PATENT SPECIFICATION

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(54) Title: Symmetrical bit for directional drilling tool

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SYMMETRICAL BIT FOR DIRECTIONAL DRILLING TOOL

Field of the Invention

The present invention relates to horizontal directional drilling and, in particular, to a drill bit for a directional drilling tool.

Background to the Invention

It is known to use directional drilling apparatus to form substantially horizontal drill holes in the ground for installing electrical or telephone cables, gas or water pipes, or the like. The directional drilling equipment usually comprises a percussion drill bit operable through a drill string and includes a steering device so that the drill bit can be steered in a desired substantially horizontal direction below and along the route of roads and streets, and under river beds, roads and the like.

In a typical directional drilling system, a drill string incorporating a percussion hammer, to apply axial impact forces to the drill bit, is utilised to drill an initial pilot hole of a smaller diameter (for example 133 mm) than the diameter of the ultimate passage desired. The ultimate drill passage may have a diameter of anything from 200 mm to 760 mm depending upon the size of the cables, pipes or conduits to be inserted in the drilled passageway. With the known horizontal drilling method, when the percussion drill bit and hammer breaks through the surface after having drilled the pilot hole, the percussion hammer system is removed and a reamer bit is fixed to the protruding drill rod. Using the drill string, the reamer bit is then pulled back against the face of the drilled pilot hole. The present invention is concerned with directional drilling tools for drilling the initial pilot hole.

Steering of such horizontal directional drill tools is typically carried out by providing a percussion drill bit having an asymmetric chisel-shaped or slant-faced bit head. US Patent No. 4.867,255 discloses a technique for steering a downhole hammer. The hammer has a forward most cutting bit, which is asymmetrically configured with respect to the elongation axis of the hammer. In order to cause the hammer to move along a straight path, the asymmetrical cutting bit is rotated continuously either clockwise or

counter clockwise at a constant speed. To cause the hammer to turn, rotation of the cutting bit is modulated in a particular way, depending upon how the hammer is to turn.

Other directional drilling apparatuses having slant-faced bit heads are described in US Patent No. 6,397,956, US Patent No. 6,454,025, US Patent No. 6,533,052 and US Patent No. 6,705,415.

One example of a known directional drilling apparatus using a slant-faced bit head will now be described with reference to Figures 1, 2, 5a, 5b and 6 of the accompanying drawings. As shown in Figure 6, the percussion drill bit has a head portion formed with an axially extending shank. The head portion of the bit is similar to that of a normal percussion drill bit, but with a portion machined off one side of the bit to provide a slant face for steering purposes. In the example shown, the slant face is provided with flat-wear carbides, although these are not essential. Figures 1, 2, 5a and 5b show the slant-faced bit in assembly with the hammer and a locating device known as a sonde. The sonde is located in a locator housing in a fixed axial and angular location. The sonde sends out a signal which provides data at the surface which indicates depth, angle or pitch and angular position of the drill tool. The locator housing is threadably connected to a hammer with the slant-faced bit located at the end of the hammer. The connection between the locator housing and the hammer can be made using either a bent or a straight sub. A bent sub allows for more aggressive steering of the tool. The bend is typically of the order of 1 to 3 degrees. The bit is assembled so that the slant face is located at the six o'clock position of the sonde.

In order to steer the hammer in an upward direction, the sonde locator is checked so that its angular position reads six o'clock, indicating that the slant face of the bit is at the six o'clock position. The assembly is rocked about this point by about 60 degrees (or two "hours") either side of the initial point as the hammer drills forward, causing the hammer to steer upwards. When the required direction has been achieved, normal rotation is applied and the system drills straight.

There are a number of disadvantages of this type of system. In particular, all of the steering forces act on a single area of the bit which can cause extreme bending stresses on the bit shank and these stresses can lead to failure of the bit.

Summary of the Invention

According to an aspect of the present invention, there is provided a percussion drill bit for directional drilling tools comprising:

a head portion formed with an axially extending shank;

engagement means on the shank engageable with complementary engagement means formed on a drive chuck whereby rotational drive from the chuck may be transmitted to the shank;

characterised in that the head portion of the drill bit is formed with a plurality of slant faces arranged symmetrically about the head portion.

The term "slant faces" is used herein to indicate that the faces are angled with respect to an elongate axis of the bit.

The term "arranged symmetrically" is used herein to indicate that the slant faces are arranged radially around the head portion of the bit in such a way that the positioning of the slant faces is symmetrical about at least one axis through the head portion of the bit. Preferably, the slant faces are spaced at regular intervals around the circumference of the head portion of the bit.

In one embodiment, each of the slant faces comprises a substantially planar surface angled with respect to an elongate axis of the bit. In another embodiment, each of the slant faces may comprise a plurality of contiguous planar surfaces, wherein each of the planar surfaces is angled with respect to the elongate axis of the bit. Each of the planar surfaces may be continuous or non-continuous.

The angle at which the slant faces are arranged with respect to the elongate axis of the bit may be selected depending on how aggressively the bit is required to steer. The less acute the angle of the slant faces, the more aggressively the bit may be steered.

An advantage of the present invention is that, because a plurality of slant faces are provided, the forces on the bit due to steering can be spread over the circumference of the bit by indexing the bit in the chuck. In this way, each of the slant faces may be used in turn to steer the bit, so that no one area of the bit shank is subjected to extreme bending stresses, thereby increasing the lifetime of the bit.

The head portion of the drill bit is preferably formed with an odd number of slant faces. This allows the slant faces to be arranged around the circumference of the bit such that carbides may be provided diametrically opposite to each slant face to allow cutting of material in the steering direction, while maintaining symmetry of the bit. For example, if the tool is to be steered upwards, the bit may be positioned such that one of the slant faces is at the six o'clock position in the drill assembly, that is, at the bottom of the assembly. In order to drill upwards, it is preferable that carbides are provided at the top of the drill bit, that is, at the 12 o'clock position, to allow the drill to move upwards.

Ideally, the head portion of the drill bit is provided with three slant faces.

The slant faces may be provided with a hard-wearing material to improve the wear resistance of the slant faces. In one embodiment, the hard-wearing material is provided in the form of flat wear carbides. In another embodiment, a layer of a hard-wearing material may be applied to the slant faces. In other embodiments, strips of the material may be applied to the slant faces.

In a preferred embodiment, the engagement means comprises a plurality of axially extending splines on the shank slideably engageable with complementary splines formed on the drive chuck. Ideally, the number of splines is an integer multiple of the number of slant faces provided on the bit.

Brief Description of the Drawings

Figure 1 is a side elevation of a known horizontal directional drilling tool;

Figure 2 is a side elevation of an alternate embodiment of a known horizontal directional drilling tool;

Figure 3 is a side elevation of a horizontal directional drilling tool in accordance with an embodiment of the invention;

Figure 4 is a side elevation of a horizontal directional drilling tool in accordance with an alternate embodiment of the invention;

Figure 5a is an isometric view of the drilling tool of Figure 1;

Figure 5b is an isometric view of the drilling tool of Figure 2;

Figure 5c is an isometric view of the drilling tool of Figure 3;

Figure 5d is an isometric view of the drilling tool of Figure 4;

Figure 6 is an isometric view of the percussion drilling bit of the drilling tool of Figures 1 and 2;

Figure 7 is an isometric view of a percussion drilling bit according to an embodiment of the invention;

Figure 8 is an isometric view of a percussion drilling bit according to an alternate embodiment of the invention;

Figure 9 is a plan view of the drilling bit of Figure 7; and

Figure 10 is a plan view of the drilling bit of Figure 8.

Detailed Description of the Drawings

Referring first to Figures 7 and 9, there is illustrated a percussion drill bit 1 for a directional drilling tool 10. The drill bit 1 comprises a head portion 2 formed with an axially extending shank 3. The head portion has a front cutting face 6, which is provided with a plurality of carbide buttons or inserts 7. Gauge row carbides 8 are provided at the periphery of the bit. The drill bit further comprises twelve axially extending splines 4 on the stub shank 3 slideably engageable with complementary splines formed on a drive chuck. In accordance with the invention, the head portion 2 of the drill bit 1 is formed with three slant faces 5 arranged symmetrically about the head portion 2. The three slant faces 5 are equally spaced around the circumference of the head portion 2 of the bit. Each of the slant faces 5 is provided with a plurality of flat wear carbides 9.

As can be seen from Figure 7, the slant faces 5 are inclined at an angle with respect to the elongate axis X-X of the bit. Each of the slant faces 5 comprises two contiguous planar surfaces 5a and 5b, and each of the planar surfaces 5a, 5b is angled with respect

to the elongate axis of the bit. In the illustrated embodiment, each of the planar surfaces is non-continuous, in the sense that each of the surfaces is interrupted by a channel 15 in the bit head 2.

As can be seen from Figure 9, the slant faces 5 are arranged radially around the head portion 2 of the bit 1 at regular intervals in such a way that the positioning of the slant faces is symmetrical about axis Y-Y.

Because the head portion 2 of the drill bit 1 is formed with an odd number of slant faces, the slant faces can be arranged around the circumference of the bit such that gauge row carbides 8 are provided diametrically opposite to each slanted face.

An alternate embodiment of the percussion drill bit of the invention is shown in Figures 8 and 10. In this embodiment, a fewer number of larger carbides 8 are provided on the gauge. This allows larger slant faces 5 to be machined off the bit head 2, so that each of the slant faces has a larger surface area.

Figures 3, 4, 5c and 5d show the percussion drill bit 1 according to the present invention in assembly with a hammer and a locating device known as a sonde. A directional drilling tool 10 comprises a locator housing 11, a sub 12 and a hammer 13. The drill bit 1 is disposed at a forward end 14 of the hammer 13. The sonde is located in the locator housing 11 in a fixed axial and angular location, as described above in relation to Figures 1 and 2. The sonde sends out a signal which provides data at the surface which indicates depth, angle or pitch and angular position of the drill tool. The locator housing 11 is threadably connected to a hammer 13 with the symmetrical slant-faced bit located at the end 14 of the hammer. The connection between the locator housing and the hammer can be made using either a bent or a straight sub 12. A bent sub allows for more aggressive steering of the tool. As shown in Figure 3, the bend is typically of the order of 1 to 3 degrees. The bit is assembled so that one of the slant faces 5 is located at the six o'clock position of the sonde.

In order to steer the hammer 13 in an upward direction, the sonde locator is checked so that its angular position reads six o'clock, indicating that a slant-face is at the six

o'clock position. The assembly is rocked by about 60 degrees (or 2 "hours") either side of this initial position as the hammer drills forward, causing the hammer to steer upwards. When the required direction has been achieved, normal rotation is applied and the system drills straight. In order to distribute the forces on the bit 1 due to steering, the bit may be indexed in the chuck. In this way, each of the slant faces 5 may be used in turn to steer the bit, so that no one area of the bit shank is subjected to extreme bending stresses, thereby increasing the lifetime of the bit.

The words "comprises/comprising" and the words "having/including" when used herein with reference to the present invention are used to specify the presence of stated features, integers, steps or components but does not preclude the presence or addition of one or more other features, integers, steps, components or groups thereof.

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable sub-combination.

Claims

1. A percussion drill bit for directional drilling tools comprising:

a head portion formed with an axially extending shank

engagement means on the shank engageable with complementary engagement means formed on a drive chuck whereby rotational drive from the chuck may be transmitted to the shank;

characterised in that the head portion of the drill bit is formed with a plurality of slant faces arranged symmetrically about the head portion.

2. The percussion drill bit of claim 1, wherein each of the slant faces comprises a substantially planar surface angled with respect to an elongate axis of the bit and optionally, each of the slant faces comprises a plurality of contiguous planar surfaces and each of the planar surfaces is angled with respect to the elongate axis of the bit.

3. The percussion drill bit of any preceding claim, wherein the head portion of the drill bit is formed with an odd number of slant faces, optionally three slant faces.

4. A directional drilling tool comprising a locator housing threadably connected to percussion hammer by means of a sub, and a percussion drill bit disposed at a forward end of the hammer, wherein the percussion drill bit is percussion drill bit as claimed in any one of the preceding claims.

5.A percussion drill bit or a directional drilling tool substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.

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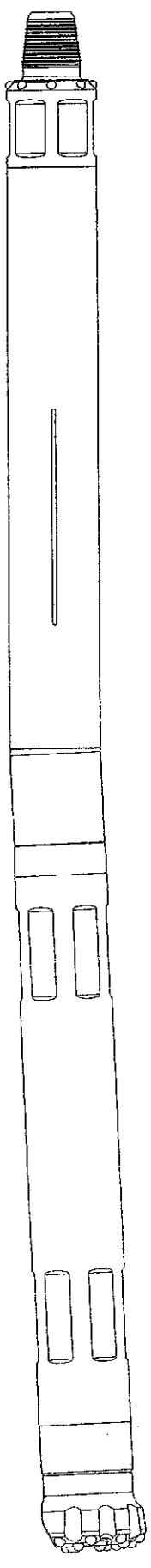


FIGURE 1

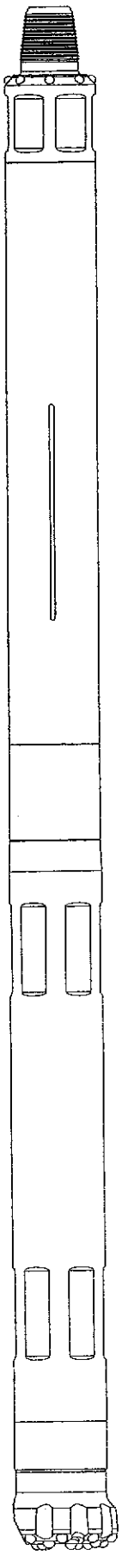


FIGURE 2

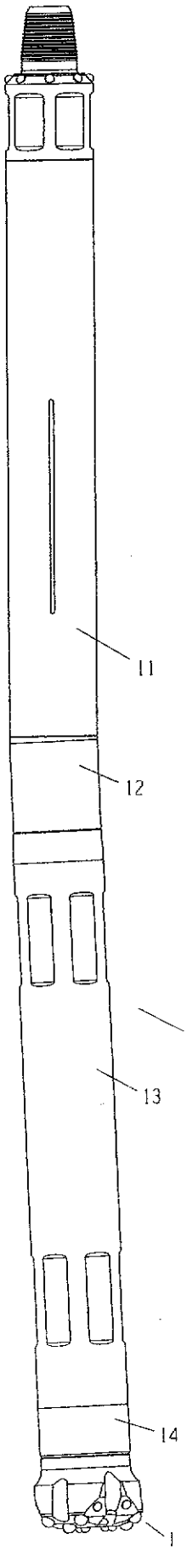


FIGURE 3

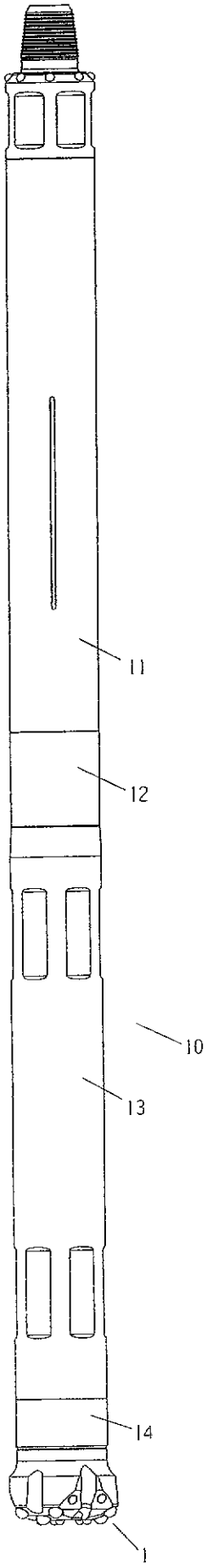


FIGURE 4

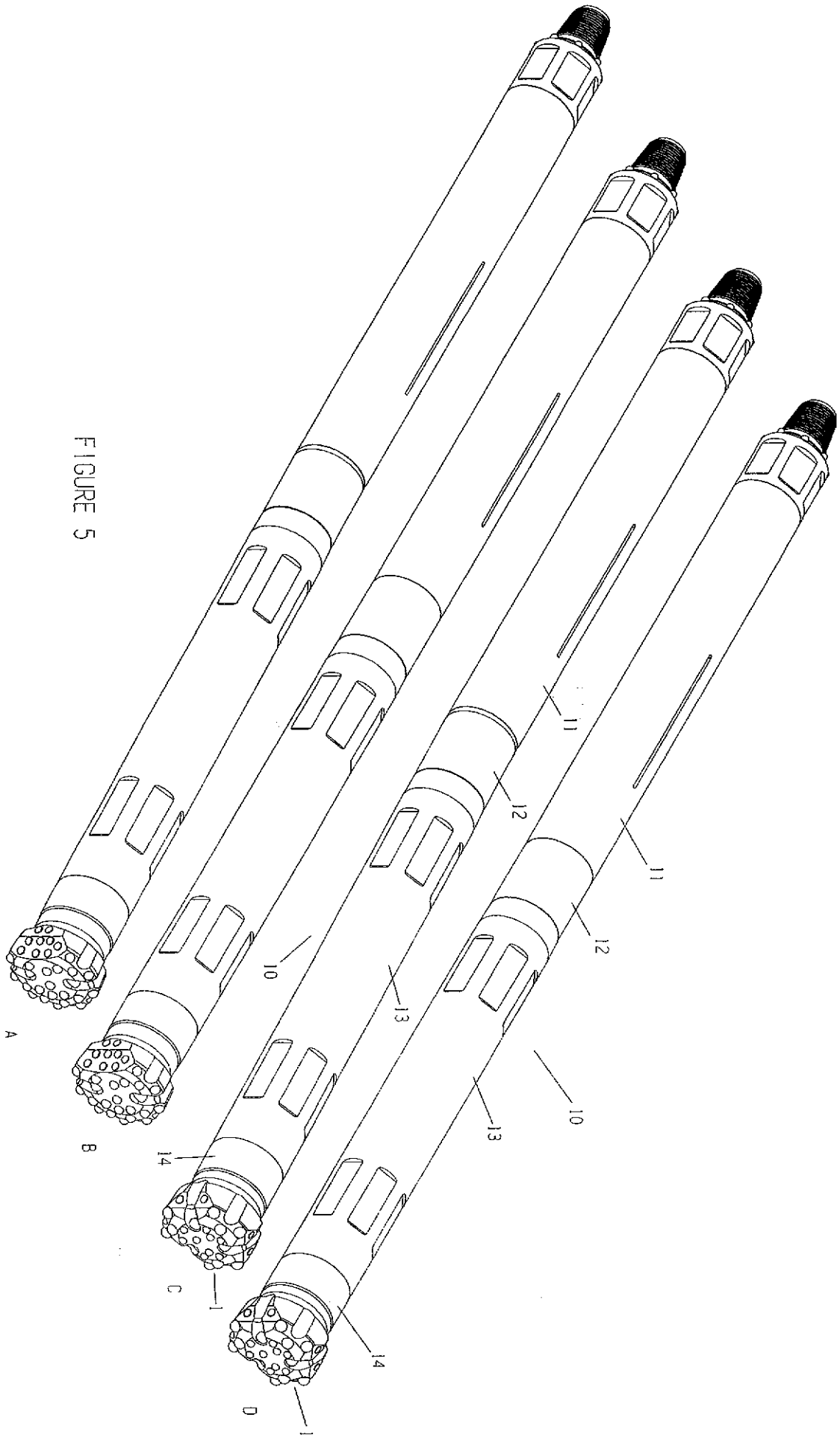


FIGURE 5

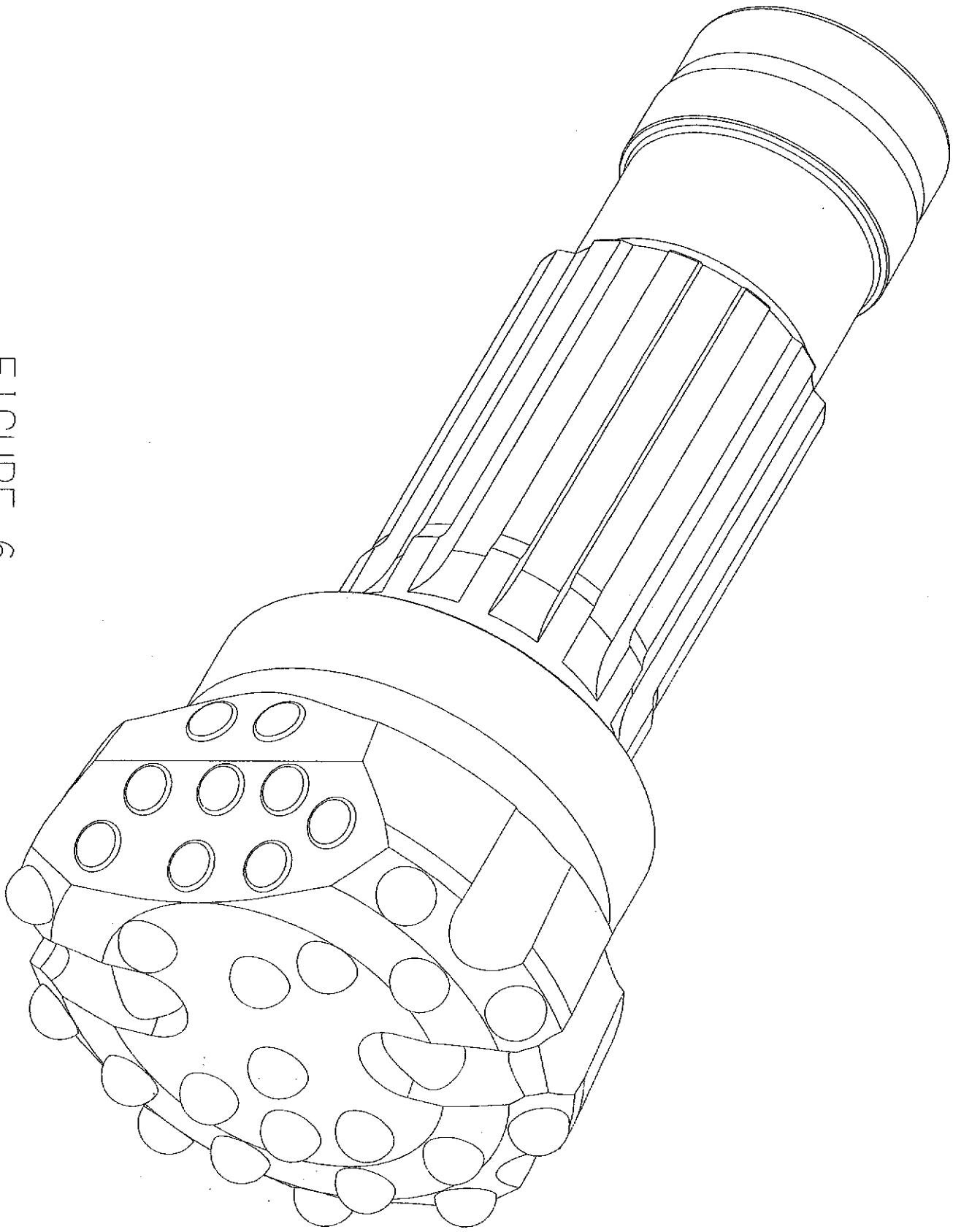
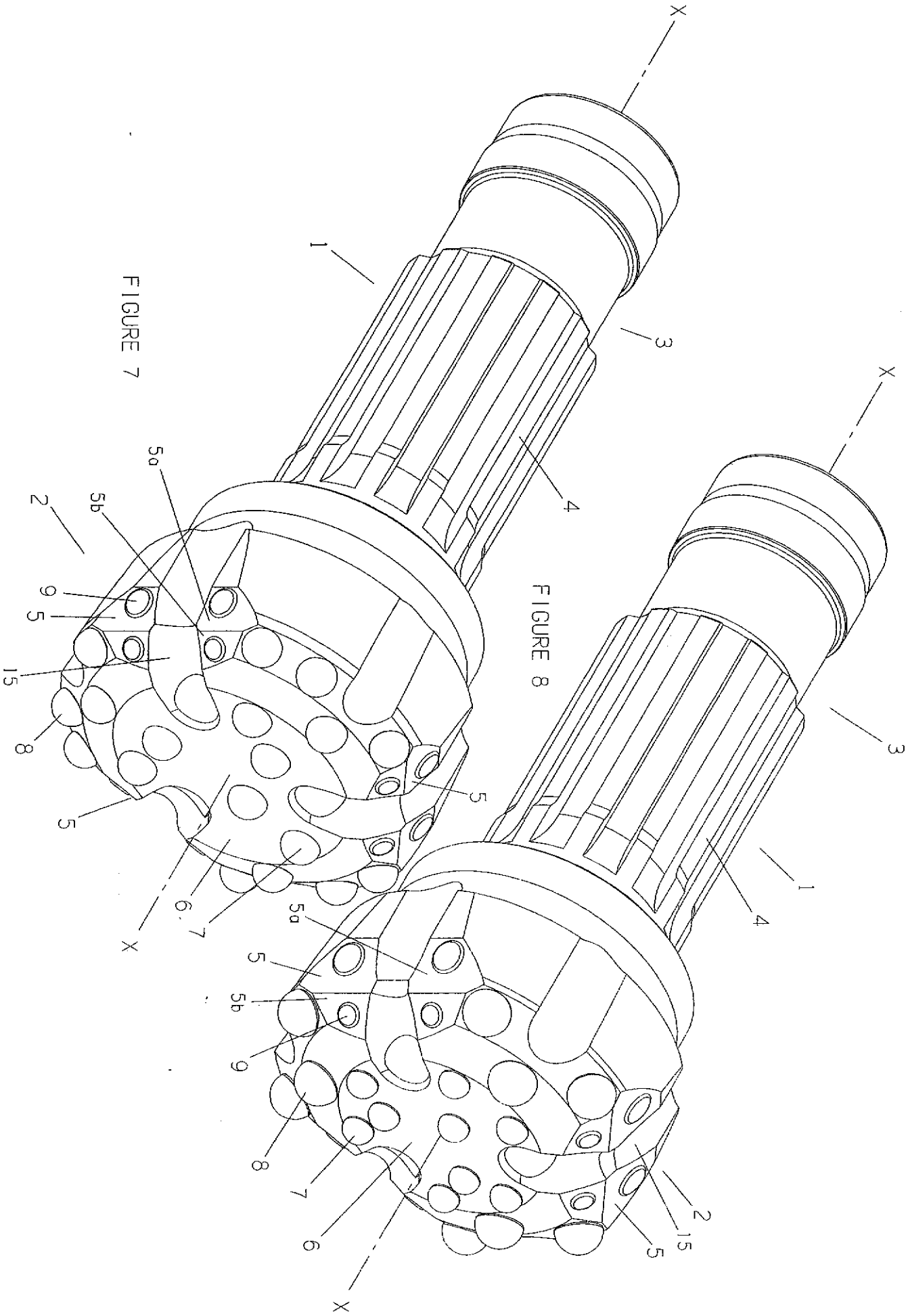


FIGURE 6


X
1
3
4
2
5a
5b
9
5
15
8
5
6
7
X
FIGURE 7
X
3
1
4
5a
5
5b
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8
7
6
X
2
15
5
FIGURE 8

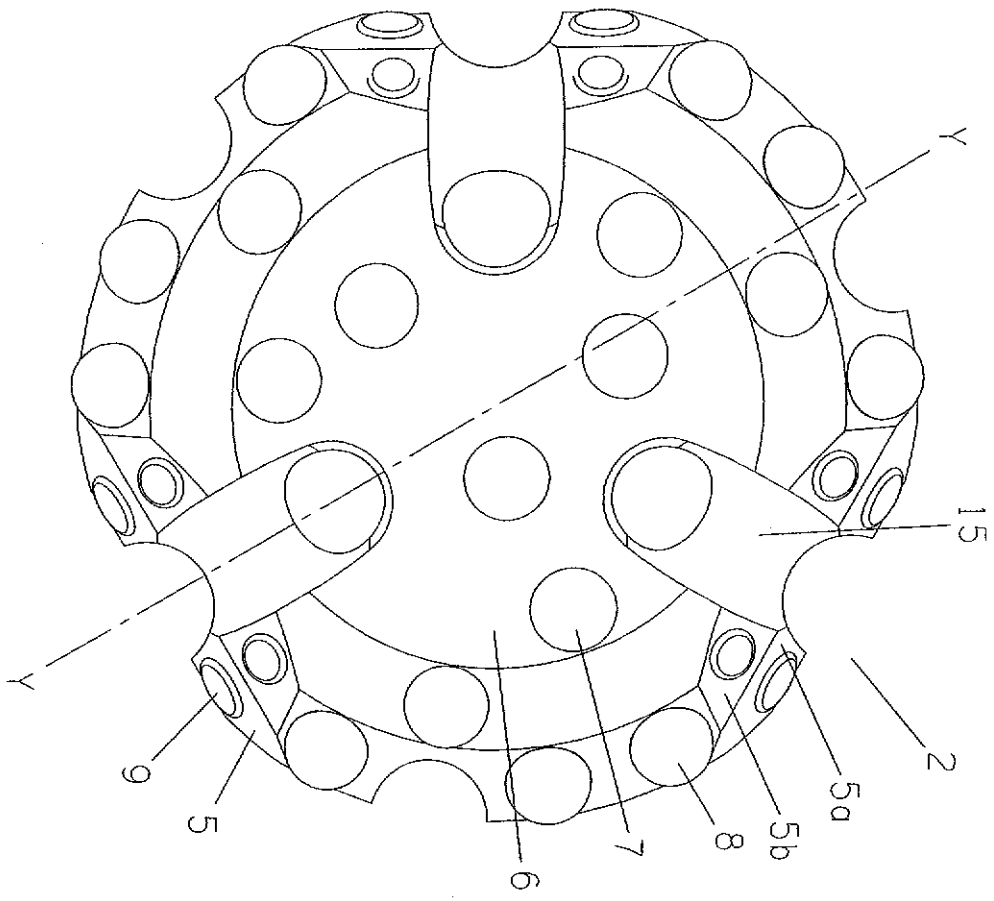

FIGURE 9

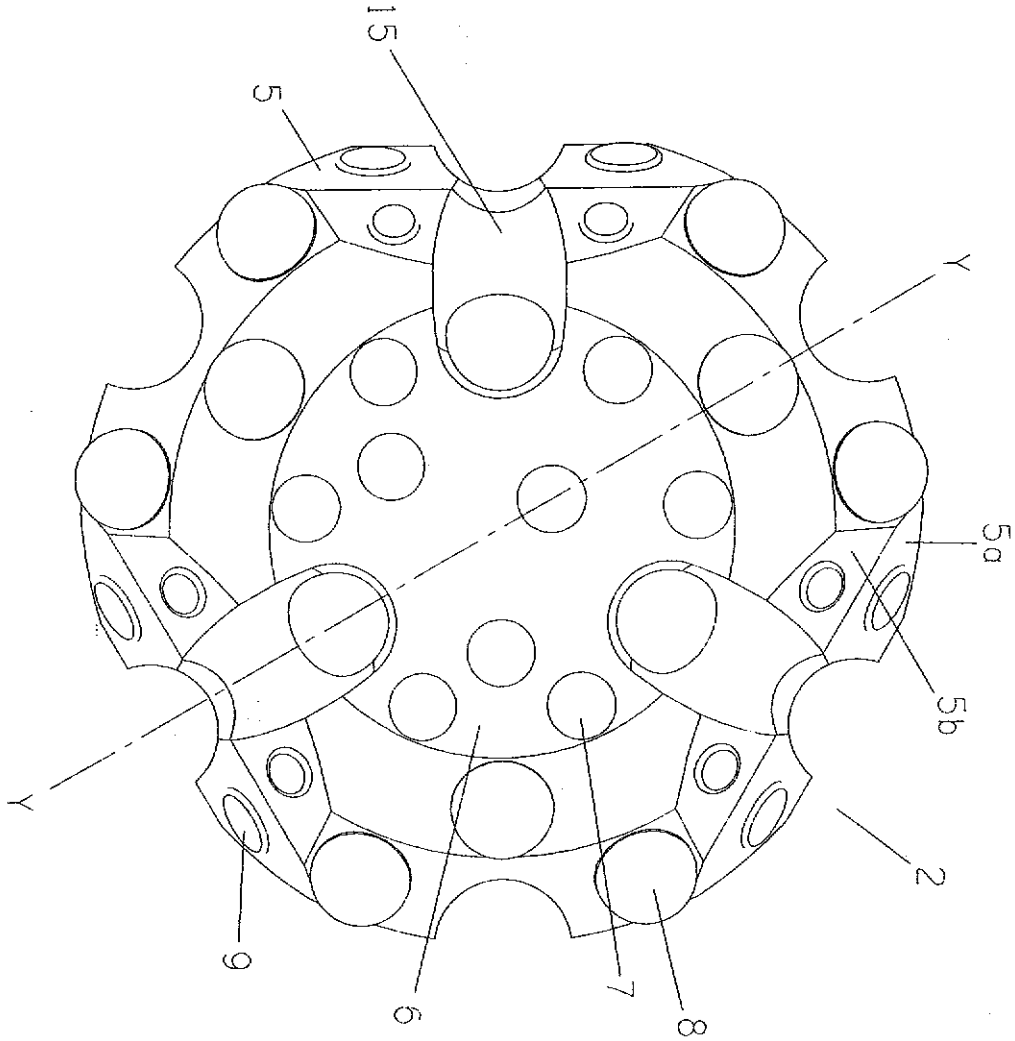

FIGURE 10