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(54)	Benevnelse	**Screw element**
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The present invention relates to a screw element according to the preamble of Claim 1.

A screw element of the generic type is disclosed in EP 1 411 252 A2. A screw element of this type serves, in particular, for screwing into the widest variety of materials, such as wood or plastic, and specifically without prior pre-drilling of a core hole. The screw element is directly screwed into the respective material, wherein a displacement effect is achieved in that the material is initially penetrated by the threaded tip. The thread, which runs up to the front end, when viewed in the screw-in direction, acts as a gripping tip, in order to achieve good engagement and penetration by the screw element with low axial compression, that is to say, mainly by way of rotation alone. In the known screw element, the region having the polygonal core cross section should extend in each case up to the terminal front end of the threaded tip. Moreover, the polygonal core cross section should have side surfaces which are curved in a convex manner, and corners which may likewise be rounded. The corners of the polygon lie on an enveloping circle of which the diameter may be smaller than/equal to, but in particular also equal to, the diameter of the cylindrical shank core of the threaded shank. It is to be achieved here by the known connection element that chip formation is largely avoided when screwing-in, in that the self-tapping effect of the connection element is based on the threaded tip, on account of its polygonal core cross section, pressing itself into the material, a radial displacement effect being achieved by torque momenta which rise and ebb during rotation.

In the case of this known screw element, however, in particular when screwing into hardwood, splitting arises on account of the displacement effect of the screw tip which is polygonal in its cross section. In addition, a comparatively high axial force is necessary during initial screwing-in for the screw tip, having the thread, to grip.

The present invention is based on the object of further improving a screw element of the generic type with respect to its properties, in order to, in particular, largely avoid splitting and to further reduce the axial forces for screwing-in.

This is achieved according to the invention by the features of the characterizing part of Claim 1. By connectively combining, when viewed in the screw-in direction, the front tip portion which tapers off, having adjacent thereto the radially oriented end face edge, which acts as a cutting edge and/or milling edge, with the polygonal tip portion adjacent to the front portion and with continuous running of the screw thread from the front first tip portion to the second tip portion, adjacent thereto, of the screw tip, easy penetration by the screw is enabled, on the one hand, and the continuously running thread, on the other hand, grips immediately upon penetration by the front conical region, and the application of force, which is not interrupted and is axial through the thread, supports the cutting effect of the radially oriented end face edge of the polygonal portion and thus enables easy further penetration by the screw element according to the invention into the respective material. On account of the design of the front conically running portion with a maximum diameter which is smaller than the enveloping circle diameter of the polygonal portion adjacent thereto, easy penetration into the respective material is enabled. On account thereof, the splitting effect is also significantly reduced. According to the invention, it is of advantage for the front tip portion which tapers off to be configured as a pointed cone and to have a cone angle of 10° to 40°, in particular 20°. Here, it is expedient for the part-length of the conical front tip portion to be in a range of 0.8 to 2.0 times the thread lead of the screw thread of the screw element according to the invention. On account of the small cone angle and the diameter which is reduced in comparison with the diameter of the screw shank, the design according to the invention of the conical portion of the threaded tip supports easy penetration of the screw element according to the invention into the respective material. The polygonal tip portion which is adjacent to the conical portion preferably has an enveloping circle diameter which is larger than/equal to a maximum core diameter of the threaded shank which, in the cross section, is circular. On account thereof it is achieved that, on account of the core edges which are configured on the polygonal tip portion and which preferably run parallel to the central longitudinal axis, the screw hole produced, when viewed in the screw-in direction, by the front end face edge acting as a cutting edge cannot constrict itself again as a result of the resilience of the respective material into which the screw element according to the invention is screwed. The potentially resilient material is radially displaced or removed by the formed core edges, respectively, so that the screw shank which is adjacent to the polygonal tip portion can penetrate without great resistance into the drill hole produced by the screw tip.

Further advantageous embodiments are contained in the dependent claims and are described in more detail by means of the exemplary embodiments illustrated in the following drawings, in which:

Fig. 1 shows a perspective view of a screw element according to the invention,

Fig. 2 shows a perspective view of the screw element according to Fig. 1, but without screw thread,

Fig. 3 shows a longitudinal section through Fig. 2, but without screw head,

Fig. 3a to Fig. 3c show sectional views according to the cut lines A-A, B-B and C-C in Fig. 3,

Fig. 4, Fig. 5 and Fig. 6 show sections through alternative embodiments of the polygonal tip portion of the screw element according to the invention,

Fig. 7 shows a side view of the screw element according to the invention, according to Fig. 1,

Fig. 7a to Fig. 7c show sections through the screw element according to the invention, according to Fig. 7, along the cut lines A-A, B-B and C-C,

Fig. 8	shows a side view of the screw element according to Fig. 7, but in a position which is rotated by 45° in relation to the position in Fig. 7,
Fig. 8a to Fig. 8c	show sectional illustrations along the cut lines A-A, B-B and C-C in Fig. 8,
Fig. 9	shows a perspective view of a further embodiment of a screw element according to the invention,
Fig. 10	shows a perspective view of the screw element according to the invention, according to Fig. 9, but without screw thread.

In the various figures of the drawing, same parts are always provided with the same reference signs.

As is illustrated in the figures, a screw element 1 according to the invention comprises a threaded shank 2 and a screw tip 4 which is configured on one end of the former, and a screw head 5 which is on an end which is opposite to the screw tip 4 and which has a force application means 7 for a screwing tool. The screw head 5 may be configured as, for example, a countersunk head, a round head or a flat head. The screw head 5 may also be shaped as a cylindrical extension of the threaded shank 2. The force application means 7 may be configured as a slot, a cross slot or as a socket force application means, for example in the form of a hexagonal socket or of a star socket or also, for example, as a hexagonal head on the screw head 5.

A screw thread 12 runs on the threaded shank 2 and on the screw tip 4. The thread is preferably formed by a thread turn 13 which runs in a helical shape and which, in the cross section, is configured to be triangular, for example, cf. Figs. 7, 8. It is also within the scope of the invention for the thread 12 to be configured as a multi-turn thread, for example consisting of two thread turns which are of helical shape and arranged in a circumferentially offset manner.

The screw thread 12 is advantageously configured as a self-tapping or self-forming thread, respectively. The thread 12 may have a constant thread lead, or else a variable thread lead, over the entire thread region. The thread 12 has a maximum thread diameter d_g, i.e. the nominal diameter of the screw element according to the invention, which, in the illustrated exemplary embodiment, is constant in the region of the threaded shank, so that no change in the thread diameter is present in this region. The thread lead of the screw thread is preferably 40% to 70% of the nominal diameter d_g of the screw thread, and specifically in relation to a single-turn thread.

According to the invention, the screw tip 4 is composed of two tip portions 4a and 4b, and specifically, when viewed in the screw-in direction Z, of the front first tip portion 4a which tapers off towards the end of the screw element, and of the second tip portion 4b, which is adjacent to said first tip portion 4a. The tip portion 4b, when viewed in the cross section perpendicular to a central longitudinal axis X-X, has a polygonal cross section of its core having an enveloping circle 14 having a diameter d_{h1}, which runs through its polygon corners, cf. Fig. 3b. The first tip portion 4a is preferably configured as a pointed cone, as illustrated in Fig. 1, wherein its cone angle α may be 10° to 40°, in particular 20°, cf. Fig. 3. The conical first tip portion 4a, in relation to the central longitudinal axis X-X, has a perpendicularly running circular cross section. The screw thread 12 runs over the entire threaded tip 4, wherein its radial thread height decreases to zero up to the end of the conical portion 4a. In the region of the second tip portion 4b which is of polygonal cross-sectional shape, the thread 12 preferably runs at a constant thread height, so that, also in the region of the tip portion 4b, the thread 12 has the nominal thread diameter d_g, as in the region of the threaded shank 2. The enveloping circle 14 of the polygonal tip portion 4b is larger than the core diameter d_k of the screw core in the region of the tip portion 4a, cf. Fig. 3. According to the invention, on the transition between the first tip portion 4a and the second tip portion 4b, at least one end edge face 9 which, in relation to the longitudinal centre axis X-X, is radially oriented, specifically in the sense of a diameter enlargement, and which terminates in a vertex 15 of the polygonal cross section, which lies on the enveloping circle of the second tip portion 4b, is present. This radially running end edge face 9 forms a type of cutting edge or milling edge, respectively. In the illustrated exemplary embodiment, the polygonal cross section of the second tip portion 4b has four vertices 15, so that the four end edge faces 9 are configured, specifically in relation to the circumference of the screw element 1 according to the invention, cf. Fig. 2. As can be seen in particular in Fig. 1, the screw thread 12 runs without interruption over the first and second tip portions 4a, 4b, so that the screw thread 12 is also configured in the region of the end face edges 9. In Fig. 2, in which only the screw core of the screw element 1 according to the invention is illustrated, specifically the screw core in the region of the threaded shank 2 and in the region of the threaded tip 4, the configuration of the end face edge 9 is clearly visible in the transition from the first tip portion 4a to the second tip portion 4b. Here, the end face edges 9 run radially in relation to the longitudinal axis X-X. The enveloping circle of the second tip portion 4b advantageously has a diameter d_h which is larger than/equal to a maximum core diameter d_s of the threaded shank 2 which is circular in cross section. It is of advantage here for the enveloping circle diameter of the second tip portion 4b, which is polygonal in its cross section, to be constant over its axial length. As can be seen from the individual figures, the diameter of the pointed conical first threaded portion 4a, on its base face in the transition between the first and the second tip portions 4a, 4b, is smaller than the maximum core diameter d_s of the threaded shank 2. It is furthermore provided according to the invention that the screw thread 12, in the region of the second tip portion 4b and likewise on the shank portion 2, has a larger outer diameter d_g than the maximum enveloping circle diameter d_h of the polygonal tip portion 4b.

In the illustrated exemplary embodiment, the thread 12 runs over the entire length of the threaded shank 2. It is likewise within the scope of the invention for the thread 12 not to run over the entire length of the threaded shank 2, but for there to be a thread-free shank portion to be configured, for example between the threaded portion of the threaded shank 2 and the screw head 5, such that only a part-thread is present on the threaded shank 2.

Furthermore, it may be of advantage, according to the invention, for the part-length of the first tip portion 4a to be in the range of a minimum of 0.8 times to a maximum of 2.0 times the lead s of the thread 12.

As can be seen in particular from Figs. 3a to 3c and 4 to 6, the second tip portion 4b, in its cross section, is configured in a polygonal manner such that it forms a quadrangle having four vertices 15. It is expedient here for the four vertices 15 to lie in each case on intersecting straight lines g_1, g_2, running orthogonally to the central longitudinal axis X-X, of the polygonal cross section, and in each case to be at the same distance b from the longitudinal axis X-X. It is expedient here, when viewed in the cross section, if the core sides 22 connecting the vertices 15 are configured so as to be concave, as can be seen, in particular, in Fig. 6. In the illustrated exemplary embodiments, a quadrangle is illustrated as the polygonal cross section of the tip portion 4b, but, likewise, a triangular cross section or a cross section which has more than four corners may also be selected. It is preferred for a regular cross section to be configured. The vertices 15 of the individual cross sections, which lie behind one another in the longitudinal direction of the tip portion 4b, which is polygonal in its cross section, lie on straight lines which are parallel to the central longitudinal axis X-X, so that straight core edges 18 are formed and may thus have an additional milling effect, if a resilience of the material into which the screw element 1 according to the invention is screwed arises. As is illustrated in Fig. 6, the polygonal quadrangular cross section of the tip portion 4b may in each case be configured to be symmetrically folding about the orthogonal straight lines g_1, g_2. A shape which deviates therefrom is illustrated in Fig. 4, wherein the core sides 22 and/or the core side faces of the entire portion resultant therefrom are configured in such a manner that an asymmetry results in relation to the orthogonal straight lines g_1, g_2. A design is shown in Fig. 4, in which the side portions or face portions, respectively, which point towards the turning direction and which originate from the respective vertex 15 and/or the core edges 18, run radially steep in the direction towards the longitudinal axis X-X in such a manner that they enclose an acute angle $\beta < 20°$ with the respective straight line running through the vertex 15 and, adjacent thereto, run in an almost straight line to that vertex 15 which follows in the turning direction. In Fig. 4, a shape of this type according to the invention for a clockwise turning direction D is illustrated, and in Fig. 5, a corresponding shape with the turning direction D being counter-clockwise is illustrated. In Figs. 3 to 3c, a polygonal cross-sectional shape of the tip portion 4b, corresponding to Fig. 4, is illustrated. A corresponding cross-sectional shape of the polygonal tip portion 4b is also selected in Figs. 7 and 8. On account of the configuration of the polygonal cross section according to Figs. 4 and 5, an improved cutting effect and/or milling effect of the cutting edges 18 is achieved, which applies to the embodiment according to Fig. 4. In the embodiment according to Fig. 5, the effect is accordingly that in the case of a turning direction D, which is present when subjecting a screw according to the invention to rotation when loosening, loosening is met with a higher resistance.

In Figs. 9 and 10 a design of a screw element 1 according to the invention, which substantially corresponds in a corresponding manner to the screw element 1 according to Figs. 1 to 8 is illustrated, wherein, however, there is one difference in that the enveloping circle diameter d_h of the enveloping circle 14 of the polygonal tip portion 4b is not constant and not of the same size over the entire length of the tip portion 4b, but that the enveloping circle diameter d_h, commencing with a diameter d_{h1} in the region of the end edge faces 9, becomes larger, specifically preferably continuously larger, towards the threaded shank 2, up to the maximum enveloping circle diameter d_{h2} in the remaining region of the polygonal tip portion 4b. Here, the length over which an increase of the enveloping circle diameter d_h up to the maximum diameter takes place is preferably 10% to 50% of the entire length of the polygonal tip portion 4b. The difference in diameter between the enveloping circle diameter d_{h1} in the region of the end face edge 9 and the maximum enveloping circle diameter dh_2 in the region of the polygonal tip portion 4b, in which a constant enveloping circle diameter d_{h2} is present, is 5% to 20% of the maximum enveloping circle diameter d_h.

As illustrated in the individual figures, in the screw element 1 according to the invention the outer thread edge of the thread 12, in the region of the threaded shank 2 and also over the polygonal tip portion 4b, runs at a constant radius and a constant thread height. Over the region of the tip portion 4a in the shape of a truncated cone and up to the end of the same, the thread turn 13 runs helically and with a radius which continuously decreases to zero and with a decreasing thread height.

In one advantageous design which is not illustrated in the drawings, the thread edge of the thread 12, at least in the region of the threaded portion 4 and simultaneously in the region of the flank face of the thread, may moreover be configured in a wavelike manner such that a sequence of wave crests and wave troughs is present. Here, reference is made in full to document DE 3335092 A1.

List of reference signs:

1	Screw element
2	Threaded shank
4	Screw tip
4a	Tip portion
4b	Tip portion
5	Screw head
7	Force-application means
9	End edge face (end face edge)
12	Screw thread
13	Thread turn
14	Enveloping circle
15	Vertices
18	Core edges (cutting edges)
22	Core sides
b	Distance
D	Turning direction
d_g	Thread diameter
d_h	Diameter of the enveloping circle
d_{h1}	Diameter of the enveloping circle
d_{h2}	Diameter of the enveloping circle
d_k	Core diameter of 4a
d_s	Maximum core diameter of the threaded shank 2
g_1	Orthogonal straight lines
g_2	Orthogonal straight lines
X-X	Central longitudinal axis
Z	Screw-in direction

Patentkrav

1. Skruelement (1), omfattende et gjengeskaft (2) og en skruetupp (4) utformet på én skaftende og et skruehode (5) med et kraftangrepssted (7) og utformet på den motstående skaftenden, og med en skrugjenge (12) som strekker seg på gjengeskaftet (2) og skruetuppen (4), der skruetuppen (4) har et, sett i innskruingsretningen (Z), fremre første tupparti (4a) som blir smalere i retningen mot skruelement-enden, og tilsluttende dertil et andre tupparti (4b) med et, sett i tverrsnitt, polygonalt tverrsnitt hvis rullsirkeldiameter (d_h) er større enn en kjernediameter (d_k) til det første tuppartiet (4a),
karakterisert ved at det første tuppartiet (4a) har et sirkelformet tverrsnitt, og på overgangen mellom det første tuppartiet (4a) og det andre tuppartiet (4b) finnes det på sistnevnte minst én endekantflate (9) som, med formål om en diameterforstørrelse, er rettet radialt i forhold til en langsgående midtakse (X-X) og ender i et av det polygonale tverrsnittets hjørnepunkter (15) som ligger på det andre tuppartiets (4b) rullsirkel (14), samt at skrugjengen (12) er utformet kontinuerlig uavbrutt over skruetuppens (4) første og andre tupparti (4a, 4b).

2. Skruelement ifølge krav 1,
karakterisert ved at det andre tuppartiets (4b) rullsirkel (14) har en diameter (d_h) som er større/lik en maksimal kjernediameter (d_s) til gjengeskaftet (2) som fortrinnsvis er sirkelformet i tverrsnitt.

3. Skruelement ifølge krav 1 eller 2,
karakterisert ved at rullsirkeldiameteren (d_h) til skruetuppens (4) andre tupparti (4b) er konstant over sin aksiale lengde.

4. Skruelement ifølge krav 1 eller 2,
karakterisert ved at skruetuppens (4) andre tupparti (4b) har en rullsirkeldiameter (d_{h1}) på overgangen fra det første tuppartiet (4a) til det andre tuppartiet (4b) som er mindre enn rullsirkeldiameteren (d_{h2}) i det andre tuppartiets (4b) ende som vender mot gjengeskaftet (2).

5. Skruelement ifølge et av kravene 1 til 4,
karakterisert ved at det første tuppartiet (4a) er utformet som spiss konus med en konusvinkel (α) i området fra 10° til 40°, spesielt 20°.

6. Skruelement ifølge krav 5,
karakterisert ved at diameteren (d_k) til det første tuppartiet (4a) som er utformet som spiss konus, på sin grunnflate ved overgangen mellom det første og andre tuppartiet (4a, 4b) er mindre enn gjengeskaftets (2) maksimale kjernediameter (d_s).

7. Skruelement ifølge et av kravene 1 til 6
karakterisert ved at skrugjengen (12) i området ved det andre tuppartiet (4b) og skaftpartiet (2) har en ytterdiameter (dg) som er større enn den maksimale rullsirkeldiameteren (d_h) i området ved det polygonale tuppartiet (4b).

8. Skruelement ifølge et av kravene 1 til 7,
karakterisert ved at det første tuppartiets (4a) dellengde tilsvarer 0,8 til 2,0 ganger en maksimal gjengestigning (S) til skrugjengen (12), der gjengestigningen (S) fortrinnsvis tilsvarer 40 % til 70 % av den maksimale gjengediameteren (dg) ved en enkeltgjenget gjenge.

9. Skruelement ifølge et av kravene 1 til 8,
karakterisert ved at gjengeytterdiameteren (dg) på det første tuppartiet (4a) øker, begynnende ved skurelement-enden, fra 0 til den maksimale gjengeytterdiameteren (dg) på det andre tuppartiet (4b).

10. Skruelement ifølge et av kravene 1 til 9,
karakterisert ved at det polygonale tuppartiets (4b) polygonale tverrsnitt har minst tre, fortrinnsvis fire hjørnepunkter (15) som ligger på det polygonale tuppartiets (4b) rullsirkel (14).

11. Skruelement ifølge krav 10,
karakterisert ved at de fire hjørnepunktene (15) skjærer på to rette linjer (g_1, g_2) til det polygonale tverrsnittet som skjærer hverandre ortogonalt i den sentrale lengdeaksen (X-X), og har samme avstand (b) fra lengdeaksen (X-X).

12. Skruelement ifølge krav 10 eller 11,
karakterisert ved at de fire hjørnepunktene (15) til det polygonale tuppartiets (4b) polygonale tverrsnitt er anordnet i lengderetning etter hverandre på rette linjer som strekker seg parallelt med den sentrale lengdeaksen (X-X), slik at det dannes rettlinjede kjernekanter (18).

13. Skruelement ifølge krav 11 eller 12,
karakterisert ved at det polygonale tverrsnittets hjørnepunkter (15) er forbundet via kjernesider (22) hvis konkav utforming er slik at det dannes et polygonalt tverrsnitt som er utformet aksialsymmetrisk i forhold til de ortogonale rette linjene (g_1, g_2) som går gjennom hjørnepunktene (15).

14. Skruelement ifølge krav 11 eller 12,
karakterisert ved at kjernesidene (22) som forbinder det polygonale tverrsnittets hjørnepunkter (15), er utformet asymmetrisk i forhold til de ortogonale rette linjene (g_1, g_2) som går gjennom hjørnepunktene (15), på en slik måte at det oppnås en økt skjære- eller fresvirkning i inndreiingsretningen (D) eller i utdreiingsretningen (D) til et skruelement (1) ifølge oppfinnelsen.

15. Skruelement ifølge et av kravene 1 til 14,
karakterisert ved at gjengen (12) har en ytre gjengekant som, sett i den sentrale lengdeaksens (X-X) aksiale retning, strekker seg spiralformet og i området ved gjengeskaftet (2) i konstant radius og over området ved skruetuppen (4) spiralformet med kontinuerlig avtagende radius.

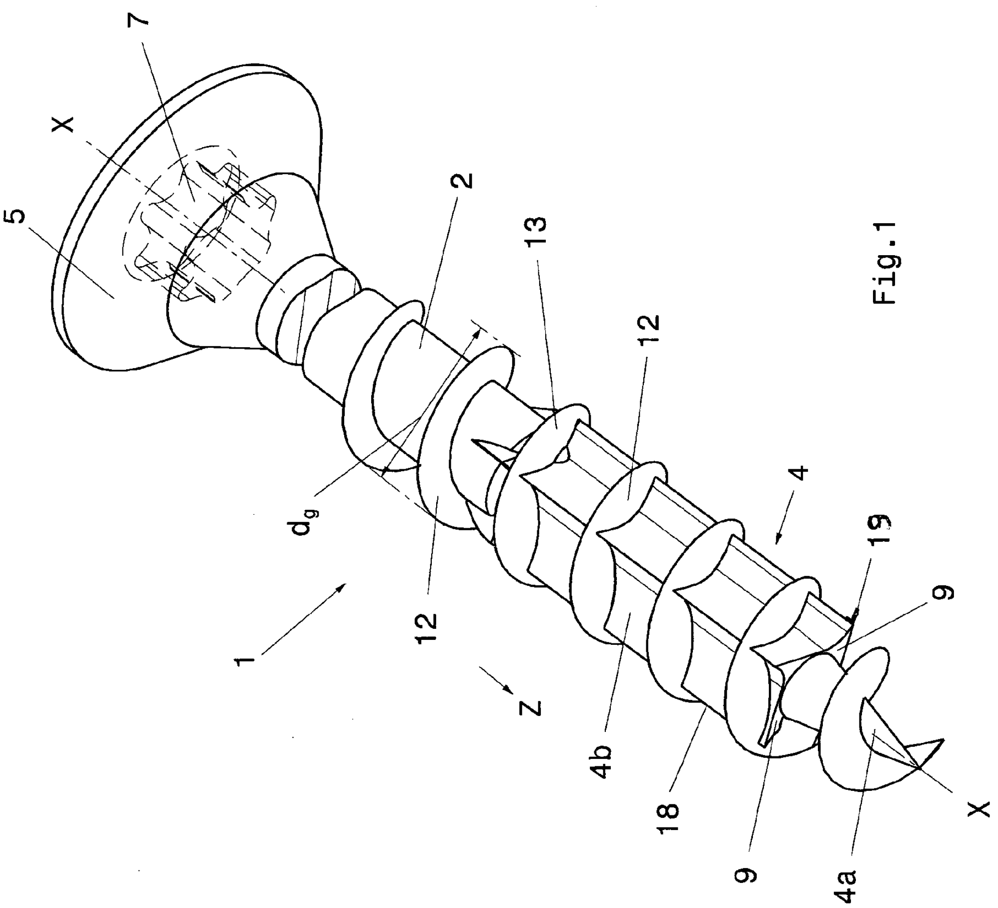

Fig.1

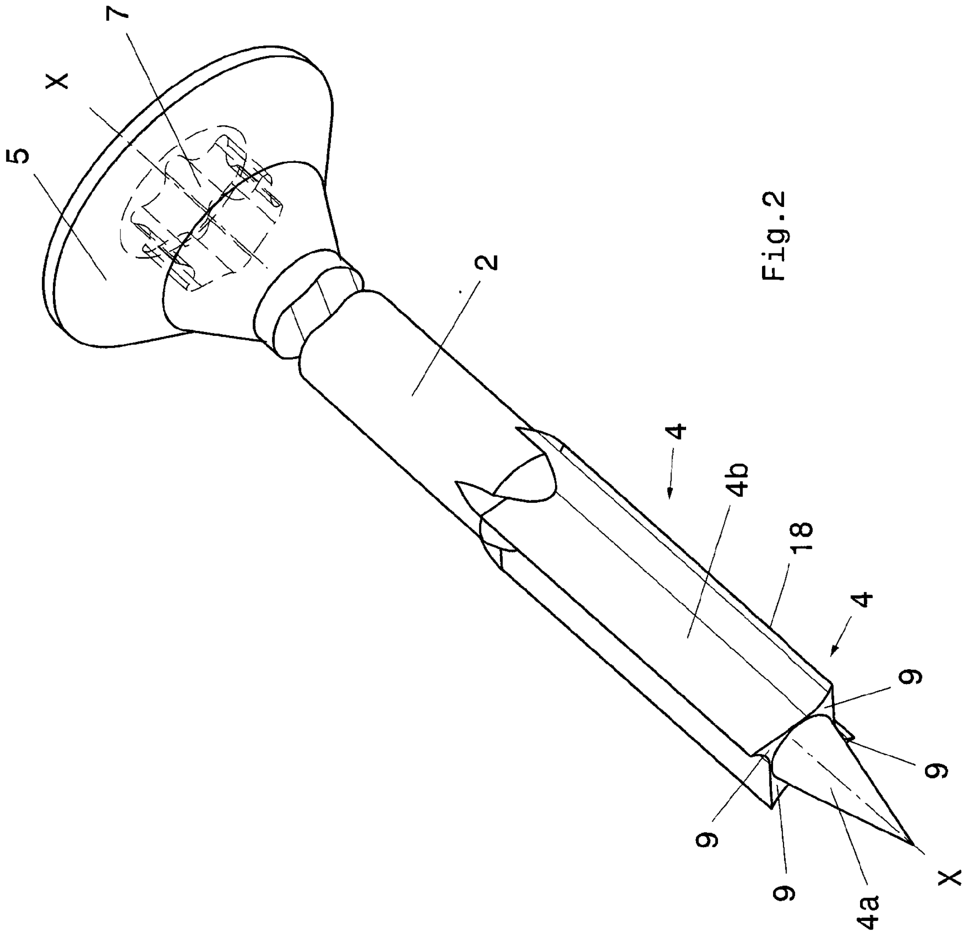

Fig.2

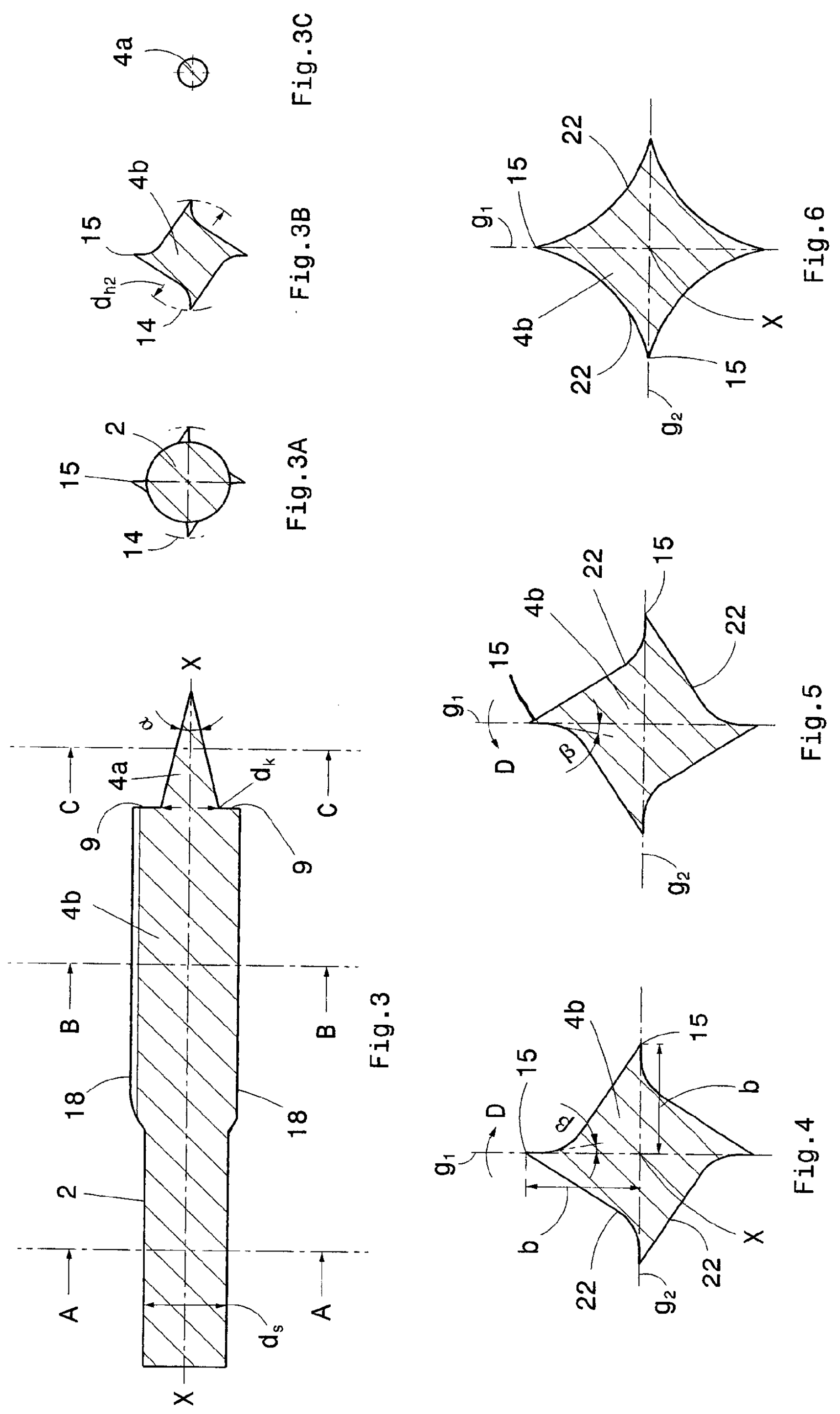

Fig.3

Fig.3A

Fig.3B

Fig.3C

Fig.4

Fig.5

Fig.6

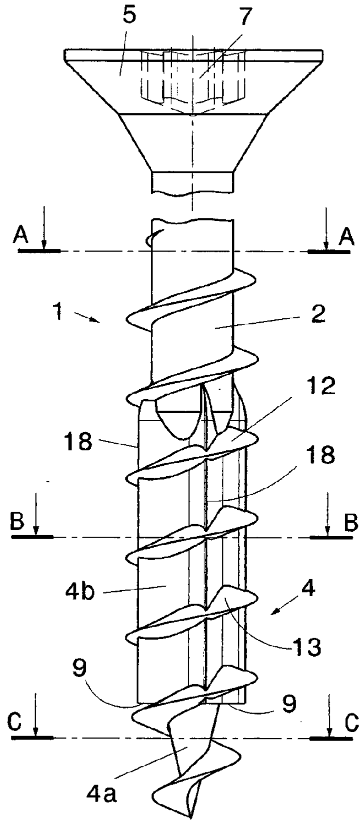

Fig.7

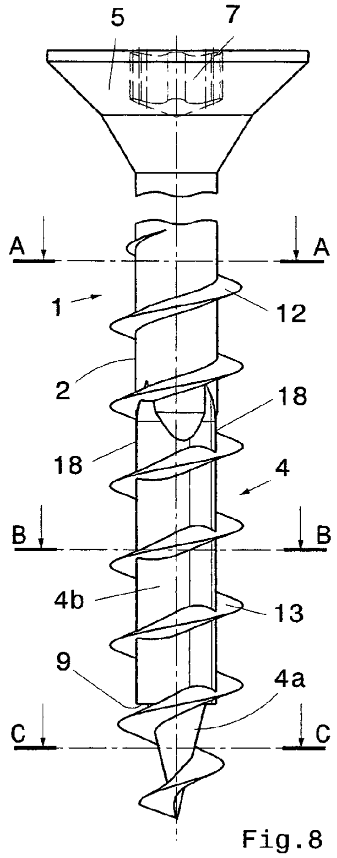

Fig.8

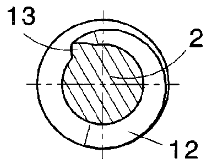

Fig.7A

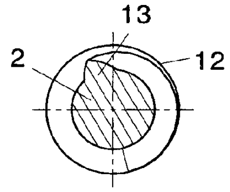

Fig.8A

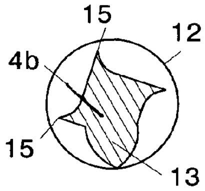

Fig.7B

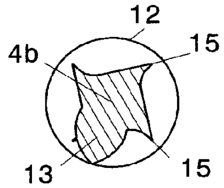

Fig.8B

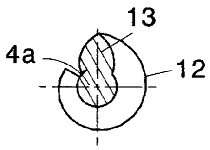

Fig.7C

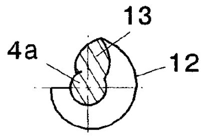

Fig.8C

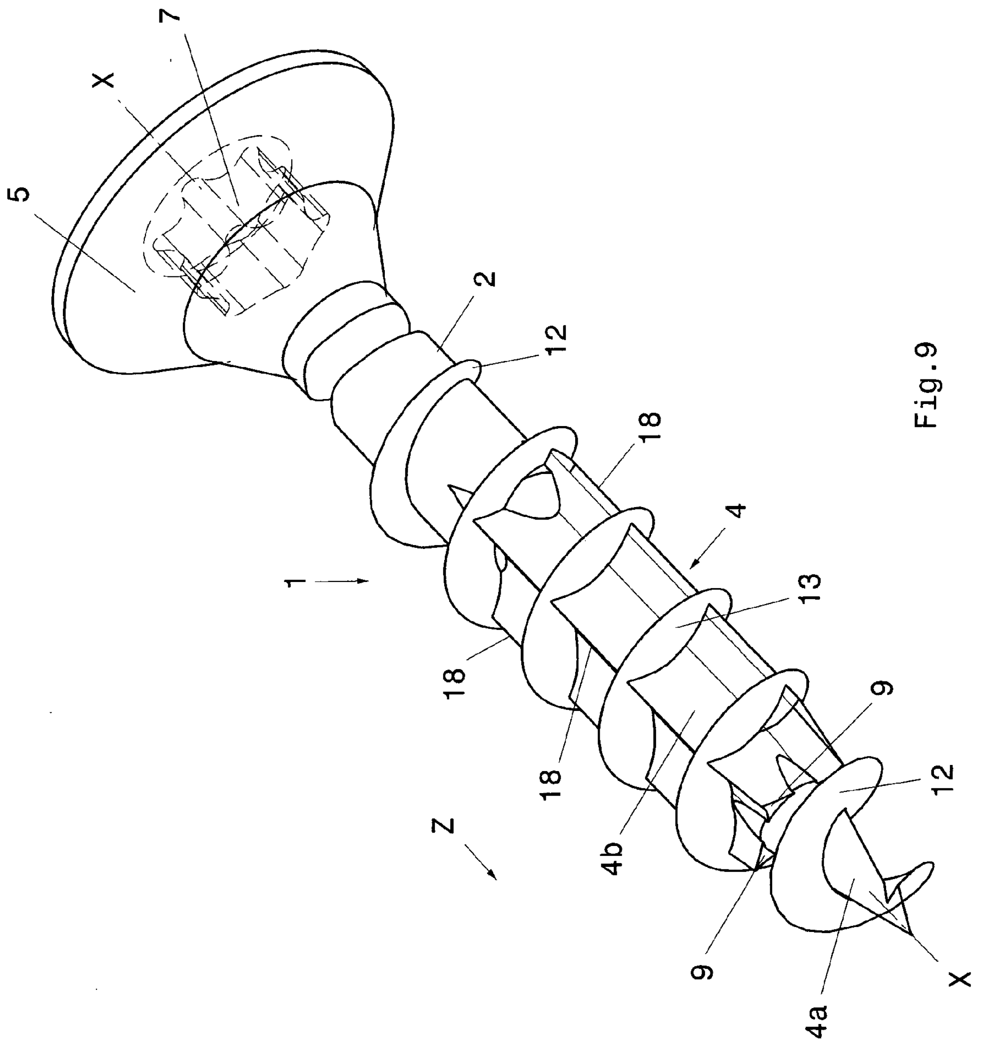

Fig.9

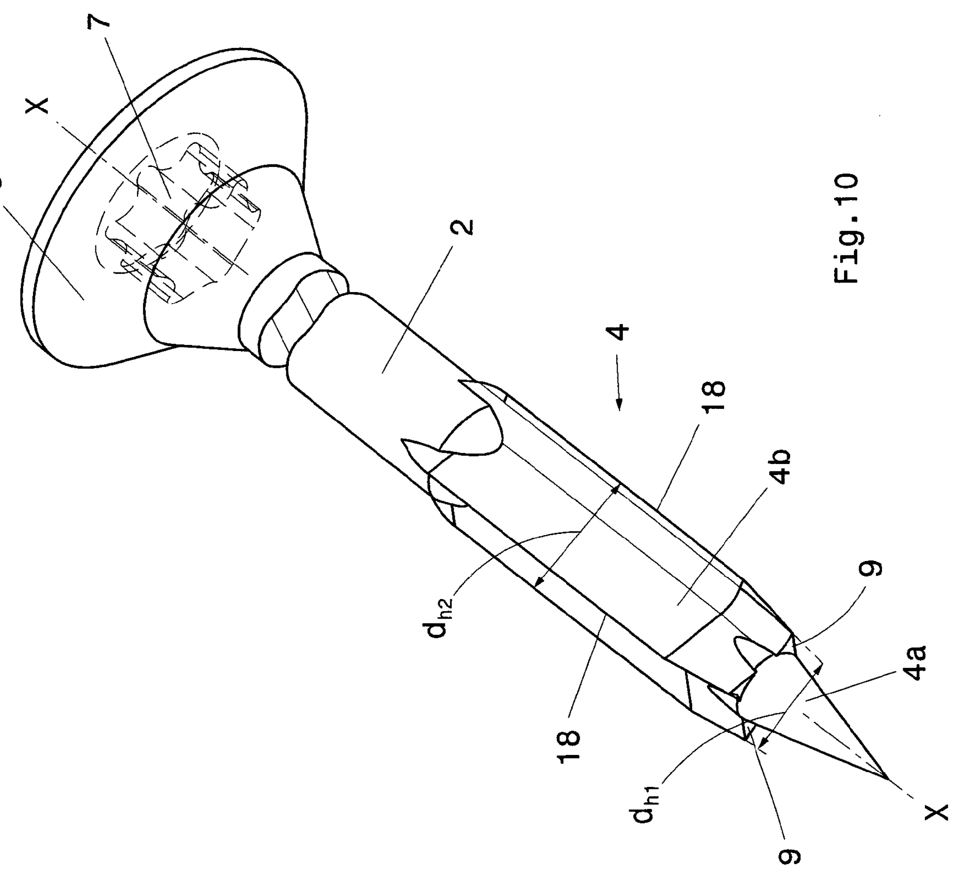

Fig.10