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(54) Benævnelse: **Knogleplade og fastgørelsessystem med en knogleplade**

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Description

Field of the Invention

The invention relates to a bone plate having a plurality of holes for receiving bone screws, which holes are aligned in a direction of a longitudinal axis of the plate.

Background of the Invention

In a known bone plate of this type (EP 0 760 632 B1) the holes have a circumferentially spherical shape towards the upper side of the bone plate in order to be capable of supporting a bone screw having a head with a spherical lower surface in different angular positions. On the lower surface of the plate facing the bone the holes have a partially threaded region of smaller diameter in order to be capable of furthermore accommodating a bone screw that has a cylindrical threaded head and which is intended to be sunk perpendicularly to the plane of the plate.

In another bone plate of the indicated type (EP 1 158 915 B1 and EP 1158916 B1) elongated holes are provided having an internal thread which extends at one side of the elongated hole from the top surface to the bottom surface of the bone plate over a circumferential arc defined by a central angle in a range from 190° to 280º. The internal thread covers the entire depth of the elongated hole conically tapering towards the lower surface of the bone plate with a cone angle ranging from 5° to 20º.

In another known bone plate (EP 1 255 498 B1) elongated holes are provided in the bone plate, which may have an oval, elliptical, or rectangular shape or a combination of such shapes; only circular holes are explicitly excluded from the definition of the elongated hole. The elongated hole is combined with a circular hole which is provided with a three-dimensional structure in form of an internal thread or a peripheral lamella or lip. A conical internal thread is disclosed which extends from the top surface to the bottom surface of the bone plate and covers a circumferential arc or central angle in a range from 190° to 280°.

DE 198 58 889 A1 discloses a fixation system for bones comprising a bone plate which has elongated holes having projections close to the bottom surface facing the bone, which projections extend in parallel to the plane of the plate in the lower portion of the elongated hole. Towards the top surface of the bone plate seat surfaces are provided for spherical heads of the bone screws. In order to cooperate with the projections in the bone plate, the bone screw is threaded along a short distance below the spherical head, which thread is capable of deforming the protrusions in the elongated hole and to adapt. The bone screw can be screwed in in different angular positions relative to the axis of the through holes. Bone plates cooperating with bone screws as a fixation system are also known from documents WO 2004/0841701 A2, FR 2 880 929 A1, EP 1 949 866 A2; US 2005/010226 A1, EP 1 649 819 A1, and EP 2 016 918 A1.

Document EP 1 859 752 A1 from which claim 1 is derived discloses a bone plate which together with corresponding bone screws allows to compress bone fragments, while the bone screws establish an angularly stable connection. The holes provided for this purpose consist of an elongated hole and an adjacent round hole, the round hole having thread grooves along a portion of its periphery.

General description of the invention

The invention is based on the object to provide a bone plate which permits to apply different types of bone screws - those with conical bearing surfaces and those with spherical bearing surfaces – in order to meet different requirements when fixing a broken or damaged bone. In particular it should be possible to displace bone fragments relative to each other during the fixing.

This object of the invention is achieved by a bone plate according to claim 1. Advantageous embodiments of the invention are specified in the dependent claims.

In detail, the bone plate has a preferably elongated plate body of tissue-compatible rigid material defining
upper and lower surfaces and a longitudinal axis. Hole formations are provided transversely to the plane of the plate, comprising a first, larger round hole and a second, smaller round hole which intersect to form edges between which a passage is formed for the screw shaft of a bone screw. Exactly one radial rib is provided circumferentially around the two round holes, which rib extends from the wall of the holes in a plane towards the centre of the round holes. According to the invention, the rib extends in a single plane and do not has a pitch like a thread. In this manner, embodiments with a peripherally closed or closed loop rib permit to provide an improved strength, especially higher rigidity, which would generally not be possible with a thread.

A bone screw having a thread on the screw head may bear upon the rib of the smaller round hole and allow engagement of the rib of the larger round hole, which results in mutual locking.

According to the invention, this locking or clamping may furthermore result in an elastic deformation, which however will substantially not leave a lasting deformed portion after a removal of the bone screw from the bone plate, which means that this deformation does not include plastic deformation in addition to the purely elastic component. Therefore, there will be no ridges or grooves discernible on the bone screw or on the bone plate once the bone screw is separated from the plate. However, should there be any surface modifications resulting from improper use, these will typically not include grooves, furrows or ridges but rather friction surface areas.

According to a preferred embodiment, the first, larger round hole has three portions, namely an upper round neck-shaped portion above the peripheral rib, a central round neck-shaped portion below the peripheral rib, and a lower truncated cone-shaped portion which tapers towards the lower surface of the plate body and has a maximum diameter that is smaller than the diameter of the upper and central portions. The smaller round hole comprises an upper portion having an introductory or lead-in slope inclined towards the top surface of the plate, furthermore a central portion with an inclined rounded surface below the plane of the circumferential rib, and a lower cylindrical or conical portion having a diameter that is smaller than the diameter of the upper and middle portions.

In all embodiments, bone screws can be used that have a head which is provided with screw threads in its upper portion and with a conical bearing surface in its lower portion in such a manner that upon being screwed vertically into a bone, a displacement of the head relative to the hole formation occurs in such a way that bone fragments can be approached to one another during fixing. However, the novel bone plate furthermore allows to use bone screws having a spherical bearing surface on the lower surface of the screw head. Such ball head screws may be screwed in at an angle to the bone plate, as is sometimes necessary.

Further details of the invention will become apparent from the description of the illustrated exemplary embodiments and the appended claims.

In the drawings:

Fig. 1 is a plan view of a hole formation in a bone plate;

Fig. 2 is a sectional view of the hole formation;

Fig. 3 is a perspective view of the hole formation; and

Fig. 4 shows a bone screw engaged in a hole formation;

Fig. 5 is a perspective view of a second embodiment of a bone plate;

Fig. 6 is a sectional view of the hole formation;

Fig. 7 is a side view of the hole formation;

Fig. 8 shows a bone screw engaged in a hole formation, together with an enlarged detail thereof;

Fig. 9 shows a further embodiment of a bone plate having a circumferential rib with differing height in the radial direction;

Fig. 10 shows an enlarged detail of a cross-sectional view taken along line A-A and thus in parallel to the longitudinal axis of the further embodiment of the bone plate shown in Fig. 9, with a bone screw inserted;

Fig. 11 is a cross-sectional view taken along line A-A and thus in parallel to the longitudinal axis of the further embodiment of the bone plate shown in Fig. 9, with a bone screw inserted;

Fig. 12 shows an enlarged detail of a cross-sectional view taken along line B-B and thus perpendicular to the longitudinal axis of the further embodiment of the bone plate shown in Fig. 9, with a bone screw inserted;

Fig. 13 is a cross-sectional view taken along line B-B and thus perpendicular to the longitudinal axis of the further embodiment of the bone plate shown in Fig. 9, with a bone screw inserted;

Fig. 14 shows yet another embodiment of a bone plate having a circumferential rib with differing height in the radial direction, in which the axis of symmetry of the circumferential rib is offset relative to the axis of symmetry of the conical portion of the larger round hole below the rib, and in which respective radii around the respective axes of symmetry are shown in dot-dashed line, so that the relative offset can be better identified;

Fig. 15 shows the yet further embodiment of the bone plate with circumferential rib with differing height in the radial direction illustrated in Fig. 14, but without the respective radii around the respective axes of symmetry, so that the actual shape can be better identified;

Fig. 16 is a cross-sectional view of the yet further embodiment illustrated in Figs. 14 and 15 taken along a line which would correspond to the line A-A in Fig. 9 and thus in parallel to the longitudinal axis of the yet further embodiment of the bone plate illustrated in Figs. 14 and 15, but without a bone screw inserted;

Fig. 17 is a cross-sectional view of the yet further embodiment illustrated in Figs. 14 and 15 taken along a line which would correspond to the line B-B in Fig. 9 and thus perpendicular to the longitudinal axis of the further embodiment of the bone plate illustrated in Figs. 14 and 15, but without a bone screw inserted.

Detailed Description of Preferred Embodiments

In the following detailed description of preferred embodiments, the same reference numerals designate substantially identical parts in or on these embodiments, for the sake of clarity.

The figures show a portion of a bone plate consisting of a preferably elongated plate body of tissue-compatible rigid material and in which a number of hole formations are provided, one hole formation 2 of which is shown. Apart from being elongated, the plate body 1 may be oval, round, or polygonal, or may have a shape adapted to the respective application.

Tissue-compatible material refers, for example, to metals and their alloys that are commonly used for producing implants. Preferred metals include titanium in any form, preferably the alloys TiAl6V4 and TiCp thereof, inter alia. Steels such as implant steel, for example the alloy 1.4441, can also be used advantageously.

Another class of materials for this purpose includes resorbable materials, such as magnesium or resorbable synthetic materials such as PLA. PLA is a biocompatible and resorbable synthetic material of lactic acid molecules chemically bound to each other which can be used besides other absorbable plastics.

A bone plate is considered to be rigid if it structurally provides the stiffness necessary for its intended use and application purpose. This can be ensured through the thickness and width of the plate depending on the tissue-compatible material used and will usually be obvious for a person having ordinary skills in the art.

For example, bone plates for small and less stressed parts of the body such as hand and foot bones are thinner and often have a smaller width than bone plates for the larger and more heavily stressed parts such as parts of the lower leg and thigh bone.

The bone plate has a upper surface 11 and a lower surface 12 which usually extend in parallel to the plane of the plate, and the lower surface 12 faces the bone to be fixed. The hole formations 2 are lined up along the longitudinal axis of the elongated plate body 1, each comprising two stepped round holes, 21 and 22, extending transversely to the plane of the plate and having axes 21a, 22a that intersect the longitudinal axis of the bone plate. The smallest diameter of the first round hole 21 is larger than the smallest diameter of the second round hole 22, and the spacing between the two axes 21a and 22a is smaller than the smallest diameter of the first round hole 21.

Due to the intersection of holes 21, 22, edges 23, 24 are defined which delimit the regions of the round holes against each other and leave a passage for the comparatively thin screw shaft of a bone screw, if in case of an inclined position of a bone screw the latter extends from one round hole into the other round hole. The circumferential arc of the wall surfaces of the round holes 21, 22 is 250° for the larger hole and 220º for the smaller hole. Deviations by 10° less and 20° more are possible.

Due to the stepped configuration of the round holes 21, 22 one may distinguish an upper region 25 and a lower region 26 of round hole 21 as well as an upper region 27 and a lower region 28 of round hole 22.

Upper regions 25 and 27 have a bowl-shaped flaring design, while the lower regions 26 and 28 define lateral surfaces with straight lateral surface lines. The upper regions 25 and 27 have larger diameters than the lower regions 26 and 28. Lower region 26 defines a frustoconical portion which tapers towards the lower surface of plate body 1. Lower region 28 is cylindrical, but a frustoconical shape is likewise possible.

While the two upper regions 25 and 27 of the two round holes 21, 22 have a generally bowl-shaped design, a radial rib 33 extends from the hole walls around hole formation 2 in a defined plane. Rib 33 is in form of a circumferential web and has a wedge-shaped cross-section which tapers towards the center of the respective round hole. In a plan view, rip 33 resembles number eight.

While rib 33 may extend uniformly all around, a ridge 61 is provided at the rib portion extending around the larger round hole 21 in parallel to the plane of rib 33 at the outer edge of the larger round hole, whereby an edge 24 is defined towards the second round hole 22. Starting from the longitudinal axis of plate body 1, the height of ridge 61 increases towards the periphery of plate body 1, as can be best seen from a comparison of Fig. 4 and Fig. 3. A thread groove is defined between ridge 61 and rib 33 facilitating the engagement of the threads 41 of headed screw 40.

Each of the two round holes 21, 22 is divided into three portions: the larger round hole 21 has an upper round neck-shaped portion 31 above rib 33, with or without ridge 61, and below rib 33 it has a central round neck-shaped portion 36 and a lower truncated cone-shaped or tapering portion 26. The smaller round hole 22 comprises an upper portion 35 with a lead-in slope 62, a central portion 36 with an inclined rounded surface 63 below the plane of rib 33, and a lower portion 28 which is preferably cylindrical, but may be conical.

The bone plate is configured for cooperating with at least two different types of bone screws.

One type has a bone screw head with a partially spherical lower surface, which lower surface of the head may bear upon the inclined rounded surface 63. In this case, an inclination of the screw axis with respect to the plane of the plate is possible, both in the longitudinal direction of the bone plate and (to a lesser extent) in the transverse direction thereof. This is possible due to the spacing between edges 23 which is chosen in accordance with the application purpose.

Another type of a suitable bone screw 4 is shown in Fig. 4. This bone screw 4 has a screw head 40 with an engagement recess and with an external thread 41 provided at the upper end and a conical bearing surface 42 at the lower end, with a cone inclination that corresponds to the cone inclination of the lower region 26 of the larger round hole 21.

The cone inclination of the lower region 26 of the larger round hole 21 and the cone inclination of the conical bearing surface 42 at the lower end of screw head 40 of bone screw 4 has an angle relative to the longitudinal or symmetry axis of the bone screw or of the round hole 21, respectively, in a range from 3° to 30°. Preferably, this cone angle is in a range from 6° to 20°, and most preferably in a range from 8° to 12°. A most preferred design having a cone angle of about 10° has proven to exhibit high fatigue strength values and good releasability of the connection between bone screw and bone plate.

Very good stability values in terms of tilting of the bone screw relative to the bone plate are provided in an angular range from about 8° to 12°, together with only moderate self-locking.

The external thread 41 may be cylindrical, however, a conical thread is preferred. The screw head 40 merges into a screw shaft 43 which is intended to be anchored in a bone segment to be fixed. Circumferential rib 33 extends in a plane, preferably in parallel to the plane of the plate, while the thread 41 extends along screw planes which by their nature are inclined relative to the plane of radial rib 33, even if the bone screw 4 is brought into engagement in parallel or coincident with the axis 21a of round hole 21. This leads to a locking between threads 41 and rib 33.

In this regard the ridge 61 is useful because it provides an abutment for the thread of the screw head, thereby providing for defined clamping with defined self-locking effect.

In conjunction with the illustrated bone plate, bone screw 4 may be used for approaching bone fragments and pressing them together. For this purpose, bone screw 4 is placed with its axis in parallel to the axis 22a of round hole 22. When the lower edge of the conical bearing surface 42 reaches the lead-in slope 62 of the smaller round hole 22, a lateral force is applied on screw head 40 while it is screwed in, which leads to a displacement of the bone fragment to be fixed relative to the bone plate. Thus, in the case that one bone fragment has already been fixed to the bone plate, this bone fragment will be pushed against the bone fragment to be fixed, as desired.

It should be noted that when the screw head 40 is tightly fitted a sufficiently strong connection is established between the plate body 1 and the bone screw 4 because of the large circumferential arc of the conical surface of lower region 26 that ranges from 250° to 290°, since once the screw threads 41 are locked the circumferential rib 33 develops a sufficient elastic clamping force to hold the conical surfaces at 26 and 42 pressed together.

Figs. 5 to 8 illustrate another embodiment of the bone plate, and the same reference numerals are used for corresponding parts.

The main difference is in the configuration of the circumferential radial rib 33 which is partially cut away in the region of the smaller round hole 22 in order to provide an inclined rounded sliding surface 35a and a transition surface 35b useful for guiding the head of a bone screw that has a head with a partially spherical lower surface. The residual rib 37 which is formed increases to the full dimension of the rib 33 in the region of the larger round hole 21. The remaining peripheral edge 34 extends around less than 180° so as to permit bone screws to be laterally introduced from the smaller round hole 22 into the larger round hole 21.

Reference is now made to Fig. 9 which shows another embodiment of a bone plate 1 having a circumferential rib 33, and this circumferential rib 33 has a differing height in the radial direction, i.e. towards the symmetry axis which is designated by reference numeral 71 and is approximately defined by the intersection of plane A-A and plane B-B.

Fig. 9 shows a bone screw 4 inserted into this bone plate 1.

The circumferential rib 33 of bone plate 1 has a wedge-shaped cross-section, wherein in this further embodiment the height in the radial direction of the wedge-shaped cross-section is not constant along a circumference, which means it does not have the same value in each region.

In this further embodiment, the wedge-shaped cross-section of the circumferential rib 33 is flattened in some regions, as can be seen particularly well in Fig. 10 which shows an enlarged detail of a cross-sectional view taken along line A-A and thus in parallel to the longitudinal axis of the further embodiment of the bone plate 1 illustrated in Fig. 9.

The flattening 72 reduces the radial height, so that in this embodiment the clamping forces caused by the pitch of the thread of bone screw 4 are reduced. In the region of flattening 72 the thread of the bone screw can be arranged freely in front of the circumferential rib 33, which can be seen well in Fig. 11 with respect to the arrangement of bone screw 4 relative to bone plate 1. As a result thereof, an engagement of the circumferential rib 33 with the thread of bone screw 4 only occurs substantially at two sides, as can be seen for example in Figs. 12 and 13.

Fig. 12 shows an enlarged detail of the cross-sectional view of Fig. 13 taken along line B-B and thus perpendicular to the longitudinal axis of the further embodiment of the bone plate shown in Fig. 9, with a bone screw inserted, and it can be clearly seen from this figure that both the left and the right side of the thread of the bone screw is engaged with rib 33. This configuration permits to reduce to some degree the pitch of the thread of the bone screw with its locking effect caused by friction, so that selectively reduced frictional and self-locking forces can be provided as compared to a rib 33 having a uniform radial height.

In this case it is further within the scope of the invention that the radial height of the wedge-shaped cross-section of the circumferential rib 33 substantially assumes the value of zero in some regions.

Fig. 14 shows yet another embodiment of a bone plate 1 having a circumferential rib with differing height in the radial direction, in which the axis of symmetry 71 of the circumferential rib is offset relative to the axis of symmetry of the conical portion 26 of the larger round hole below the rib, and in which respective radii 72 and 73 around the respective axes of symmetry are shown in dot-dashed line and indicated by a circle, so that their relative offset can be better identified.

The circumferential rib 33 may even have a uniform radial height over its entire circumference, so that a more or less engagement with the thread of the head of the bone screw 4 is only caused by the offset.

In this case, the circle defined by radius 72 extends symmetrically to the symmetry axis 71 of the circumferential radial rib 33, and the circle defined by radius 73 extends symmetrically to the symmetry axis 74 of the conical portion 26 of the larger round hole.

The offset between symmetry axes 73 and 74 designated "x" in Fig. 14 defines the change in the radial height of rib 33.

This offset is not limited to the direction shown in Fig. 14, rather it may be provided in any other direction.

If this offset is equal to or greater than the radial height of rib 33 in one direction, there will be regions 75 in which the radial height of the wedge-shaped cross-section of the circumferential rib 33 substantially assumes the value of zero.

These regions are shown particularly well in Figs. 15 to 17.

Here, Fig. 15 shows the yet further embodiment of the bone plate 1 illustrated in Fig. 14, but without the respective radii 72, 73 around the respective axes of symmetry 71, 74, so that their actual shape can be better identified.

Fig. 16 shows a cross-sectional view of the yet further embodiment illustrated in Figs. 14 and 15, taken in parallel to the longitudinal axis of the yet further embodiment of the bone plate 1 illustrated in Figs. 14 and 15, but without a bone screw 4 inserted, so that the extension of rib 33 can be better identified.

Fig. 17 is a cross-sectional view of the yet further embodiment illustrated in Figs. 14 and 15 taken perpendicular to the longitudinal axis of the further embodiment of the bone plate 1 illustrated in Figs. 14 and 15, so that also in this view the extension of rib 33 can be better identified.

As with the embodiment shown in Figs. 9 to 13, a decreasing engagement of the thread of the bone screw 4 with rib 33, which is predefineable by the offset x, is provided depending on the offset x, and in this case, again, the friction between the thread of the bone screw 4 and rib 33 may be reduced in defined manner as compared to a rib having a constant radial height.

Fig. 17 shows an arrangement in which an engagement of the rib 33 with the threads of the bone screw 4 only occurs at two sides, substantially similarly to what is illustrated in Fig. 13.

The circumferential rib 33 may have an effect like a chamfer which counteracts risks of scoring and breaking at higher stresses such as bending stresses on the bone plate.

As a result, embodiments with a circumferential rib in which the radial height of the rib 33 remains constant are very beneficial for the strength and resistance to bending of the bone plate 1.

The invention provides a fixation system for bones comprising a bone plate and bone screws, which permits to place bone screws that have a round head in different inclination angles relative to the bone plate. Furthermore, when using bone screws having a conical head the fixation system allows for a relative displacement between a bone fragment to be fixed and the bone plate, allowing the surgeon to move bone fragments against each other during their fixation.

Patentkrav

1. Knogleplade til samvirke med knogleskruer (4), som har et hoved (40) og et skrueskaft (43), og som tjener til at kunne fiksere dele af en brækket eller beskadiget knogle, hvilken knogleplade omfatter:

et fortrinsvis aflangt pladelegeme (1) af især vævsforligeligt, fortrinsvis stift materiale, som fastlægger et plade-plan og en længdeakse,

huldannelser (2), som forløber på tværs af plade-planet, og som består af et første rundt hul (21) og et andet rundt hul (22), som skærer hinanden under dannelse af kanter (23, 24), og hvor det første runde hul (21) er større end det andet runde hul (22), og hvor nogle øvre områder (25, 27) i det første og andet runde hul (21, 22) har en større diameter end nogle nedre områder (26, 28) i det første og andet runde hul (21, 22), og at det nedre område (26) i det første runde hul (21) er keglestubformet, **kendetegnet ved, at** der udrager nøjagtigt en rundtgående radial ribbe (33) i de to runde huller, hvilken ribbe udgår fra væggen af de to runde huller og fører rundt om begge de runde huller (21, 22) og i et plan strækker sig rundt på midten af det runde hul.

2. Knogleplade ifølge krav 1,
hvor der ved oversiden (11) af knoglepladen og ind i det første runde hul (21), og parallelt med den radiale ribbe (33), forløber en grat (61), som ender ved en kant (24) i det andet runde hul (22).

3. Knogleplade ifølge krav 1 eller 2,
hvor den rundtgående radiale ribbe (33) i det andet runde huls (22) område er reduceret for at danne en hældende og afrundet glideflade (35a) og en overgangsflade (35b).

4. Knogleplade ifølge krav 1 til 3,
hvor den rundtgående ribbe (33) i det andet runde hul (22) forløber hen til oversiden (11) af knoglepladen med en vis skrå tilføring (62).

5. Knogleplade ifølge et af de foregående krav,
hvor det øvre område (25) i det første store runde hul (21) – ved hjælp af en rundtgående ribbe (33) er delt i en øvre rundt halsrundet del (31) oven over ribben (33) og en midterste, rund halsformet del (36) under ribben (33), og hvor et nedre område (26) af det nedre store hul (21) er udformet som en nedre keglestubformet del, der indsnævrer sig hen mod den nedre side (12) af pladelegemet (1), og hvis største diameter er mindre end diameteren af den øvre eller den midterste del (31, 32).

6. Knogleplade ifølge krav 5,
hvor et øvre område (27) i det andet mindre, runde hul (22) har et øvre afsnit (35) med et vist tilledende skråt parti (62), og et midterste afsnit (36) med en hældende afrundet flade (63) neden under den rundtgående ribbes (33) plan.

7. Knogleplade ifølge krav 1 til 6,
hvor den rundtgående ribbe (33) har et kileformet tværsnit, og hvor især højden målt i den radiale retning af det kileformede tværsnit, langs periferien ikke er konstant.

8. Knogleplade ifølge krav 7, og som har en rundtgående ribbe med forskellig højde målt i radial retning, og hvor symmetriaksen for den rundtgående ribbe er anbragt forskudt i forhold til symmetriaksen for den koniske del af det forholdsvis store runde hul under ribben.

9. Knogleplade ifølge krav 7, hvor det kileformede tværsnit af den rundtgående ribbe (33) i visse områder er udfladet, især hvor højden i radial retning af det kileformede tværsnit i den rundtgående ribbe (33), i visse områder i hovedsagen antager værdien nul.

10. Knogleplade ifølge et af kravene 1 til 6, hvor den rundtgående ribbe (33) har et kileformet tværsnit, uden at dette tværsnit antager en radial højde, som er i hovedsagen nul.

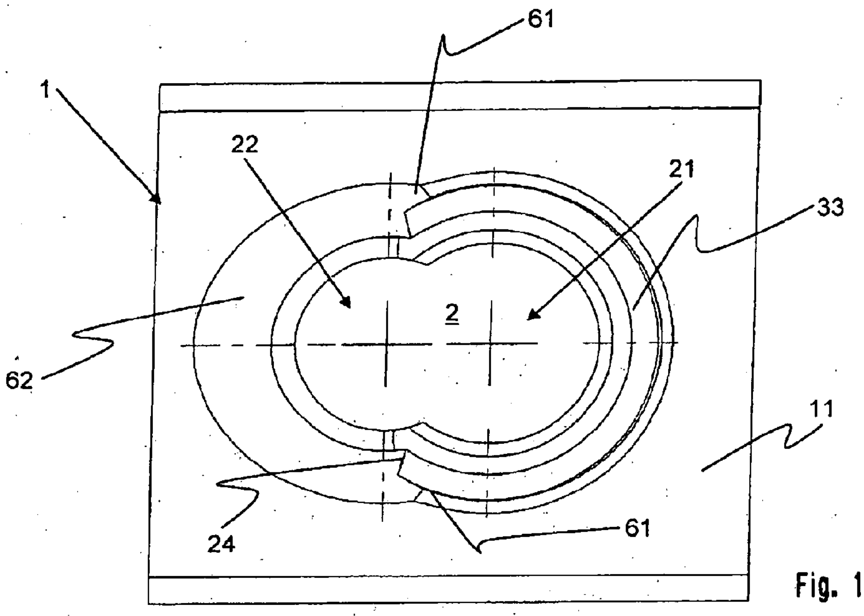
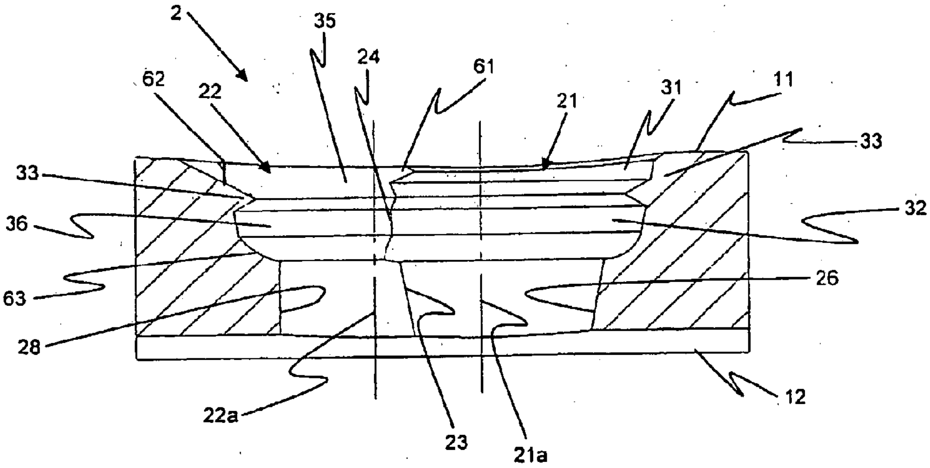

61
1
22
21
33
2
62
11
24
61

Fig. 1


2
35
24
61
62
22
21
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33
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32
63
26
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22a
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21a
12

Fig. 2

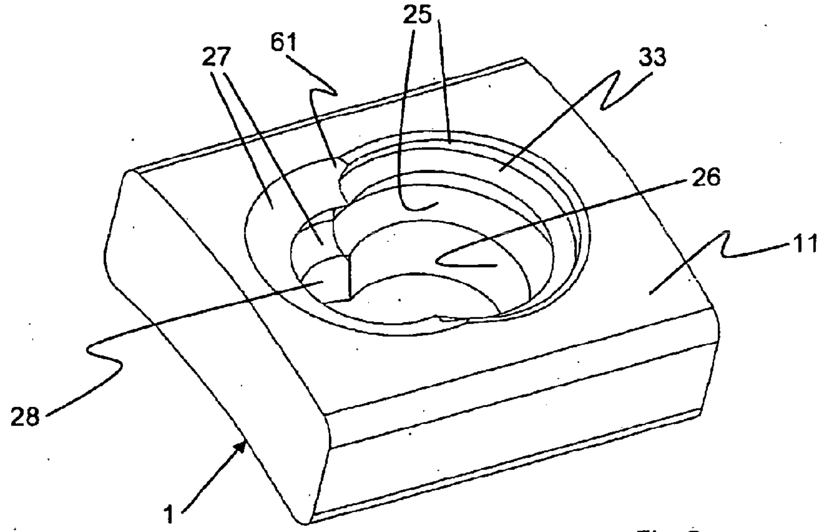


Fig. 3

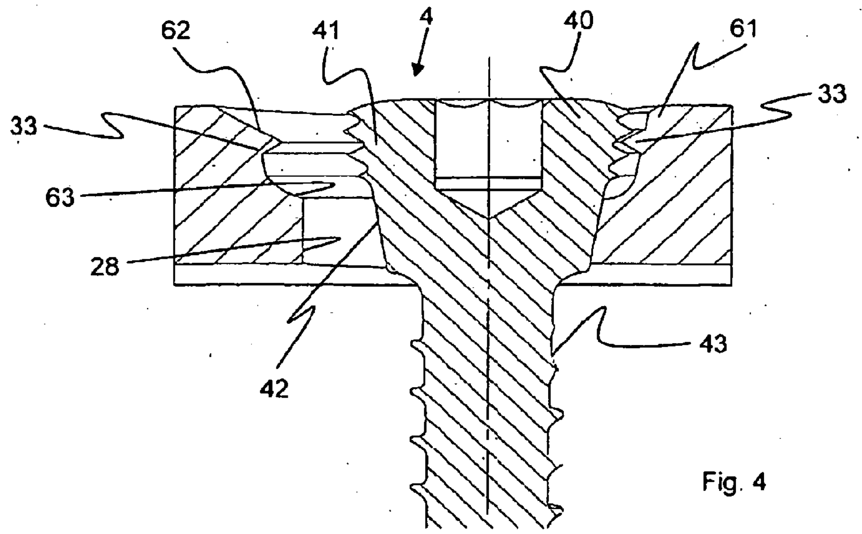


Fig. 4

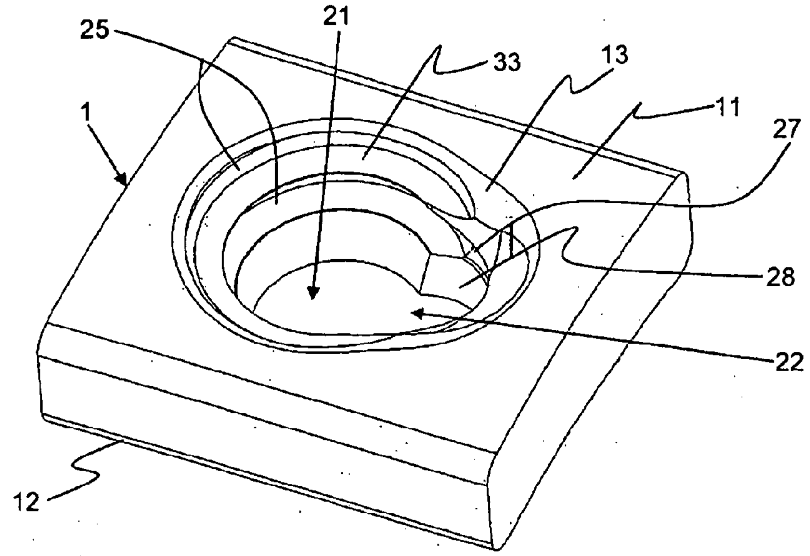


Fig. 5

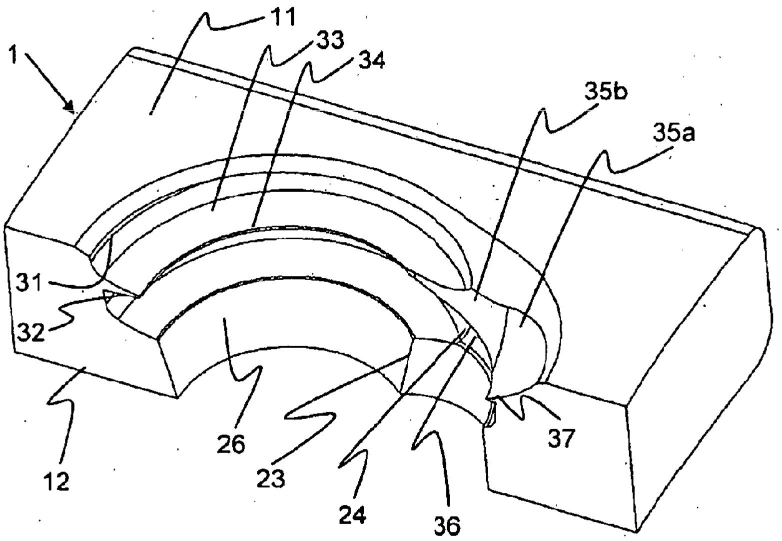
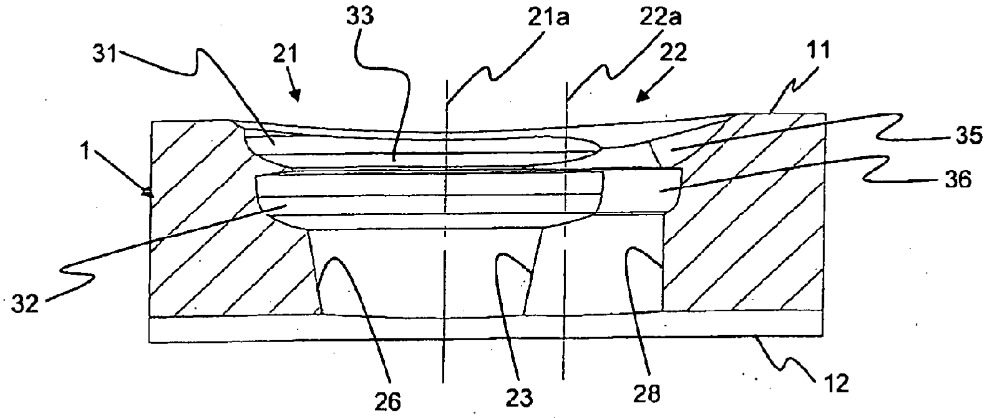
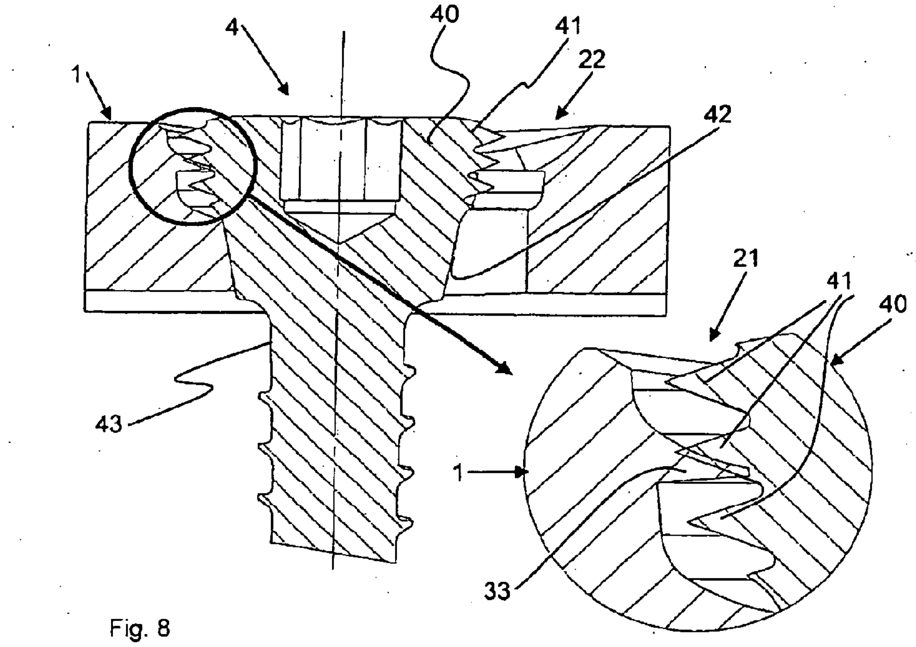


Fig. 6



33
21a
22a
31
21
22
11
1
35
36
32
26
23
28
12

Fig. 7



4
40
41
22
1
42
21
41
40
43
1
33

Fig. 8

Fig. 9

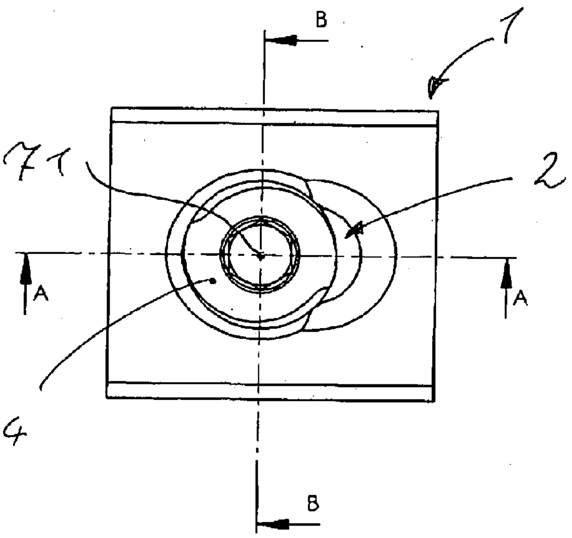


Fig. 10

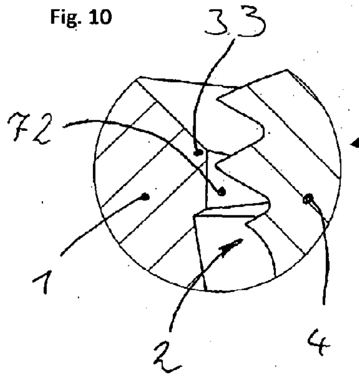


Fig. 11

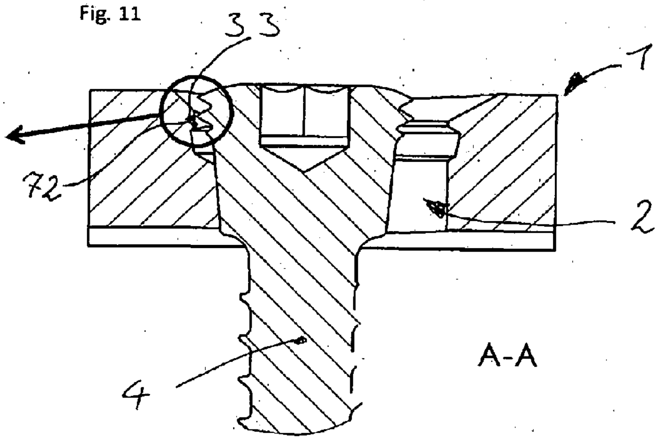


Fig. 12

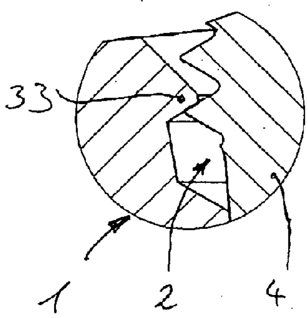


Fig. 13

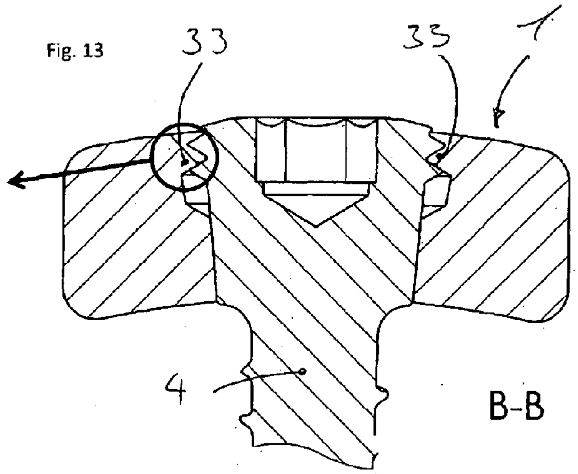


Fig. 14

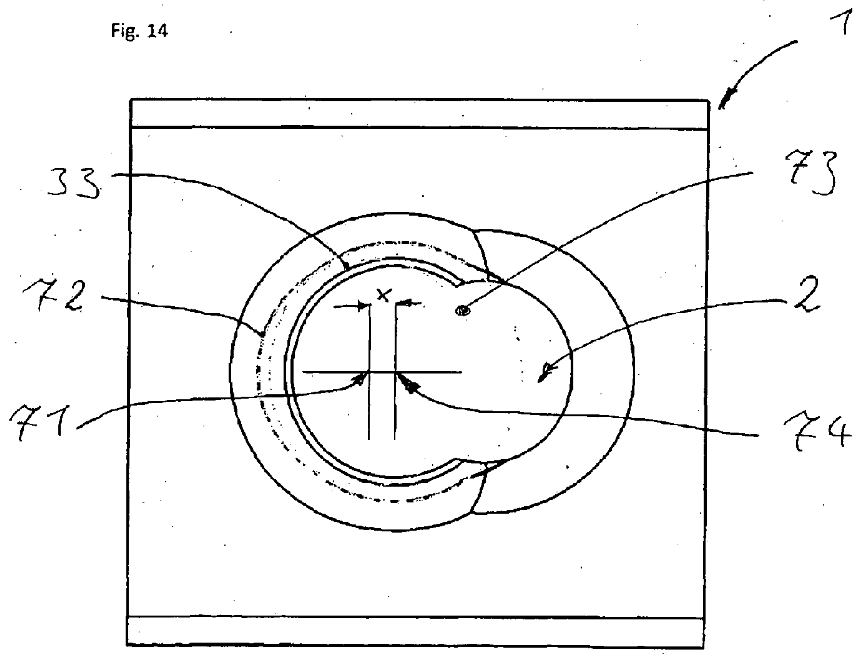


Fig. 15

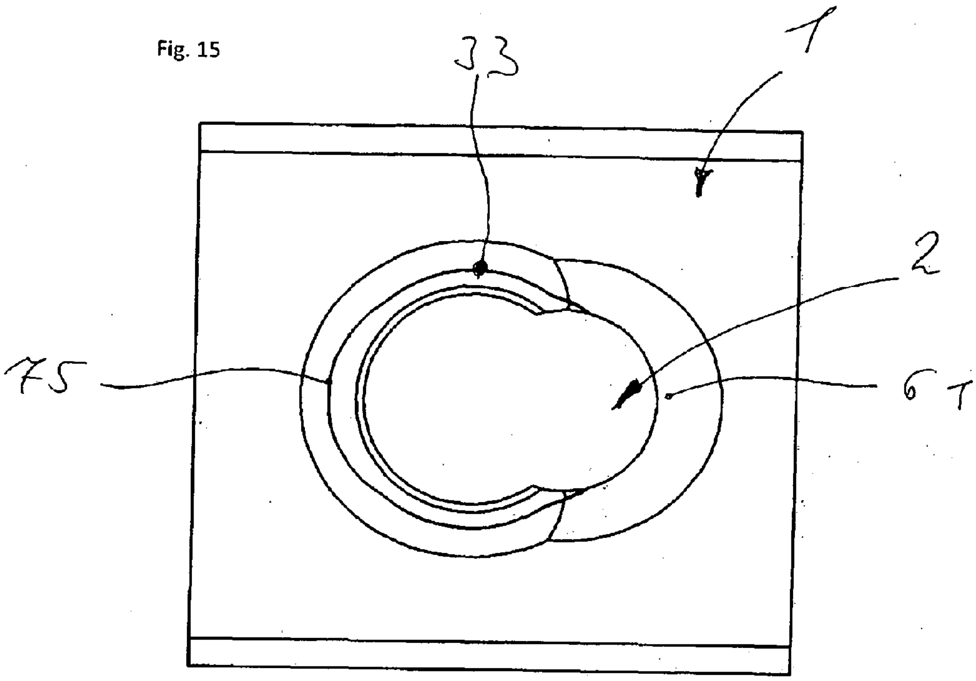


Fig. 16

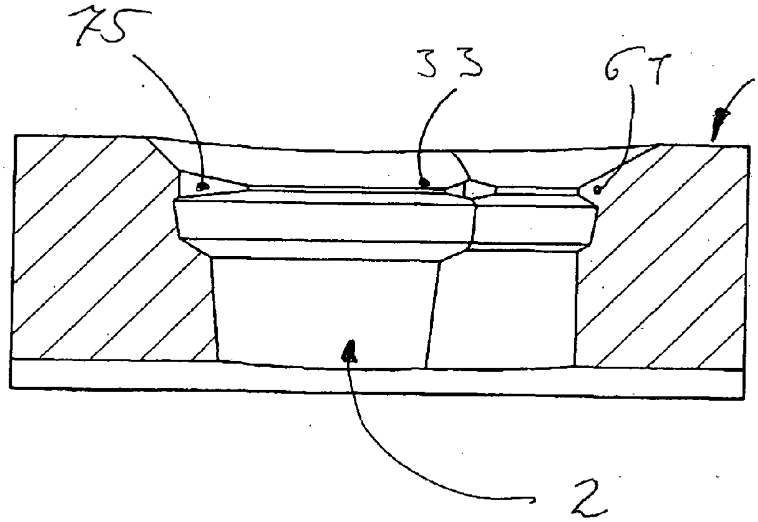


Fig. 17