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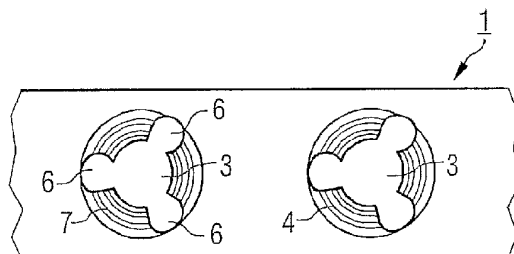
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(54) Title: BONE PLATE

(54) Bezeichnung: KNOCHENPLATTE



(57) Abstract: The invention relates to a bone plate (1) having a bottom surface (2) on the bone side, a top surface (8) and several plate holes (3) with a central hole axis (5), connecting the bottom surface (2) to the top surface (8). At least one of said plate holes (3) has an inner lateral surface (4) tapering in the direction of the bottom surface (2), wherein the inner lateral surface (4) has recesses extending radially from the hole axis (5).

(57) Zusammenfassung: Die Knochenplatte (1) besitzt eine knochenseitige Unterseite (2), eine Oberseite (8) und mehrere die Unterseite (2) mit der Oberseite (8) verbindende Plattenlöcher (3) mit einer zentralen Lochachse (5). Mindestens eines dieser Plattenlöcher (3) weist eine sich gegen die Unterseite (2) hin verjüngende Innenmantelfläche (4) auf, wobei die Innenmantelfläche (4) sich radial von der Lochachse (5) weg erstreckende Ausnehmungen (6) aufweist.

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BONE PLATE

The invention concerns a bone plate.

- 5 A reference herein to a patent document or other matter which is given as prior art is not to be taken as an admission that that document or matter was, in Australia, known or that the information it contains was part of the common general knowledge as at the priority date of any of the claims.

- 10 Bone plates are indicated for the entire skeleton. Particularly significant are, however, the usual large and small fragment indications for treating bone breakages by surgery.

- DE-A 198 32 513 discloses one type of bone plate. In the case of this device
15 the angular alignment of the bone screws relative to the bone plate and their angularly stable fixing is achieved by a ring arranged between the head of the screw and the hole in the plate. A disadvantage of this construction is on the one hand the more expensive manufacture with an additional component (ring), the danger that the tiny ring falls out or is pushed out from the hole in
20 the plate, thus making the device unusable, and the more expensive OP technique on the other hand, because the axis of the ring has to be correspondingly aligned before inserting the screw.

- According to the present invention, there is provided a bone plate with an
25 underside on the side of the bone, an upper side and a plurality of plate holes connecting the underside with the upper side, with each hole having a central axis, an internal jacket surface and a pitch, whereby each internal jacket surface has a number $N \geq 3$ recesses which extend radially away from the central hole axis and interrupt the pitch, and wherein the peripheral extension
30 of the recesses is approximately the same or greater than the peripheral extension of the neighbouring sections of the pitches.

According to the present invention, the bone plate as described above can be used with a drilling bush, wherein at an end which is arranged to contact the hole in a bone plate, the drilling bush has a geometry that is the negative of the geometry of the internal jacket surface of the hole in the plate.

- 5
- Advantageously, the invention can provide a bone plate, that is in the position without additional components to accommodate conventional locking capscrews in a stable manner as far as angle and axis are concerned.
- 10
- Another advantage which can be achieved by the invention is that, as a result of the bone plate according to the invention, a bone screw can be introduced at an angle that is different from the specified axis of the hole (usually at right angles to the plane of the bone plate) and secured in this position, without significantly sacrificing the stability, as is the case in devices known to the Applicant.
- 15
- By virtue of the at least three recesses in the internal jacket surface of the holes in the plate, centralising bearing surfaces can be produced for a capscrew, even when the bone screw is inclined, said bearing surfaces advantageously resulting in an even distribution of the load. In an embodiment having bone
- 20
- screws with a threaded head and holes in the plate with an inner thread, when the screw is inclined, the threaded head can "jump over" the pitches of the thread in the hole of the plate interrupted by the recesses, without "cutting through" them.
- 25
- A further advantage of the bone plate according to the invention is the possibility to use the at least three recesses in the hole in the plate to guide drilling bushes or guide bushes, by which the bone screws can be guided during their insertion. In this case the drilling bushes or guide bushes no longer need to be screwed into the holes in the plate (as is the case in the state-of-the-art), but
- 30
- due to the recesses need only to be inserted into the holes in the plate, resulting in a simple manner in the centre and direction of the axis of the hole. All is required for this purpose is that the tips of the cannulated drilling bushes or guide bushes need to have the negative geometry of the holes in the plate,

without any thread or other, similarly acting, structures. A snap-in mechanism may possibly be used in conjunction.

5 In one embodiment, the internal jacket surface of the hole in the plate is provided with a three-dimensional structure. It serves the purpose of guiding of a correspondingly structured capscrew. Preferably, the three-dimensional structure is macroscopic and further preferably includes partial or complete pitches of the thread, ribs or protuberances. The internal jacket surface may be a multi-start thread also.

10 The geometry of the surface of the N "locking leg", formed by the N recesses, can be advantageously so constructed such that the compatibility with the bone screw to be introduced can be facilitated. This can be in the form of a classic helical thread, a thread-like shape with or without pitch or also only a certain
15 number of grooves or ribs, or also a quasi-thread with or without pitch. The number of grooves or ribs is preferably always odd (e.g. 3, 5, 7 or 9).

20 The internal jacket surface can have a concave, preferably spherical, tapered or ellipsoidal shape. This shape can facilitate the insertion of a bone screw in such a manner, that at the first contact of the bone screw with the internal jacket surface the bone screw is automatically pulled into the hole in the plate, without exerting prior a compression force on the bone via the bone plate, as is partly the case with devices known to the Applicant.

25 In the case of a further embodiment, at least one of the holes in the plate is constructed as an oblong hole.

30 Preferably, the N recesses are arranged at a distance of $360^\circ/N$ relative to the central axis. The recesses preferably have a peripheral expansion of at least 1° and a maximum of 119° . At the same time the N recesses divide the internal jacket surface into N sections of the jacket surface.

In the case of a particular embodiment the recesses extend exclusively within the internal jacket surface. In the case of another embodiment the recesses extend radially away from the axis of the hole past the internal jacket surface.

- 5 The recesses may extend cylindrically or tapered from the upper side to the underside. The advantage of this is, that the recesses can be used for the fixing of a drilling bush for pre-drilling or for the insertion of the Kirschner wires. Thus the drilling bush no longer has to be screwed into the hole in the plate, only to be inserted without damaging the bearing area for the screw.

- 10 The recesses can extend from the upper side to the underside over the entire height of the bone plate.

- 15 The bone plate can be made from steel or titanium or also from a plastic material. In the case of plastic plates from polyacryl etherketone (PEAK) or polyether etherketone (PEEK) with an elongation at break of 40-70 % and a modulus of elasticity of 3000-6000 N/mm² are preferred. However, polysulphon, having an elongation at break of 80-120 % and a modulus of elasticity of 2000-3500 N/mm² may also be used. Furthermore, liquid crystal polymer (LCP)
- 20 having an elongation at break of 1.5-2.5% and a modulus of elasticity of 5000-20000 N/mm² may be suitable. Finally, polyoxymethylene (POM) with an elongation at break of 10-50 % and a modulus of elasticity of 2000-3500 N/mm² and polyphenylene sulphide (PPS) having an elongation at break of 0.2-1.0 % and a modulus of elasticity of 12000-20000 N/mm² may be used.

- 25 Bone plates made from plastic material may be reinforced with metal, plastic or carbon fibres.

- 30 Various bone screws can be used with the bone plates. For example, those having a convex, preferably spherical or tapered head portion. The head portion of the bone screws may also have a three-dimensional structure. In the case of a special embodiment the head portion of the bone screw is made from a material that is harder than the internal jacket surface of the bone plate. The

internal jacket surface of the bone plate and the head portion of the bone screw preferably have matching threads.

5 In the case of a plastic plate the holes in the plate may be executed as metallic thread inserts. Conversely, in the case of a metal bone plate the holes in the plate are executed as polymer thread inserts.

The invention and developments of the invention are explained in detail based on the partly schematic illustrations of several embodiments. They show in:

10 Fig.1 - a longitudinal section through a bone plate with tapered holes in the plate,

15 Fig.2 - a longitudinal section through a bone plate with spherical holes in the plate,

Fig.3 - a top view on a bone plate with three recesses in the internal jacket surface of the holes in the plate,

20 Fig.4 - a variation of the bone plate according to Fig.3 with larger recesses in the internal jacket surface of the holes in the plate,

Fig.5 - a top view on a bone plate with thread inserts with four recesses in the internal jacket surface of the elliptic holes in the plate,

25 Fig.6 - a perspective view of a bone plate according to Fig.1 from above with the bone screws inserted,

30 Fig.7 - a perspective view of a bone plate according to Fig.1 from below with the bone screws inserted,

Fig.8 - a longitudinal section through a bone plate with a bone screw inserted without angular misalignment, and

Fig.9 - a longitudinal section through a bone plate with a bone screw inserted with angular misalignment.

5 The bone plate 1 illustrated in Figs.1 and 3 has an underside 2 on the side of the bone, an upper side 8 and a plurality of holes 3 in the plate connecting the underside 2 with the upper side 8, the holes having a central hole axis 5. The holes 3 in the plate have an internal jacket surface 4 that tapers towards the underside 2. Furthermore, the internal jacket surface 4 has three recesses 6 which extend radially away from the hole axis 5 of the hole at a uniform distance of 120° from one another. Their peripheral extension is approx. 40° and they extend exclusively within the internal jacket surface 4. The recesses 6 extend tapered over the entire height of the bone plate 1 from the upper side 8 to the underside 2. In addition, the internal jacket surface 4 is provided with a three-dimensional structure 7 in the form of a thread.

15 Fig.4 illustrates a variation of the execution according to Fig.3, wherein the recesses extend radially away from the axis of the hole past the internal jacket surface.

20 Figs.2 and 5 illustrate a further alternative embodiment, wherein the holes 3 in the plate are constructed as oblong holes. The bone plate is made basically from a plastic material (PEEK) with embedded metallic thread inserts 9 from titanium, forming the holes 3 in the plate. In the case of this embodiment the holes 3 in the plate have four recesses 6, which extend radially away from the axis 5 of the hole past the internal jacket surface 4. The internal jacket surface 4 is divided into four sections of the jacket surface. The recesses extend tapered over the entire height of the bone plate 1 from the upper side 8 to the underside 2. In addition, the internal jacket surface 4 is provided with a three-dimensional structure 7 in the form of a multi-start thread. As far as material is concerned, this embodiment may also be inverted, whereby the bone plate is basically made from metal (titanium) and the embedded therein thread inserts 9 are made from plastic material (PEEK), forming the holes 3 in the plate.

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Fig.6 illustrates the bone plate according to Fig.1, with bone screws 10 inserted from above, the head portions 11 of which are spherical. Fig.7 shows the same bone plate 1 from below.

- 5 In Fig.8 a bone plate 1 is illustrated with bone screws 10 inserted therein without angular misalignment. The internal jacket surface 4 of the hole of the bone plate 1 and the head portion 11 of the bone screw 10 have matching threads 13.
- 10 Fig.9 illustrates the same variation as Fig.8, while the bone screw 10 is angularly misaligned.

- 15 The invention described herein is susceptible to variations, modifications and/or additions other than those specifically described and it is to be understood that the invention includes all such variations, modifications and/or additions which fall within the spirit and scope of the above description.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A bone plate with an underside on the side of the bone, an upper side
5 and a plurality of plate holes connecting the underside with the upper
side, with each hole having a central axis, an internal jacket surface and
a pitch, whereby each internal jacket surface has a number $N \geq 3$
recesses which extend radially away from the central hole axis and
interrupt the pitch, and wherein the peripheral extension of the recesses
10 is approximately the same or greater than the peripheral extension of
the neighbouring sections of the pitches.
2. A bone plate according to claim 1, wherein the internal jacket surface
has a concave shape.
- 15 3. A bone plate according to claim 2, wherein the internal jacket surface
has a spherical, tapered or ellipsoidal shape.
4. A bone plate according to any one of claims 1 to 3, wherein the at least
one of the holes in the plate is constructed as an oblong hole.
- 20 5. A bone plate according to any one of claims 1 to 4, wherein the three-
dimensional structure is macroscopic and preferably includes partial or
complete pitches of the thread, ribs or protuberations.
- 25 6. A bone plate according to any one of claims 1 to 5, wherein the N
recesses are arranged at a distance of $360^\circ/N$ relative to the central
hole axis.
7. A bone plate according to any one of claims 1 to 6, wherein the
30 recesses have a peripheral expansion of at least 1° .
8. A bone plate according to any one of claims 1 to 7, wherein the
recesses have a maximum peripheral expansion of 119° .

9. A bone plate according to any one of claims 1 to 8, wherein the recesses extend exclusively within the internal jacket surface.
10. A bone plate according to any one of claims 1 to 9, wherein the recesses extend radially away from the central hole axis of the hole past the internal jacket surface.
11. A bone plate according to any one of claims 1 to 10, wherein the *N* recesses divide the internal jacket surface into *N* sections of the jacket surface.
12. A bone plate according to any one of claims 1 to 11, wherein the recesses extend cylindrically or tapered from the upper side to the underside.
13. A bone plate according to any one of claims 1 to 12, wherein the recesses extend from the upper side to the underside over the entire height of the bone plate.
14. A bone plate according to any one of claims 1 to 13, wherein the bone plate is made from material including steel or titanium.
15. A bone plate according to any one of claims 5 to 14, wherein the internal jacket surface has a multi-start thread.
16. A bone plate according to any one of claims 5 to 15, wherein the internal jacket surface has continuous ribs on the periphery at right angle to the central hole axis.
17. A bone plate according to any one of claims 1 to 16, wherein the bone plate is made from material including a plastic material.
18. A bone plate according to claim 17, wherein the bone plate is made from polyacryl etherketone (PEAK) or polyether etherketone (PEEK) with an elongation at break of 40-70 % and a modulus of elasticity of 3000-6000 N/mm².

19. A bone plate according to claim 17, wherein the bone plate is made from polysulphon with an elongation at break of 80-120 % and a modulus of elasticity of 2000-3500 N/mm².
- 5 20. A bone plate according to claim 17, wherein the bone plate is made from liquid crystal polymer (LCP) with an elongation at break of 1.5-2.5% and a modulus of elasticity of 5000-20000 N/mm².
- 10 21. A bone plate according to claim 17, wherein the bone plate is made from polyoxymethylene (POM) with an elongation at break of 10-50 % and a modulus of elasticity of 2000-3500 N/mm².
- 15 22. A bone plate according to claim 17, wherein the bone plate is made from polyphenylene sulphide (PPS) with an elongation at break of 0.2-1.0 % and a modulus of elasticity of 12000-20000 N/mm².
23. A bone plate according to claim 17, wherein the bone plate is made from a metal, plastic or carbon fibre reinforced plastic material.
- 20 24. A bone plate according to any one of claims 1 to 23, wherein the bone plate includes at least one bone screw with a tapered head portion suitable for an angularly stable anchoring in the at least one hole in the plate and a threaded portion intended for anchoring in the bone.
- 25 25. A bone plate according to claim 24, wherein the head portion has a convex, preferably spherical or tapered construction.
26. A bone plate according to claim 24 or 25, wherein the head portion has a three-dimensional structure.
- 30 27. A bone plate according to any one of claims 24 to 26, wherein the head portion of the bone screw is made from a material that is harder than the internal jacket surface.

28. A bone plate according to any one of claims 24 to 27, wherein the internal jacket surface and the head portion of the bone screw have matching threads.
- 5 29. A bone plate according to any one of claims 16 to 28, wherein the at least one of the holes in the plate is constructed as a metallic thread insert.
30. A bone plate according to any one of claims 1 to 28, wherein the bone plate is made from material including a metallic material and the at least one of the holes in the plate is constructed as a polymer thread insert.
- 10 31. A drilling bush to be used with a bone plate according to any one of claims 1 to 30, wherein at an end which is arranged to contact the at least one hole in the bone plate, the drilling bush has a geometry that is the negative of the geometry of the internal jacket surface of the at least one hole in the plate.
- 15 32. A bone plate according to any one of the embodiments substantially as herein described and illustrated.
- 20 33. A drilling bush used with a bone plate according to any one of the embodiments substantially as herein described and illustrated.

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FIG 1

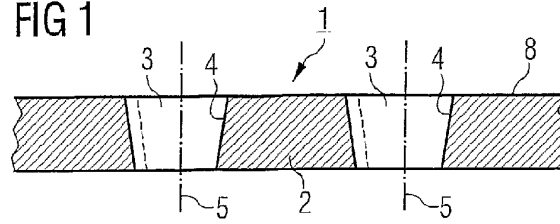


FIG 2

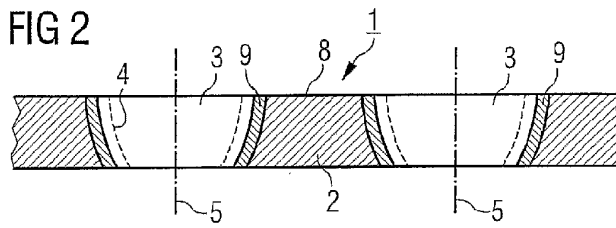


FIG 3

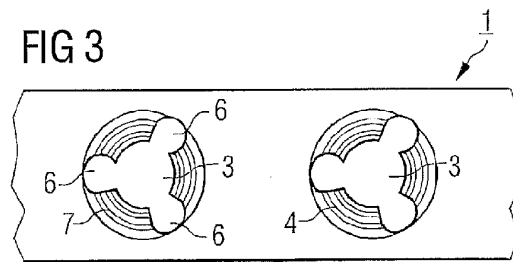
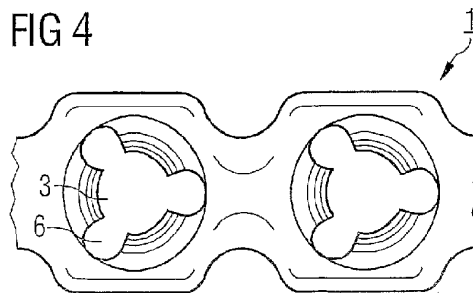


FIG 4



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FIG 5

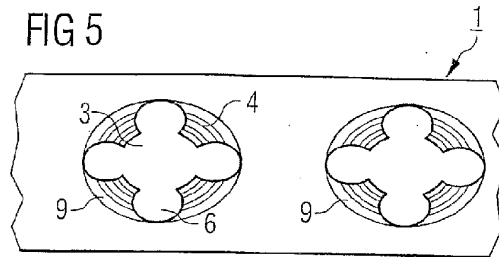


FIG 6

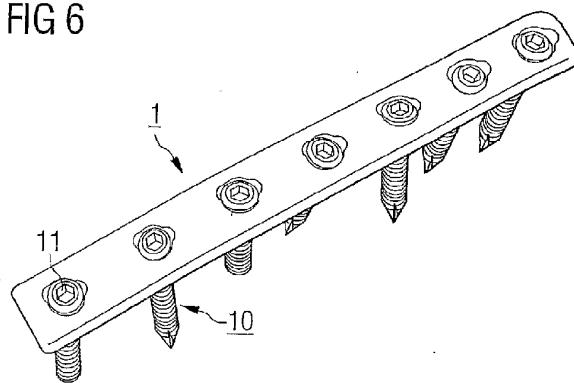


FIG 7

