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Description

The invention relates to a thread-tapping screw to be screwed into a drill hole in a hard material, in particular concrete or granite, in a screw-in direction.

A thread-tapping screw is known from WO 2004/074 697 A1. A tapping thread of the screw is provided with at least one tapping member which taps or cuts a drill hole thread into an inner circumferential surface of a drill hole. Using this screw for tapping a drill hole into a material of high hardness is problematic since when the screw is being screwed in, reactive forces occur which are applied to the screw by the material surrounding the drill hole in a direction radial and/or tangential to the central longitudinal axis of the screw in the form of pressures acting on the screw, said pressures making it difficult or impossible to screw in the screw. In particular, there is the risk that when an increased screw-in torque is applied to a screw, this will cause the screw to shear off, thus leading to the destruction of the screw.

A thread-tapping screw is known from EP 2 055 970 A2, wherein a tapping thread is provided with recesses, with a tapping body being inserted into each of the recesses. The material of the tapping body has a hardness that is greater than the hardness of the thread. Other self-tapping screws are for instance known from EP 2 055 969 A1, from EP 2 204 244 A1, and from EP 2 048 382 A2.

It is the object of the invention to provide a thread-tapping screw to be screwed into a drill hole in a hard material, in particular concrete or granite, in a screw-in direction such that the screw-in process is facilitated.
This object is achieved by the features of claim 1. The gist of the invention is that a tapping thread of a thread-tapping screw is provided with at least one tapping member comprising at least one tapping edge, wherein the tapping edge is arranged at a front end of the at least one tapping member when seen in a screw-in direction, and wherein the tapping edge is supported against the tapping thread by a support portion arranged downstream thereof when seen in

a direction opposite to the screw-in direction. The at least one tapping edge ensures that each tapping member has a comparatively small contact surface with an inner drill hole wall. The tapping member acts like a chisel. The at least one tapping member has a tapping material which has a hardness greater than that of a cylindrical core of the thread-tapping screw. The cylindrical core has a central longitudinal axis. In order to tap a drill hole thread into the material, the tapping thread is formed in one piece with the core and extends along a thread portion. The tapping thread has a tapping thread diameter.

The screw has a tapping insert of the tapping member which extends in the direction of the central longitudinal axis substantially in the shape of a segment of a circular arc and protrudes into the core. The tapping insert is easy to produce. It is in particular conceivable to produce a tapping insert in the form of a welding spot on the thread flanks of the tapping thread which is then ground to obtain a helical tapping thread. A tapping insert of this type extends from an outer edge of the tapping thread in a direction perpendicular to the central longitudinal axis substantially in the shape of a segment of a circular arc and protrudes into the core of the screw.

A screw according to claim 2 provides for a secure and permanent connection with the drill hole thread tapped by means of the tapping thread of the screw.
A screw according to claim 3 facilitates the application of a screw-in torque to the screw.

A screw according to claim 4 provides for an improved engagement of the tapping thread comprising the tapping member with the material surrounding the drill hole when screwing in the screw.

A screw according to claim 5 is adapted to receive, collect and transport waste material removed from the material surrounding the drill hole in a tapping process performed by means of a tapping member.

A screw according to claim 6 has several tapping members, wherein at least one pre-tapping member and at least one main tapping member are provided, wherein the main tapping member is provided downstream of the pre-tapping member in particular in a direction opposite to the screw-in direction. The at least one tapping edge of the pre-tapping member is then arranged at a smaller radial distance from the central longitudinal axis than the at least one tapping edge of the main tapping member. As a result, the at least one pre-tapping member pre-taps the drill hole thread into the in particular intact inner drill hole wall. To this end, the pre-tapping members may have a comparatively thinner width perpendicular to the helical thread and in particular a smaller tip width than the main tapping members. The main tapping members ensure that the pre-tapped tapping thread has the required dimensions as far as for instance a tapping thread diameter, a tapping thread depth and/or a tapping thread width are concerned.

A screw according to claim 7 provides for an improved pre-tapping of the drill hole thread since tapping is performed by more than one pre-tapping member. As a result, the mechanical load acting on the individual pre-tapping members and the resulting wear thereof are reduced.

A screw according to claim 8 has several main tapping members which may in particular configured identically. Using more than one main tapping member allows for a larger maximum engagement depth of the screw. Initially, only the first main tapping member comes into engagement along the screw-in direction if all main tapping members are configured identically. If the at least one tapping edge of one or several subsequent main tapping members is arranged at a greater radial distance form the central longitudinal axis, these tapping members allow the thread depth of the drill hole depth to be increased. If an upstream main tapping member wears out in a tapping process and for instance the geometry of the main tapping member is changed such that a tapping edge is arranged at a radial distance from the central longitudinal axis that is reduced compared to the initial state, tapping is performed by said worn-out main tapping member and by the tapping member arranged downstream of said tapping member. This means that when a tapping member wears out, this does not affect the suitability of the screw for use as a tapping screw. The main tapping members are preferably configured redundantly. A tapping member may for instance be considered worn out when the tapping edge thereof no longer protrudes beyond the diameter of a support thread.

A screw according to claim 9 has a particularly advantageous tapping behaviour. Due to the substantially serrated cross-section perpendicular to a helical flight of the tapping thread of the at least one tapping member, said tapping member has a reduced contact surface for engagement with the inner drill hole wall, in other words the rocky ground. At an identical screw-in torque, the reduced contact surface applies a comparatively higher pressure to the material surrounding the drill hole so that the tapping performance is improved. In particular, the serrated tapping member may for instance have a front tapping member flank oriented substantially radially relative to the central longitudinal axis and a rear tapping member flank oriented substantially tangentially relative to the central longitudinal axis. Correspondingly, the tapping member has a stable and rugged support portion. The risk that the tapping member breaks out in a tapping process is reduced. The at least one tapping edge is in particular arranged between the front and the rear tapping member flank and in particular oriented perpendicularly to the two tapping member flanks.

A screw according to claim 10 ensures an improved removal of material from the inner drill hole wall. The front tapping member flank is inclined relative to the radial direction of the central longitudinal axis, thus allowing the tapping behaviour to be adapted to the tapping material and/or the material surrounding the drill hole. An angle of inclination relative to the radial direction is in an angular range of +/- 10°, in particular +/- 8°, and in particular +/- 5°.

A screw according to claim 11 facilitates engagement of the front tapping member flank with the rocky ground. In a direction perpendicular to the helical flight of the tapping thread, the front tapping member flank may be linear, concave or convex, the respective shape allowing the edge to be adapted to the material surrounding the drill hole.

A screw according to claim 12 ensures a minimum length of the support portion such that a screw of this type has an increased stability. The rear tapping member flank has a convex shape in particular in a cross-section along the helical flight. A radius of the rear tapping member flank tapers, in particular continuously, from the tapping edge arranged at a front end of the rear tapping member flank in the screw-in direction.

The tapping member cross-section of a screw according to claim 13 has a particularly advantageous design. A tapping member of this type combines an improved tapping performance due to an increased abrasive behaviour with an increased stability of the tapping member due to the improved support.

A screw according to claim 14 has an improved effectiveness as far as the tapping process is concerned since a volumetric proportion removed from the material surrounding the drill hole by means of the individual tapping members is increased.

A screw according to claim 15 is adapted to perform pre-tapping and re-tapping by means of a single tapping member.

A screw according to claim 16 provides a simple manner of manufacturing a tapping member comprising at least two tapping edges.

A screw according to claim 17 has an improved tapping behaviour due to the fact that removed material is collected in a notch between two tapping edges for removal. This may prevent the screw from becoming jammed.

A screw according to claim 18 has improved tapping characteristics due to the fact that when the at least two tapping edges are arranged at different radial distance from the central longitudinal axis, the first tapping edge performs an effective pre-tapping process while the second tapping edge performs a reliable re-tapping process to produce the drill hole thread.

Additional features and details of the invention will be apparent from the ensuing description of three embodiments in conjunction with the drawing in which

Fig. 1 shows a partially open side view of a screw according to the invention;

Fig. 2 shows an illustration of the screw when completely screwed into a drill hole;

Fig. 3 shows a longitudinal section through a pre-tapping member along section line III-III in Fig. 1;

Fig. 4 shows a cross-section of the pre-tapping member along section line IV-IV in Fig. 1;

Fig. 5 shows a longitudinal section through a main tapping member according to a first exemplary embodiment along section line V-V in Fig. 1;

Fig. 6 shows a cross-section of the main tapping member along section line VI-VI in Fig. 1;

Fig. 7 shows a longitudinal section, corresponding to Fig. 5, through a main tapping member according to a second exemplary embodiment;

Fig. 8 shows a cross-section of the main tapping member according to Fig. 7;

Fig. 9 shows a longitudinal section, corresponding to Fig. 5, through a main tapping member according to a third exemplary embodiment; and

Fig. 10 shows a cross-section through the main tapping member according to Fig. 9.

The following sections describe a thread-tapping screw 1 according to the invention with reference to Figs. 1 and 2. The thread-tapping screw is adapted to be screwed into a drill hole 3 in a hard material 4, in particular concrete or hard natural stones such as granite, in a screw-in direction 2. It is conceivable as well to use the screw 1 for softer materials.

The screw has a substantially cylindrical core 5 with an insert end 6 and a central longitudinal axis 7. A tapping thread 8 is formed in one piece with the core 5, the tapping thread 8 extending from the insert end 6 helically, i.e. in the shape of a helix, so as to form a helical flight relative to the central longitudinal axis 7 along a tapping thread portion A_{SG}. The tapping thread 8 is self-tapping and allows a drill hole thread 9 to be tapped into an inner wall 10 of the drill hole 3 in the material 4. To this end, the tapping thread 8 is provided with several tapping members 11, 12 which are shown schematically in Figs. 1, 2. The core 5 has a core diameter D_K, and the tapping thread 8 has a tapping thread diameter D_{SG}, wherein the tapping thread diameter D_{SG} is greater than the core diameter D_K. The tapping thread diameter D_{SG} is defined by the tapping members 11.

The tapping members 12 arranged at a start 13 of the tapping thread 8 near an insert end 6 are also referred to as pre-tapping members 12. Correspondingly, the tapping members 11 arranged on the helical flight downstream of the pre-tapping members 12 in a direction opposite to the screw-in direction 2 are referred to as main tapping members 11. The main tapping members 11 are in particular arranged outside the insert end 6 and are in particular spaced from the start 13 of the thread by one pitch H_G. According to the exemplary embodiment of the screw 1 shown in Fig. 1, three pre-tapping members 12 are provided at the start 13 of the thread which are arranged one behind the other and at a distance from each other along the helical flight of the tapping thread 8 in the direction opposite to the screw-in direction 2. The pre-tapping members 12 are adjoined by the main tapping members 11 which are arranged along the helical flight of the tapping thread 8 in the direction opposite to the screw-in direction. According to the exemplary embodiment of the screw 1 shown in Fig. 1, four tapping members 11, 12 are provided along a helical flight circumference, in other words along one 360° revolution of the thread helices about the central longitudinal axis 7. A distance along the central longitudinal axis 7 between two points spaced from each other along the helical flight by one 360° revolution relative to the central longitudinal axis 7 is referred to as pitch H_G. It is conceivable as well to arrange more or less tapping members 11, 12 along the circumference of the helical flight. The pitch H_G substantially corresponds to a length of the insert end 6 along which the core 5 tapers in the shape of a conical portion.

The tapping thread portion A_{SG} is adjoined by a carrier thread portion A_{TG} along which a carrier thread 14 extends which is formed in one piece with the core 5. The carrier thread 14 is required for screwing the screw into the drill hole thread 9. The carrier thread 14 substantially corresponds to the tapping thread 8, wherein no tapping members are provided in the region of the carrier thread 14. Correspondingly, a carrier thread diameter D_{TG} is smaller than a tapping thread diameter D_{SG}. According to the exemplary embodiment shown in Fig. 1, the tapping thread 8 and the carrier thread 14 have an identical pitch H_G. This is advantageous as it allows the carrier thread 14 of the screw 1 to be screwed into the drill hole thread 9 tapped by the tapping thread 8 more easily.

The same applies to a length A_G of a total thread portion along the central longitudinal axis 7 of the screw 1: $A_G = A_{SG} + A_{TG}$. The total thread portion A_G may be adjoined by a circular cylindrical cylinder portion which has a substantially smooth surface. Further adjoined thereto is a collar portion A_K arranged opposite to the insert end 6, the collar portion A_K being provided with a collar 15 which is formed in one piece with the core 5 and protrudes radially relative to the core 5. The collar 15 has a plane front face 16 extending perpendicularly to the central longitudinal axis 7. The axial thickness of the collar 15 reduces as the radial distance increases, in other words the collar 15 is bounded by the front face 16 and a flank face 17 extending obliquely thereto, the two faces intersecting at an acute angle. Other cross-sectional shapes of the collar 15, such as a disk shape, are generally conceivable as well. The collar 15 has an outer diameter D_{KR}, with $D_{KR} / D_K \geq 1.2$, in particular ≥ 1.3, and in particular ≥ 1.5. The collar 15 allows the screw 1 to be countersunk in the drill hole 3 such that the front face 16 of the screw 1 is plane with a surface of the material 4.

It is conceivable as well for the screw 1 to be made without collar 15. In the region of the collar 15, a screw-in means in the form of a hexagon socket profile 18 is provided which allows a screw-in torque to be applied to the screw 1 in order to screw the screw 1 into the material. It is conceivable as well to provide a differently shaped screw-in means 18 such as a screw head attached to the core 5 so as to protrude beyond the core diameter D_K, the screw head for instance having a cross-section in the shape of a polygon head profile, in particular a hexagon head profile. The screw head allows a component to be secured in place. Other conventional screw-in means 18 are conceivable as well. The screw-in means 18 may for instance also be configured as a triangular socket or a square socket. Generally speaking, the screw-in means 18 may be a polygon socket. According to a preferred embodiment, the screw-in means 18 is a connection thread 18 with a polygon drive. Alternatively, the screw-in means 18 may also be provided in the form of a polygon socket arranged below an internal thread portion. Alternatively, in a screw 1 without collar 15, the screw-in means 18 is a polygon socket below an internal thread portion, allowing the screw 1 to be screwed in particularly deeply.

Along the central longitudinal axis 7, the screw 1 has a total length L which is such that $L \geq A_G + A_K$.

In the following sections, a pre-tapping member 12 is explained in more detail with reference to Figs. 3 and 4. The Figures show an enlarged sectional view of a longitudinal section along the helical flight of the tapping thread 8 along section line III-III in Fig. 1 which, corresponding to the plane of representation according to Fig. 3, is oriented perpendicularly to the central longitudinal axis 7. Near the start 13 of the thread, several pre-tapping members 12 are arranged one behind the other in a direction opposite to the screw-in direction 2. Each pre-tapping member 12 has a tapping edge 19 which is arranged at a front end of the pre-tapping member 12 along the screw-in direction 2. Seen in the screw-in direction 2, the tapping edge 19 is adjoined by a support portion 20. Via the support portion 20, the tapping edge 19 is supported against the tapping thread 8.

The pre-tapping member 12 has a tapping material which has a hardness greater than that of the core 5. The tapping material is configured as a tapping insert 21, thus protruding from the helical flight into the tapping thread 8 substantially in the shape of a segment of a circular arc such that it protrudes into the core at least partly. The core 5 may for instance consist of a metal having a carbon content of between > 0 and 0.5 wt.%. The pre-tapping member is configured as a welded body of metal connected to the tapping thread 8 and has a carbon content of more than 0.8 wt.%. The carbon content of the tapping material, in other words the metal of which the pre-tapping member is made, in particular amounts to at least 1.0 wt.%, in particular more than 1.5 wt.%, and in particular more than 2.0 wt.% of carbon.

The screw 1 is provided with several pre-tapping members 12, wherein the radial distances r_{VSi} thereof, with i = 1, 2, 3, ... n, of the respective tapping edge 19 increases in the direction opposite to the screw-in direction 2, i.e. $r_{VS1} < r_{VS2} < r_{VS3} < \ldots r_{VSn}$. This ensures that the screw 1 is drawn into the drill hole 3 as soon as the tapping process has started. This facilitates the self-tapping mechanism of the screw 1 as the first pre-tapping member 12 arranged at the start 13 of the thread performs a comparatively small part of the tapping work. The second pre-tapping member 12 arranged downstream thereof in the direction opposite to the screw-in direction 2 also contributes to the tapping work which is due to the fact that the trailing pre-tapping member 12 is larger than the leading pre-tapping member 12. Larger in this context means that the radial distance of the tapping edge 19 is increased. Furthermore, a width of the second pre-tapping member 12 is larger than that of the first pre-tapping member 12. Due to the fact that the tapping work is performed by more than one pre-tapping member 12, the mechanical load acting on each pre-tapping member 12, and therefore the risk of wear thereof, is reduced. Furthermore, the screw-in torque is reduced as well which allows the screw to be screwed in more easily. It is conceivable as well to adjust the sizes of pre-tapping members 12 arranged in succession along the helical flight such that the tapping work is evenly distributed among several, in particular three, pre-tapping members 12.

As shown in Fig. 4, each of the pre-tapping members 12 has a triangular, in particular isosceles, cross-section oriented perpendicularly to the helical flight of the tapping thread 8 with two identical side flanges intersecting at the tapping edge 19 in the form of an acute angle. The pre-tapping members 12 are used to pre-tap the drill hole thread 9, i.e. a thread is tapped into the inner wall 10 of the drill hole 3 which has a thread depth and thread width smaller than the drill hole thread 9 to be produced. The final and precisely required thread depth and thread width are produced by means of the main tapping members 11.

In the following sections, a fist exemplary embodiment of a main tapping member 11 is explained in more detail with reference to Figs. 5 and 6.

The main tapping member 11 according to the first exemplary embodiment has a substantially serrated cross-section along the helical flight of the tapping thread 8. The serrated cross-section has a front tapping member flank 22 oriented substantially radially relative to the central longitudinal axis 7, and a rear tapping member flank 23 connected thereto which is oriented substantially tangentially relative to the central longitudinal axis 7. Between the two tapping member flanks 22, 23, the tapping edge 19 is arranged at a radial distance r_{HS} from the central longitudinal axis 7. According to the exemplary embodiment shown in Fig. 5, the main tapping members 12 are configured identically. It is conceivable as well that main tapping members arranged one behind the other when seen in the direction opposite to the screw-in direction 2 have an increasing radial distance r_{HS} of the tapping edge 19 from the central longitudinal axis 7. According to the exemplary embodiment shown in Fig. 5, the front tapping member flank 22 is, starting from the central longitudinal axis 7, inclined relative to the radial direction by a positive angle of inclination $\underline{a}$ of 10°. It is conceivable as well that the front tapping member flank 22 is inclined relative to the radial direction by a negative angle of inclination $\underline{a}$. In this case, the main tapping member 12 is provided with a tapping member flank at the front tapping member flank 22 that is inclined inwardly, in other words towards the inside of the material. The inclination of the front tapping member flank 22 may be adjusted correspondingly, depending on the rock to be processed. The angle of inclination a amounts to an absolute value of at most 10 °, in particular at most 8 °, and in particular at most 5 ° relative to the radial direction of the central longitudinal axis 7. It is conceivable as well to provide a front tapping member flank 22 which is not linear but for instance concave or convex. This may for instance be advantageous in order to carry removed material away and out of the material.

The main tapping member 12 has a tapping insert 24. The tapping insert 24 comprises the tapping material which has already been explained with reference to the pre-tapping members 12.

The tapping edge 19 protrudes beyond the tapping thread diameter D_{SG}. This means that the drill hole thread 9 tapped into the drill hole 3 by the tapping thread 8 has a greater depth than the carrier thread 14. This allows the carrier thread 14 to be easily screwed into the tapped drill hole thread 9 at a reduced screw-in resistance. Due to the fact that the tapping thread 8 and the carrier thread 14 are substantially equal at least in terms of their thread widths, the screw 1 is securely held in the drill hole thread 9 with its carrier thread 14. The tapping edge 19 is arranged at a front end of the main tapping member 11 along the screw-in direction 2. The tapping edge 19 is adjoined by a support portion 20 in the direction opposite to the screw-in direction 2, the support portion 20 supporting the tapping edge 19 against the tapping thread 8.

The radial distance r_{HS} of the tapping edge 19 from the central longitudinal axis 7 is greater than the tapping thread diameter D_{SG}, i.e. the tapping thread 19 protrudes beyond the tapping thread 8.

According to the illustration in Fig. 5, adjacent main tapping members 11 are arranged in direct succession along the tapping thread 8, in other words they are not spaced from each other. It is conceivable as well to arrange adjacent tapping members 11, 12, in particular adjacent main tapping members 11, at a distance from each other along the tapping thread 8. A distance between the adjacent tapping members 11, 12 in particular amounts to at most 15% of the pitch H_G, in particular at most 12%, and in particular at most 10%.

A radial distance r_{VS} of the tapping edge 19 of a pre-tapping member 12 is smaller than the radial distance r_{HS} of the tapping edge 19 of the main tapping member 11. The same applies to a thread width perpendicular to the helical flight of the tapping thread 8. Such a thread width of the main tapping member 11 is greater than that of the pre-tapping member 12. The main tapping member 11 has a trapezoidal cross-section in a direction perpendicular to the helical flight of the tapping thread 8.

Due to the fact that the pre-tapping member 12 has a triangular cross-section relative to the helical flight, it is provided with sharp edges for performing a tapping process in the screw-in direction 2. The pre-tapping member 12 provides a substantially linear contact with the material 4 surrounding the drill hole 3. As a result, the contact surface between the pre-tapping member 12 and the material 4 is minimized.

Starting from the tapping edge 19, the rear tapping member flank 23 has a cylinder surface portion 25 oriented opposite to the screw-in direction relative to the central longitudinal axis 7. In this portion 25, the rear tapping member flank 23 is arranged concentrically to the central longitudinal axis 7. Said portion is adjoined by another portion of the rear tapping member flank 23 which has a radius that tapers continuously relative to the central longitudinal axis 7 in the direction opposite to the screw-in direction 2 such that starting from the radius r_{HS} of the tapping edge 19, the radius is reduced to a minimum of the radius r_{min}. The minimum radius r_{min} represents the end of the preceding main tapping member 11 when seen in the screw-in direction 2 and, at the same time, the beginning of the next subsequent main tapping member 11 when seen in the direction opposite to the screw-in direction 2. In contrast to the representation shown in Fig. 5, if two adjacent main tapping members 11 are arranged at a distance from each other, the end of the preceding pre-tapping member 11 is arranged at a distance from the beginning of the subsequent main tapping member 11. Between the end of the first and the beginning of the second main tapping member 11, the screw 1 may for instance have a constant minimum radius r_{min}. It is conceivable as well that a different radius is provided which may in particular be smaller than the minimum radius r_{min}.

The front tapping member flank 22 has a length L_{VF} of at most 15% of the tapping thread diameter D_{SG}, in particular of at most 10%, and in particular of at most 5%. According to the exemplary embodiment shown in Fig. 5, the front tapping member flank 22 is configured as a plane trapezoidal surface inclined by the angle of inclination a relative to the radial with respect to the central longitudinal axis 7. The front tapping member flank may also be concave or convex.

Correspondingly, the convex rear tapping member flank 23 has a length L_{HF} which corresponds to an arc length amounting to at least 25%, in particular at least 30%, and in particular at least 35% of the tapping thread diameter D_{SG}. This ensures that the support portion 20 provides a sufficient depth for supporting the tapping edge 19 and/or the front tapping member flank 22. The support portion 20 is required for stabilisation and provides resistance against tangential reactive forces occurring in a tapping process. In particular, a support portion 20 of this type is advantageous over pin-shaped tapping members which extend radially outwardly from the core 5 of a screw since the tapping members 11, 12 have an increased stability and rigidity in particular against forces oriented tangentially to the central longitudinal axis 7.

The length L_{HF} of the rear tapping member flank 23 is in particular greater than the length L_{VF} of the front tapping member flank 22, wherein the ratio L_{HF} / L_{VF} amounts to in particular at least 1.6, in particular at least 3, and in particular at least 7.

In the following sections, a second exemplary embodiment of the invention will be described with reference to Figs. 7 and 8. Identical components are designated by the same reference numerals as in the first exemplary embodiment to the description of which reference is made. Components configured differently but having the same function are designated by the same reference numerals followed by an a. The greatest difference with respect to the first exemplary embodiment is that the main tapping members 11a are provided with two tapping edges 19a, 26a. Correspondingly, a support portion 20a is provided downstream of the first tapping edge 19a while a support portion 27a is provided downstream of the second tapping edge 26a. The first tapping edge 19a is arranged at the front end along the screw-in direction 2 of the main tapping member 11a.

A respective radial distance of the tapping edges 19a, 26a from the central longitudinal axis 7 is greater than the tapping thread diameter D_{SG} of the tapping thread 8. Between the two tapping edges 19a, 26a, a radially outwardly open notch 28 of the main tapping member 11a is provided, wherein the second tapping edge 26a is arranged along the screw-in direction 2 at a rear notch end. The notch 28 is substantially semicircular and is also referred to as fillet. Due to the fact that an outer circumferential surface of the main tapping member 11a is reduced by the notch 28, the tapping behaviour of the tapping member 11a is improved. Furthermore, the notch 28 arranged along the screw-in direction 2 between the two tapping edges 19a and 26a may be used to collect and carry off waste material removed in the tapping process. This in particular prevents the screw 1 from getting jammed when being screwed in. Due to the fact that the tapping member 11a is provided with two tapping edges 19a, 26a, the tapping behaviour, in particular the effectiveness of a tapping process, is improved. If in particular the front tapping edge 19a should become worn out, the rocky bottom is then engaged by the second tapping edge 26a of the same tapping member 11a. The main tapping member 11a is also provided with a tapping insert 24a made of a material which is harder than that of the core 5.

In a direction perpendicular to the helical flight of the tapping thread 8, the main tapping member 11a has a substantially identical cross-sectional shape, just like the main tapping member according to the first exemplary embodiment. The cross-sectional shape is trapezoidal.

In the following sections, a third exemplary embodiment of the invention will be described with reference to Figs. 9 and 10. Identical components are designated by the same reference numerals as in the first exemplary embodiment to the description of which reference is made. Components configured differently but having the same function are designated by the same reference numerals followed by a b. As in the second exemplary embodiment, the main tapping member 11b has two tapping edges 19b and 26b each of which is supported by a support portion 20b or 27b, respectively, arranged downstream thereof in the direction opposite to the screw-in direction. The greatest difference with respect to the second exemplary embodiment is the arrangement of the tapping edges 19b, 26b as far as their radial distance to the central longitudinal axis 7 is concerned. The main tapping member 11b has a step-like cross-section along the helical flight of the tapping thread 8. The step-like cross-section comprises a first step portion 29 and a second step portion 30 arranged downstream thereof in the direction opposite to the screw-in direction 2. Correspondingly, the first tapping edge 19b is arranged at a front end of the first step portion 29, and therefore at the front end of the tapping member 11b. The second tapping edge 26b is arranged at the front end of the second step portion 30. The radial distance r_{1TA} of the first tapping edge 19b from the central longitudinal axis 7 is smaller than the radial distance r_{2TA} of the second tapping edge 26b. The main tapping member 11b has a tapping insert 24b.

Due to the fact that the tapping member 11b according to the third exemplary embodiment has two tapping edges 19b, 26b which are arranged on the tapping edge 8 at different radial distances r_{1TA}, r_{2TA} from the central longitudinal axis 7, the functions of pre-tapping and fine blanking are performed by one single tapping member 11b. The first tapping edge 19b arranged at the front of the tapping member 11b when seen in the screw-in direction 2 has a radial distance r_{1TA} which is smaller than the radial distance r_{2TA} of the subsequent second tapping edge 26b. Pre-tapping is performed by the first tapping edge 19b while the tapping process is completed by the second tapping edge 26b. The tapping process is thus performed in two stages by means of one tapping member 11b, which results in a reduced screw-in resistance.

All exemplary embodiments of the thread-tapping screw have in common that the tapping thread 8 is provided with a redundant number of tapping edges and in particular main tapping members. This means that even if one of the front tapping members when seen in the screw-in direction 2 has worn out, the screw is still able to perform a tapping process as the required additional tapping work related to the worn out tapping member will then be performed by the subsequent tapping members. A tapping member no longer contributes to the tapping process and is therefore worn out when the respective tapping edge no longer protrudes beyond the diameter of the carrier thread 14. A wear of a tapping member, in other words an abrasion of the tapping material in the region of the tapping insert only causes the geometry of the tapping member to change so that in particular the radial distance of the tapping edge from the central longitudinal axis 7 reduces. At this stage, however, a tapping operation is still possible using the partly worn out tapping member.

Due to the fact that the pre-tapping members 12 have a comparatively small width in a direction perpendicular to the helical flight of the tapping thread 8 and in particular meet at an acute angle in the region of the tapping edge, in other words they have an acute shape, the pre-tapping members are perfectly suitable for tapping processes, in other words for tapping the drill hole thread, also referred to as “drawing” the screw into the drill hole. By means of the main tapping members, a drill hole thread can be produced such as to have the required precision, thread width and thread depth.

Patentkrav

1. Gevindskærende skrue til indskruning i en indskruningsretning (2) i et borehul (3) i hårdt materiale (4), hvilken skrue (1) omfatter:

a. en i hovedsagen cylindrisk kerne (5) med en langsgående midterakse (7),
b. et skær-gevind (8), som strækker sig langs et skær-gevind-afsnit (A_{SG}), som er udformet ud i ét med kernen (5), og som tjener til skæring af et borehul-gevind i materialet (4), hvilket skær-gevind (8) har

i. en skær-gevind-diameter D_{SG} og
ii. mindst et skær-organ (11, 12; 11a, 12; 11b, 12), hvilket mindst ene skær-organ (11, 12; 11a, 12; 11b, 12) har

c. et skær-materiale med en i forhold til kernen (5) større hårdhed og
d. mindst én skær-kant (19, 19a, 26a; 19b, 26b),

i. som er indrettet langs indskruningsretningen (2) ved en forreste ende af det mindst ene skær-organ (11, 12; 11a, 12; 11b, 12) og
ii. som ved hjælp af et – i en retning modsat indskruningsretningen (2) betragtet - efterfølgende støbeafsnit (20; 20a, 27a; 20b, 27b) er støbt ved skær-gevindet (8),

e. en skær-indsats (21, 24: 24a; 24b), som strækker sig i retning af den langsgående midterakse (7) og i hovedsagen foreligger som et cirkelbue-segment,

kendetegnet ved, at skær-indsatsen (21, 24; 24a; 24b) rager ind i kernen (5).

2. Skrue ifølge krav 1, **kendetegnet ved, at** den har et bære-gevind (14), som er udformet ud i ét med kernen (5) og strækker sig langs et bæregevindafsnit (A_{TG}) med henblik på at kunne indskrues i borehulgevindet (9).

3. Skrue ifølge et af de foregående krav, **kendetegnet ved** et indskruningsmiddel (18), som tillader, at skruen (1) kan påvirkes med et indskruningsdrejningsmoment.

4. Skrue ifølge et af de foregående krav, **kendetegnet ved, at** den mindst ene skær-kant (19; 19a, 26a; 19b, 26b) rager radialt ud over skærgevinddiameteren D_{SG}.

5. Skrue ifølge et af de foregående krav, **kendetegnet ved, at** nogle langs skær-gevindet (8) anbragte skær-organer (11, 12; 11a, 12; 11b, 12) er anbragt med indbyrdes afstand, og at en afstand mellem de ved siden af hinanden anbragte skær-organer (11, 12; 11a, 12; 11b, 12) højst udgør 15% af en stigning H_G, især højst 12% af en stigning H_G, og helt særligt højst 10% af en stigning H_G.

6. Skrue ifølge et af de foregående krav, **kendetegnet ved, at** den har flere skær-organer (11, 12; 11a, 12; 11b, 12), som omfatter mindst et for-skær-organ (12) og i det mindste et hoved-skær-organ (11); 11a, 11b), og hvor en radial afstand r_{VS} mellem den mindst ene skær-kant (19) på for-skær-organet (12) og den langsgående midterakse (7) er mindre end en radial afstand r_{HS} mellem den mindst ene skær-kant (19; 19a, 26a; 19b, 26b) på hoved-skær-organet (11; 11a; 11b) og den langsgående midterakse (7).

7. Skrue ifølge krav 6, **kendetegnet ved, at** den har flere for-skær-organer (12), og at den radiale afstand r_{VS} af den mindst ene skær-kant (19) på for-skær-organerne (12) øges i en retning modsat indskruningsretningen (2).

8. Skrue ifølge krav 6 eller 7, **kendetegnet ved, at** den har flere hoved-skær-organer (11; 11a, 11b), og at den radiale afstand r_{HS} gældende for den mindst

ene skærekant (19; 19a, 26a; 19b, 26b) på et hovedskær-organ (11, 11a; 11b) er større end eller lig med den radiale afstand r_{HS} af den mindst ene skær-kant (19; 19a, 26a; 19b, 26b) på et – i modsat retning af indskruningsretningen (2) betragtet – efterfølgende indrettet hoved-skærorgan (11; 11a, 11b).

9. Skrue ifølge et af de foregående krav, **kendetegnet ved, at** den har et i hovedsagen savtakformet tværsnit langs en gevindskruelinje i forbindelse med skær-gevindets (8) udførelse med mindst et skær-organ (19), især omfattende en forreste skær-organ-flanke (22), som er orienteret i hovedsagen tangentialt i forhold til den langsgående midterakse (7) og med en bageste skær-organ-flanke (23), som er orienteret i hovedsagen tangentialt i forhold til den langsgående midterakse (7).

10. Skrue ifølge krav 9, **kendetegnet ved, at** den forreste skær-organ-flanke (22) hælder med en hældningsvinkel (a) på højst 10°, især højst 8°, og helt særligt højst 5° – i forhold til den radiale retning i relation til den langsgående midterakse (7).

11. Skrue ifølge krav 9 eller 10, **kendetegnet ved, at** den forreste skær-organ-flanke (22) har en længde L_{VF} på højst 5% af skær-gevind-diameteren D_{SG}, især højst 10% af skær-gevind-diameteren D_{SG}, og helt særligt højst 5% af skær-gevind-diameteren D_{SG}.

12. Skrue ifølge et af kravene 9 til 11, **kendetegnet ved, at** den bageste skær-organ-flanke (23) har en længde L_{HF}, som er mindst 25% af skær-gevind-diameteren D_{SG}, især mindst 30% af skær-gevind-diameteren D_{SG}, og helt særligt mindst 35% af skær-gevind-diameteren D_{SG}.

13. Skrue ifølge krav 9 til 12, **kendetegnet ved, at** længden L_{HF} af den bageste skær-organ-flanke (23) er større end længden L_{VF} af den forreste skær-organ-flanke (22), og især mindst 1,6 gange, særligt mindst 3 gange, og helt særligt mindst 7 gange længden L_{VF} af den forreste skær-organ-flanke (22).

14. Skrue ifølge et af kravene 9 til 13, **kendetegnet ved, at** den bageste skær-organ-flanke (23) – regnet fra den mindst ene skær-kant (19) – har et i forhold til den langsgående midterakse (7) orienteret cylinderkappeflade-afsnit (25).

15. Skrue ifølge et af kravene 1 til 8, **kendetegnet ved, at** den har mindst to skær-kanter (19a, 26a; 19b, 26b).

16. Skrue ifølge krav 15, **kendetegnet ved** en radialt udadrettet åben kærv (28) på skær-organet (11a), og at mindst en af skær-kanterne (26a) er indrettet ved en kærvende, især en bageste kærvende – set i indskruningsretningen (2)

17. Skrue ifølge krav 15 eller 16, **kendetegnet ved, at** der findes en kærv (28) mellem to skær-kanter (19a, 26a).

18. Skrue ifølge krav 15, **kendetegnet ved, at** den har et trappeagtigt tværsnit langs en gevind-skruelinje for skær-gevindet (8) hørende til skær-organet (11b), hvilket trappeagtige tværsnit har et første trappeafsnit (29) og et andet trappe-afsnit (30), og hvor en første radial afstand (r_{1TA}) vedrørende den mindst ene skær-kant (19b) i det første trappeafsnit (29) – set i forhold til længdemidterak-sen (7) – er mindre end en anden radial afstand (r_{2TA}) gældende for den mindst ene skær-kant (26b) ved det andet trappeafsnit (30) i forbindelse med den langsgående midterakse (7).

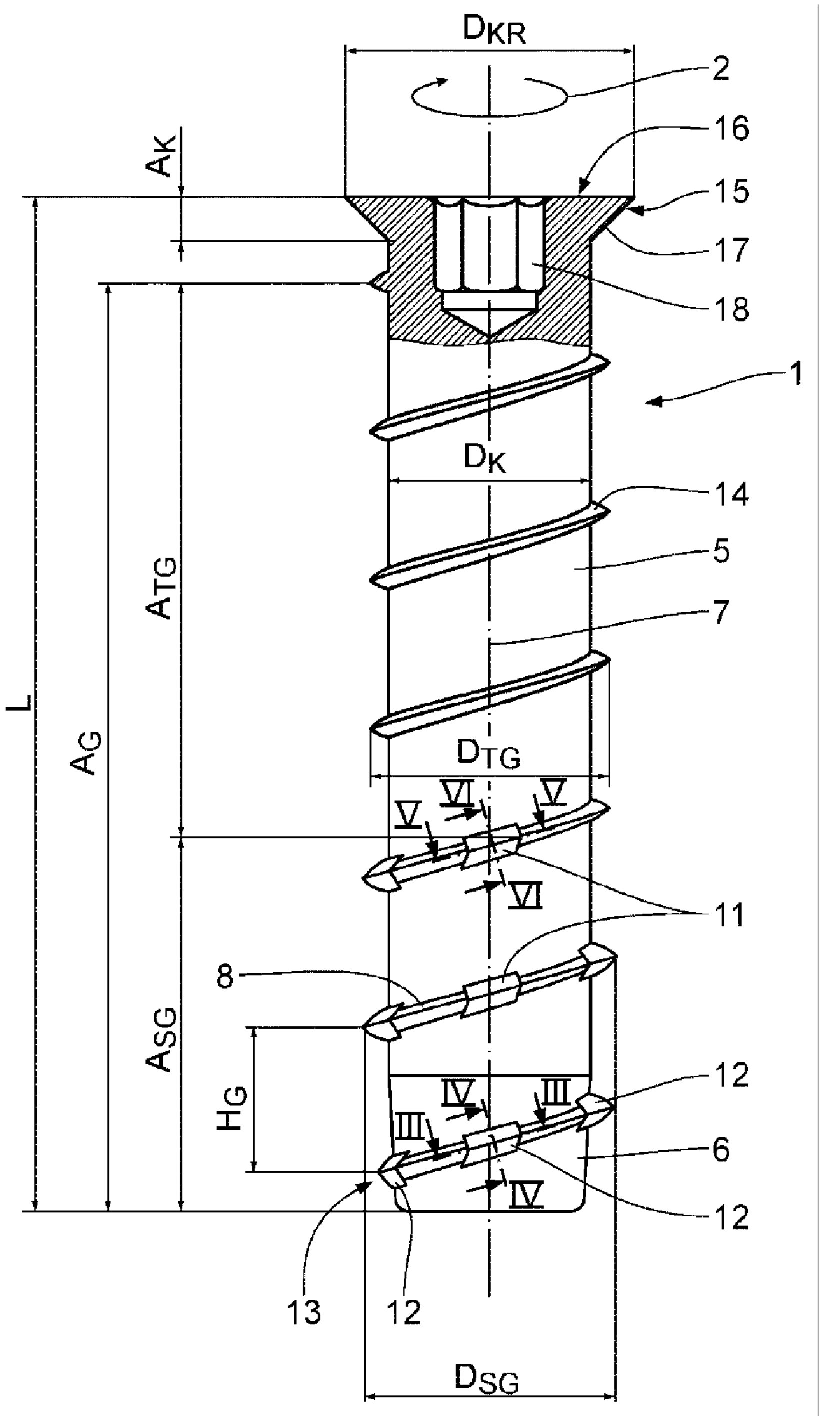
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Fig. 1

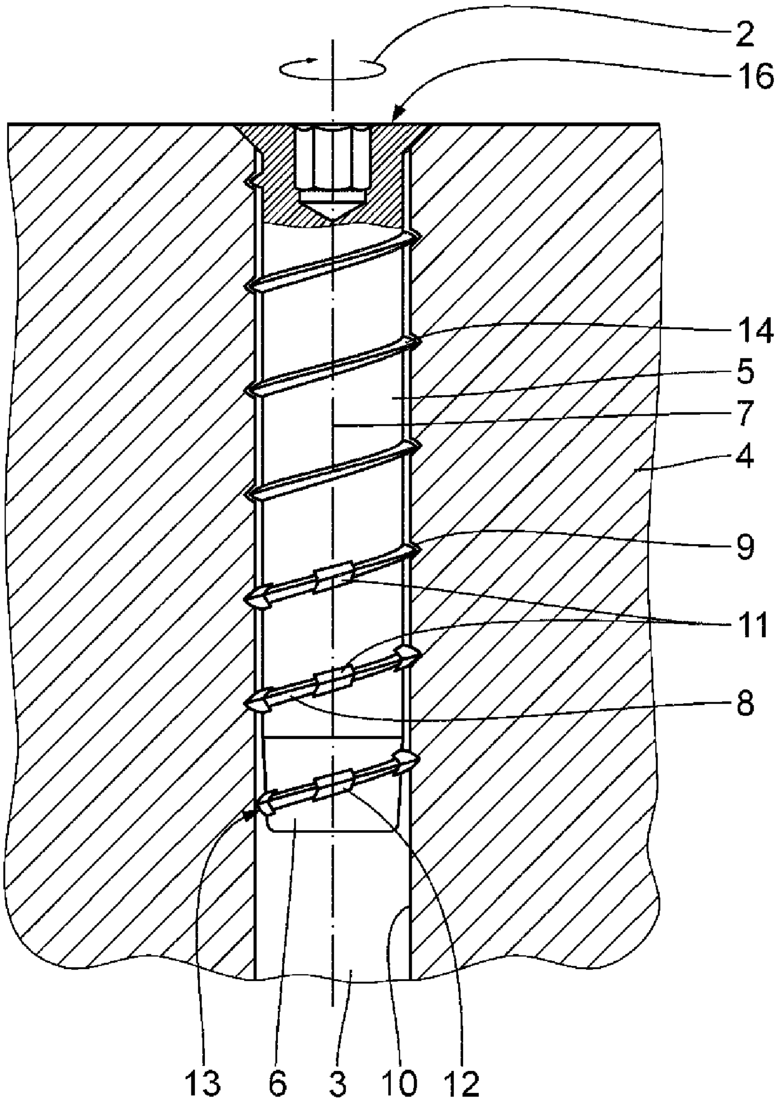

Fig. 2

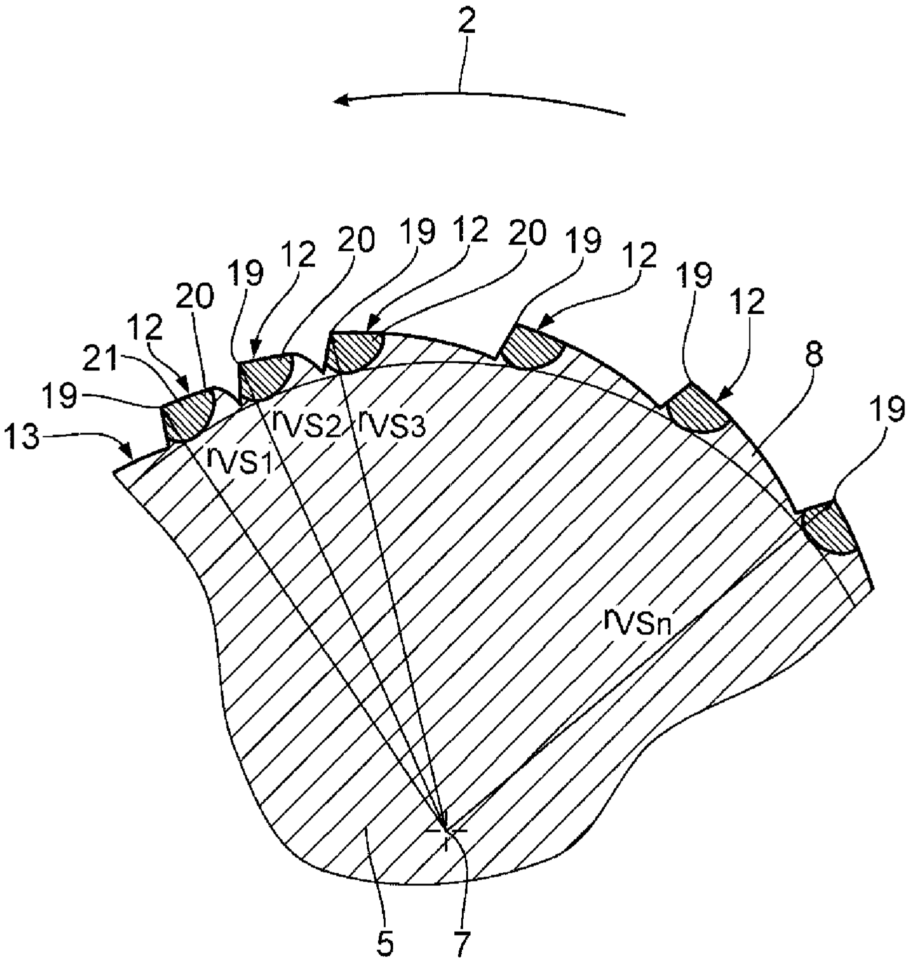
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Fig. 3

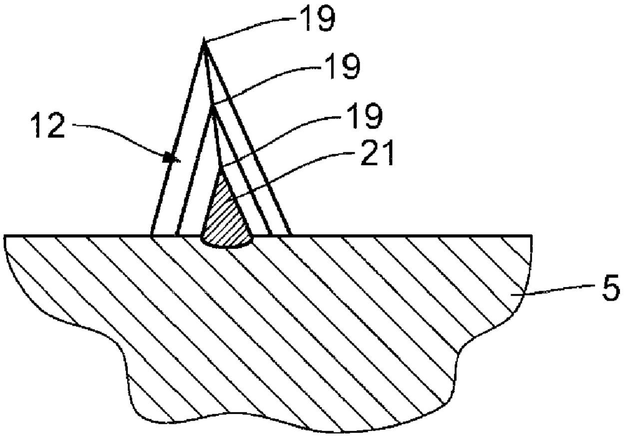

Fig. 4

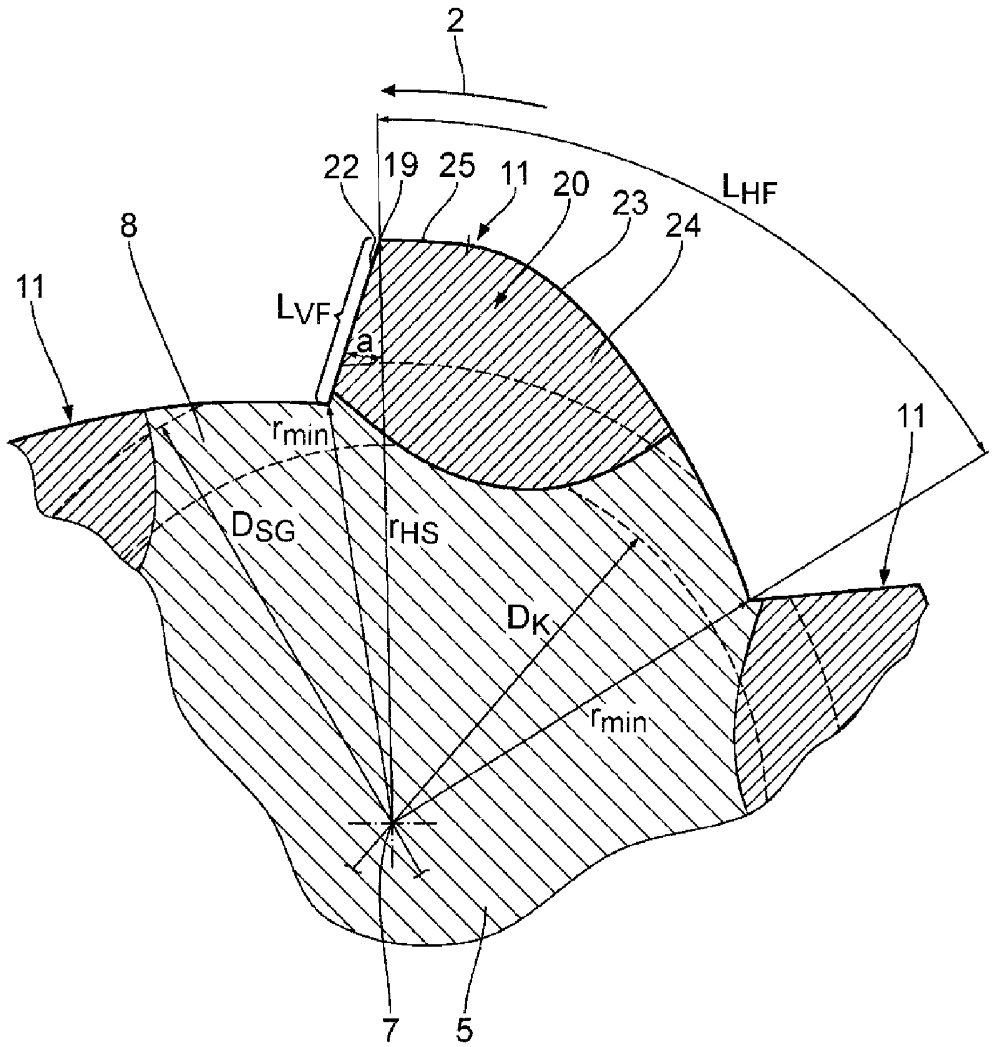

Fig. 5

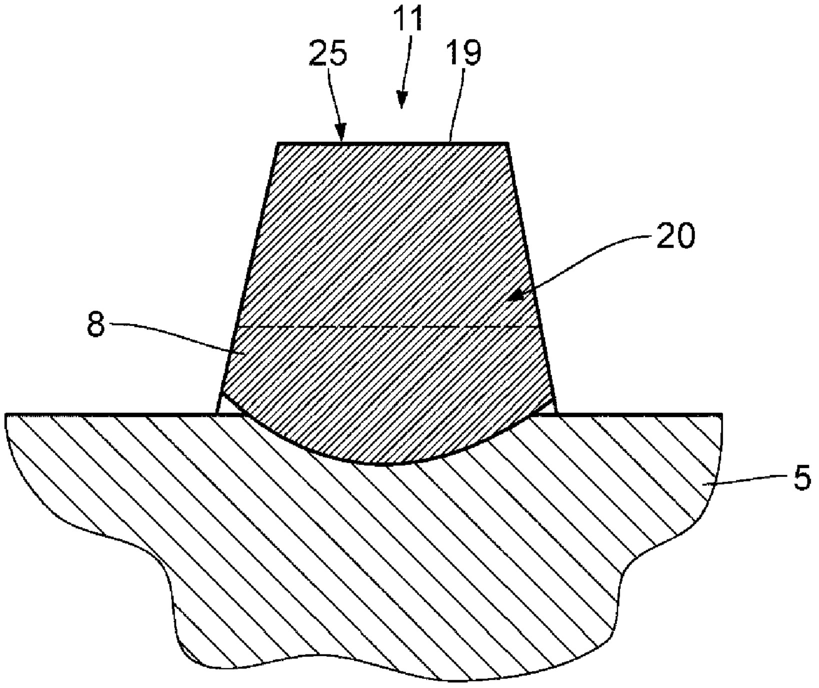

Fig. 6

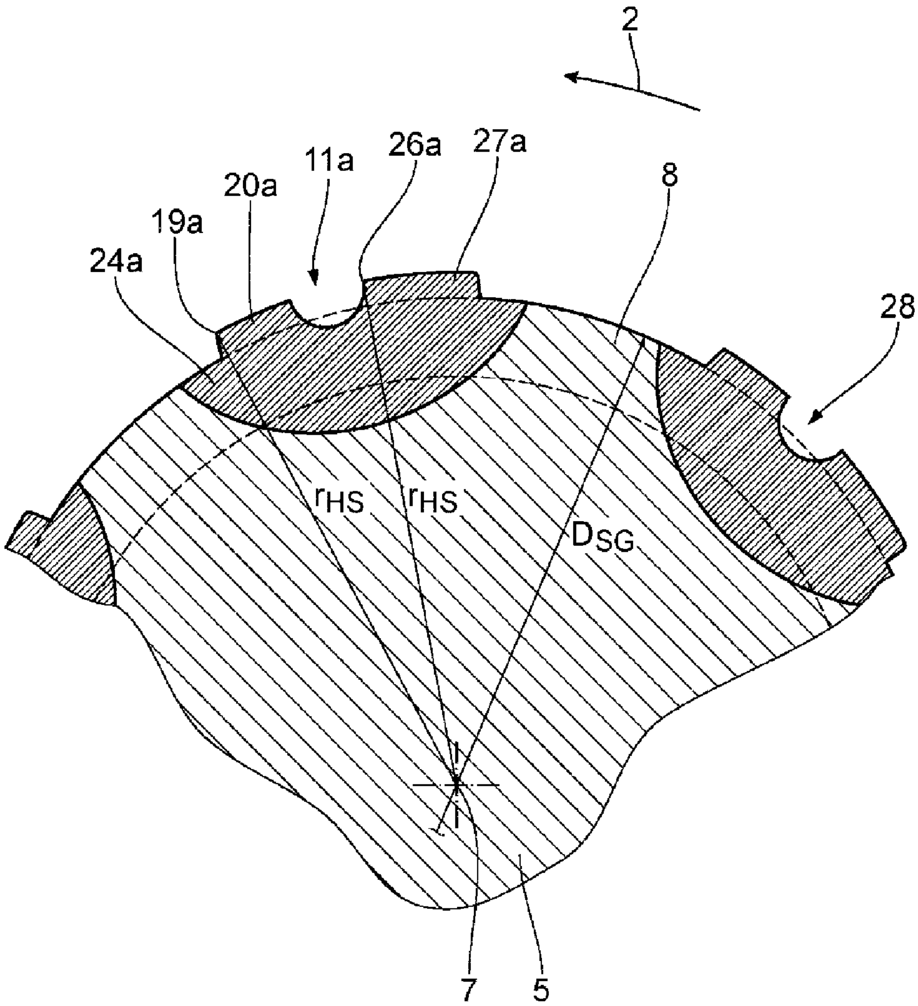

Fig. 7

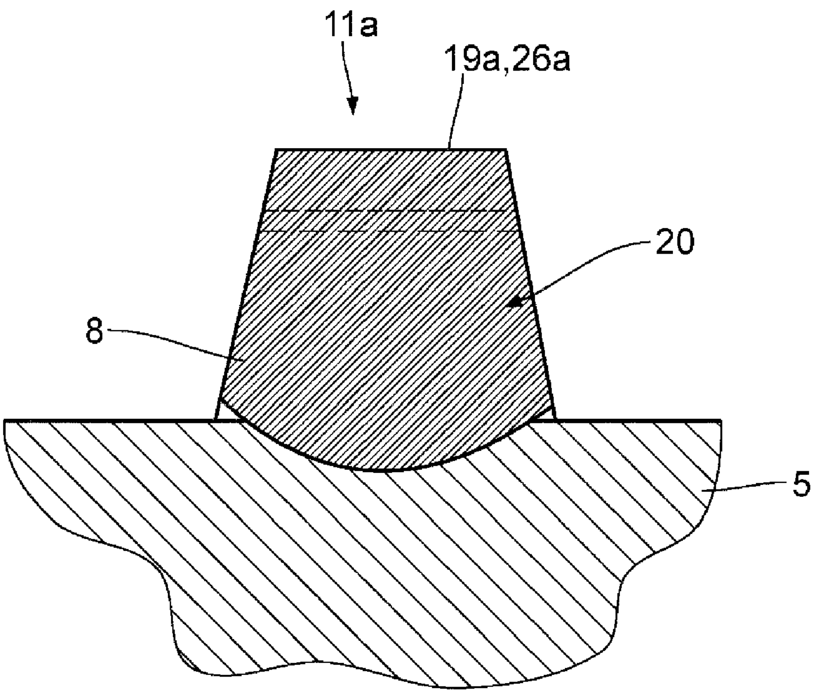

Fig. 8

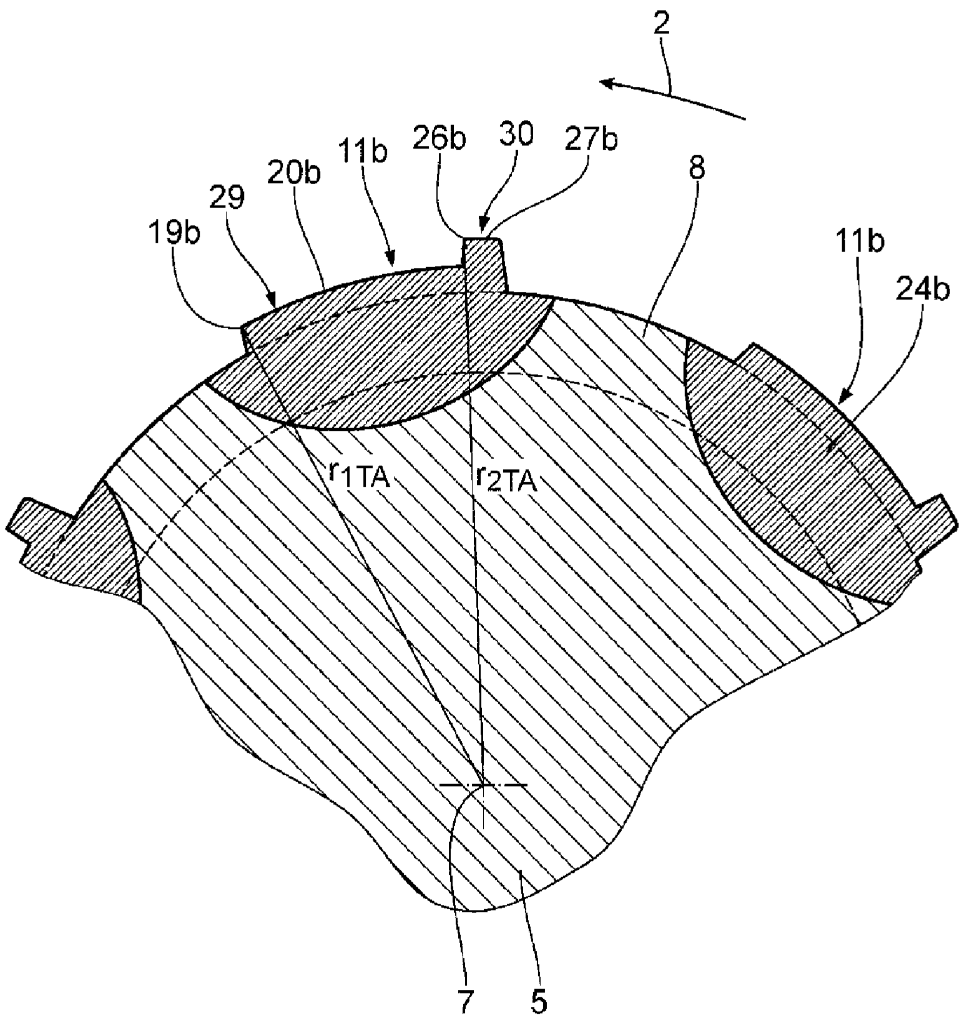

Fig. 9

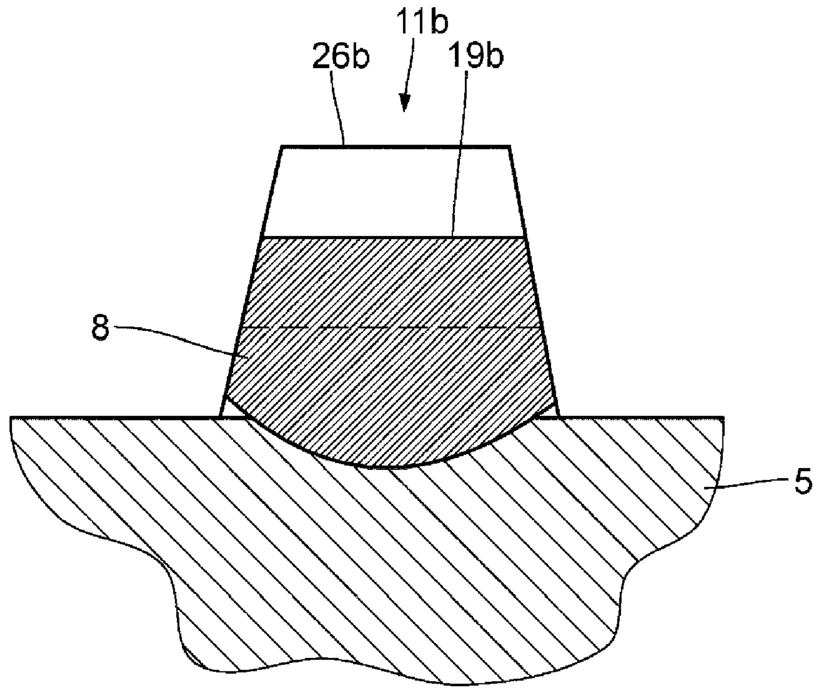

Fig. 10