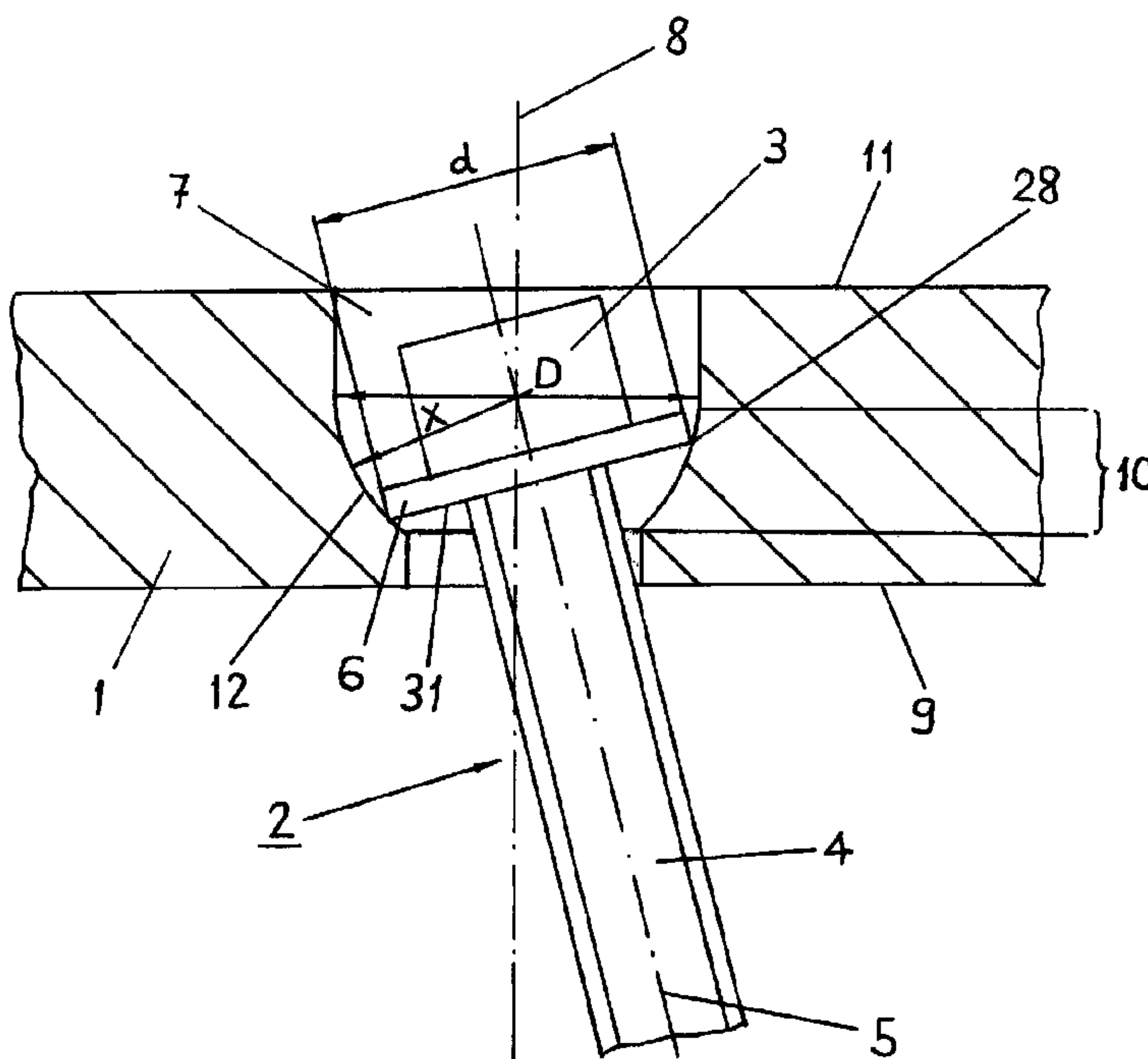




(22) Date de dépôt/Filing Date: 1999/07/07  
(41) Mise à la disp. pub./Open to Public Insp.: 2001/01/18  
(62) Demande originale/Original Application: 2 375 533

(51) Cl.Int./Int.Cl. *A61B 17/68* (2006.01),  
*A61B 17/86* (2006.01)  
(71) Demandeur/Applicant:  
SYNTHES USA, LLC, US  
(72) Inventeurs/Inventors:  
FRIGG, ROBERT, CH;  
FERUS, ROBERT, CH  
(74) Agent: OSLER, HOSKIN & HARCOURT LLP

(54) Titre : VIS A OS A AJUSTAGE ANGULAIRE ET DISPOSITIF DE FIXATION POUR OS EN OS DE SYNTHESE  
(54) Title: ANGLE-ADJUSTABLE BONE SCREW AND DEVICE FOR THE OSTEOSYNTHETIC BONE FIXATION



(57) **Abrégé/Abstract:**

A bone screw (2; 14) with a screw shank (4; 21) to be anchored concentric to a longitudinal axis (5; 24) of the screw in a bone or bone part, and with a screw head (3; 22), characterized in that the bone screw (2; 14) has, between the screw head (3; 22) and the screw shank (4; 21), a disk-shaped collar (6; 23) which is concentric to the longitudinal axis (5; 24) of the screw and whose diameter is greater than the diameter of the screw shank (4; 21). A device for osteosynthetic bone fixation with A) at least one such bone screw (2; 14); and B) at least one plate-shaped, prismatic or cylindrical fixation body (1; 15) which has at least one bore (7; 17) with a central axis (8; 16) for receiving the bone screw (2; 14), an underside (9; 19) toward the screw shank, and an upper side (11; 18) toward the screw head, C) the bore (7; 17) comprising a portion (10; 26) tapering toward the underside (9; 19), and D) the diameter *d* of the collar (6; 23) being dimensioned such that the collar (6; 23), in the concave portion (10; 26) of the bore (7; 17), can be made to bear on the wall (12; 27) of the bore (7; 17) at different angles between the longitudinal axis (5; 24) of the screw and the central axis (8; 16).

Abstract

A bone screw (2; 14) with a screw shank (4; 21) to be anchored concentric to a longitudinal axis (5; 24) of the screw in a bone or bone part, and with a screw head (3; 22), characterized in that the bone screw (2; 14) has, between the screw head (3; 22) and the screw shank (4; 21), a disk-shaped collar (6; 23) which is concentric to the longitudinal axis (5; 24) of the screw and whose diameter is greater than the diameter of the screw shank (4; 21).

A device for osteosynthetic bone fixation with

A) at least one such bone screw (2; 14); and

B) at least one plate-shaped, prismatic or cylindrical fixation body (1; 15) which has at least one bore (7; 17) with a central axis (8; 16) for receiving the bone screw (2; 14), an underside (9; 19) toward the screw shank, and an upper side (11; 18) toward the screw head,

C) the bore (7; 17) comprising a portion (10; 26) tapering toward the underside (9; 19), and

D) the diameter  $d$  of the collar (6; 23) being dimensioned such that the collar (6; 23), in the concave portion (10; 26) of the bore (7; 17), can be made to bear on the wall (12; 27) of the bore (7; 17) at different angles between the longitudinal axis (5; 24) of the screw and the central axis (8; 16).

**ANGLE-ADJUSTABLE BONE SCREW AND DEVICE FOR  
THE OSTEOSYNTHETIC BONE FIXATION**

The invention relates to a bone screw with a screw  
5 shank to be anchored concentric to a longitudinal axis  
of the screw in a bone or bone part, and with a screw  
head, characterized in that the bone screw has, between  
the screw head and the screw shank, a disk-shaped  
collar which is concentric to the longitudinal axis of  
10 the screw and whose diameter is greater than the  
diameter of the screw shank and to a device for  
osteosynthetic bone fixation with at least one bone  
screw with a screw shank to be anchored concentric to a  
longitudinal axis of the screw in a bone or bone part,  
15 and with a screw head, characterized in that the bone  
screw has, between the screw head and the screw shank,  
a disk-shaped collar which is concentric to the  
longitudinal axis of the screw and whose diameter is  
greater than the diameter of the screw shank; and

20 a) at least one plate-shaped, prismatic or  
cylindrical fixation body which has at least one bore  
with a central axis for receiving the bone screw, an  
underside toward the screw shank, and an upper side  
toward the screw head,

25 b) the bore comprising a portion tapered toward  
the underside, characterized in that

c) the diameter  $d$  of the collar is dimensioned  
such that the collar, in the concave portion of the  
bore, can be made to bear on the wall of the bore at  
30 different angles between the longitudinal axis of the  
screw and the central axis.

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Various devices for internal fixation of bone fragments in the human or animal body are already known from the prior art.

In the case of internal fixation of the spinal column or of parts of the spinal column, such devices often essentially comprise pedicle screws which are anchored by means of threads in the pedicles of the individual vertebrae to be joined, and one or more longitudinal supports which extend in the direction of the spinal column and have to be connected securely to the pedicle screw. For stable anchoring of the whole implant, the pedicle screws must on the one hand be screwed securely into the pedicles and, on the other hand, connected rigidly to the longitudinal supports. The connection between the screw head of the pedicle screws and the longitudinal support is normally effected by means of clamp mechanisms which must permit a stable connection, even at different angles of the pedicle screw in relation to the longitudinal support. The clamp connection must be releasable so that the whole implant can be removed again without large tissue openings in the area of the spinal column.

Secure connections between bone screws and plates or supports are also common in other internal bone fixations. Here too, different angles of the bone screws relative to the plate or the support must be possible without adversely affecting the connections in terms of their stability.

Such a connection between a bone-anchoring screw and a stabilizer rod for internal fixation of vertebrae is known from US 5,466,237 BYRD. This known invention has a bone-anchoring screw with a screw head which is designed as a segment of a sphere on its side facing

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the screw shank and is convex at its end. The spherical segment part of the screw is mounted in a bore of the anchoring element, this bore comprising a concave portion which tapers toward the screw shank so that a ball-joint-type connection is obtained between the bone screw and the anchoring element. This ball-joint-type connection is blocked by tightening a nut on the anchoring element, which nut presses against the longitudinal support which has been placed in the anchoring element and which consequently presses against the terminal convex part of the screw head and thus blocks the screw head in the anchoring element. However, because of the often inexactly matching spherical surfaces on the bone screw and in the anchoring element, such a blockable ball-joint-type connection is unsuitable for taking up the forces which arise in bone fixation. In addition, such a ball-joint-type connection can only be blocked with frictional engagement.

The invention is intended to remedy this situation. The invention is based on the object of providing a connection between bone screw and anchoring element which permits different angles between screw axis and anchoring element and which is stable, in particular permitting a form fit with suitable material pairing.

The object set is achieved by the invention with a bone screw with a screw shank to be anchored concentric to a longitudinal axis of the screw in a bone or bone part, and with a screw head, characterized in that the bone screw has, between the screw head and the screw shank, a disk-shaped collar which is concentric to the longitudinal axis of the screw and whose diameter is

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greater than the diameter of the screw shank, and with a device for osteosynthetic bone fixation with at least one bone screw with a screw shank to be anchored concentric to a longitudinal axis of the screw in a bone or bone part, and with a screw head, characterized in that the bone screw has, between the screw head and the screw shank, a disk-shaped collar which is concentric to the longitudinal axis of the screw and whose diameter is greater than the diameter of the screw shank; and

a) at least one plate-shaped, prismatic or cylindrical fixation body which has at least one bore with a central axis for receiving the bone screw, an underside toward the screw shank, and an upper side toward the screw head,

b) the bore comprising a portion tapering toward the underside, characterized in that

c) the diameter  $d$  of the collar is dimensioned such that the collar, in the concave portion of the bore, can be made to bear on the wall of the bore at different angles between the longitudinal axis of the screw and the central axis.

The bone screw according to the invention comprises a screw shank to be anchored concentric to a longitudinal axis in a bone or bone part, and a likewise concentric screw head, and also, between screw head and screw shank, a disk-shaped collar which is

concentric to the longitudinal axis. The diameter of the collar is greater than the diameter of the screw shank. Depending on the embodiment of the bone screw according to the invention, the diameter of the collar is preferably between 8 and 10 mm or between 4 mm and 6 mm, while the diameter of the screw shank is preferably between 5 and 6 mm or between 3 and 5 mm. The thickness of the collar, again depending on the embodiment of the bone screw according to the invention, is preferably between 1 and 2 mm or between 0.5 and 1 mm.

The rim of the collar is preferably stepped and has a lower edge for bearing against the wall of a bore formed with a curved surface.

In another embodiment of the bone screw according to the invention, the collar comprises, on the side toward the screw shank, a plurality of circular edges concentric to the longitudinal axis of the screw, with diameters  $d > d_1 > d_2$  decreasing toward the screw shank. The diameters  $d$ ;  $d_1$ ;  $d_2$  are preferably dimensioned such that the edges run on an imaginary convex surface on the screw shank side. In a special embodiment of the bone screw according to the invention, this imaginary surface can be designed as a spherical zone concentric to the central axis and with the radius  $Y$ .

The screw head can be of convex design, in particular spherical or semispherical.

Depending on the embodiment, screw head and screw shank are made in one piece or in more than one piece, the screw head being able to be secured in a releasable manner on the screw shank by means of a cone connection, a screw connection or a bayonet lock connection.

Depending on the embodiment, the bone screw according to the invention can be used for fixation of bones or bone parts in an osteosynthesis fixation device and can serve, for example, for the fixation of

bones or bone parts on a bone plate or for fixation of vertebrae in a spinal column fixation device.

The device according to the invention for osteosynthetic bone fixation comprises at least one  
5 bone screw with a screw shank to be anchored in the bone or bone part and with a screw head, and at least one fixation body which serves for stable fixation of the bones or bone parts. The fixation body has at least one bore for receiving the bone screw, this bore  
10 passing through the fixation body and comprising a concave portion tapering toward the end at the screw shank side. The bone screw has a disk-shaped collar arranged between screw head and screw shank and concentric to the longitudinal axis of the bone screw.  
15 The diameter of the collar is dimensioned such that the collar, in the concave portion of the bore, can be made to bear on the wall of the bore at different angles between the longitudinal axis of the bone screw and the central axis of the bore. This configuration of the  
20 disk-shaped collar with a plane surface on the screw shank side, which surface bears on the concave wall of the bore upon tightening of the screw, permits a linear contact between the bone screw and the fixation body.

In one embodiment of the device according to  
25 the invention, this is used to connect a longitudinal support to the bone screw, designed as pedicle screw, within a spinal column fixation system. The fixation body is designed as a receiving head which serves to connect the longitudinal support to the pedicle screw.  
30 Besides the through-bore passing through the receiving head in order to receive the pedicle screw, there is additionally a channel extending transverse to the central axis of the receiving head and open toward the screw head end in order to receive the longitudinal  
35 support. The device additionally comprises clamping means which can be connected to the receiving head in a releasable manner at the screw head end and serve for fixing the longitudinal support and the pedicle screw within the receiving head. The through-bore comprises a

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concave portion tapering toward its screw shank end, so that the collar on the pedicle screw can be made to bear on the wall of the through-bore, in the concave portion of the through-bore, at different angles  
5 between the screw axis and the central axis of the bore.

In a further embodiment of the device according to the invention, the disk-shaped collar on the bone screw has the diameter  $d$ , and the concave portion is of  
10 spherical design and has the diameter  $D$ , where  $D = d$ . However, with this design, only small angles of the screw axis relative to the central axis of the bore in the fixation body are possible, since otherwise the linear contact is obtained only on one part of the  
15 collar circumference. For greater angles, a design of the concave portion is suitable with a diameter  $D$ , where  $D > d$ . In this case, the ratio  $d:D$  can be chosen between 0.5 and 1.0, preferably between 0.85 and 0.95. In addition, the diameter of the screw head is chosen  
20 such that, if the bone screw is in an inclined position, the screw head does not bear on the wall of the bore and thereby restrict an inclined position of the bone screw.

In yet another embodiment of the device  
25 according to the invention, the concave portion is designed in the manner of a spherical segment, where the spherical segment has a radius  $X$  while the diameter of the concave portion is  $D$ , so that  $X \geq D/2$ . The ratio of  $D/2$  to  $X$  is between 0.5 and 1.0, preferably between  
30 0.85 and 0.95.

In a particular embodiment of the device according to the invention, the convex screw head of the bone screw is of spherical or semispherical design. In the case of the connection device between  
35 longitudinal support and pedicle screw, the advantage of this design lies in the fact that a longitudinal support clamped between screw head and clamping means presses on the screw head concentric to the central

axis even if the pedicle screw is in an inclined position.

The convex screw head can be made in one piece with the screw shank or, in the case of a two-piece bone screw, can be connected to the screw shank in a releasable manner. By means of the two-piece design, the means for inserting a screwdriver into the screw shank, for example a hexagon socket or internal thread, can above all be more easily provided. In addition, in the case of a central arrangement of, for example, a hexagon socket in the screw shank, the bearing between longitudinal support and screw head is not adversely affected by application of the screw head after implantation of the bone screw.

The rim of the collar on the bone screw is advantageously stepped, especially on the underside toward the screw shank, so that a lower edge is formed which is intended for linear contact with the wall of the concave portion.

Another embodiment of the device according to the invention differs from the above-described embodiment only in that the collar between screw head and screw shank comprises a plurality of edges concentric to the longitudinal axis of the screw, with diameters  $d > d_1 > d_2$  decreasing toward the screw shank.

The edges are circular on the screw shank side. The diameters  $d; d_1; d_2$  are preferably dimensioned here such that the edges run on an imaginary convex surface on the screw shank side and, in the concave portion of the bore, can be made to bear against the wall of the bore at different angles between the longitudinal axis of the screw and the central axis.

The diameters  $d; d_1; d_2$  are preferably chosen such that the imaginary surface is a spherical zone concentric to the central axis and with the radius  $Y$ .

Depending on the embodiment of the bone screw according to the invention, the diameter  $D$  of the concave portion and the diameter  $d$  of the collar is advantageously between 8 and 10 mm, or between 4 and

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6 mm, while the collar advantageously has a thickness of 1 to 2 mm or of 0.5 to 1 mm depending on the embodiment of the bone screw according to the invention.

5           The external diameter of the screw shank is advantageously 5 to 6 mm or 3 to 5 mm depending on the embodiment of the bone screw according to the invention.

10           In another embodiment of the device according to the invention, the fixation body is designed as a bone plate with at least one through-bore for receiving a bone screw. The device can additionally comprise a grub screw with means for receiving a screwdriver, the grub screw being able to be screwed in an internal  
15           thread introduced from the upper side into the at least one bore and being able to be pressed against the screw head of the bone screw upon tightening.

          The advantages afforded by the invention are essentially that, by virtue of the inventive design of  
20           the bore for receiving a bone screw and the design of the bone screw with a collar which is intended to bear in a concave portion of the bore, a linear contact can be obtained which, upon fixation of the device, leads to a secure connection between bone screw and fixation  
25           body. In the case of a deformable bore wall, a form-fit connection between collar and bore wall can also be obtained as a result of the linear contact. The advantages which can be afforded by the two-part design of the bone screw are that the surface of the convex  
30           screw head in the area of contact with another implant part, for example the longitudinal support, is smooth and this contact zone is not impeded by means for receiving a screwdriver.

          The invention and developments of the invention  
35           are discussed in greater detail below with reference to the partially diagrammatic representations of a number of illustrative embodiments.

          Fig. 1 shows a section through an embodiment of the device according to the invention;

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Fig. 2 shows a section parallel to a longitudinal support through a further embodiment of the device according to the invention;

Fig. 3 shows a section through the embodiment of the device according to the invention represented in Fig. 2, transverse to a longitudinal support;

Fig. 4 shows a view of an embodiment of the multi-part bone screw according to the invention;

Fig. 5 shows a view of a further embodiment of the multi-part bone screw according to the invention;

Fig. 6 again shows a view of a further embodiment of the multi-part bone screw according to the invention;

Fig. 7 shows a section through a further embodiment of the device according to the invention; and

Fig. 8 shows a view of a further embodiment of the bone screw according to the invention.

A part of a bone fixation body 1 is shown in Fig. 1 together with a bone screw 2 according to one embodiment of the device according to the invention. The bone fixation body 1 is designed as a bone plate and has an underside 9 toward the screw shank and an upper side 11 toward the screw head, the upper side 11 being intended to bear on the bone when the bone plate is screwed tight. The bone screw 2 is received in the bone fixation body 1 in a bore 7 which has a central axis 8, passes through the bone fixation body 1 and is provided with a concave portion 10 tapering toward the underside 9. The concave portion 10 is of spherical design, with a radius of curvature X, and opens toward the upper side 11 into a cylindrical portion with the diameter D. In the embodiment of the device according to the invention shown here, the radius of curvature X corresponds to the radius of the cylindrical portion  $X = D/2$ . The bone screw 2 comprises, concentric to a longitudinal axis 5 of the screw, a screw shank 4 to be anchored in the bone or bone part and a screw head 3, as well as a circular disk-shaped collar 6 arranged between screw shank 4 and screw head 3 and concentric

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to the longitudinal axis 5 of the screw, and with a plane bearing surface 31 toward the screw shank. The outer periphery of plane bearing surface 31 forms a substantially sharp edge 28.

5 As regards its diameter  $d$ , the collar 6 is dimensioned such that, in the concave portion 10, it can bear on the wall 12 of the bore 7 at different angles between the longitudinal axis 5 of the screw and the central axis 8 of the bore 7. This ensures that the  
10 bone screw 2 can be screwed into the bone or the bone part at different angles relative to the bone fixation body 1.

Figures 2 and 3 show an embodiment of the device according to the invention which serves to connect a  
15 longitudinal support 13 to a pedicle screw 14 in a spinal column fixation system. This device comprises a pedicle screw 14 which, concentric to its longitudinal axis 24, has a screw shank 21 to be anchored in the bone and a convex screw head 22, a receiving head 15  
20 with the central axis 16, which serves to connect a longitudinal support 13 to the pedicle screw 14, and clamping means 25 which essentially have the shape of a nut and, by means of an internal thread 32, can be screwed in a releasable manner via an external thread  
25 31 adjoining the upper side 18 of the receiving head 15 and serve to fix the longitudinal support 13 and the pedicle screw 14 within the receiving head 15.

The convex screw head 22 is designed in the form of segment of a sphere, the zenith 29 of the  
30 spherical segment lying on the longitudinal axis 24 of the screw and forming the screw-head end of the pedicle screw 14. Also arranged on the screw head 22 are two or more surfaces 30 oriented parallel to the longitudinal axis 24 of the screw and forming two external edges for  
35 screwing the pedicle screw 14 into the bone by means of a screwdriver. An external hexagon is also possible instead of the external two edges.

The receiving head 15 has an upper side 18 toward the screw head, an underside 19 toward the screw

40

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shank, a through-bore 17 passing through the receiving head 15 coaxial to the central axis 16 for receiving the pedicle screw 14, and additionally a channel 20 extending transverse to the central axis 16, open toward the upper side 18 and receiving a longitudinal support 13. In this way, the longitudinal support 13 can be inserted into the open channel 20 from the direction of the upper side 18 and can be fixed therein in a releasable manner by the clamping means 25.

10 The through-bore 17 comprises a concave portion 26 which tapers toward the underside 19 and which, in the embodiment of the device according to the invention shown here, is designed as a segment of a sphere.

15 The pedicle screw 14 additionally has, between the convex screw head 22 and the screw shank 21, a disk-shaped collar 23 which is concentric to the longitudinal axis 24 of the screw and is dimensioned such that the collar 23, in the concave portion 26 of the through-bore 17, can bear on the wall 27 of the through-bore 17 at different angles between the longitudinal axis 24 of the screw and the central axis 16.

25 An embodiment of the two-part bone screw 2 according to the invention is shown in Fig. 4. The connection between screw head 3 and screw shank 4 is a cone connection. Arranged on the screw head 3 there is a conical peg 32 which is concentric to the longitudinal axis 5 of the screw and which can be secured in a bore 33 concentric to the longitudinal axis 5 of the screw, with an inner cone 34 at the screw head end of the screw shank 4.

35 Fig. 5 shows a further embodiment of the two-part bone screw 2 according to the invention. Here, the connection between screw head 3 and screw shank 4 is a screw connection. Arranged on the screw head 3 there is a threaded peg 35 which is concentric to the longitudinal axis 5 of the screw and which can be screwed into a bore 36, concentric to the longitudinal

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axis 5 of the screw, with an internal thread 37 at the screw-head end of the screw shank 4.

Fig. 6 again shows a further embodiment of the two-part bone screw 2 according to the invention. Here, the connection between screw head 3 and screw shank 4 is a bayonet lock. Arranged on the screw head 3 there is a peg 38, concentric to the longitudinal axis 5 of the screw, with a radially protruding pin 39 which can be snapped into a bore 40, with groove 43, concentric to the longitudinal axis 5 of the screw, the groove 43 having a part 42 extending parallel to the longitudinal axis 5 of the screw and a part 41 extending peripherally in the bore 40.

Fig. 7 shows an embodiment of the device according to the invention which differs from the embodiment shown in Fig. 1 only in that the fixation body 1 is a bone plate with at least one through-bore 7 for a bone screw 2 and the device additionally comprises a grub screw 45 with means 47 for receiving a screwdriver, which can be screwed in an internal thread 46 introduced from the upper side 11 into the bore 7 and can be pressed against the screw head 22 upon tightening. By means of this grub screw 45 which can be tightened, a stable-angle fixation of the bone screw 2 in the bone plate 1 is achieved.

Fig. 8 shows an embodiment of the bone screw 2 according to the invention which differs from the embodiments shown in Figures 4 through 6 only in that the collar 6 comprises several circular edges 53; 54; 56 toward the screw shank, the diameters  $d$ ;  $d_1$ ;  $d_2$  of these edges 53; 54; 56 being dimensioned such that the edges 53; 54; 56 run on an imaginary convex surface 55, on the screw shank side, which is designed as a spherical zone concentric to the central axis 5 and with the radius  $Y$ .

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The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A bone fixation system comprising:

a bone screw having a longitudinal axis,

a head;

a shank;

a collar disposed between the head and shank and comprising a top portion and a plurality of lower portions, at least two adjacent lower portions forming at least one edge generally concentric to a longitudinal axis of the bone screw, wherein each edge is disposed along an imaginary convex surface that is generally spherical; and

a receiving member comprising at least one bore having a longitudinal axis, the bore defining an inner surface having an upper portion and a lower generally spherical portion for contacting the imaginary convex surface for permitting the longitudinal axis of the bone screw to be angulated with respect to the longitudinal axis of the bore.

2. The bone fixation system of claim 1, wherein the collar has two edges.

3. The bone fixation system of claim 2, wherein at least a portion of the head is substantially semispherical.

4. The bone fixation system of claim 3, wherein the head is integrally formed with the shank.

5. The bone fixation system of claim 3, wherein the head and shank are separately formed.

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6. The bone fixation system of claim 5, wherein the head is releasably associated with the shank.
7. The bone fixation system of claim 5, wherein the head is threadably associated with the shank.
8. The bone fixation system of claim 5, wherein the head is connected to the shank by a conical peg that is received in a conical bore, with the conical peg and conical bore being disposed along the longitudinal axis.
9. The bone fixation system of claim 5, wherein the head is connected to the shank by a bayonet lock.
10. The bone fixation system of claim 3, wherein the head further comprises a zenith disposed on the longitudinal axis.
11. The bone fixation system of claim 1, wherein each edge has a diameter, and the diameters of the edges decrease as a function of increasing distance from the head.
12. The bone fixation system of claim 1, wherein the collar is disk-shaped.
13. The bone fixation system of claim 1, wherein the head is convex with respect to the shank.
14. The bone fixation system of claim 1, wherein each edge forms a generally circular shape having a diameter between about 4 mm and about 10 mm.
15. The bone fixation system of claim 1, wherein each edge forms a generally circular shape having a diameter between about 8 mm and about 10 mm.

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16. The bone fixation system of claim 1, wherein the collar has a thickness defined between a top surface and a bottom surface between about 0.5 mm and about 2 mm.

17. The bone fixation system of claim 1, wherein the shank has an external diameter between about 3 mm and about 6 mm.

18. The bone fixation system of claim 1, wherein each edge forms a substantially circular shape.

19. The bone fixation system of claim 1, wherein each edge is substantially sharp.

20. A bone fixation assembly comprising;

a bone fastener comprising a head, a shank having threads to be anchored into bone, and a plurality of disk-shape collars, each collar having a top surface, a bottom surface and a lateral sidewall extending between the top surface and the bottom surface, the intersection of the lateral sidewall with the bottom surface forming a substantially sharp edge; and

a receiving member comprising at least one bore that defines an inner surface with a first cylindrical portion and a second non-cylindrical portion, wherein the diameters of the collars are sized and configured so that they decrease from the head to the shank so that the sharp edges of the collars form an imaginary convex surface, each of the sharp edges containing the second non-cylindrical portion.



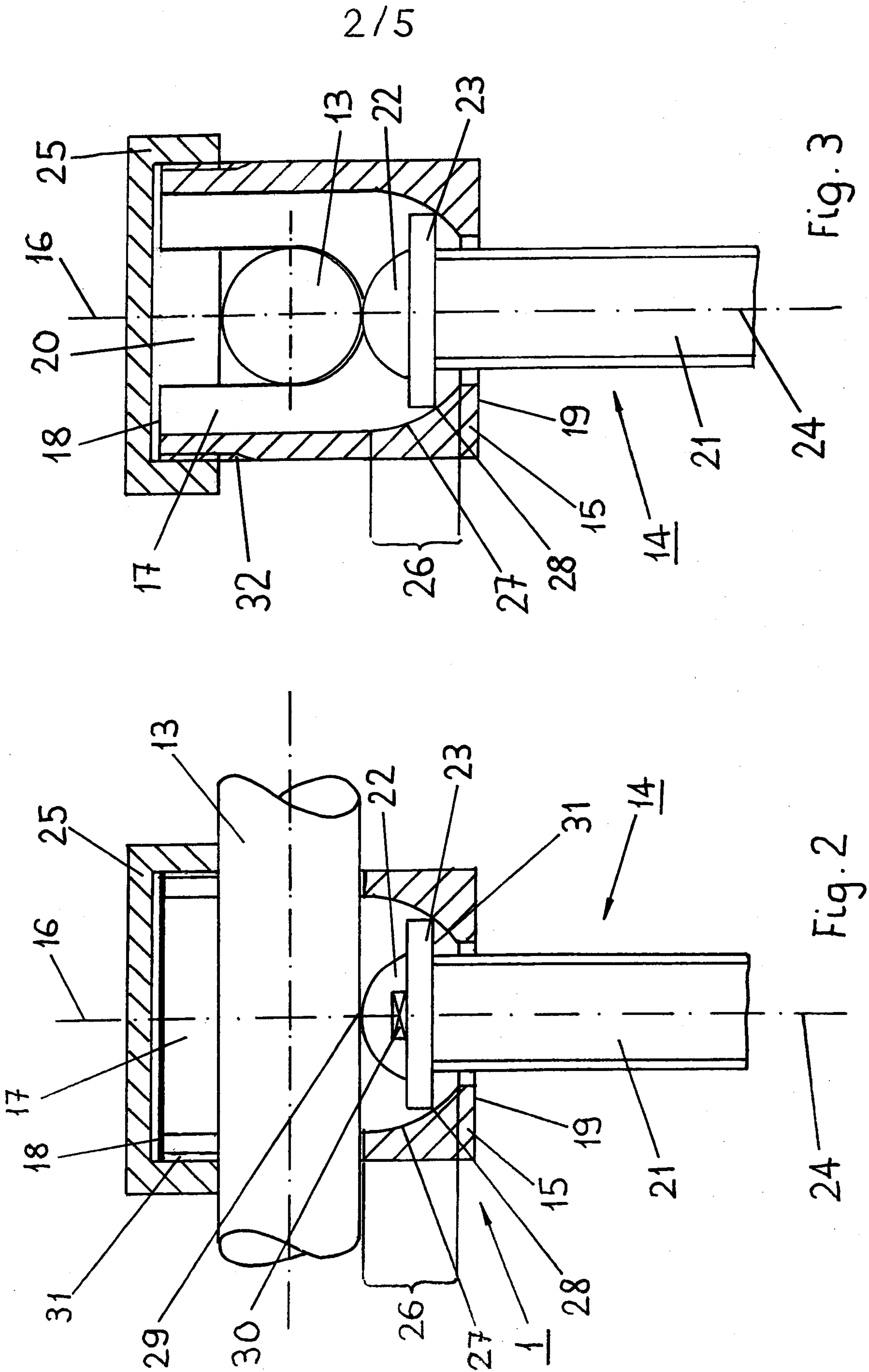


Fig. 4

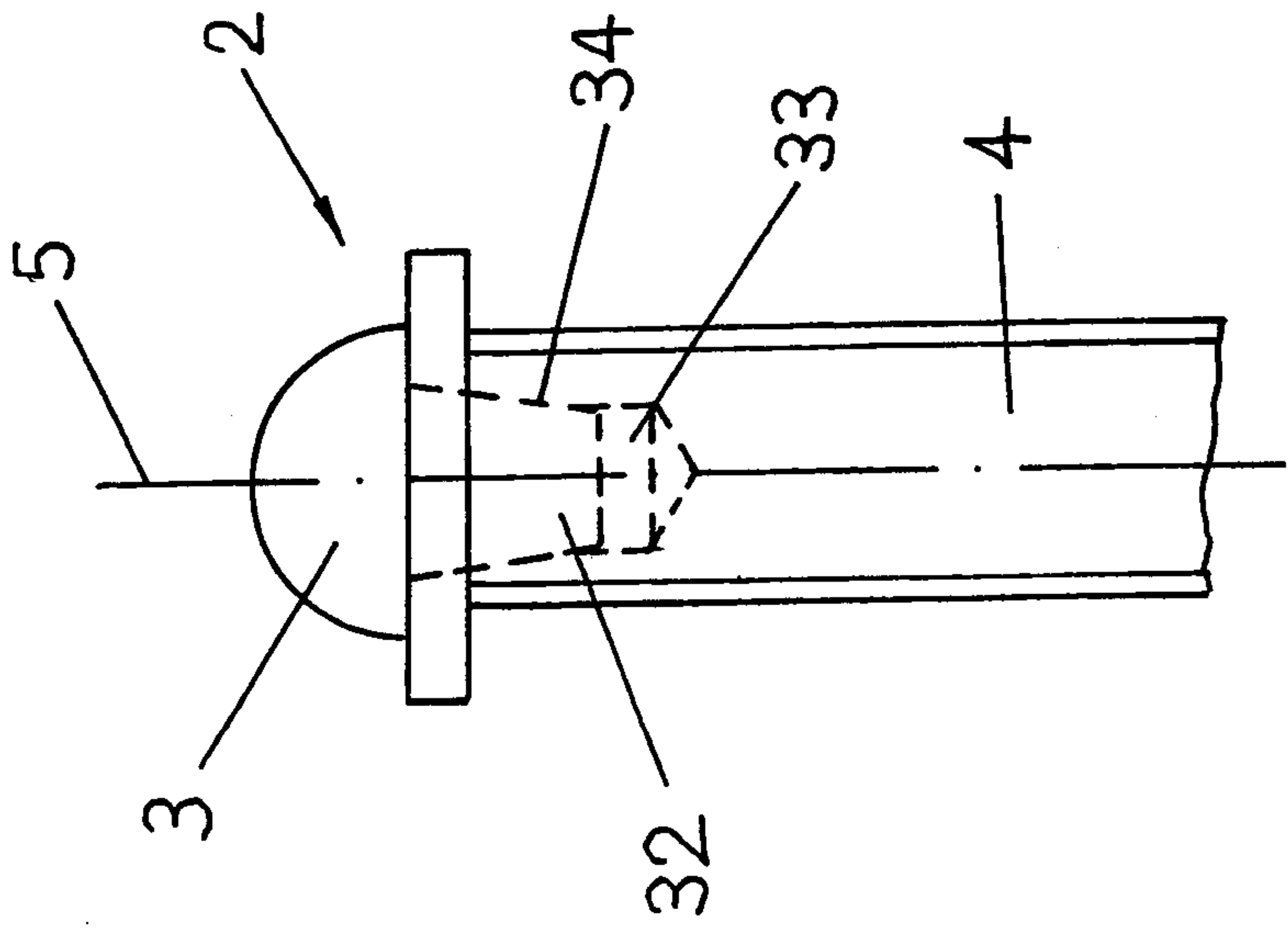


Fig. 5

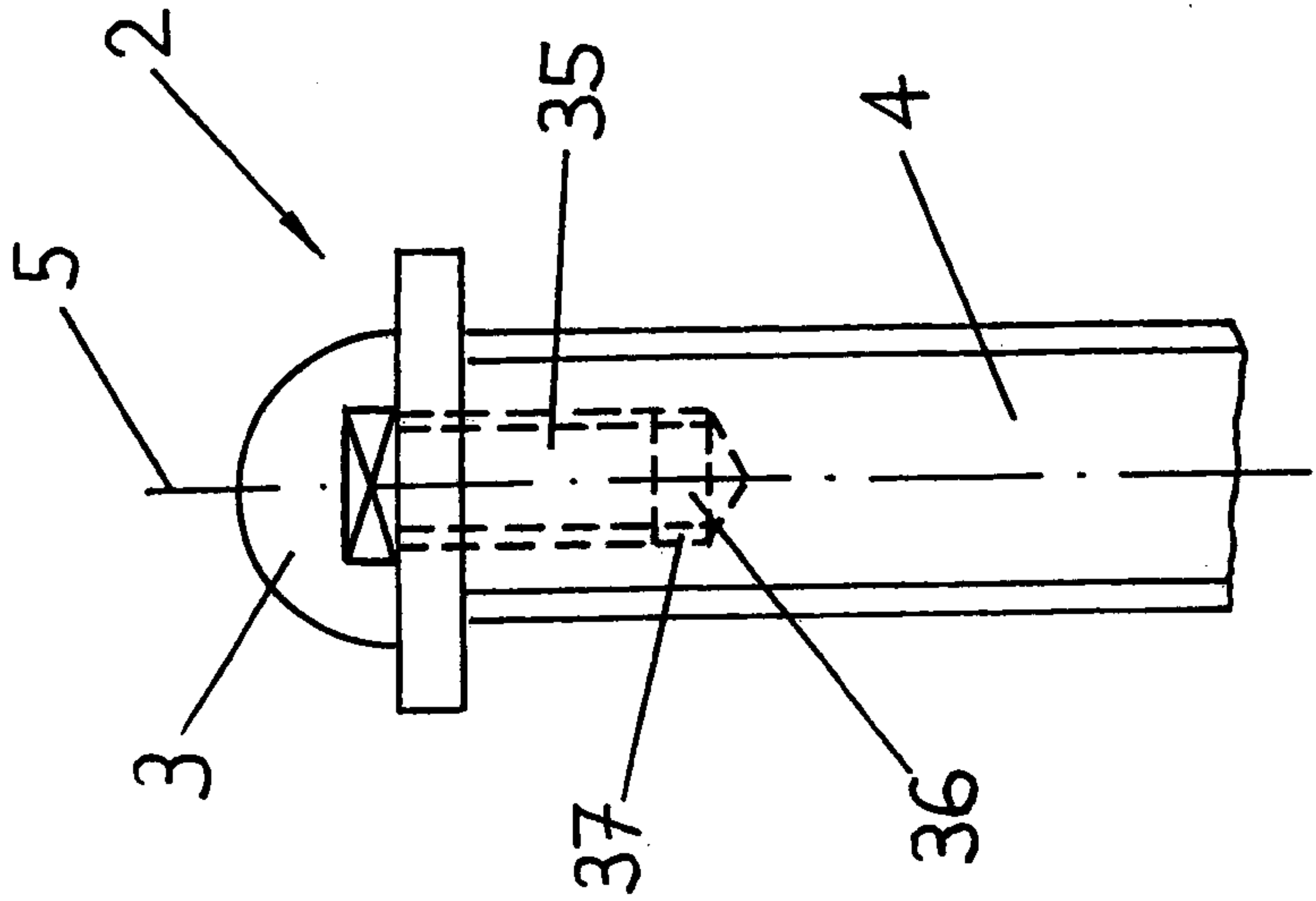
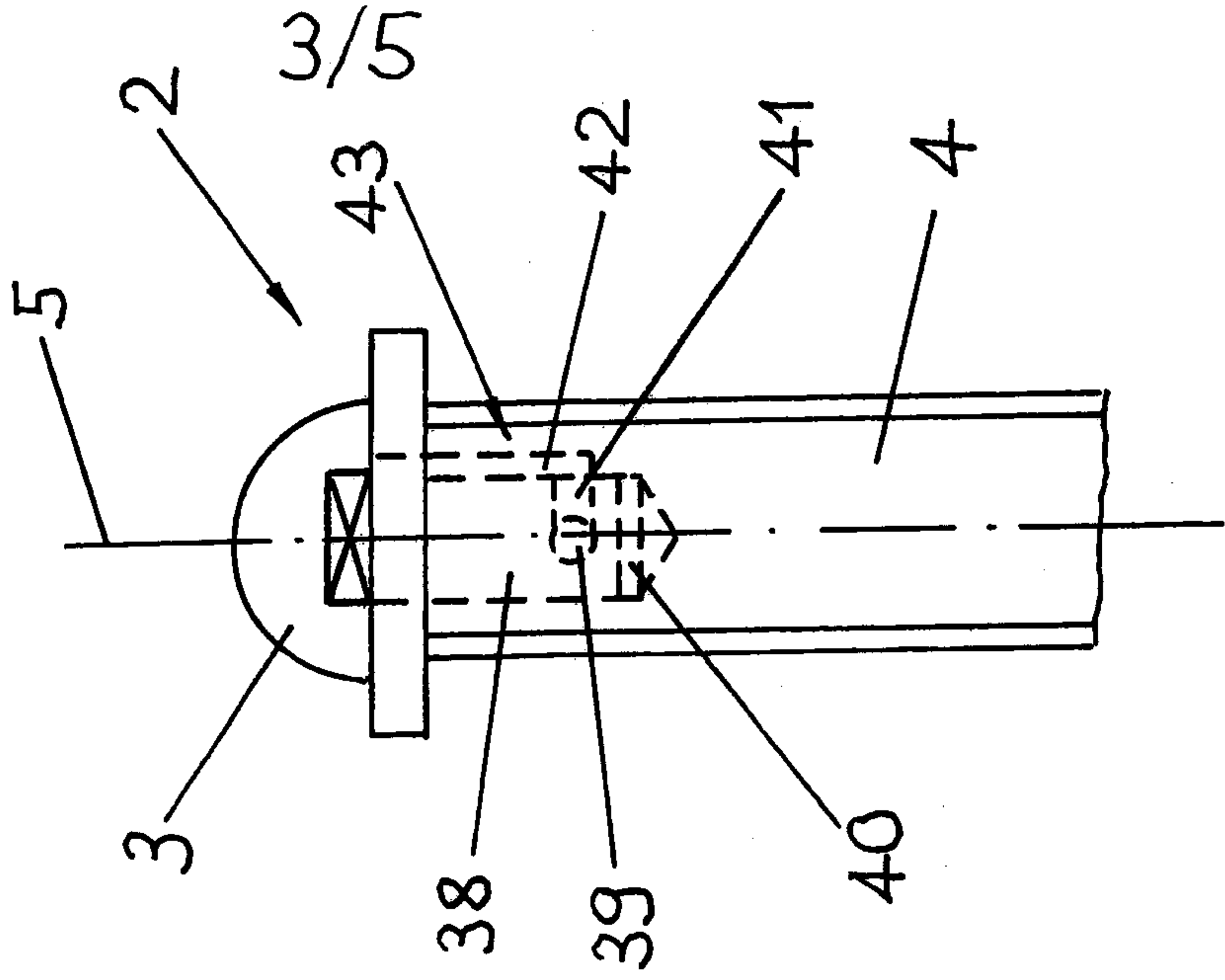


Fig. 6



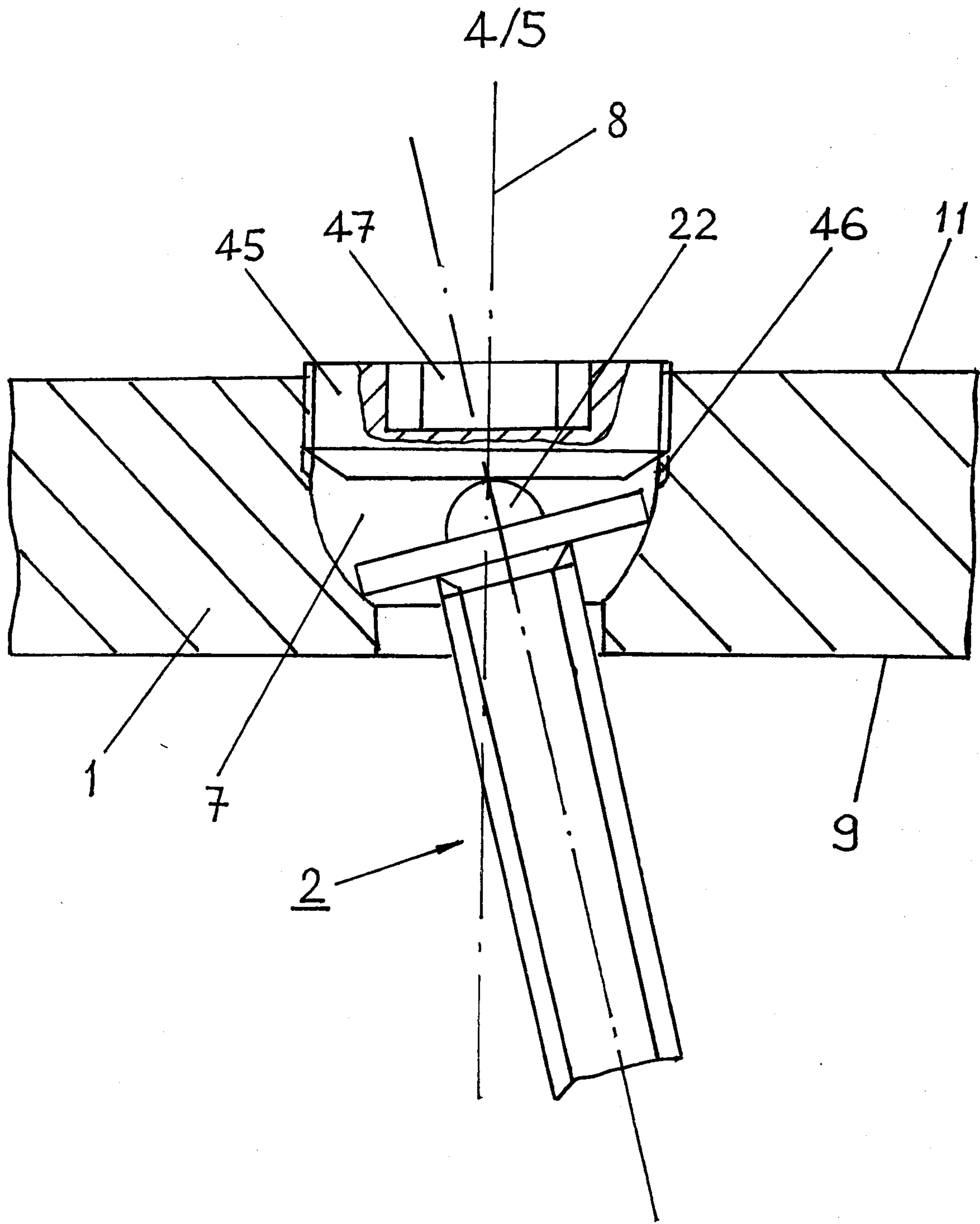


Fig. 7

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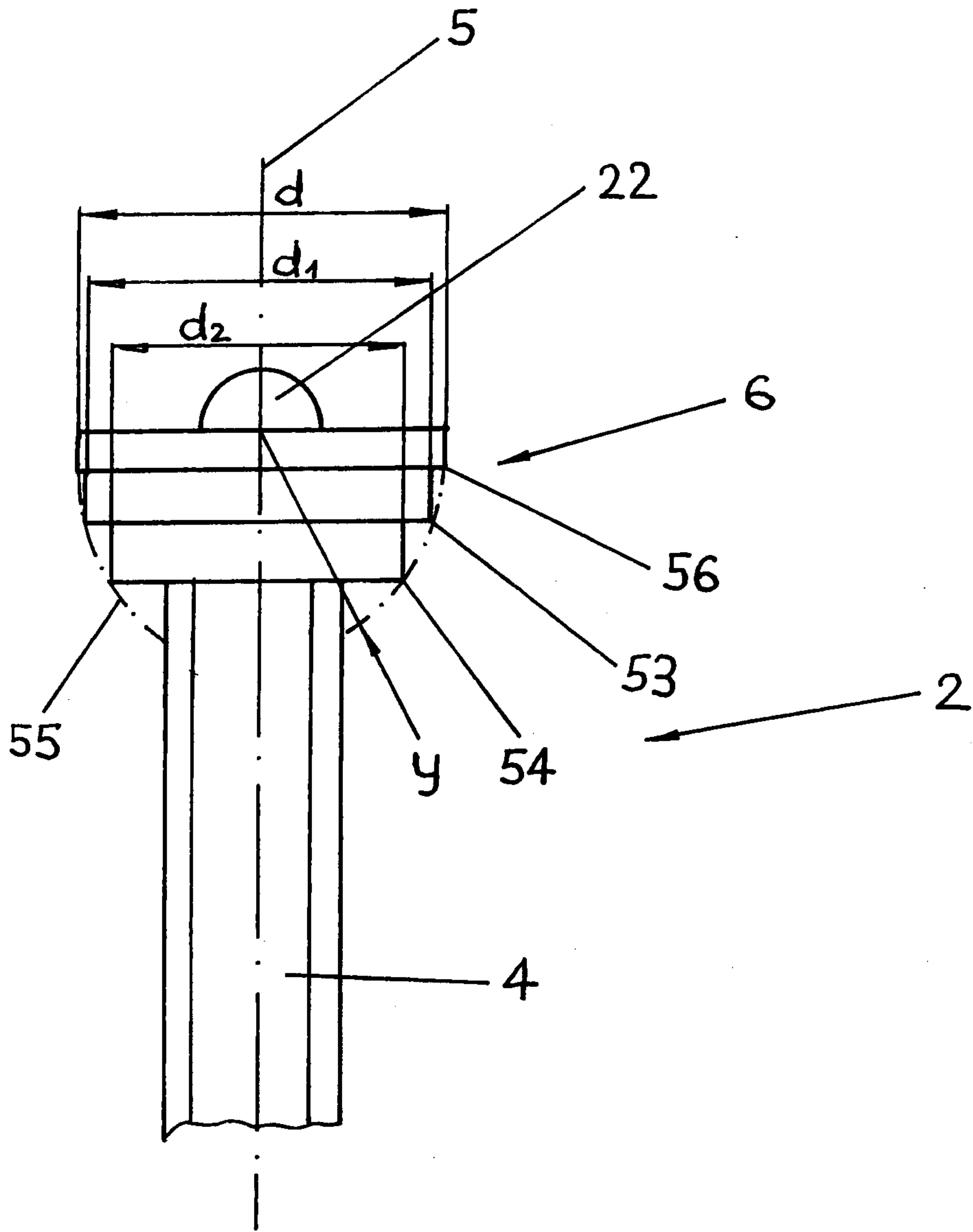


Fig. 8

