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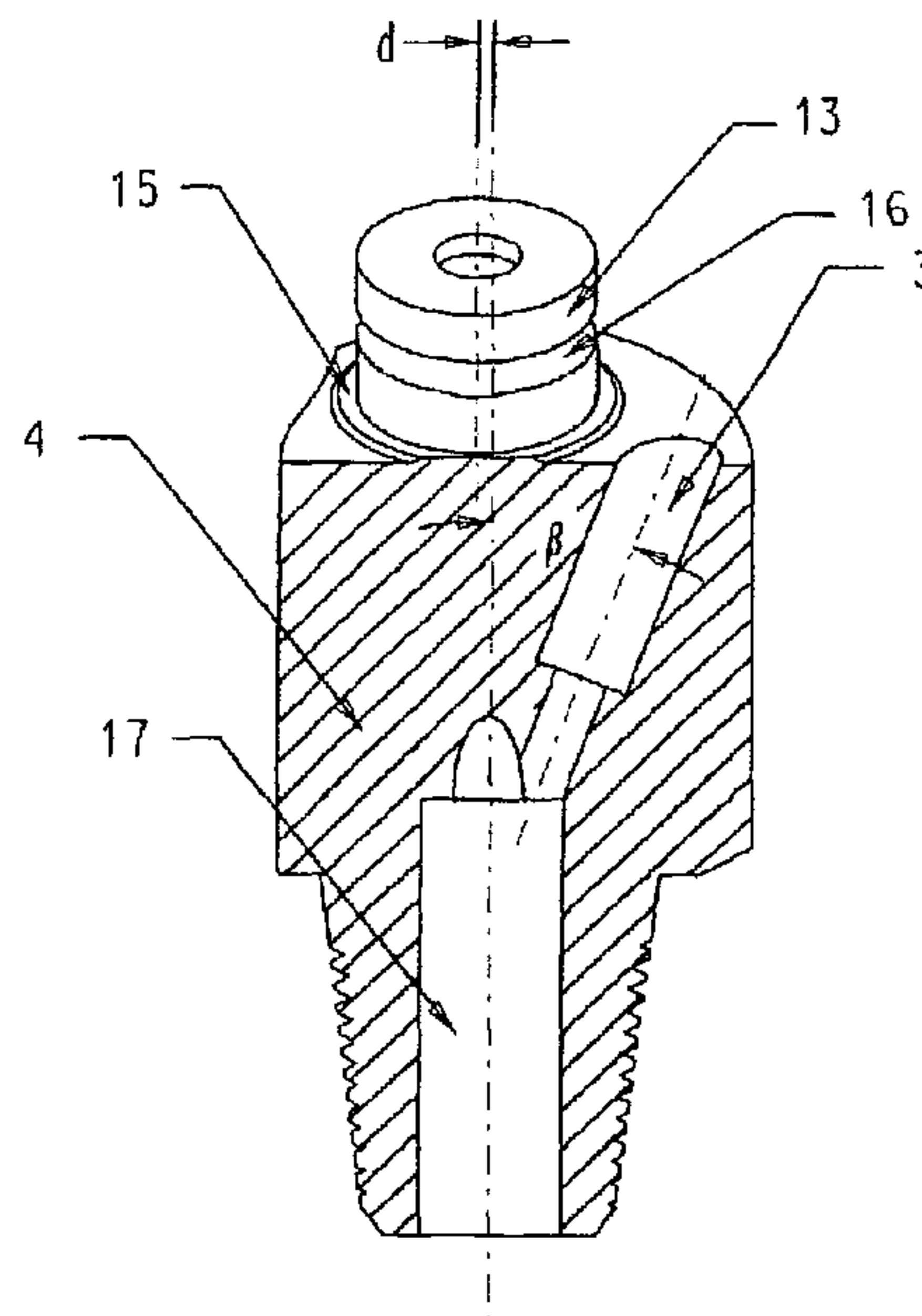
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(54) Titre : TREPAN A CONE UNIQUE DECALE PAR RAPPORT A L'AXE CENTRAL DE CELUI-CI ET CONES
COMPOSITES

(54) Title: A SINGLE CONE BIT WITH OFFSET AXIS AND COMPOSITE CONES



(57) Abrégé/Abstract:

This invention relates to a single cone bit with offset axis and composite cones for oil and gas drilling, mining and other subterranean drilling operations. The bit consists of a head body and a cone. The cone section has a shape of composite cones. The outer circumference of the cone is composed of from back face of the cone to top of the cone an extended gage surface, an outer cone surface and a main cone surface. A plurality of cutting elements is mounted onto each cone surface. A head journal at lower end of the head body is for rotatably connection with the cone. Between the axis of head journal and the axis of the bit, there is an offset value d along rotating direction of the cone. A gage pad is arranged on head body at a location opposite to the offset direction of the head journal. The gage pad is fitted with inserts or hardfaced with wear resistant alloy to prevent bit from whirling and prevent head body from being worn out and to ensure gage protection. Junk slots are machined along the side of head body and jet ports are arranged at lower bevel of the head body to guarantee cuttings removal and effective cleaning results. This invention improves the bit's ability to break rocks through impact for specific use in hard formations. The bit performance is obviously improved and overall drilling cost reduced.

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Abstract

This invention relates to a single cone bit with offset axis and composite cones for oil and gas drilling, mining and other subterranean drilling operations.

5 The bit consists of a head body and a cone. The cone section has a shape of composite cones. The outer circumference of the cone is composed of from back face of the cone to top of the cone an extended gage surface, an outer cone surface and a main cone surface. A plurality of cutting elements is mounted onto each cone surface. A head journal at lower end of the head body
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20 drilling cost reduced.

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A single cone bit with offset axis and composite cones

BACKGROUND OF THE INVENTION

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Field of the Invention

This invention relates to a single cone bit with offset axis and composite cones for oil and gas drilling, mining and other subterranean drilling operations. The bit performs excellent when drilling in hard formations.

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The technical background

Conventional single cone bits normally consist of cone and head sections and the shape of the cone is mostly spherical or spherical with steps. A plurality of cutting elements is mounted onto the spherical surface. The head has a head body and a journal; the cone is mounted onto the head journal via its inner cavity for rotation around the journal and thus forms the bit. Gage pads are uniformly arranged on the cylindrical portion of the head, and the lower jet port in the head journal and the upper watercourse in the head body form the hydraulic structure of the bit. Such single cone bit is so-called full-hole bit and it breaks formation mainly by cutting. While the cone cuts bottom hole rock through rotating around the bearing, the cone surface also has a slip motion relative to the bottom of the hole, and such slip motion varies at different portions on the cone surface so that each insert of the cone moves along different tracks on bottom hole surface and cuts out a networked bottom hole pattern. Single cone bit of such structure drills steadily in soft to medium hard formations, but the inserts get wear fast and the bit performs unsatisfactory when used in hard formation. Extensive researches show that existing single cone bits are not suitable for drilling in hard formation with shear and slip rock breaking modes. Bit for drilling in hard formation must normally have the powerful impact ability to break formation rocks. Better drilling

performance can only be obtained with the bit featuring abilities of impact, crush and scrape in minor spaces for rock breaking.

SUMMARY OF THE INVENTION

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The general object of the present invention is to provide a single cone bit with offset axis and composite cones with better impact ability to break formation rocks suitable for drilling in hard formations.

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According to a preferred embodiment of the invention, a single cone bit with offset axis and composite cones i comprises a head body which includes: a head journal disposed at a beveled lower end of the head body, a central axis of the head journal being off set from a central axis of the bit on an offset value d , a gage pad disposed on a side of the head body opposite to an offsetting direction of the axis of the head journal, a junk slot defined in a side of the head body opposite to the gage pad, and a plurality of jet ports defined in the beveled lower end of the head body; and a cone section rotatably connected to the head journal of the head body, the cone section having a shape of composite cones defined by an extended gage surface, an outer cone surface and a main cone surface from a back face to a top of the cone section, thereby forming an outer circumference of the cone section, a plurality of cutting elements being mounted onto each of the surfaces, the main cone surface defining a recessed generatrix thereof, an angle ε between the generatrix and a rotation axis of the cone section being not greater than 90° ($\varepsilon \leq 90^\circ$).

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According to the preferred embodiment of the present invention, generatrices of the said extended gage surface, outer cone surface and main cone surface can be straight line or curve.

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According to the preferred embodiment of the present invention, the said main cone surface is a negative cone surface, and the angle ε formed by generatrix of the main cone surface and centerline of the cone rotation is equal

to or less than 90° (i.e. $\varepsilon \leq 90^\circ$).

According to the preferred embodiment of the present invention, the said extended gage surface can be step shaped.

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According to the preferred embodiment of the present invention, the vertical height of said extended gage surface is 20 to 80 percent of the height of the cone section.

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According to the preferred embodiment of the present invention, the back angle θ of said extended gage surface equals to 30° to 80° .

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According to the preferred embodiment of the present invention, the said offset value d is a distance the centerline of the head journal that offsets from the centerline of the bit and the offset value d equals to 1~10mm.

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According to the preferred embodiment of the present invention, wherein at least two jet ports are arranged at lower bevel of the head body, the left port is located at one side of the lower bevel of the head body, the angle β between centerline of the left port and the longitudinal symmetrical plane in which the bit axis locates is equal to 10° to 30° , the centerline of the center port is within the longitudinal symmetrical plane and the angle α between it and axis of the head body is equal to 15° to 30° , back ends of both jet ports are connected with inlet hole in the head body.

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According to the preferred embodiment of the present invention, the head journal is a mono-axis journal.

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According to the preferred embodiment of the present invention, junk slots are machined along the side of the head body.

According to the preferred embodiment of the present invention, wherein the diameter of the outer circumference of said gage pad is 0.80~1.00 times of the bit diameter.

5 According to the preferred embodiment of the present invention, the said gage pad is mounted with gage inserts or hardfaced with wear resistant alloy.

 According to the preferred embodiment of the present invention, wherein
10 junk slots with circular arc surface are arranged on head body at the side
opposite to gage pad and the range of the radian of the junk slots is from 60° to
150° .

 According to the preferred embodiment of the present invention, one or
15 more junk slots are arranged at the side of the gage pad.

 According to another preferred embodiment of the present invention, a
single cone bit with offset cones comprise a head body which includes: a head
journal disposed at a lower end of the head body and an axis of the head
journal intersecting an axis of the bit, and a gage pad, a plurality of gage inserts
20 and a plurality of junk slots, uniformly arranged on a cylindrical portion of the
head body; and a cone section fitted with the head journal of the head body, the
cone section including: an outer circumference thereof having from a back face
to a top of the cone section, an extended gage surface, an outer cone surface
and a main cone surface, thereby forming a composite cone profile, and a
25 plurality of cutting elements mounted onto each of the surfaces.

 According to the preferred embodiment of the present invention, at least
two jet ports are arranged at lower bevel of the head body and back ends of
the jet ports are all communicated with inlet hole in the head body.

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Main advantages of the present invention include:

1. During drilling, the single cone cutting structure formed by setting inserts

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onto composite cone surfaces can reduce the number of inserts that instantaneously contact the bottom hole, shorten each insert's slip distance on formation rock, feature the bit with abilities of impact, crush and scrape in minor spaces for rock breaking and forms near parabola bottom hole pattern, thus obviously improves the bit's performance and rate of penetration (ROP) and reduces overall drilling costs when the bit is used in medium hard and harder formations.

2. The offset of the head journal adds the cone an offset value along rotating direction of the cone during operation, which results an alteration of single cone bit's full hole drilling mechanism, enhances the bit's ability to break formation rocks by impact and improves the bit's performance in drilling hard formations.

3. The arrangement of gage pad at a location opposite to the offset direction of the head journal can effectively help the bit to anti whirl, prevent head body from wearing out, and also function as gage protection.

4. Jet ports arranged at lower bevel of the head body and junk slots machined at side of the head body ensure cuttings can be carried timely out of the borehole by drilling fluid, obtaining good cleaning and cutting removal results.

DESCRIPTION OF THE DRAWINGS

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FIG. 1 is a front view of the single cone bit with offset axis and composite cones according to one of the embodiments of the present invention.

FIG. 2 is a solid view of the cone with composite cone surfaces according to one of the embodiments of the present invention.

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FIG. 3 is a front sectional view of the cone with composite cone surfaces according to one of the embodiments of the present invention.

5 FIG. 4 is a front view of the head body according to one of the embodiments of the present invention.

FIG. 5 is a cutaway view showing left jet port of the head body and offset distance d of the head bearing according to one of the embodiments of the present invention.

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FIG. 6 is a longitudinal symmetric sectional view of the head body showing center jet port according to one of the embodiments of the present invention.

15 FIG. 7 is a cross sectional view of the head body showing three junk slots according to one of the embodiments of the present invention.

FIG. 8 is a cross sectional view of the head body showing one junk slot according to one of the embodiments of the present invention.

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FIG. 9 is a front view of the single cone bit with offset axis and composite cones according to another embodiment of the present invention.

FIG. 10 is a front sectional view of the head body showing the left jet port according to another embodiment of the present invention.

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FIG. 11 is a longitudinal symmetric sectional view of the head body showing center jet port according to another embodiment of the present invention.

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FIG. 12 is a cross sectional view of the head body showing uniformly distributed junk slots, gage pad and gage inserts according to another embodiment of the present invention.

5 DESCRIPTION OF THE PREFERRED EMBODIMENTS

1. The preferred embodiment A is a single cone bit with offset axis and composite cones.

See figures 1, 3, 4, 5 and 6, which comprises head body 4 and cone 6. Head
 10 body 4 is fitted with cone via head journal 13 at the lower part of the head in cone ID 12. Between the axis of head journal 13 and the axis of the bit, there is an offset value d along the rotating direction of cone 6. The said offset value d is a distance the centerline of the head journal that offset from the centerline of the bit and the range of d equals to 1~10mm. Normally, the range of d is from 2
 15 to 6mm. The head journal 13 is a mono-axis journal. The head bearing consists of sealing surface 15 and ball lock groove 16, etc. The cone 6 that mounted onto head journal 13 has a shape of composite cones; see figures 2 and 3 for its outer profile. The outer circumference of the cone 6 is composed of from back face of the cone to top of the cone the extended gage surface 10,
 20 outer cone surface 9 and main cone surface 8 so that the cone 6 has a composite cone profile. A plurality of cutting elements 7 is mounted onto each cone surface. The said main cone surface 8 is a negative cone surface, i.e. the angle ε formed by generatrix of the main cone surface 8 and centerline of the rotation of cone 6 is equal to or less than 90° (i.e. $\varepsilon \leq 90^\circ$). The back angle
 25 θ of said extended gage surface 10 equals to 30° to 80° . The extended gage surface 10 can be step shaped, and the vertical height of said extended gage surface 10 is 20 to 80 percent and normally 40 to 80 percent of the height of cone 6. The generatrices of the said extended gage surface 10, outer cone surface 9 and main cone surface 8 can be straight line or curve. Insert
 30 (compact) holes 11 are drilled on extended gage surface 10, outer cone

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surface 9 and main cone surface 8 of the cone 6 and inserts 7 are mounted in insert holes 11. Multiple rows of staggered inserts 7 are mounted onto extended gage surface 10. Inserts 7 are conical carbide inserts or polycrystalline diamond compacts. Cone 6 is mounted onto the head journal
 5 13 via its bearing cavity 12.

See figures 1 and 4, an anti-whirl gage pad 1 is arranged on head body 4 at a location opposite to the offset direction of the head journal 13 and the diameter of the outer circumference of said gage pad is 0.80~1.00 times of the
 10 bit diameter. The gage pad 1 is mounted with gage inserts 14 or hardfaced with wear resistant alloy. Gage inserts 14 are flat-topped inserts or polycrystalline diamond compacts. Junk slots 5 with circular arc surface are arranged on head body 4 at the side opposite to gage pad 1 and the range of the radian of junk slot 5 is from 60° to 150° . Depending on specific designs, one or more junk
 15 slots 5 can be arranged at the side of gage pad 1. In addition, two jet ports are arranged at the lower bevel of head body 4 (see figures 1, 4, 5, 6, 7 and 8) among which the left jet port 3 is at one side of the lower bevel of head body 4 and the angle β between centerline of the left port 3 and the longitudinal symmetrical plane in which the bit axis locates is equal to 10° to 30° , the
 20 centerline of the center port 2 is within the longitudinal symmetrical plane and the angle α between it and axis of the head body 4 is equal to 15° to 30° , back ends of both jet ports are connected with inlet hole 17 in the head body 4.

2. The preferred embodiment B is a single cone bit with composite cones
 25 but without offset axis. To be more specifically, the axis of head journal 13 is overlapped with the axis of the bit in this embodiment (see figures 9 and 10).

See figures 3, 9, 10, 11 and 12, which comprises head body 4, cone 6, cutting elements 7, gage pad 18, gage inserts 14 and junk slots 5, etc. Head
 30 body 4 is fitted with cone via head journal 13 at the lower part of the head in

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cone ID 12. The axis of head journal 13 is overlapped with the axis of the bit. The head journal 13 is a mono-axis journal. The head bearing consists of sealing surface 15 and ball lock groove 16, etc. The cone 6 that mounted onto head journal 13 has a shape of composite cones; see figures 2 and 3 for its outer profile. The outer circumference of the cone 6 is composed of from back face of the cone to top of the cone the extended gage surface 10, outer cone surface 9 and main cone surface 8 so that the cone 6 has a composite cone profile. A plurality of cutting elements 7 is mounted onto each cone surface. The said main cone surface 8 is a negative cone surface, i.e. the angle ε formed by generatrix of the main cone surface 8 and centerline of the rotation of cone 6 is equal to or less than 90° (i.e. $\varepsilon \leq 90^\circ$). The back angle θ of said extended gage surface 10 equals to 30° to 80° . The extended gage surface 10 can be step shaped, and the vertical height of said extended gage surface 10 is 20 to 80 percent and normally 40 to 80 percent of the height of cone 6. The generatrices of the said extended gage surface 10, outer cone surface 9 and main cone surface 8 can be straight line or curve. Insert (compact) holes 11 are drilled on extended gage surface 10, outer cone surface 9 and main cone surface 8 of the cone 6 and inserts 7 are mounted in insert holes 11. Multiple rows of staggered inserts 7 are mounted onto extended gage surface 10. Inserts 7 are conical carbide inserts or polycrystalline diamond compacts. Cone 6 is mounted onto the head journal 13 via its bearing cavity 12.

In addition, at least two jet ports are arranged at the lower bevel of head body 4 (see figures 9, 10, 11 and 12) among which the left jet port 3 is at one side of the lower bevel of head body 4, left jet port 3 can be one or more, and the angle β between centerline of the left port 3 and the longitudinal symmetrical plane in which the bit axis locates is equal to 10° to 30° , the centerline of the center port 2 is within the longitudinal symmetrical plane and the angle α between it and axis of the head body 4 is equal to 15° to 30° , back ends of jet ports are all connected with inlet hole 17 in the head body 4.

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Junk slots 5, gage pad 18 and gage inserts 14 are uniformly arranged on the cylindrical portion of the head body.

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What is claimed is:

1. A single cone bit with offset axis and composite cones, the single cone bit comprising:

5 a head body including:

a head journal disposed at a beveled lower end of the head body,

a central axis of the head journal being off set from a central axis of the bit
on an offset value d ,

10 a gage pad disposed on a side of the head body opposite to an offsetting
direction of the axis of the head journal,

a junk slot defined in a side of the head body opposite to the gage pad,
and

a plurality of jet ports defined in the beveled lower end of the head body;
and

15 a cone section rotatably connected to the head journal of the head body, the
cone section having a shape of composite cones defined by an extended
gage surface, an outer cone surface and a main cone surface from a back
face to a top of the cone section, thereby forming an outer circumference
of the cone section, a plurality of cutting elements being mounted onto
20 each of the surfaces, the main cone surface defining a recessed
generatrix thereof, an angle ε between the generatrix and a rotation axis
of the cone section being not greater than 90° ($\varepsilon \leq 90^\circ$).

2. The single cone bit with offset axis and composite cones according to claim 1
25 wherein the said extended gage surface defines a generatrix in one of stepped and
curved shapes.

3. The single cone bit with offset axis and composite cones according to claim 1
wherein the vertical height of said extended gage surface is between 20 and 80
30 percent of the height of the cone section.

4. The single cone bit with offset axis and composite cones according to claim 1 or 2 wherein a back angle θ between said extended gage surface and a plane normal to the rotation axis of the cone section equals an angle between 30° and 80° .
- 5 5. The single cone bit with offset axis and composite cones according to claim 1 wherein the said offset value d is a distance between 0 and 10mm, including 10mm ($10 \geq d > 0\text{mm}$).
6. The single cone bit with offset axis and composite cones according to claim 1
10 wherein the diameter of an outer circumference of said gage pad is between 0.80 and 1.00 times a diameter of the bit.
7. The single cone bit with offset axis and composite cones according to claim 1 wherein said junk slot comprises a circular arc surface defined in an angular range
15 of between 60° and 150° .
8. The single cone bit with offset axis and composite cones according to claim 1 wherein said gage pad is fitted with carbide inserts.
- 20 9. The single cone bit with offset axis and composite cones according to claim 1 wherein said gage pad is hard faced with wear-resistant alloy.
10. The single cone bit with offset axis and composite cones according to claim 1 wherein said jet ports comprise at least a left port and a center port, an angle β
25 between a centerline of the left port and a longitudinal symmetrical plane in which the central axis of the bit locates, being equal to an angle of between 10° and 30° , a centerline of the center port being defined within the longitudinal symmetrical plane, an angle α between the centerline of the center port and the axis of the bit being equal to an angle of between 15° and 30° , the respective left and center jet ports
30 being in communication with an inlet hole defined in the head body.

11. A single cone bit with offset cones, comprising:

a head body including:

a head journal disposed at a lower end of the head body and an axis of the head journal intersecting an axis of the bit, and

5 a gage pad, a plurality of gage inserts and a plurality of junk slots, uniformly arranged on a cylindrical portion of the head body; and

a cone section fitted with the head journal of the head body, the cone section including:

10 an outer circumference thereof having from a back face to a top of the cone section, an extended gage surface, an outer cone surface and a main cone surface, thereby forming a composite cone profile, and a plurality of cutting elements mounted onto each of the surfaces.

12. The single cone bit with composite cones according to claim 11, wherein a lower
15 end of the head body is beveled and at least two jet ports are arranged at the beveled lower end of the head body.

13. The single cone bit with composite cones according to claim 11, wherein an
20 angle between a generatrix of the main cone surface and a rotation axis of the cone section is not greater than 90° , and a back angle between said extended gage surface and a plane normal to the rotation axis of the cone section equals an angle of between 30° and 80° .

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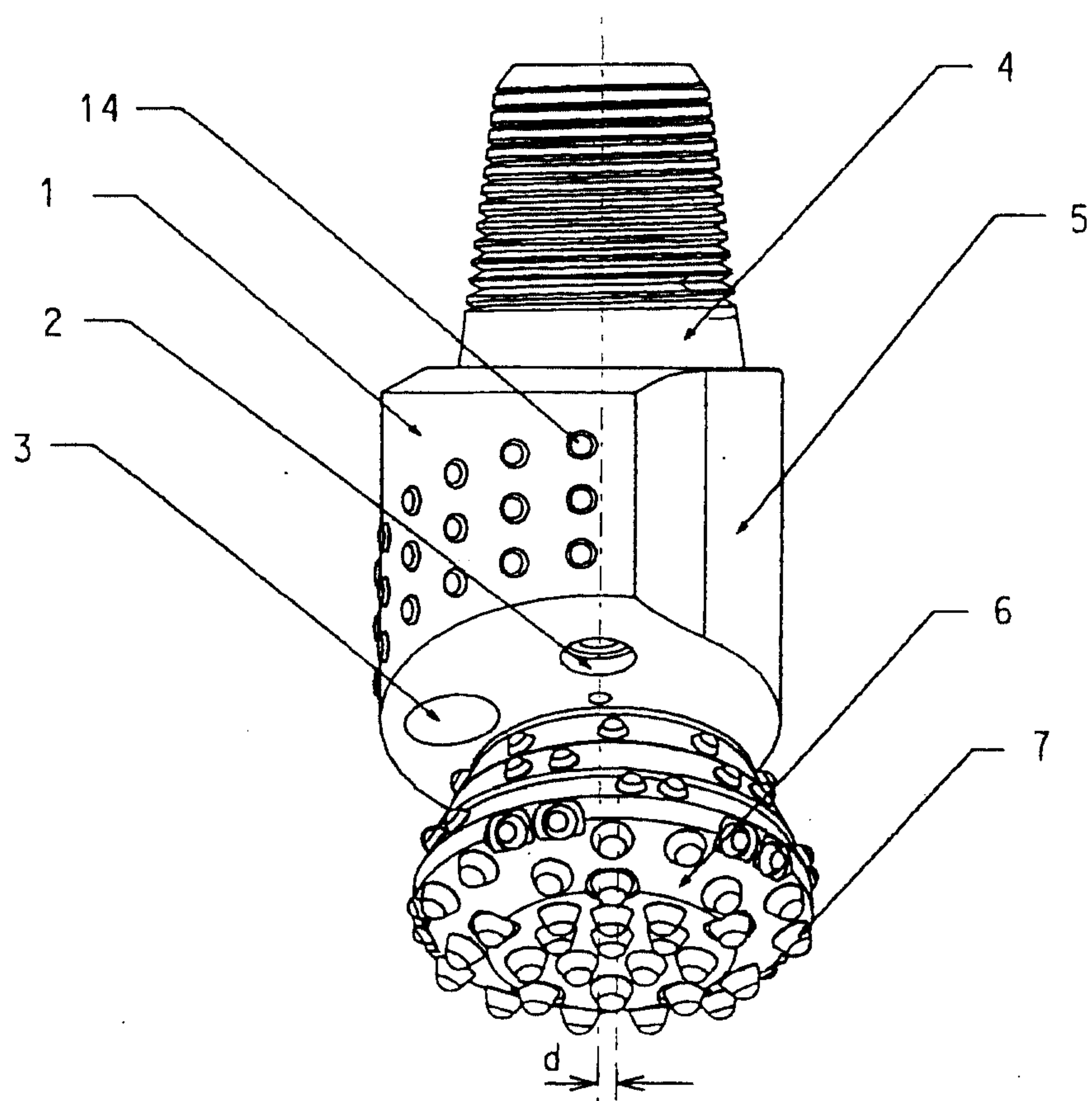


Fig.1

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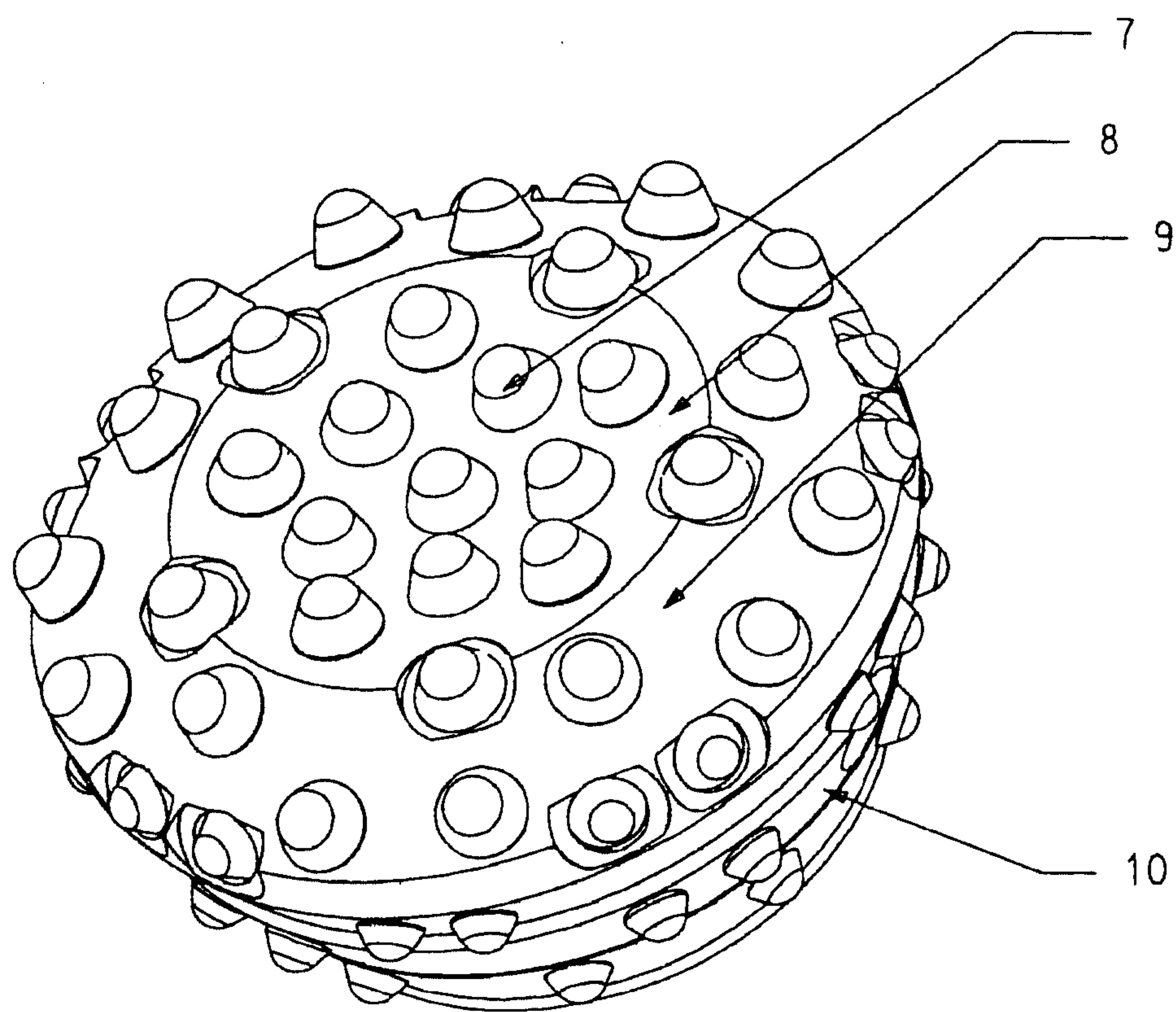


Fig.2

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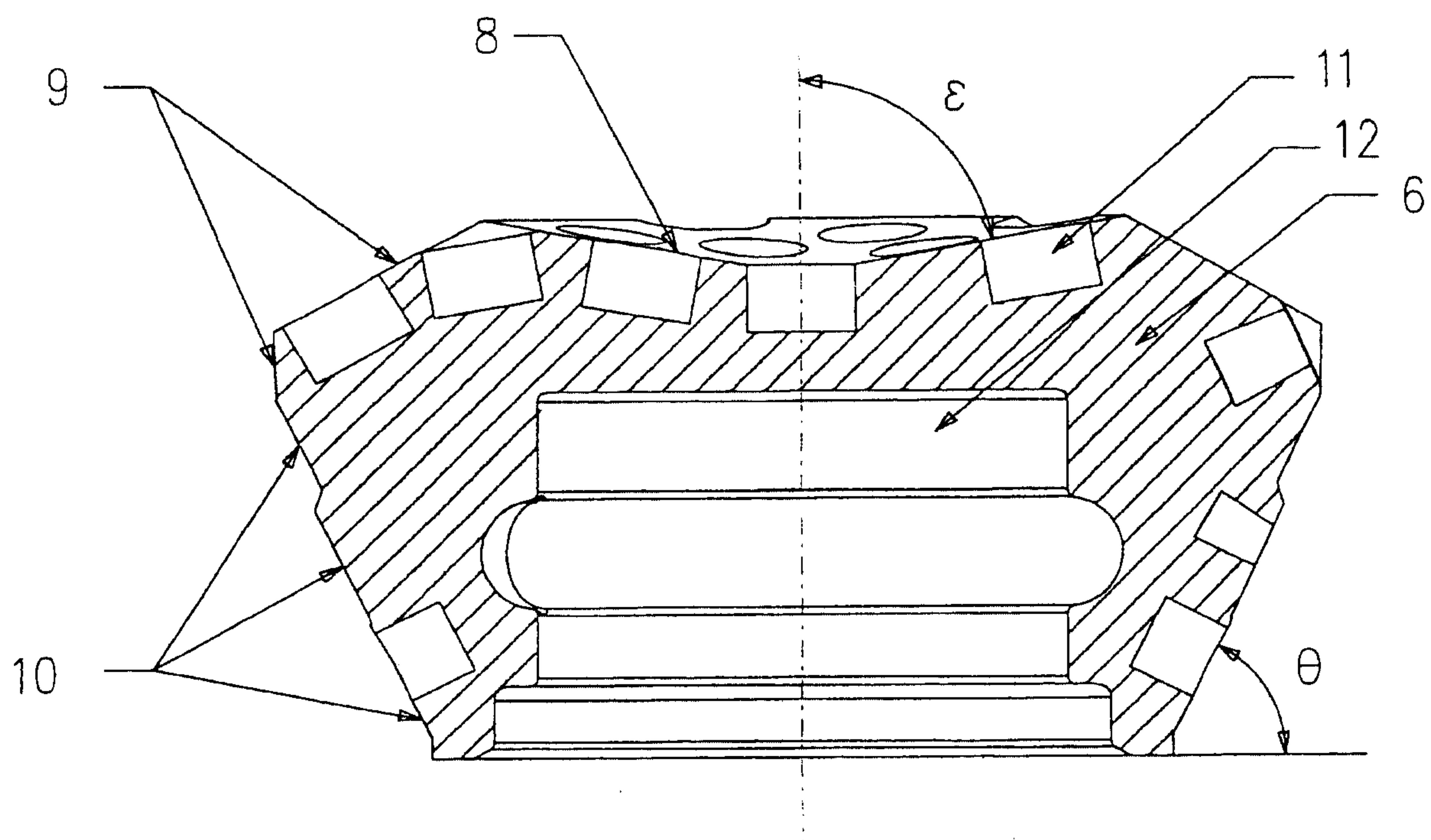


Fig.3

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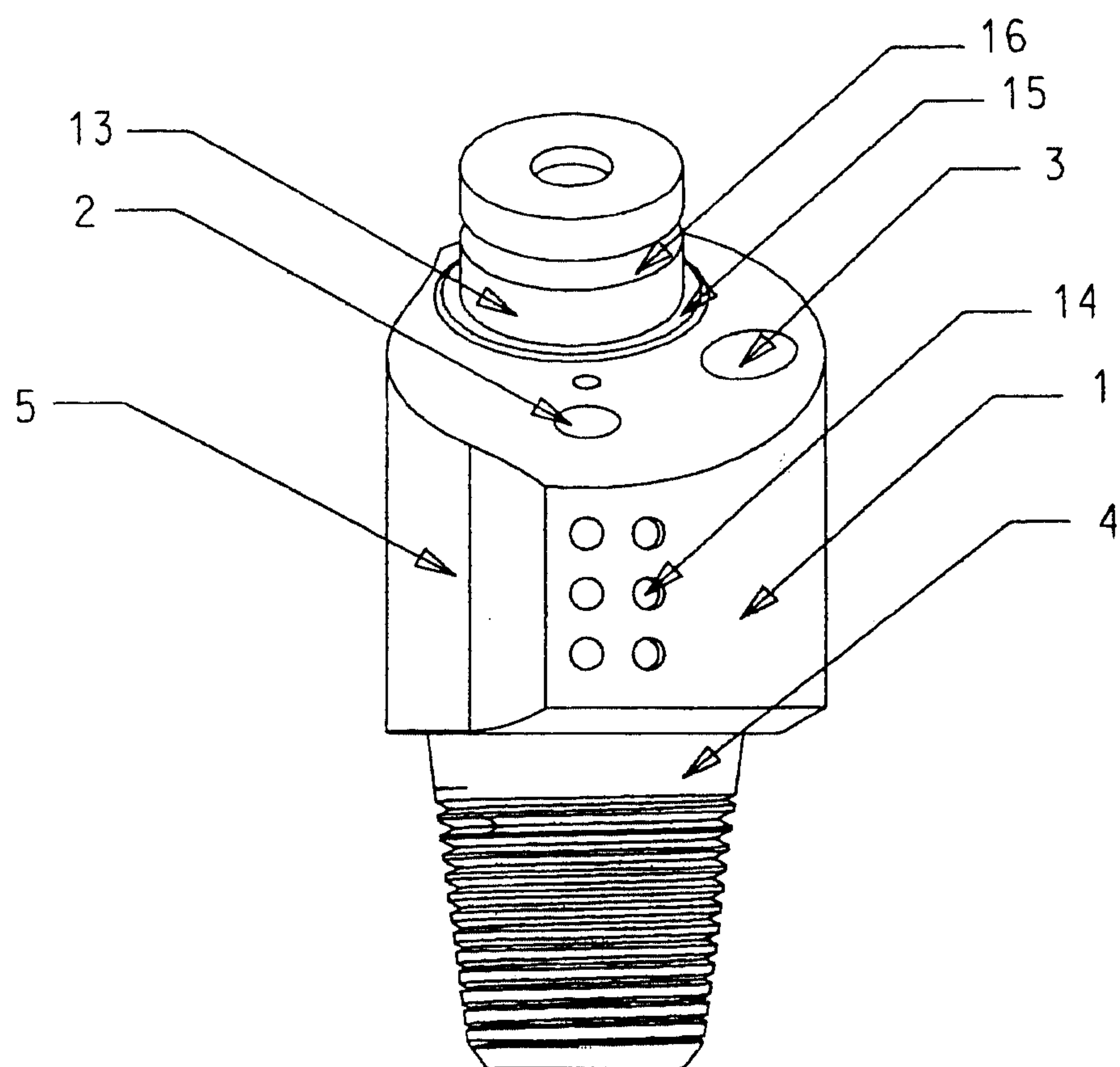


Fig.4

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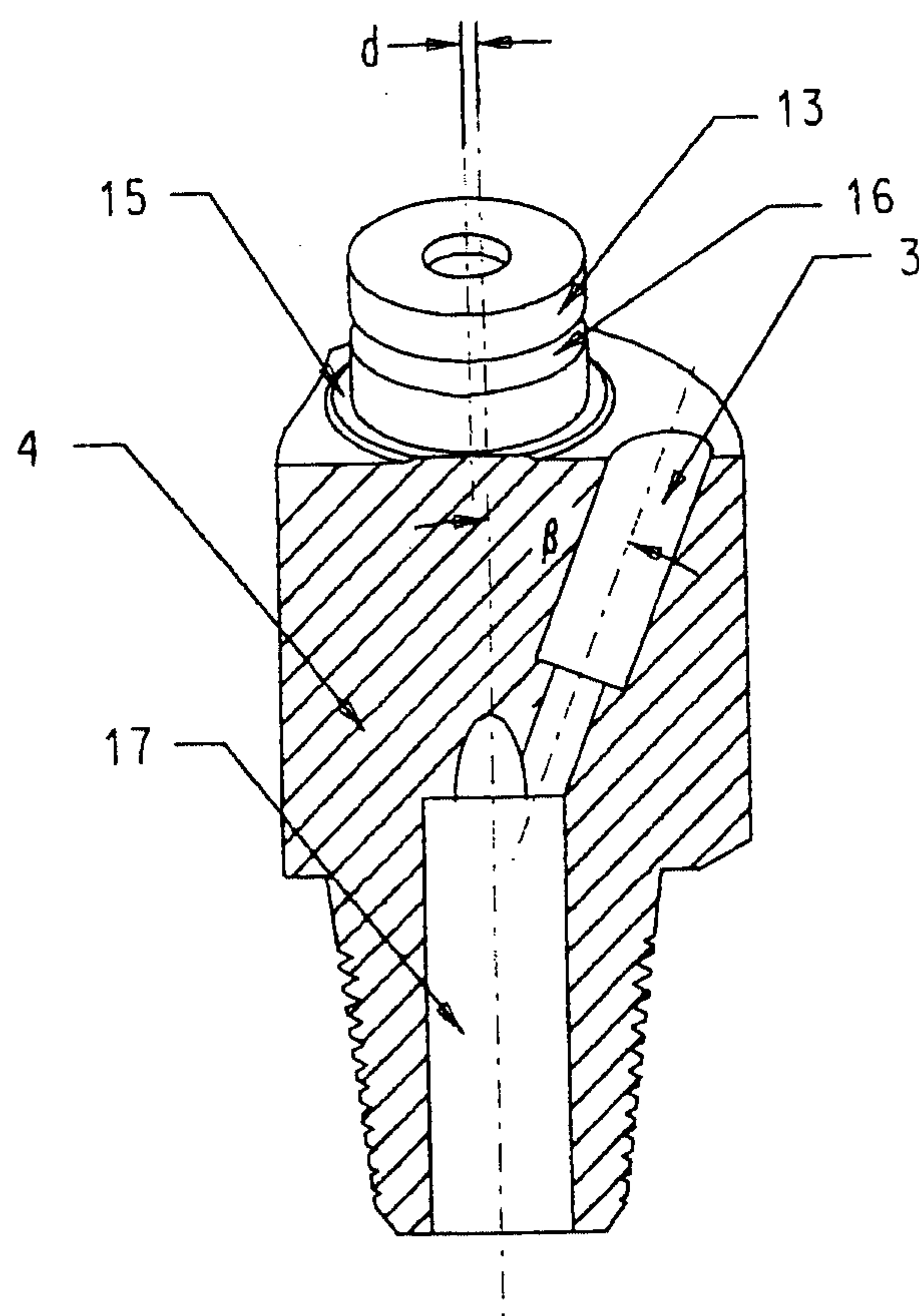


Fig.5

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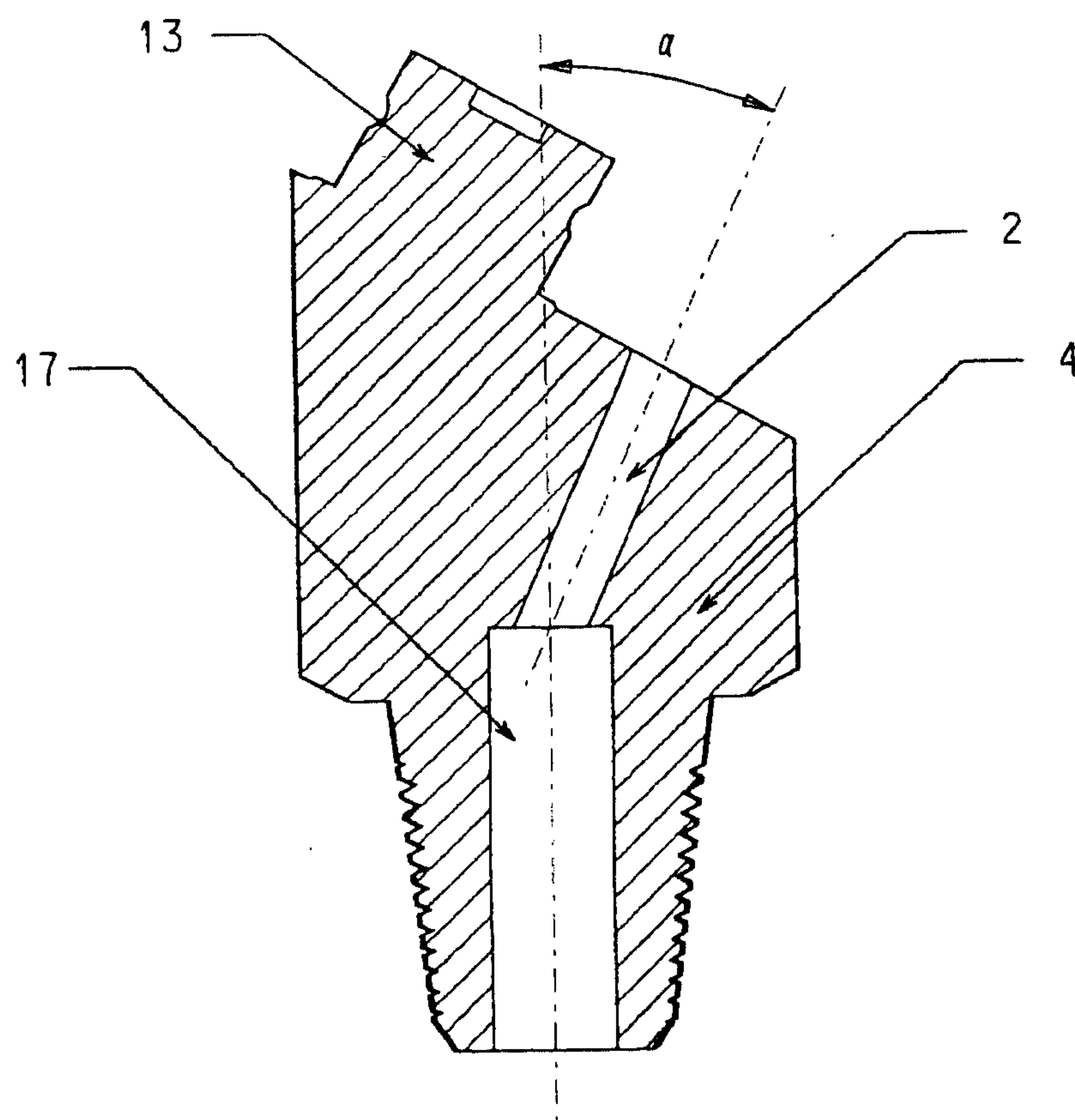


Fig.6

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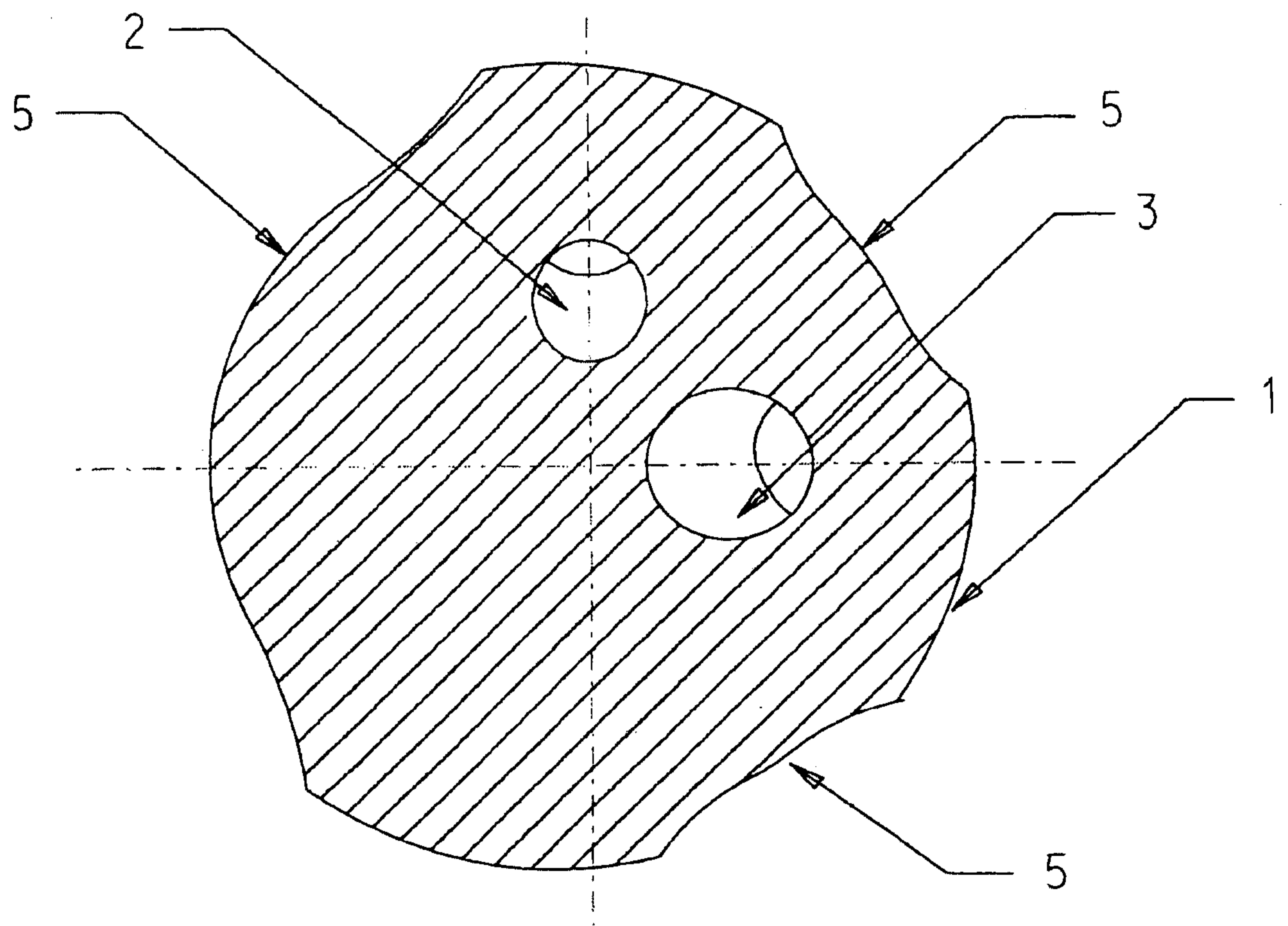


Fig.7

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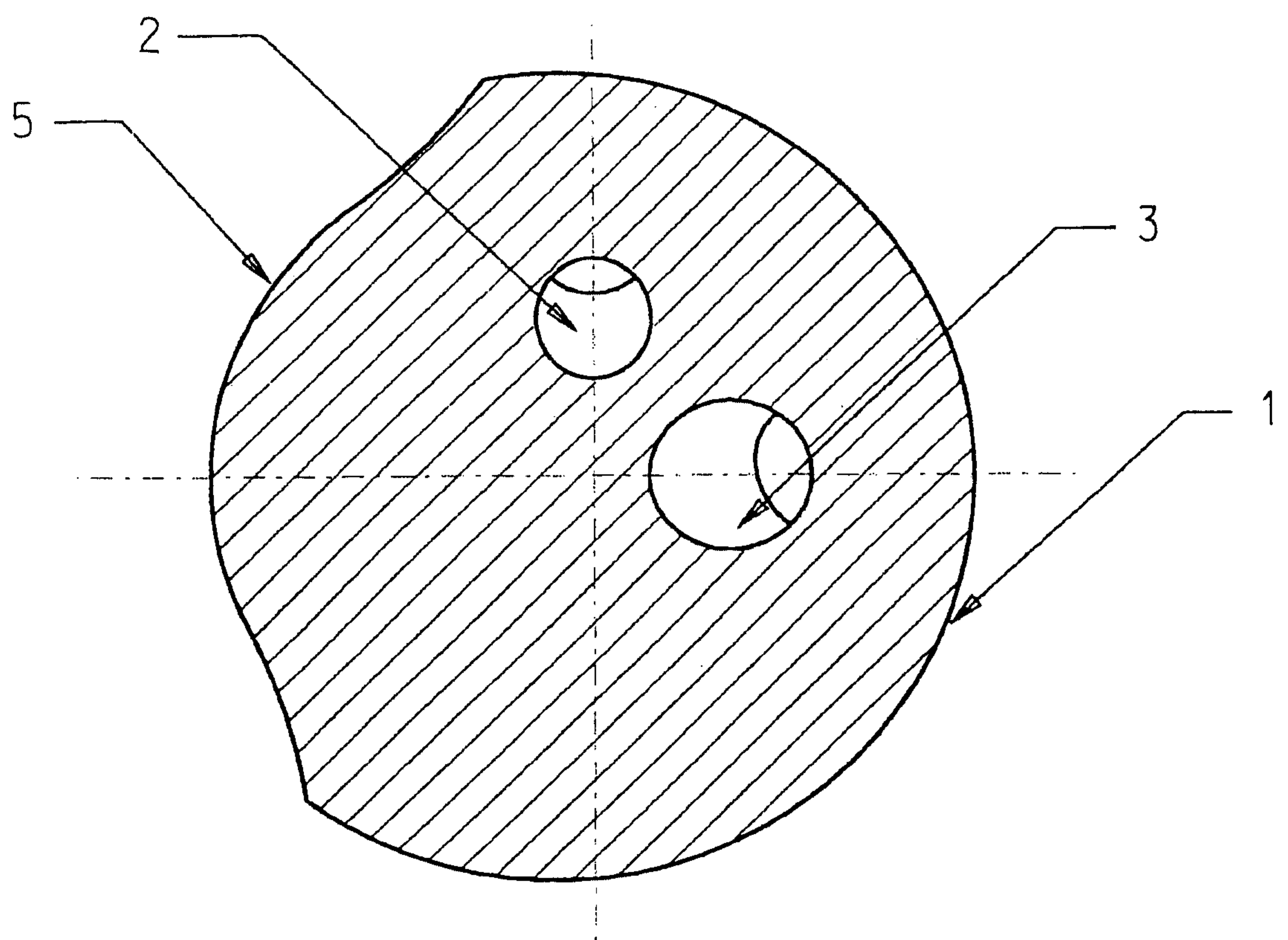


Fig.8

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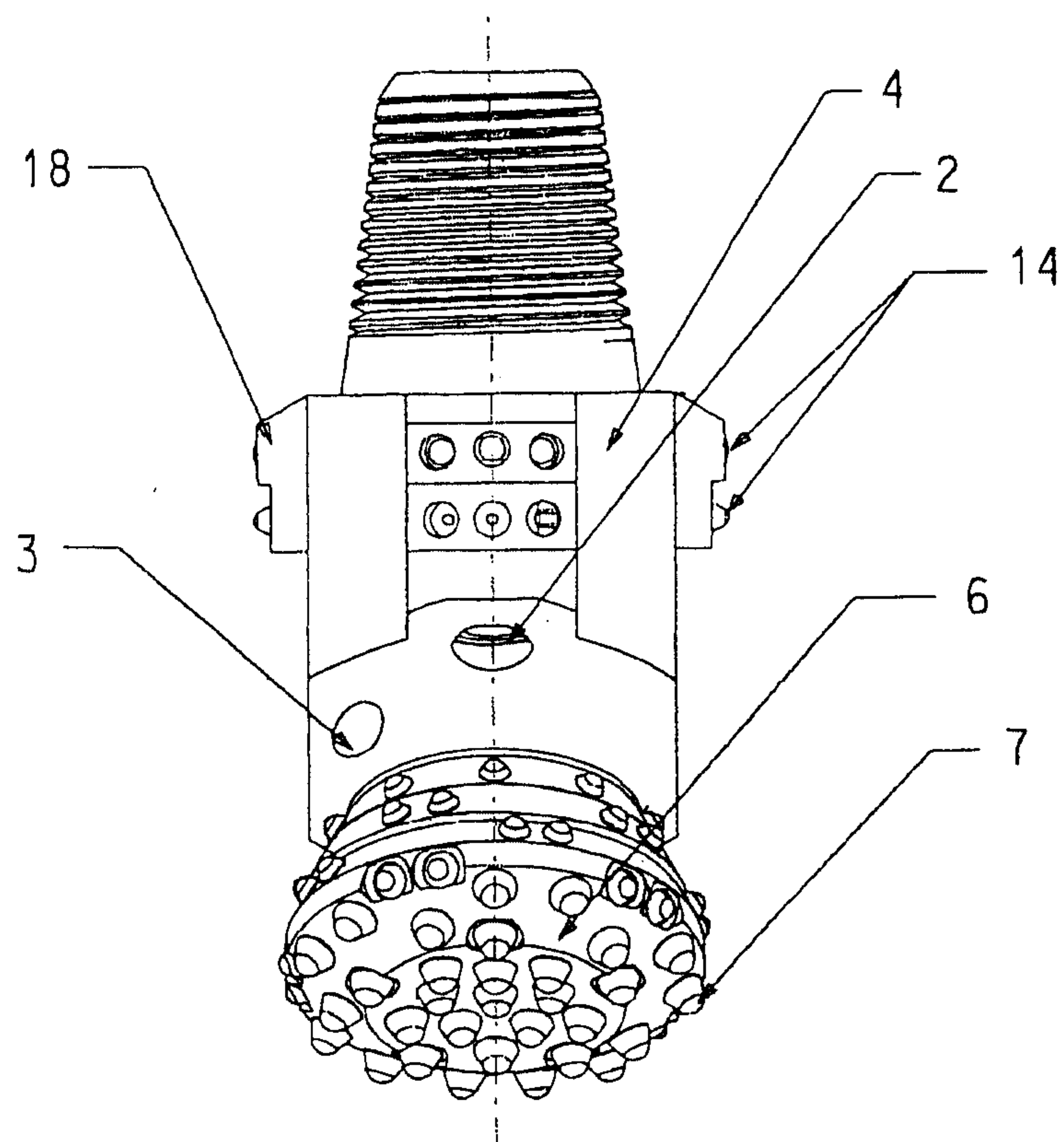


Fig.9

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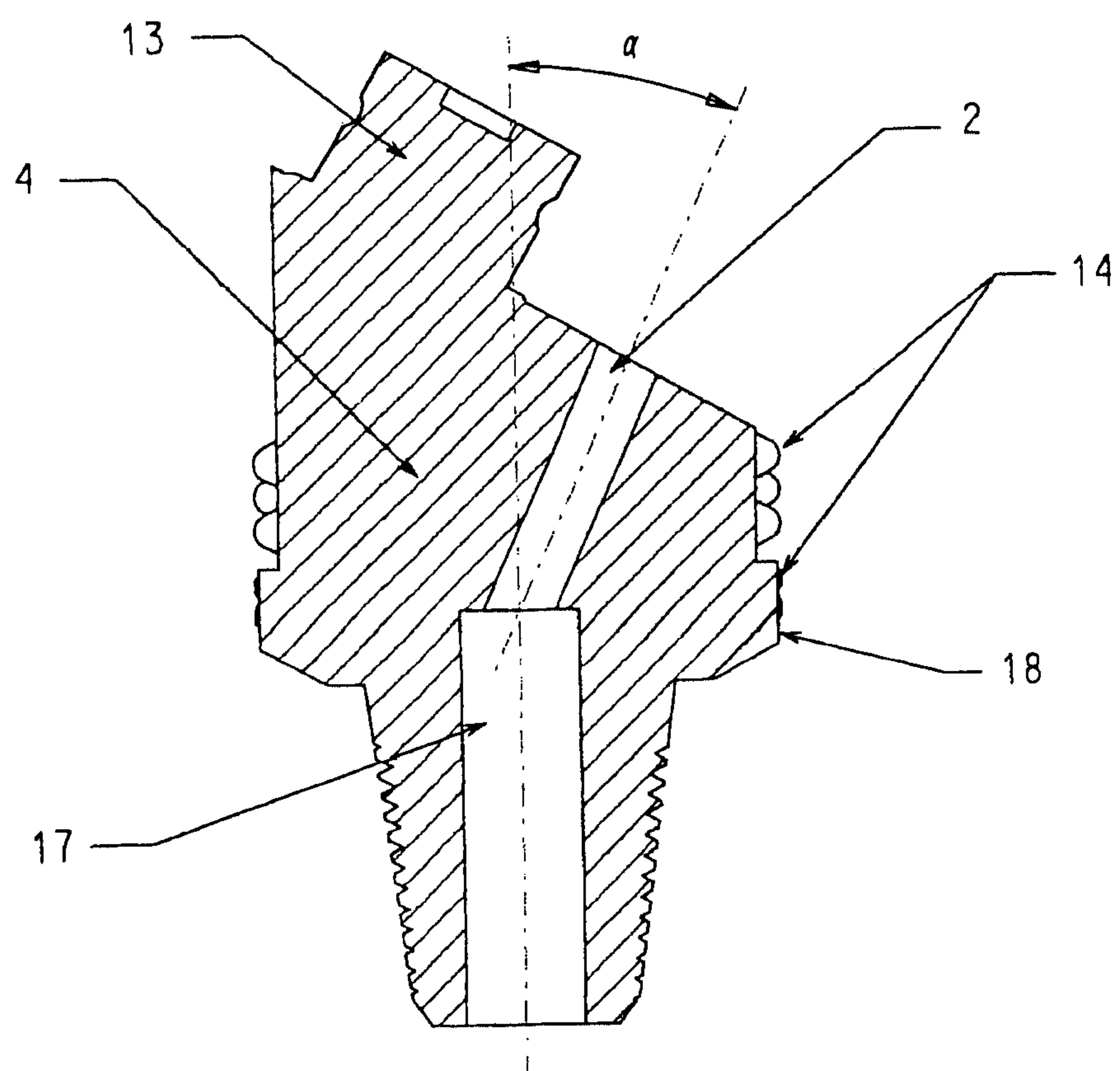


Fig.11

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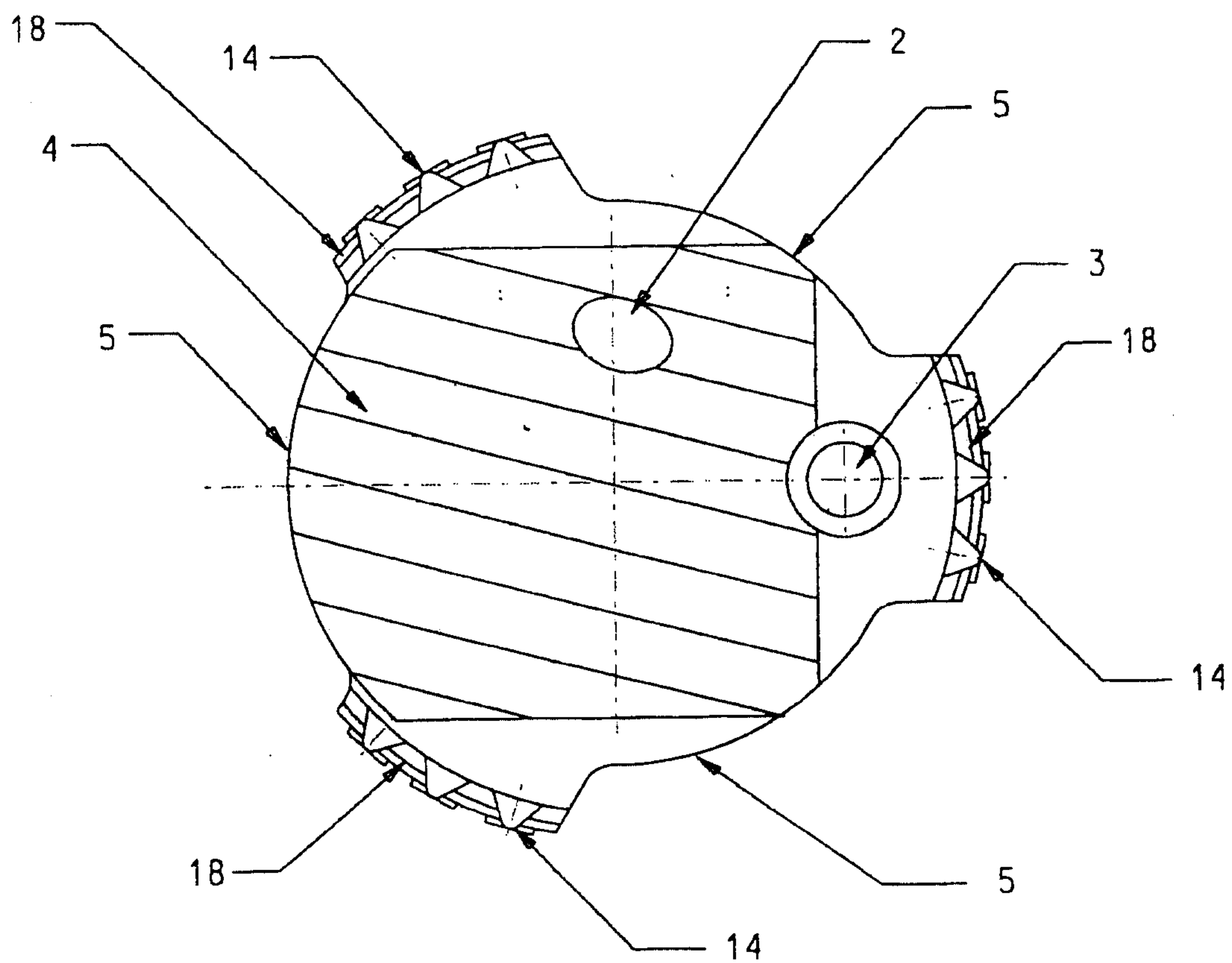


Fig.12

