(19) DANMARK

(10) DK/EP 3084233 T3

Patent- og Varemærkestyrelsen

(12) Oversættelse af europæisk patentskrift

(51) Int.Cl.: ***F 16 B 13/06 (2006.01)***

(45) Oversættelsen bekendtgjort den: **2018-01-02**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2017-11-01**

(86) Europæisk ansøgning nr.: **14812524.8**

(86) Europæisk indleveringsdag: **2014-12-16**

(87) Den europæiske ansøgnings publiceringsdag: **2016-10-26**

(86) International ansøgning nr.: **EP2014077941**

(87) Internationalt publikationsnr.: **WO2015091465**

(30) Prioritet: **2013-12-19 EP 13198324**

(84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**

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(54) Benævnelse: **Ekspansionsanker med drejningssikring**

(56) Fremdragne publikationer:
DE-A1-102008 057 584

The invention relates to an expansion anchor according to the preamble of Claim 1. An expansion anchor of this type is equipped with a stud and an expansion sleeve surrounding the stud, the stud having in the region of its forward end an expansion cone which enlarges the expansion sleeve radially when it is drawn into the expansion sleeve, wherein the stud has, especially in the region of its rearward end, a threaded portion for introducing tensile forces into the stud, wherein the stud has a shoulder which limits displacement, in particular axially directed displacement, of the expansion sleeve away from the expansion cone, and wherein the stud has at least one anti-rotation protrusion for inhibiting rotation of the expansion sleeve relative to the stud, in particular about the longitudinal axis of the stud, and wherein the anti-rotation protrusion starts from the shoulder and protrudes radially outwards from the stud.

An expansion anchor is known, for example, from DE 4116149 A1. It is used to anchor attachment parts to a borehole in a solid substrate, for example a concrete substrate. The known expansion anchor has an elongated stud which is provided with an expansion cone in the region of its forward end and has in the region of its rearward end a thread on which a nut is mounted. The expansion cone widens towards the forward end, that is, against the extraction direction. An expansion sleeve is arranged on the stud, offset in the extraction direction with respect to the expansion cone. This expansion sleeve is mounted on the stud such that it is displaceable on to the expansion cone towards the forward end of the stud. The displacement of the expansion sleeve relative to the stud towards the rearward end of the stud is limited by a stop configured as an annular shoulder.

During setting of the anchor, the stud is driven into the borehole in the substrate with its first end leading, against the extraction direction. As this happens the expansion sleeve is entrained by the annular shoulder and therefore also moves into the borehole. The nut is then screwed on until it contacts the substrate or any attachment part present as an abutment, and then is further tightened until a predefined torque is reached. This tightening of the nut causes the stud to be pulled a short distance back out of the borehole in the extraction direction. After the expansion anchor has been driven in, the expansion sleeve interlocks with the inner wall of the borehole and is therefore held back in the borehole when the stud is withdrawn. The expansion cone of the bolt is consequently pulled into the expansion sleeve, whereby the expansion sleeve is expanded because of the increasing diameter of the expansion cone. As this happens the expansion anchor jams with the expansion sleeve in the substrate, so that tensile loads can be transmitted to the substrate. This basic principle may preferably also be used in the anchor according to the invention.

When expansion anchors are used in real-world conditions, sand or drillings may in some cases enter the thread of the of the stud, which may cause an undesired increase in the friction between nut and stud and therefore a rise in the torque needed to screw on the nut. In the extreme case the friction of the nut on the thread may exceed the friction of the stud in the expansion sleeve. In this case an undesired blocking between nut and stud may occur. The stud slips round in the sleeve so that the nut cannot be tightened and the anchor cannot be set without difficulty.

To prevent such slippage, that is, such undesired rotation of the stud relative to the sleeve, the following US 3855896 A proposes to provide a knurl around the stud, starting from the annular shoulder, which knurl acts against the expansion sleeve from the inside and thereby increases the friction between stud and sleeve.

DE 2256822 A1 is concerned with means for preventing rotation of the expansion sleeve on the stud. Unlike US 3855896 A, in which the anti-rotation effect is achieved by an increase in friction, DE 2256822 A1 proposes anti-rotation means produced by corresponding geometrical shapes, that is form-fitting anti-rotation means.

Further expansion anchors with anti-rotation means between expansion sleeve and stud are disclosed by DE 29501182 U1, DE 3411285 A1, GB 1414562 A, CA 953958 A1, DE 2161224 A1, US 3750526 A, EP 0 874 167 B1 and DE 6610690 U.

According to EP 0893610 A1, an anti-rotation means for the stud is implemented by ribs projecting radially from the stud and acting directly against the borehole wall.

DE 10 2008 057 584 A1 describes an expansion anchor in the neck region of which are arranged at least three reinforcing ribs which extend as far as the abutment shoulder and are intended to divert stresses, especially under transverse loading.

According to DE 3508015 A1, the contact face for the sleeve, which is formed on the shoulder perpendicularly to the longitudinal axis of the stud, merges via a concave throat into the lateral surface of the cylindrical neck region of the stud, whereby a sharp edge tending to induce fracture is to be avoided.

It is the object of the invention to specify an especially reliable expansion anchor, which in particular can be reliably installed, which has especially good load-bearing properties and at the same time is especially simple to produce.

This object is achieved according to the invention by an expansion anchor having the features of Claim 1. Preferred embodiments of the expansion anchor are specified in the dependent claims.

An expansion anchor according to the invention is characterised in that the axial length l of the anti-rotation protrusion is less than twice the pitch p of the threaded portion arranged on the stud. Preferably, the axial length l of the anti—rotation protrusion is less than the pitch p of the threaded portion arranged on the stud. Consequently, at least:

$$\underline{l} < 2 \times p$$

and preferably:

$$l < p.$$

A basic idea of the invention can be seen to lie in making the anti-rotation protrusion, which acts on the rear end region of the expansion sleeve, for example through friction on the inside, very short, so that the anti-rotation protrusion loses effective contact with the expansion sleeve directly after the stud has begun to be withdrawn from the borehole during setting of the anchor. It has been recognised according to the invention, firstly, that, after the start of the expansion process of the expansion sleeve, an anti-rotation means is frequently no longer required. For as soon as the expansion sleeve is expanded radially by the expansion cone and is pressed against the borehole wall, the radial pressure force, and therefore the friction, between expansion sleeve and stud increases very sharply, so that from this time onwards an anti-rotation means between stud and expansion sleeve is generally no longer required. It has been further recognised according to the invention that, in the course of the expansion process during setting of the anchor and in the subsequent loaded state of the anchor, an anti-rotation means may even, under certain circumstances, be disadvantageous. For example a simple friction-based anti-rotation means increases the friction not only in the circumferential direction but also in the axial direction. This in turn can, firstly, impede the expansion process. In addition, it may prevent advantageous further expansion of the sleeve of the anchor once installed, and/or sliding back and forth of the expansion cone in the sleeve of the installed anchor, for example in the event of cyclically opening and closing cracks in the concrete. Furthermore, simple anti-rotation means can also lead to undesired point loading or linear loading of the sleeve. On the basis of these considerations, the invention proposes a particular anti-rotation means which acts only at the start of the setting process and is rapidly disengaged as soon as expansion of the sleeve has begun. Accordingly, the anti-rotation means acts only when it is actually needed whereas, in the state of the anchor in which it may potentially be disadvantageous, it no longer exerts any effect.

This only temporary effect of the anti-rotation means is produced, firstly, because the anti-rotation protrusion starts from the shoulder, that is, immediately adjoins the shoulder, and secondly because the axial extent of the anti-rotation protrusion is very small, said axial extent lying, in particular, within the order of magnitude of the thread pitch. Because of this dimensioning, the anti-rotation protrusion acts against the sleeve only immediately at the start of the setting process. As soon as the nut is tightened by approximately one revolution, the anti-rotation protrusion is disengaged from the expansion sleeve and can no longer impede the further expansion process. The advantages of an anti-rotation means can therefore be achieved without having to incur its potential disadvantages. According to the invention, this advantage can also be achieved at especially low manufacturing outlay because, according to the invention, the anti-rotation protrusion directly adjoins the shoulder, so that during manufacture it can be formed especially simply together with the shoulder, for example by upsetting.

The thread pitch may be understood, in the technically usual sense, to mean, in particular, the distance between two thread stages, in particular within the same thread turn, along the longitudinal axis of the stud; that is, the axial distance travelled as a result of one revolution of the threaded portion and/or one revolution of the nut on the threaded portion. The stud may also have additional threaded portions, in particular offset axially from the first threaded portion. If additional threaded portions are present the first threaded portion, the thread pitch of which is relevant here, may be in particular that on which the nut is arranged.

According to the invention, the expansion sleeve is arranged, in particular fastened, on the stud and is displaceable along the stud. When the terms “radial”, “axial” and “circumferential direction” are used in the text of this description, they may relate, in particular to the longitudinal axis of the stud which may be, in particular, the axis of symmetry and/or the centre axis of the stud. The expansion anchor may be, in particular, an expansion anchor which expands in a force-controlled manner. The expansion sleeve and/or the stud consist appropriately of a metal material which may also be coated, for example to influence friction in a specified manner.

According to the invention, the expansion cone can be pulled into the expansion sleeve by a common axial movement of the stud and of the expansion cone relative to the expansion sleeve. For this purpose the expansion cone is arranged on the stud in a suitably fixed manner, at least in the axial direction. The expansion cone is preferably formed integrally with the stud. The expansion anchor according to the invention may preferably also be referred to as a stud anchor.

According to the invention the expansion sleeve is forced radially outwards by the oblique surface of the expansion cone, and is thereby pressed against the borehole wall in the substrate, when the expansion cone is displaced axially relative to the expansion sleeve in the extraction direction of the stud. The expansion anchor is thereby anchored in the borehole. The extraction direction is preferably disposed parallel to the longitudinal axis of the stud and/or faces out of the borehole. Advantageously, the distance of the surface of the expansion cone from the longitudinal axis of the stud increases in the direction opposite to the expansion direction, that is, with increasing distance from the threaded portion. The surface of the expansion cone may be strictly conical. In keeping with the technically usual definition of an expansion cone, however, it is not necessarily so. For example, the surface of the expansion cone may also be convex or concave in longitudinal section.

The shoulder forms a rearward stop for the expansion sleeve which limits displacement of the expansion sleeve away from the expansion cone, that is, displacement of the expansion sleeve in the extraction direction. The shoulder preferably has an annular or at least intermittently annular abutment surface for the expansion sleeve, which abutment surface may preferably be disposed perpendicularly to the longitudinal axis of the stud. The shoulder is advantageously arranged axially between the expansion cone and the threaded portion and/or axially between the expansion sleeve and the threaded portion. The stud preferably has an annular collar running around it which may be formed, in particular, integrally with the stud, and/or which forms an at least local maximum diameter of the stud, the shoulder against which the expansion sleeve abuts being formed on the front side of the collar.

The anti-rotation protrusion is preferably formed integrally with the stud, which may be advantageous from a manufacturing point of view. According to the invention, the anti-rotation protrusion starts from the shoulder, in particular from the abutment surface for the expansion sleeve formed on the shoulder, which may imply, in particular, that it projects axially from the shoulder and/or from the abutment surface and/or merges directly into the shoulder and/or into the abutment surface.

It is especially advantageous that the axial length of the anti-rotation protrusion is less than 0.1 times the maximum axial extent of the expansion sleeve, that the axial length of the anti-rotation protrusion is less than the maximum thickness of the expansion sleeve, and/or that the axial length of the anti-rotation protrusion is less than 0.1 times the maximum diameter of the stud. According to these variants anti-rotation protrusions can be obtained which disengage especially reliably at the start of the expansion process of the expansion sleeve. The diameter of the stud is advantageously measured perpendicularly to its longitudinal axis.

It is further especially advantageous that the anti-rotation protrusion acts, in particular in an at least partially frictional manner, against the inner side of the expansion sleeve oriented, in particular radially, towards the stud. According to this embodiment the expansion sleeve covers the anti-rotation protrusion, at least partially radially toward the outside, in particular after the anchor has been driven into the borehole and/or at the start of the expansion process. In terms of manufacture, this can be implemented especially easily, for example by simply winding a sheet metal strip around the stud. In addition, in this case the anti-rotation protrusion can also be used for initial centring of the expansion sleeve. For a purely positive fit, or for a combined non-positive and positive fit, the inner side of the expansion sleeve may be provided with a radially oriented impression in which the anti-rotation protrusion is received. However, the inner side of the expansion sleeve in the region of the anti-rotation protrusion may also, preferably, be smooth. The inner side of the expansion sleeve against which the anti-rotation protrusion acts is, in particular bush-shaped and/or at least approximately cylindrical and/or is oriented towards the neck region of the stud. Preferably, an at least partially friction-based anti-rotation effect between expansion sleeve and stud is provided by the anti-rotation protrusion. This may imply, in particular, that the anti-rotation protrusion presses from radially inside against the expansion sleeve, so that a rotational movement of the sleeve relative to the anti-rotation protrusion around the longitudinal axis of the stud generates friction between the surface of the anti-rotation protrusion and the inner surface of the expansion sleeve.

Preferably, the maximum height of the anti-rotation protrusion, measured in the radial direction, is less than the pitch of the threaded portion arranged on the stud. This can be advantageous in manufacture since the required degree of deformation is relatively small.

A further preferred embodiment of the invention provides that the stud has at least one further anti-rotation protrusion. The reliability of the anti-rotation effect can thereby be further increased. Moreover, with a plurality of anti-rotation protrusions the expansion sleeve can be centred especially simply with respect to the stud, so that especially well-defined force relationships are present at the start of the expansion process. Preferably, a total of at least three anti-rotation protrusions may be provided. With this configuration, friction can be concentrated especially simply on the anti-rotation protrusions at the start of the expansion process, which can increase reliability still further. If a plurality of anti-rotation protrusions are provided, the features mentioned in this description in relation to a single anti-rotation protrusion may apply to some or all of the anti-rotation protrusions. If a plurality of anti-rotation protrusions are provided, they may be arranged, in particular equidistantly, around the circumference of the stud.

Furthermore, it may be provided that the expansion sleeve has at least one, in particular axially disposed, slot. This slot can facilitate the expansion process. The slot may separate two adjacent expansion segments. If a slot is provided, the stud may have a locking projection which engages in the slot. In this case an additional anti-rotation means which acts positively may be provided. The slot extends preferably as far as the forward end and/or the rearward end of the expansion sleeve.

According to the invention the threaded portion may be, in particular, an externally threaded portion. This can be advantageous with regard to ease of handling. The threaded portion serves primarily to introduce tensile forces acting in the extraction direction into the stud. In particular, the direction vector of the extraction direction may be oriented from the expansion cone to the threaded portion.

A further preferred configuration of the invention provides that a nut with a thread, in particular an internal thread, corresponding to the threaded portion is arranged on the threaded portion. This nut may serve to fasten the attachment part and to draw the stud with the expansion cone into the expansion sleeve. The nut is arranged rotatably, in particular about the longitudinal axis of the stud, on the threaded portion. The threaded portion, the pitch of which is relevant according to the invention, may be located, in particular, inside the nut.

The invention is explained in more detail below with reference to preferred exemplary embodiments represented schematically in the appended Figures, it being possible in principle for individual features of the exemplary embodiments shown below to be implemented singly or in any desired combination, in the context of the invention. In the Figures:

Fig. 1 shows schematically a partially sectional longitudinal view of an expansion anchor according to the invention set in a concrete substrate in a first embodiment;

Fig. 2 shows schematically a perspective view of the stud of the anchor from Fig. 1 with expansion sleeve;

Fig. 3 shows schematically a perspective view of the stud of the anchor from Fig. 1 without expansion sleeve;

Fig. 4 shows schematically a longitudinal sectional view of the stud of the anchor from Fig. 1;

Fig. 5 shows schematically a side view of the stud of the anchor of Fig. 1 represented in the detail X of Fig. 4, and

Fig. 6 shows schematically a cross-sectional view A-A according to Fig. 5 of the stud of the anchor from Fig. 1 including expansion sleeve.

The Figures show an exemplary embodiment of an expansion anchor 1 according to the invention. The expansion anchor 1 comprises a stud 10 and an expansion sleeve 20, the expansion sleeve 20 surrounding the stud 10 in an annular manner. In the region of its forward end 51 the stud 10 has an expansion cone 12 for the expansion sleeve 20, which expansion cone 12 is permanently adjoined at the rear by a neck region 11. The expansion cone 12 is arranged rigidly on the stud 10 and is preferably formed integrally with the stud 10.

In the neck region 11 the stud 10 has a substantially constant, preferably cylindrical cross section. On the expansion cone 12 adjoining the neck region 11 the surface of the stud 10 is configured as an oblique surface 13, and the diameter of the stud 10 increases from this point towards the first end 51; that is, starting from the neck region 11, the stud 10 widens along the expansion cone 12 towards its forward first end 51. The oblique surface 13 on the expansion cone 12 may be conical in the strict mathematical sense, but need not be.

At the end of the neck region 11 oriented away from the expansion cone 12, the stud 10 has a stop, configured as an annular shoulder 17, for the expansion sleeve 20. In the region of its rearward end 52 the stud has a threaded portion 18, configured with an external thread, for introducing tensile forces into the stud 10. A nut 8 is mounted on this threaded portion 18.

As shown, in particular, in Figs 2 and 6, the expansion sleeve 20 has axially disposed slots 22 and 22’ which facilitate the spreading of the expansion sleeve 20.

During a setting of the expansion anchor 1, the stud 10 is pushed with its forward end 51 leading through an attachment part 6 in the direction of the longitudinal axis 100 of the stud 10 and into a borehole 99 in the substrate 5 of Fig. 1. As this happens, because of the shoulder 17 which limits displacement of the expansion sleeve 20 away from the expansion cone 12, the expansion sleeve 20 is also moved into the borehole 99. Through tightening of the nut 8 bearing against the attachment part 6, the stud 10 is then immediately pulled back a short distance out of the borehole 99 in the extraction direction 101 disposed parallel to the longitudinal axis 100. As a result of its friction against the substantially cylindrical wall 98 of the borehole 99, the expansion sleeve 20 remains in the borehole 99, so that a displacement of the stud 10 relative to the expansion sleeve 20 takes place. In the course of this displacement the oblique surface 13 of the expansion cone 12 penetrates more and more deeply into the expansion sleeve 20, so that the expansion sleeve 20 is enlarged radially in the region of its forward end by the oblique surface 13 and is pressed against the wall 98 of the borehole 99. By means of this mechanism the expansion anchor 1 is fixed in the substrate 5. The set state of the expansion anchor 1, in which it is fixed in the substrate 5, is shown in Fig. 1.

As is shown, in particular, in Figs. 3, 5 and 6, the stud 10 has three anti-rotation protrusions 80, 80' and 80". The anti-rotation protrusions 80, 80' and 80" are arranged in the neck region 11 of the stud 10 and start from the shoulder 17; that is, they directly adjoin the shoulder 17. As shown, in particular, in Fig. 6, the anti-rotation protrusions 80, 80' and 80" are arranged equidistantly around the circumference of the stud 10, viewed in the cross section of the stud 10. As is further indicated in Fig. 6, the anti-rotation protrusions 80, 80' and 80" press radially from the inside against the approximately cylindrical inner side 21 of the expansion sleeve 20. They thereby provide for increased friction between expansion sleeve 20 and stud 10 and thus counteract undesired rotational slippage of the stud 10 in the expansion sleeve 20 as the anchor is set. Depending on their configuration, the anti-rotation protrusions 80, 80' and 80" may act only superficially or may be pressed more or less deeply into the expansion sleeve 20 in order to obtain a mixed, positive and non-positive, rotational coupling.

As can be seen, in particular, in Fig. 5, the axial length l of the rotational protrusions 80, that is, in particular, their maximum extent in the direction of the longitudinal axis 100, is less than the pitch p of the threaded portion 18; that is:

$$l < p.$$

The anti-rotation protrusions 80 therefore act only at the very beginning of the setting process and disengage from the expansion sleeve 20 as soon as the expansion process has progressed and the expansion sleeve 20 has been displaced a short distance away from the shoulder 17 towards the expansion cone 12. It can thereby be ensured, in particular, that the anti-rotation protrusions 80 do not impair the interaction between expansion sleeve 20 and expansion cone 12 once the anchor is set.

Seen from a different point of view, the axial length l of the anti-rotation protrusions 80 may be less than 0.1 times the maximum diameter d_{max} of the stud 10, which diameter d_{max} may be present, in particular, on the shoulder 17, as shown in Fig. 4. Seen from a further point of view, the axial length l of the anti-rotation protrusions 80 may be less than 0.1 times the maximum axial extent $l_{s,max}$ of the expansion sleeve 20, which is marked in Fig. 1. Seen from yet another point of view, the axial length l of the anti-rotation protrusions 80 may be less than the maximum thickness $t_{s,max}$ of the expansion sleeve 20, measured perpendicularly to the longitudinal axis 100, which thickness $t_{s,max}$ is marked in Fig. 6.

As shown, in particular, in Figs. 2 and 6, the expansion sleeve 20 may have projections 90 and 91 on its outer side, for better anchorage to the borehole wall 98. These may be formed, for example, as radial embossments, so that, as can be seen in Fig. 6, corresponding recesses may be formed on the inner side 21 of the expansion sleeve 20.

P a t e n t k r a v

1. Ekspansionsanker (1) med
- en bolt (10) og
- et ekspansionshylster (20), som omgiver bolten (10),
- hvor bolten (10) i området ved sin forreste ende (51) har en ekspansions-konus (12), som udvider ekspansionshylsteret (20) radialt, når den trækkes ind i ekspansionshylsteret (20),
- hvor bolten (10) har et gevindafsnit (18) til indføring af trækkræfter i bolten (10),
- hvor bolten (10) har en skulder (17), som begrænser en forskydning af ekspansionshylsteret (20) væk fra ekpansionskonussen (12), og
- hvor bolten (10) har mindst et drejningssikringsfremspring (80) til at hæmme en drejning af ekspansionshylsteret (20) i forhold til bolten (10), hvilken går ud fra skulderen (17) og rager radialt udad på bolten (10), **kendetegnet ved,**
- **at** drejningssikringsfremspringets (80) aksiale længde (l) er mindre end det dobbelte af ganghøjden (p) af det på bolten anbragte gevindafsnit (18).

2. Ekspansionsanker (1) ifølge krav 1,
kendetegnet ved,
- **at** drejningssikringsfremspringets (80) aksiale længde (l) er mindre end ganghøjden (p) af det på bolten anbragte gevindafsnit (18),
- **at** drejningssikringsfremspringets (80) aksiale længde (l) er mindre end 0,1 gange den maksimale aksiale udvidelse ($l_{s,max}$) af ekspansionshylsteret (20),
- **at** drejningssikringsfremspringets (80) aksiale længde (l) er mindre end den maksimale tykkelse ($t_{s,max}$) af ekspansionshylsteret (20), eller/og
- **at** drejningssikringsfremspringets (80) aksiale længde (l) er mindre end 0,1 gange boltens (10) maksimale diameter (d_{max}).

3. Ekspansionsanker (1) ifølge krav 1 eller 2,
kendetegnet ved,
at drejningssikringsfremspringet (80) virker mod den inderside (21) af ekspansionshylsteret (20), der vender mod bolten (10).

4. Ekspansionsanker (1) ifølge et af de foregående krav,
kendetegnet ved,

at bolten har mindst et yderligere drejningssikringsfremspring (80', 80'').

5. Ekspansionsanker (1) ifølge et af de foregående krav,
kendetegnet ved,
at ekspansionshylsteret (20) har mindst en slids (22), og at bolten har et blokeringsfremspring, som griber ind i slidsen (22).

6. Ekspansionsanker ifølge et af de foregående krav,
kendetegnet ved,
at gevindafsnittet (18) er et udvendigt gevindafsnit.

7. Ekspansionsanker ifølge et af de foregående krav,
kendetegnet ved,
at der på gevindafsnittet (18) er anbragt en møtrik (8) med et gevind, der svarer til gevindafsnittet (18).

Fig. 1

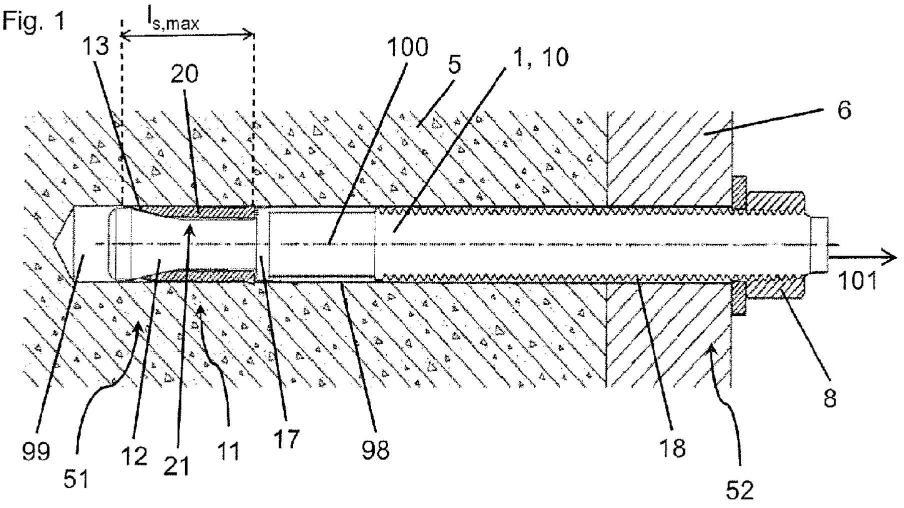

Fig. 2

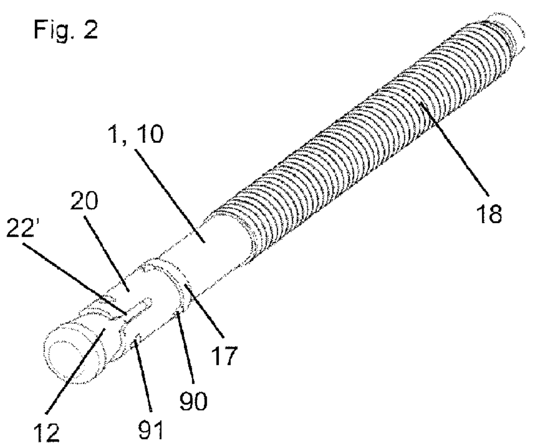

Fig. 3

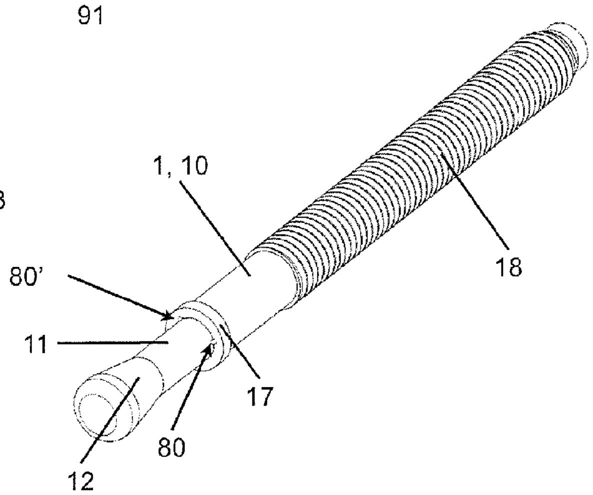

Fig. 4

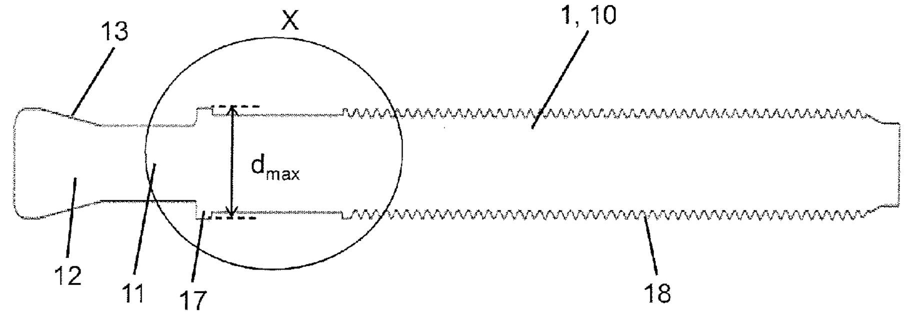

Fig. 5

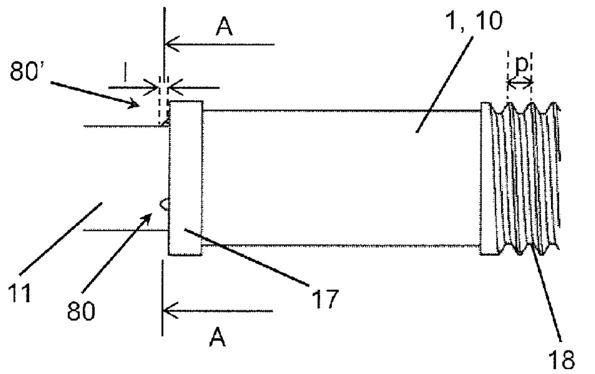

Fig. 6