] In other embodiments a sleeve may include a plurality of slits.

[0069] A plurality of slits may be used to increase the flexibility of a sleeve to deform under an applied force, allowing for more varied and complex shapes to be formed. This may be an advantage in instances where the outer surface of a shaft is non-circular, for example if the shaft has a square or polygonal shape.

[0070] A sleeve clamp according to the present invention includes a locking collar configured to push along a shaft and over a sleeve so as to bear against a surface of the sleeve.

[0071] In a preferred embodiment the locking collar bears against an outer surface of the sleeve.

[0072] Reference is made throughout this specification to the locking collar bearing against an outer surface of the sleeve. However, it should be appreciated that the collar, or part of it, may bear against some other surface of the sleeve, such as the surface of a slit in the sleeve, and that reference to the collar bearing on an outer surface of the sleeve only should not be seen as limiting.

[0073] Reference to a collar should be understood to refer to an object configured so as to restrain and hold in place an enclosed object.

[0074] The outer surface of the sleeve and the inner surface of the locking collar are configured such that pushing the locking collar over the deformable sleeve exerts a force on the sleeve, causing the sleeve to deform in a manner that reduces an inner perimeter of the sleeve.

[0075] In use in conjunction with a shaft a locking collar is pushed over and along a deformable sleeve on the shaft, causing the sleeve to deform until the sleeve clamp achieves the desired attachment to the shaft.

[0076] In most cases this involves substantially the entire inner surface of the sleeve contacting the outer surface of the shaft.

[0077] A locking collar according to the current invention may therefore be relatively non-deformable in comparison with the deformable sleeve. A relatively rigid locking collar is required in order to cause the sleeve to deform when the locking collar bears against it.

[0078] In a preferred embodiment an inner surface of the collar and an outer surface of the sleeve are tapered.

[0079] Reference to a tapered surface should be understood to refer to a surface of an object configured such that one end of the object is narrower than the other end.

[0080] The end of a sleeve or collar at which the tapered surface has the largest perimeter will be referred to as the base of the sleeve or collar. The end distal to the base (smaller perimeter) will be referred to as the top.

[0081] In a preferred embodiment an inner surface of the collar and an outer surface of the sleeve are frusto-conical.

[0082] The outer surface of the sleeve and the inner surface of the collar may be formed from similar frusto-conical sections, i.e., sections cut from identical cones with the apex removed.

[0083] Reference will be made throughout this specification to surfaces formed as frusto-conical sections. However, it should be appreciated that other forms of tapered surface may be used with the current invention, including non-uniformly
tapered surfaces, and that reference to frusto-conical surfaces only should not be seen as limiting.

[0084] A collar formed in this manner may be pushed over and along the sleeve until the inner surface of the collar is in substantially full contact with the outer surface of the sleeve. When the collar is pushed further it exerts a force on the outer surface of the sleeve, causing the sleeve to deform.

[0085] In use the sleeve of a sleeve clamp is moved into position on a shaft. The locking collar is then pushed over the sleeve sufficiently to cause an inner surface of the deformed sleeve to contact the outer surface of the shaft.

[0086] The further the collar is pushed over and along the sleeve the greater the force exerted on the sleeve.

[0087] In all embodiments following engagement of the sleeve and locking collar they are held in place with respect to one another by the reaction force of the elastically deformed sleeve pushing against the locking collar.

[0088] The sleeve clamp is held in position on a shaft by the frictional force exerted between the inner surface of the deformed sleeve and the outer surface of the shaft.

[0089] The frictional force, and hence the grip between the sleeve clamp and the shaft, is proportional, among other things, to the area of contact between the inner surface of the sleeve and outer surface of the shaft, and to the amount of force applied.

[0090] Therefore, where an increased grip is required the length of the sleeve may be increased (thus increasing the contact area) or the locking collar may be configured to press down with greater force onto the sleeve (or both).

[0091] The amount of force exerted by the locking collar onto the sleeve, and hence onto the shaft, may be adjusted by changing the angle of the tapered surfaces.

[0092] Generally for a tapered surface the force is greatest for taper angles of around 45°. It should be appreciated, however, that other factors, such as the ease of moving a collar over a sleeve, may influence the choice of taper angle for a given application.

[0093] In some embodiments the grip may be enhanced by appropriate surface preparation, for example by roughening the inner surface of the sleeve and the outer surface of the shaft. The grip between the outer surface of the sleeve and the inner surface of the collar may similarly be increased by roughening the surfaces.

[0094] In some embodiments the inner surface of the collar and/or the outer surface of the sleeve may be polished or coated or lubricated to allow the collar to move more easily over the sleeve.

[0095] Different materials may be used in some embodiments a sleeve clamp in order to provide other features. For example suitably configured materials of different hardness may be used on contact surfaces, such as that between a sleeve and a locking collar or between a sleeve and a shaft, in order to provide thread cutting.

[0096] In some embodiments the outer surface of the sleeve and the inner surface of the collar may include surface features to provide additional functionality.

[0097] Generally the inner surface of a collar may have complementary features to those of the outer surface of a sleeve, so that the two surfaces cooperate to provide the additional features.

[0098] For example the outer surface of the sleeve may include one or more ridges or grooves running around a perimeter of the surface. In this embodiment the inner surface of the collar may include grooves or ridges that correspond to the ridges and grooves respectively on the sleeve. The collar in this embodiment may be pushed over the sleeve until a ridge (for example) extending around the inner surface of the collar engages with a groove around the sleeve. At this point the collar “snaps” into a fixed position on the sleeve in what may be termed a “click and hold” position.

[0099] A number of grooves around the outer perimeter of the sleeve may be used to calibrate the connection between the sleeve and the collar as the position of the grooves along the sleeve determines how much of the sleeve is covered by the collar, and hence how much force is being exerted onto the sleeve.

[0100] In some embodiments a groove and ridge (spline) may extend longitudinally along the length of the sleeve and/or collar. For example a longitudinal groove may be formed on the outer surface of a sleeve and a complementary spline formed on the inner surface of a collar (or vice versa). The collar may then be aligned with the sleeve so that the spline engages in the groove. This may be useful in instances where the alignment of the collar and sleeve is important. It also provides a key for locking the sleeve to the collar such that rotation of the collar forces the sleeve to rotate.

[0101] A flange may be included at the base of a sleeve, the base being the wider end of the tapered sleeve that in use abuts an article to be fixed on a shaft. This may serve to prevent the collar from further movement over the sleeve, as well as to provide an additional area to the surface abutting the article to be fixed.

[0102] In some embodiments the sleeve may include a “step down” region in which the tapered surface near the base ends and is replaced with a non-tapered portion that has a smaller perimeter than the tapered surface at that point.

[0103] The inner surface of a corresponding collar may include a tapered surface near the base that ends and is replaced with a non-tapered portion that protrudes towards the centre of the collar.

[0104] In operation the collar is pushed over the sleeve such that the protruding non-tapered section of the base of the collar bears against the tapered surface of the sleeve. When the non-tapered section of the collar is pushed over the non-tapered section of the sleeve, the collar snaps into position against the sleeve so that the tapered and non-tapered sections of the sleeve and collar respectively bear against one another.

[0105] This arrangement may be useful as a means of applying a predetermined coverage (and hence force) of the collar on the sleeve.

[0106] The arrangement has the added advantage of providing a lip (between the non-tapered and tapered regions) which acts as a barrier to movement of the collar back over the sleeve, a move that would otherwise allow the sleeve clamp to loosen. The lip could be made large enough to limit the tendency of the collar to slip back on the sleeve during use, while still allowing the collar to be removed when required.

[0107] In some embodiments the outer surface of a sleeve or the inner surface of a collar may be threaded. This may be done, for example, to facilitate release of the collar from the sleeve by enabling the collar to be loosened on the sleeve by unwinding the collar with respect to the sleeve.

[0108] It may also be useful in situations where additional tightening is desired to force the collar further over the sleeve, although it is envisaged that a push may be sufficient in all cases to achieve the necessary movement of the collar over the sleeve.
A sleeve clamp may also be formed with an elastically deformable sleeve which may be held open sufficiently by a detail of a locking collar (for example a tang extending from the inner surface of a collar) to allow the sleeve to be pushed over a shaft into a fastening position where the sleeve is released to spring onto and clamp against the shaft.

In this embodiment an elastically deformable sleeve is pushed partially into a locking collar prior to the sleeve clamp being pushed over a shaft.

The deformable sleeve and locking collar are configured such that the locking collar is pushed partially over the sleeve it causes the sleeve to deform so as to increase a perimeter of the sleeve. This action has the effect of opening up the sleeve so that the combined sleeve and collar can be pushed over and along a shaft to the desired position. This may allow the sleeve to pass over any threads or raised details that may be provided as a fail safe mechanism to prevent the collar from moving back towards a non-engaged position.

The sleeve and collar are further configured such that further pushing of the collar over the sleeve causes the sleeve to revert towards its undeformed state. The material memory of the sleeve biases it toward returning to its original shape in which it has a perimeter smaller than the shaft. The sleeve is fastened against the shaft by this biasing force.

In one example of this embodiment an elastically deformable sleeve includes a slit extending along the length of the sleeve. The slit may be configured such that it has a narrow internal section having a width which is less than the width of the slit on either side of the narrow section.

Reference to an internal section of the slit should be understood to mean a section of the slit that does not include an end of the slit.

A locking collar in this embodiment includes a protuberance, which may be in the form of a tang, on the inner surface of the collar, the protuberance configured to fit into the slit at an end of the slit without touching the sides of the slit.

The protuberance or tang is further configured such that as the collar is pushed along the sleeve the protuberance moves along the slit until it bears against the sides of the slit on either side of the narrow internal section.

This action causes the sleeve to be deformed as the slit is widened, thus opening the sleeve sufficiently for the sleeve to be pushed over a shaft.

The sleeve clamp is pushed onto the shaft with the protuberance in the collar engaged in the narrow section of the slit in the sleeve.

When in position the locking collar is pushed further with respect to the sleeve such that the protuberance moves away from the narrow section of the slit, thus releasing the sleeve to clamp onto the surface of the shaft.

A sleeve clamp according to the current invention provides many advantages over the prior art devices. In its simplest form it may consist of two pieces only, a deformable sleeve and a locking collar, each of which may be readily formed. Prior art devices generally involve a plurality of interacting parts. This means that the sleeve clamp may be relatively inexpensive to make.

The pieces do not need to be preassembled, although in some instances this may be an advantage. When desired, preassembly requires only that the sleeve be pushed into the collar sufficiently for it to be frictionally held in place. No other springs or retainers are required. This is a significant benefit over prior art devices which do use springs and retainers to locate a plurality of parts, and therefore involve additional costs in materials and assembly.

A major advantage is that a sleeve clamp according to the current invention may be pushed over a shaft in order to achieve full engagement. This contrasts with the prior art fastener devices where the final tightening involves rotation of the fastener device after it has been pushed onto a shaft.

A push fit is preferable to a rotation as it is a simpler motion, both for hand operation and particularly for automated application by a machine.

For hand operation all that is required is a push on the collar. If more force is required than can be simply achieved by hand, this can be applied by engaging a suitable tool (such as a socket) against the collar and applying force to the tool, for example by striking with a hammer.

For automated application it is only necessary to have a machine adapted to hold the collar (with or without the sleeve engaged) and to push the sleeve clamp along the shaft into position, followed by an additional push to engage the sleeve clamp on the shaft. This is a much simpler motion for a machine than one involving rotation of a part.

Use of a push fit only means that the operation is quick and simple, saving time, and can be achieved with simple machinery, saving expense in capital investment on more complex machinery.

The use of a push fit only also removes a major limitation of fastening devices that require rotation on a screw thread for engagement—namely that screw threads are limited to objects having a circular cross section. Hence all threaded bolts, nuts, screws etc are limited to having a circular cross section.

Use of a push fit without the need for rotation, as in the basic sleeve clamp of the current invention, opens the opportunity to use objects that do not have a circular cross section.

In particular a shaft and sleeve may be used that do not require a circular cross section. Use of a non circular shaft and sleeve (inner surface) provides greater stability to the fastening device against rotation (as the parts are not able to rotate relative to each other). This may overcome much of the problem associated with vibrations loosening screwed fasteners.

A sleeve clamp may also be used to advantage to provide a barrier on a shaft, such as may be required to limit the movement of some object past a point on the shaft. A sleeve clamp may be fastened to a shaft by holding the sleeve in position on the shaft while the collar is push over the sleeve clamping it to the shaft. In contrast, any fastener that relies on a rotation or screwing motion to tighten requires a fixed surface to tighten against, and therefore cannot be used for this purpose.

Despite its relatively simple basic form, the sleeve clamp may be configured in a multitude of ways to provide additional functionality. These generally involve inexpensive surface modifications of the sleeve and/or collar using conventional machining or forming techniques. Various modifications, as outlined above and illustrated below and in combinations thereof, may be used to tailor a sleeve clamp to the requirements of a particular situation. This option is generally not available in prior art devices.

BRIEF DESCRIPTION OF DRAWINGS

Further aspects of the present invention will become apparent from the ensuing description which is given by way of example only and with reference to the accompanying drawings in which:
FIG. 1 shows a fastening device for use with a shaft; and
FIG. 2 shows various embodiments of a sleeve, and
FIG. 3 shows various embodiments of a sleeve, and
FIG. 4 shows a fastening device for use with a shaft, and
FIG. 5 shows a fastening device, and
FIG. 6 shows a fastening device for use with a shaft, and
FIG. 7 shows a fastening device, and
FIG. 8 shows a fastening device.

BEST MODES FOR CARRYING OUT THE INVENTION

A basic deformable sleeve (12), having a smooth tapered outer surface (4) and a smooth inner surface (6) is shown in FIG. 2(A). The sleeve includes a slit (5) to facilitate deformation under an applied force.

The inner surface (6) of a sleeve (13) may be threaded (14) as shown in FIG. 2(B).

The cross-sectional shape of the outer surface (4) of a sleeve may be non-circular. For example, a sleeve (15) having an outer surface with an oval cross-section (16) is shown in FIG. 2(C). The outer surface (4) of a sleeve may be formed into any convenient shape, such that the oval or circular cross-sections shown in FIG. 2 should not be seen as limiting.

A sleeve (15) having an oval cross section for the outer surface is used with a collar (not shown) having a similar oval shaped cross section for the inner surface. The oval shape limits or prevents rotation of the collar with respect to the sleeve (15).

The outer surface of a sleeve (17) may include surface features in the form of a groove (18) as shown in FIG. 3(D), or a plurality of grooves (20, 21 and 22) as shown in the sleeve (19) in FIG. 2(E).

A locking collar for use with sleeves (17, 19) containing a grooved outer surface includes a complementary ridge on the inner surface (7) of the locking collar (3). The grooves (20, 21 and 22) may be used to provide an indication to the user of the extent to which a complementary ridged locking collar (3) has been engaged with a sleeve (17, 19).

Using the sleeve (19) in FIG. 2(E) as an example, a complementary locking collar is pushed over the narrow end of the sleeve (19) until the ridge on the inner surface (7) of the locking collar (3) engages with the first groove (20) on the sleeve (19). The point at which the ridge snaps into the groove provides a clear indication of the engagement of the locking collar (3) with the sleeve (17) at the groove (20).

The pressure exerted by the locking collar (3) on the deformable sleeve (19) is increased by pushing the locking collar (3) along the deformable sleeve until the groove on the inner surface (7) of the locking collar (3) engages with the next groove (21) on the outer surface of the deformable sleeve (19).

Similarly further force may be exerted by pushing the locking collar (3) further until the ridge on the locking collar engages with the next groove (22) on the outer surface of the deformable sleeve (19).

In this embodiment a number of grooves may be formed at various distances along the length of the locking sleeve (19) in order to provide feedback on the extent of engagement on the locking collar (3) over the deformable sleeve (19). This feedback may be sensed by a user as the locking collar (3) is pushed over the sleeve and hence provide an indication of the extent of coverage of the collar on the sleeve (19).

Alternatively, in automated operation, in which a machine is used to push the locking collar (3) over the sleeve (19), a sensor may be used on the machine to sense when a ridge on the locking collar (3) engages with each of the one or more grooves on the deformable sleeve (19). In this manner, the applied force holding the fastener in place may be calibrated, allowing the machine to be programmed to provide a consistent, fixed force to the sleeve clamp.

In some embodiments a flange (24) may be included at the base end of the deformable sleeve (23), the base end being the wider end of the tapered deformable sleeve (23) that in use abuts the article to be held on a shaft.
A flange (24) may be used to limit further movement of the locking collar (3) over the collapsible sleeve (2), as in the embodiment shown in FIG. 2(F). A wider flange (24) is used with some embodiments to provide a larger surface to bear against an article to be held on the shaft. Such a flange (24) is illustrated in FIG. 2(G).

Note that in each of the previous two embodiments, a slit (25) extends across the flange (24).

In some embodiments the outer surface of a deformable sleeve includes surface features in the form of one or more splines (26) or grooves (27) extending the length of the outer surface of the deformable sleeve (28), as illustrated in FIG. 2(H).

A locking collar (not shown) for use with this embodiment is configured to have matching grooves and splines to engage with the splines (26) and grooves (27) respectively on the surface of the sleeve (28).

The inclusion of the splines (26) provides a guide for the locking collar (3) as it moves along and over the deformable sleeve (28). This arrangement locks the locking collar (3) with respect to the deformable sleeve (28), particularly during rotational motion.

This embodiment is particularly useful in applications where a sleeve clamp is used with a threaded shaft (9). In this case the splines (26) and grooves (27) provide a positive locking between the sleeve (28) and the locking collar (3) when the locking collar (3) is rotated to provide additional tightening of the sleeve clamp.

The outer surface of a sleeve (29) having surface features in the form of screw threads (30) is illustrated in FIG. 2(I). The locking collar for this embodiment (not shown) includes a corresponding set of complementary threads. In this embodiment the locking collar is pushed over the sleeve (29) until the threads engage. The threaded section may be used to loosen off the collar when required by unscrewing the collar with respect to the sleeve (29). Alternatively, it may be used to tighten the collar on the sleeve (29) if required.

A sleeve (31) having an outer surface configured to include a lower non-tapered section (32) is illustrated in FIG. 2 (J, J).

A sleeve (33) having a plurality of slits (34) extending at least partially along the length of the sleeve is illustrated in FIG. 2 (K).

A sleeve (34) in which the outer surface is configured in the form of a series of barbs or ridges (35) is shown in FIG. 3(A) and in side view in FIG. 3(AA). The barbs may be used to provide feedback on the extent to which a complementary collar (not shown) is pushed over the sleeve (34).

A sleeve (36) in which the outer surface is configured as a screw thread (37) is shown in FIG. 3(B) and in side view in FIG. 3(BB). Use of this sleeve and complementary collar allows additional rotation of the collar on the sleeve in order to provide further tightening if required, or conversely to allow the collar to be wound from the sleeve (36) in order to release the sleeve from a shaft (not shown).

A sleeve (38) showing deeper grooves (39) forming a helical screw thread is shown in FIG. 3(C) and in side view in FIG. 3(CC).

A sleeve (40) having a non-linear outer tapered surface is shown in FIG. 3(D) and in side view in FIG. 3-DD. The engagement of a collar with the sleeve (40) is discussed in more detail below.

It will be appreciated that numerous combinations of the embodiments illustrated in FIGS. 2 and 3 may be used in a sleeve of the current invention.

Another view of a deformable sleeve (2) and locking collar (3) in which the inner surface of the sleeve (2) is threaded for attachment to a threaded bolt (9) as shown in FIG. 4(A).

A similar arrangement is shown in FIG. 4(B) in which the inner surface of the sleeve (2) and the outer surface of the bolt (41) are not threaded.

FIGS. 4(C) and 4(D) show two ways in which a sleeve (2) and a collar (3) is pushed along a shaft (9). In FIG. 4(C) a sleeve (2) is partially inserted into a collar (3) to form a sleeve clamp (42) prior to pushing the combination along a shaft of a bolt (9). The sleeve (2) is held in place in the collar (3) by the force exerted by the elastically deformed sleeve (2) onto the collar (3).

Alternatively, as shown in FIG. 4(D) the components of a sleeve clamp may be assembled on a shaft (9) separately. In this case the sleeve (2) is pushed along the shaft (9) prior to the collar (3) being pushed along the shaft and over the sleeve (2).

This method of assembly is illustrated in FIG. 4(E) in which a deformable sleeve (2) is shown after it has been pushed along a shaft (41) and against an object (11) loaded onto the shaft (41).

A locking collar (3) is pushed over and along the shaft (41) until the inner surface of the collar (3) contacts the outer surface of the sleeve (2), as illustrated in FIG. 4(F).

The clamping action is completed by pushing the locking collar (3) further along the shaft and over the sleeve (2) so that the inner surface of the collar bears down on the outer surface of the sleeve, causing the sleeve to deform and clamp against the shaft (41), as illustrated in FIG. 4(G).

FIG. 5(A) illustrates a sleeve (2) and a collar (3) in which the outer surface of the sleeve (2) and the inner surface of the collar (3) have an oval cross section. FIGS. 5(B) and 5(C) show cutaway views of the oval sleeve (2) and oval collar (3) prior to engagement and partially engaged respectively.

FIGS. 5(D), 5(E) and 5(F) show similar views to those of FIGS. 5(A) to 5(C) for a sleeve (43) and a collar (44) in which the inner and outer surfaces of the sleeve and the collar are rectangular.

Both the oval shaped sleeve (2) and collar (3) of FIG. 5(A) and the rectangular shaped sleeve (43) and collar (44) of FIG. 5(E) illustrate examples of sleeves and collars which are constrained by their shape to lock together against rotational motion relative to each other.

FIGS. 6(A) and 6(B) illustrate the assembly of a sleeve clamp on a rectangular shaft (45), the sleeve clamp consisting of a rectangular cross section sleeve (46) and a locking collar (47) having a rectangular tapered inner surface (56) and a cylindrical outer surface (57). FIG. 6(C) shows a cutaway view of this arrangement when the sleeve (46) is partially engaged with the collar (47).

FIG. 6(D) illustrates the engagement of a sleeve clamp on a circular shaft (41), the sleeve clamp consisting of a deformable sleeve (48) having an oval shaped outer surface and a corresponding locking collar (41) having an oval shaped inner surface (not shown) and an outer surface (58) configured to accept a spanner. FIG. 6(E) illustrates a cutaway view of the sleeve clamp when partially engaged.

A sleeve clamp in which the outer surface of a deformable sleeve (50) is configured in a series of ridges (35),
is shown in FIG. 7A and in cutaway view partially engaged with a locking collar (51) in FIG. 7B. The inner surface of the locking collar (59) has a complementary shape to that of the ridges (35) on the outer surface of the sleeve (50), as shown in FIG. 7B.

A sleeve (52), similar to that shown in FIG. 3B, in which the outer surface of the sleeve (52) is threaded is shown in FIG. 7C, and partially engaged with a locking collar (53) in FIG. 7D. The inner surface of the locking collar (60) has a complementary structure to the outer surface of the sleeve (52).

Engagement of a sleeve (54) having a non linear taper on its outer surface (61) is illustrated partially inserted into a corresponding collar (55) in FIGS. 8A and 8B, and fully engaged in a perspective view in FIG. 8C.

FIGS. 8D, 8E and 8F respectively show cutaway views corresponding to FIGS. 8A, 8B and 8C respectively. As can be seen in the cutaway views, the inner surface of the locking collar (55) has a complementary shape to the outer surface of the deformable sleeve (54).

The circumference of the inner surface of the sleeve reduces as the collar moves over the sleeve, as clearly illustrated in FIGS. 8D to 8E.

Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope thereof as defined in the appended claims.

1. A fastening device for cooperating with a shaft, wherein the fastening device comprises a deformable sleeve; and a locking collar, the deformable sleeve is configured to have a perimeter relative to the shaft such that the deformable sleeve can be pushed over the shaft; and the locking collar is configured to push over the sleeve so as to bear against a surface of the sleeve and to cause the fastening device to engage with the shaft.

2. The fastening device as claimed in claim 1, wherein the locking collar is further configured to rotate over the sleeve so as to bear against a surface of the sleeve and to cause the fastening device to engage with the shaft.

3. The fastening device as claimed in claim 1, wherein the locking collar is configured to push along the shaft

4. The fastening device as claimed in claim 1, wherein the shaft is threaded.

5. The fastening device as claimed in claim 4, wherein the deformable sleeve is configured to engage with the threads of the shaft when the sleeve is deformed.

6. The fastening device as claimed in claim 1, wherein the shaft has a non circular cross section.

7. The fastening device as claimed in claim 1, wherein the locking collar includes a grip.

8. The fastening device as claimed in claim 1, wherein the fastening device includes a single sleeve only.

9. The fastening device as claimed in claim 1, wherein the sleeve includes a slit extending at least partially along the length of the sleeve.

10. The fastening device as claimed in claim 1, wherein an inner surface of the collar and an outer surface of the sleeve are tapered.

11. The fastening device as claimed in claim 1, wherein an inner surface of the collar and an outer surface of the sleeve are frusto-conical.

12. The fastening device as claimed in claim 1, wherein the locking collar is configured to push over the sleeve so as to bear against an outer surface of the sleeve.

13. A kit set for a fastening device, comprising: a deformable sleeve; a locking collar; and a shaft, wherein the deformable sleeve is configured to have a perimeter relative to the shaft such that the deformable sleeve can be pushed over the shaft, and the locking collar is configured to push over the sleeve so as to bear against a surface of the sleeve and to cause the fastening device to engage with the shaft.

14. A method of using a fastening device in relation to a shaft, the fastening device including a deformable sleeve and a locking collar, comprising: a) pushing the deformable sleeve into position along the shafts; b) pushing the locking collar along the shaft and over the deformable sleeve, so that a surface of the locking collar bears against a surface of the deformable sleeve; and c) pushing the locking collar further over the deformable sleeve until a surface of the deformable sleeve fastens to the shaft.

15. A method of using a fastening device in relation to a shaft, the fastening device including a deformable sleeve and a locking collar, comprising: a) forming a fastening device by pushing the deformable sleeve into the locking collar until the sleeve is held by the collar; b) pushing the fastening device into position along the shaft; and c) pushing the locking collar further over the deformable sleeve until a surface of the deformable sleeve fastens to the shaft.

16. (canceled)

17. (canceled)

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