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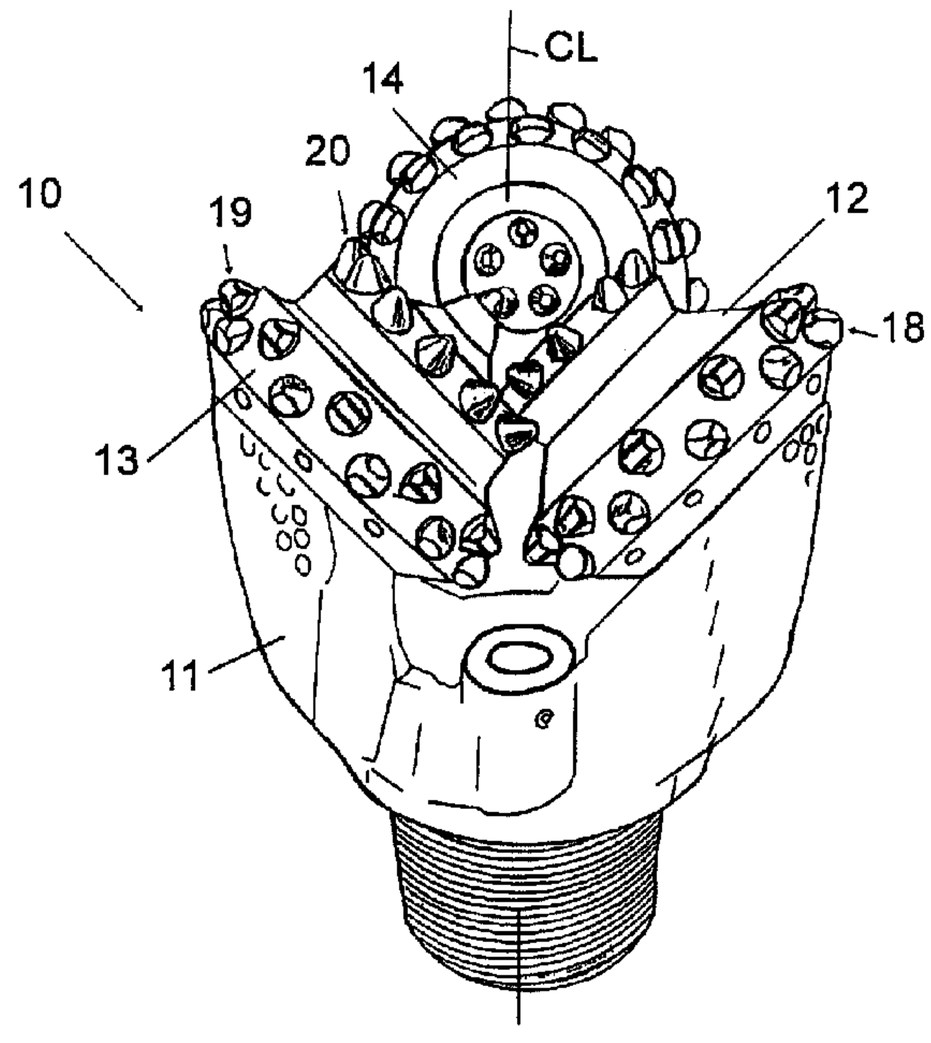
(54) Titre : TREPAN ROTATIF ET TRICONE POUR FORAGE DE ROCHES
(54) Title: A ROTARY DRILL BIT AND A ROLLER CUTTER FOR ROCK DRILLING



(57) Abrégé/Abstract:
The present invention relates to a rotary drill bit for rock drilling and a roller cutter therefore. The rotary drill bit (10) comprises a bit body (11) and three roller cutters (12, 13, 14), each said roller cutter being rotatably mounted on a journal (15) protruding from the bit body. Each roller cutter has a substantially conical basic shape with a base (16) facing towards the periphery of the drill bit and a top (17) essentially facing towards the center of the drill bit. A number of buttons (18-20) are provided on each roller cutter in circumferential rows. Each button has a working end which during rotation of a roller cutter comes into engagement with the rock and thereby is provided to form a surface of attack with the rock. A first row (I) next to the base comprises button (18) the length of attack of which against the rock is greater in the rotational direction (R) of the roller cutter than perpendicularly thereto. A second row (II) provided beyond the first row (I) in direction from the base (16) comprises buttons (19) the length of attack of which is greater in the rotational direction (R) of the roller cutter than perpendicularly thereto. A third row (III) provided beyond the second row (II) in direction from the base (16) comprises buttons (20) the length of attack of which in the rotational direction (R) of the roller cutter is smaller than the length of attack in the rotational direction (R) of the buttons (18, 19) in both the first and the second rows (I, II).

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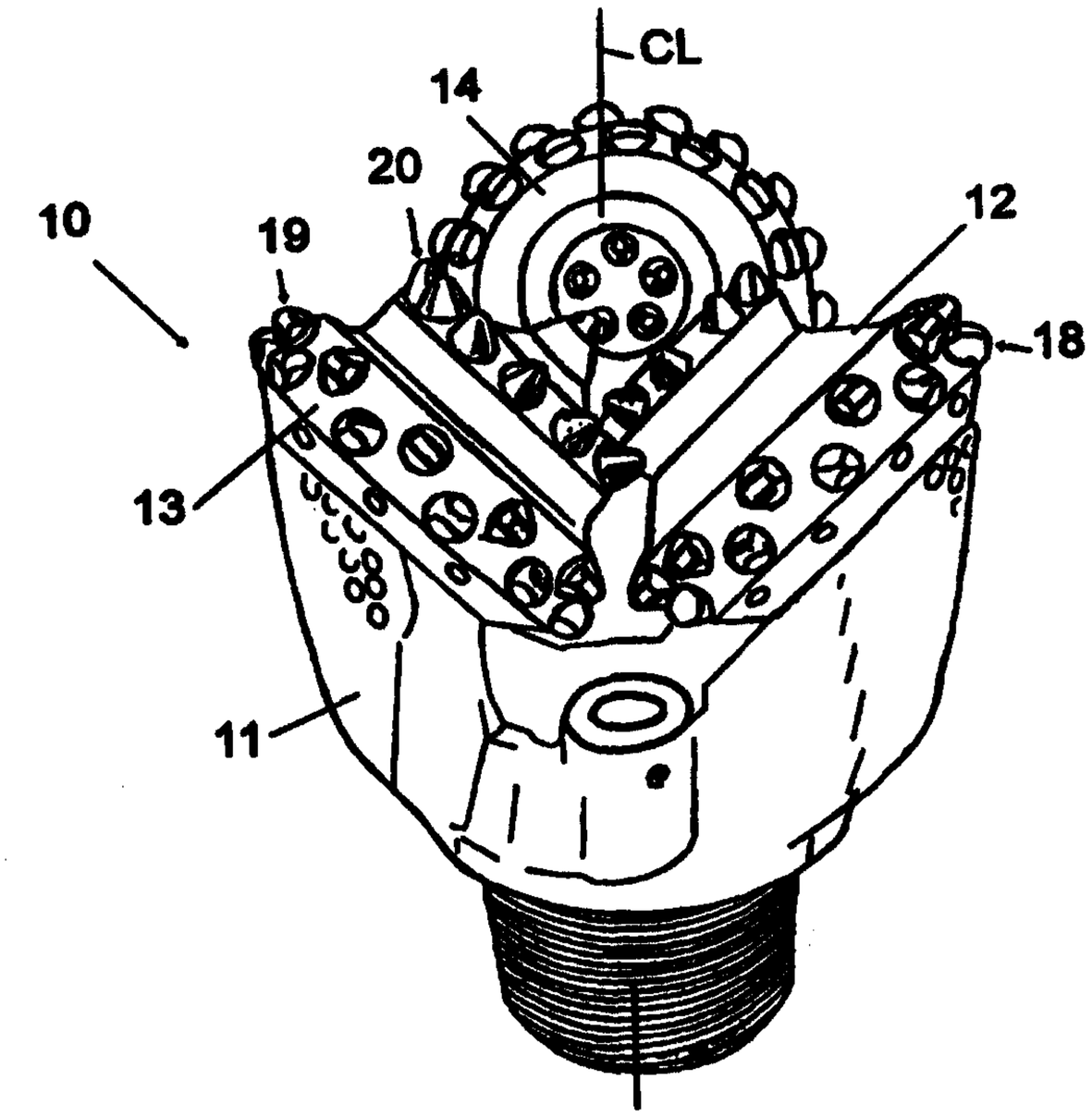
(57) Abstract

The present invention relates to a rotary drill bit for rock drilling and a roller cutter therefore. The rotary drill bit (10) comprises a bit body (11) and three roller cutters (12, 13, 14), each said roller cutter being rotatably mounted on a journal (15) protruding from the bit body. Each roller cutter has a substantially conical basic shape with a base (16) facing towards the periphery of the drill bit and a top (17) essentially facing towards the center of the drill bit. A number of buttons (18–20) are provided on each roller cutter in circumferential rows. Each button has a working end which during rotation of a roller cutter comes into engagement with the rock and thereby is provided to form a surface of attack with the rock. A first row (I) next to the base comprises button (18) the length of attack of which against the rock is greater in the rotational direction (R) of the roller cutter than perpendicularly thereto. A second row (II) provided beyond the first row (I) in direction from the base (16) comprises buttons (19) the length of attack of which is greater in the rotational direction (R) of the roller cutter than perpendicularly thereto. A third row (III) provided beyond the second row (II) in direction from the base (16) comprises buttons (20) the length of attack of which in the rotational direction (R) of the roller cutter is smaller than the length of attack in the rotational direction (R) of the buttons (18, 19) in both the first and the second rows (I, II).



A ROTARY DRILL BIT AND A ROLLER CUTTER FOR ROCK DRILLING

The field of the invention

The present invention relates to a rotary drill bit and a roller cutter for rock drilling according to the respective preambles of the subsequent independent claims.

Prior art

In conventional rock drill bits of the above-captioned type buttons of cemented carbide are arranged in rows in each roller cutter. Each button has a working end which is semi-spherical. When the round working end surface comes into engagement with the rock in the hole which is to be drilled a crater is formed by cracking the rock around the button. However, the button during the next revolution tends to be postioned in the crater such that the engagement of the trailing button cracks relatively little rock, whereby so called "tracking" appears and the hole bottom becomes very uneven. To correct this problem U.S. Patent No. 5,323,865 suggests a rock drill bit, which comprises three rotatable rolls, each comprising rows of buttons for crushing the rock. The working end of each button has a chisel shape. The direction of the chisel in the radially outmost row of a roller cutter is parallel to the axis of rotation of the roller cutter while in the remaining rows the direction of the chisel is parallel with said axis of rotation. The known solution does not have a satisfactory service life. The chisel buttons in row number 1, which are submitted to great forces from the well bore wall and the hole bottom, quickly obtain button damages. Furthermore, the known drill bit requires a high feed force.

Objects of the invention

One object of the present invention is to provide a rock drill bit for rotary crushing drilling which has the same advantages as known drill bits.

Another object of the present invention is to provide a rock drill bit for rotary crushing drilling which provides a favorable crushing pattern in the drilled hole.

Still another object of the present invention is to provide a rock drill bit for rotary crushing drilling with long service length.

Still another object of the present invention is to provide a rock drill bit and a roller cutter for rotary crushing drilling which requires relatively low feed force.

These and other objects have been achieved by means of a rotary drill bit and a roller cutter for rock drilling such as they are defined in the subsequent claims with reference to the drawings.

Short description of the drawings

Fig. 1A shows a rotary drill bit according to the present invention in a perspective view. Fig. 1B shows a magnification of one roller cutter according to Fig. 1A laid out in one plane. Figs. 1C and 1D shows buttons in two side views. Fig. 2 shows the rotary drill bit in a top view. Fig. 3 shows a part of a rotary drill bit according to the present invention, more specifically the engagement of the buttons of the roller cutters with a bore. Fig. 4 schematically shows the bottom of the drill hole in a top view after drilling with a rotary drill bit according to the present invention.

Detailed description of the invention

Figs. 1A-2 show a rotary drill bit 10 for rock drilling according to the present invention and buttons therefore. The rotary drill bit 10 comprises a bit body 11 and three roller cutters 12, 13, 14. Each roller cutter is rotatably mounted on a journal 15 which protrudes from the bit body 11. Each roller cutter has a substantially conical basic shape with a base 16 facing substantially in direction towards the periphery of the drill bit and a top 17 essentially facing in direction towards the center of the drill bit. A number of buttons 18, 19, 20 are provided in each roller cutter in circumferential rows I-III, or more. Together these rows lead to a number of circular patterns 1-7, Fig. 4, since positions for all rows apart for the first row are displaced, in the axial direction of the roller cutter, from one roller cutter to another. The working end of each button projects relative to the surrounding material in the steel bit body and it comes into engagement with the rock during rotation of a roller cutter and thereby forming a surface of attack with the rock. The surface of attack defines a length of attack against the rock in the rotational direction R of the roller cutter and a length of attack perpendicularly thereto.

The first row I is provided next to the base 16 and comprises buttons 18 (Fig. 1B). Each button 18 in the first row has a substantially cylindrical mounting portion 21 and a working end 22. The working end 22 comprises a relatively flat surface 23, which extends from said mounting portion in direction towards a forward end of said button. The working end 22 has a convex curved basic shape, preferably a ballistic basic shape, radially outside of which a greater part of the working end projects. Each button 18 is secured in a hole in the roller cutter such that their radially extreme surface 23 essentially coincides with the jacket surface of the roller cutter drill bit.

The top of the working end 22 has different radii of curvature depending on where the cross section through the longitudinal axis of the button is taken. Consequently, the radius of curvature R1 of the working end of the button 18 in the rotational direction of the roller cutter in the first row I is chosen greater than the radius of curvature R2 perpendicularly to the rotational direction R of the roller cutter. The relatively flat surface 23 connects circumferentially to at least one crest like cutting edge 24 provided perpendicularly to the axis 25 of rotation of the roller cutter. The buttons 18 are provided such that the bit body of steel does not become unnecessary worn and therefore the diameter of the drilled hole remain essentially constant during the entire drilling operation.

The second row II is provided next to the first row I and comprises buttons 19 (Fig. 1B). Each button 19 in the second row II has a substantially cylindrical mounting portion 26 and a working end 27. The working end 27 comprises two essentially concave surfaces 28, 29, which connect to a chisel 30 provided perpendicularly to the axis 25 of rotation of the roller cutter. The top of the working end 27 has different radii of curvature depending on where the cross section through the longitudinal axis of the button is taken. Consequently, the radius of curvature R3 of the working end of the button 19 in the rotational direction of the roller cutter in the second row II is chosen greater than the radius of curvature R4 perpendicularly to the rotational direction R of the roller cutter.

The third row III is provided beyond the first and second rows in direction towards the top 17 and the third row comprises buttons 20 (Fig. 1B). Each button 20 in the third row has a substantially cylindrical mounting portion 31 and a working end 32. The

working end 32 has a substantially conical, semi-spherical or ballistic basic form, wherein the radii of curvature R5 and R6 in the tip of the button are identical regardless of in which cross section through the longitudinal axis of the button the radii are measured.

When comparing the different the radii of the buttons 18-20 the following applies R3>R1>R5 and R2>R4>R6.

In the shown preferred embodiment the rotary drill bit 10 comprises three roller cutters with at least three rows of buttons, whereof one roller cutter 13 also includes a button which substantially machines the rock around the axis CL of rotation of the drill bit. Further button rows can be attributed if greater drill bits shall be used and then the further rows preferably are provided with buttons identical with buttons in the row III.

With a rotary drill bit according to the present invention is obtained a favorably crushing pattern in the drilled hole by to a great extent avoiding tracking. This gives good penetration speed to the drill bit which is important for drilling economy. In Fig. 4 is schematically shown a crushing pattern in the rock after drilling with a rotary drill bit according to the present invention. It is apparent from the figure that patterns 1-3 after the rows I to II form circumferential grooves while pattern 4 and higher after the rows III and higher form craters. From primarily Fig. 2 is apparent that each roller cutter has at least three rows of buttons. The row II in the roller cutter 14 is provided closer to the rotational axis of the drill bit as compared to with the rows II in the roller cutters 12 and 13. Therefor, there are more grooves in the hole bottom than there are rows on each roller cutter. The reason for buttons in row III and higher not being arranged with greater radii of curvature perpendicularly to the axis of rotation of the roller cutter is that maximum possible drilling speed is wanted. This means that buttons with greater radii of curvature perpendicularly to the axis of rotation of the roller cutter bring about increase of the feed force and thereby increase in energy consumption during drilling. It has proven advantageous to provide buttons with a large radius of curvature perpendicularly to the axis of rotation of the roller cutter from the periphery of the drill bit into to at least half of the diameter D, see Fig. 4, and to arrange remaining buttons more aggressive in the shape of semispherical or conical working ends for diminishing torque damages closer the center of the drill bit.

The rotary drill bit 10 comprises three geometrical different button shapes 18-20 and therefor the properties of the drill bit can be controlled a entirely new manner as regards to wear resistance, crushing pattern and power requirements. In addition to the excellent life-span a much smaller hole deviation is obtained depending on the good resistance to diametrical wear due to the wear resistant buttons in row I. Tests have shown that especially in the button rows inside row I, see pattern 1 in Fig. 4, it is advantageous if buttons work with the chisel in the rotational direction of the roller cutter, thereby obtaining efficient cracking of the rock, reduced tracking, less wear and fewer button damages.

The invention is in no manner limited to the above described embodiment. For example the number of rows of buttons can vary depending on the size of the roller cutter bit. Also in other respects the invention can be varied within the scope of the appended claims.

CLAIMS

1. A rotary drill bit for the rotary crushing drilling of rock, said bit comprising a bit body and three roller cutters, each roller cutter being rotatably mounted on a journal protruding from the bit body, each roller cutter including a roller body having a generally conical shape with a rear end facing generally towards the periphery of the drill bit and a front end facing generally towards a rotational center of the drill bit, wherein a number of rock-crushing buttons are provided in each roller body to form at least first, second and third circumferential rows of buttons, the first, second and third rows of buttons being arranged successively from the rear end toward the front end of the roller cutter, each button having a working end which projects from the roller body and which during rotation of the roller cutter comes into engagement with the rock, wherein each button of the first and second rows having a length of attack which is longer in a direction of rotation of the roller cutter than in a direction perpendicular thereto, the buttons of the third row having a length of attack in the rotational direction which is shorter than the lengths of attack of the buttons of the first and second rows in the rotational direction.

2. The rotary drill bit according to claim 1 wherein the working ends of the buttons in the first, second and third rows has a curvature extending in the direction of rotation and defined by first, second, and third radii of curvature, respectively, the radius of curvature for each of the buttons in the first and second rows being larger than the radius of curvature for each of the buttons in the third row.

3. The rotary drill bit according to claim 2 wherein each button of the first and second rows has an additional curvature extending generally perpendicularly to the direction of rotation, the additional curvature defined by an additional radius of curvature, the additional radius of curvature of the buttons of the first row being greater than the additional radius of curvature of the buttons of the second row.

4. The rotary drill bit according to any one of claims 1 to 3 wherein the buttons of the first, second, and third rows, respectively, are of different geometrically different shapes.

5. The rotary drill bit according to any one of claims 1 to 4 wherein each button of the first row includes a substantially cylindrical mounting portion mounted in a hole of the

roller cutter, the working end of each button of the first row comprising a first portion having a relatively flat button surface which extends from said mounting portion in direction towards the working end of said button, said working end also having a second portion of convexly curved basic shape, a radially outmost button surface of the button substantially coinciding with a jacket surface of the roller cutter.

6. The rotary drill bit according to claim 5, wherein the convexly curved shape of the second portion of the working end comprises a ballistical basic shape, and the relatively flat button surface in a circumferential direction connects to at least one crest-like cutting edge of the button extending perpendicularly to the axis of rotation of the roller cutter.

7. The rotary drill bit according to any one of claims 1 to 6 wherein each button of the second row comprises a substantially cylindrical mounting portion, the working end comprising two essentially concave surfaces which connect to a chisel extending perpendicularly to the axis of rotation of the roller cutter.

8. The rotary drill bit according to any one of claims 1 to 7 wherein each button of the third row comprises a substantially cylindrical mounting portion, the working end having a substantially conical shape.

9. The rotary drill bit according to any one of claims 1 to 7 wherein each button of the third row comprises a substantially cylindrical mounting portion, the working end having a substantially ballistic shape.

10. The rotary drill bit according to any one of claims 1 to 7 wherein each button of the third row comprises a substantially cylindrical mounting portion, the working end having a convex shape symmetrical about a center axis of the button.

11. A roller cutter for use in a rotary rock drill bit, the roller cutter including a roller body defining an axis of rotation and having a generally conical shape with a large rear end and a smaller front end, a number of rock-crushing buttons mounted in the roller body to form at least first, second, and third circumferential rows of buttons, the first, second, and third rows of buttons being arranged successively from the rear end toward the front end of the roller cutter, each button having a working end projecting from the roller body

for engaging rock during rotation of the cutter body, wherein the button of each of the first and second rows having a length of attack which is longer in a direction of rotation of the roller cutter than in a direction perpendicular thereto, the buttons of the third row having a length of attack in the rotational direction which is shorter than the lengths of attack of the buttons of the first and second rows in the rotational direction.

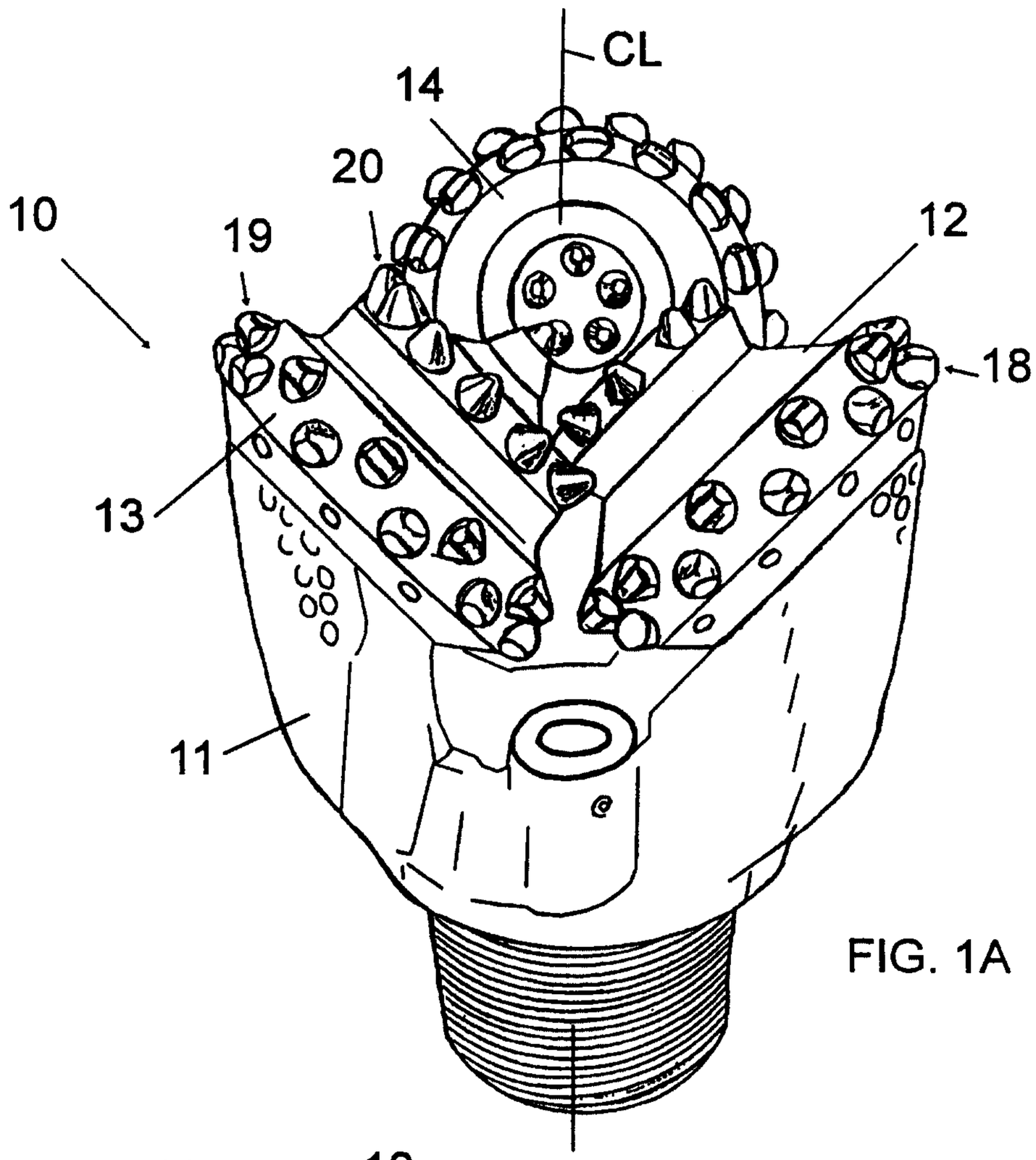

CL
14
20
10
19
12
18
13
11

FIG. 1A

10
18
14
I II III
19
I II III
13
12
R
20
I II III

FIG. 2

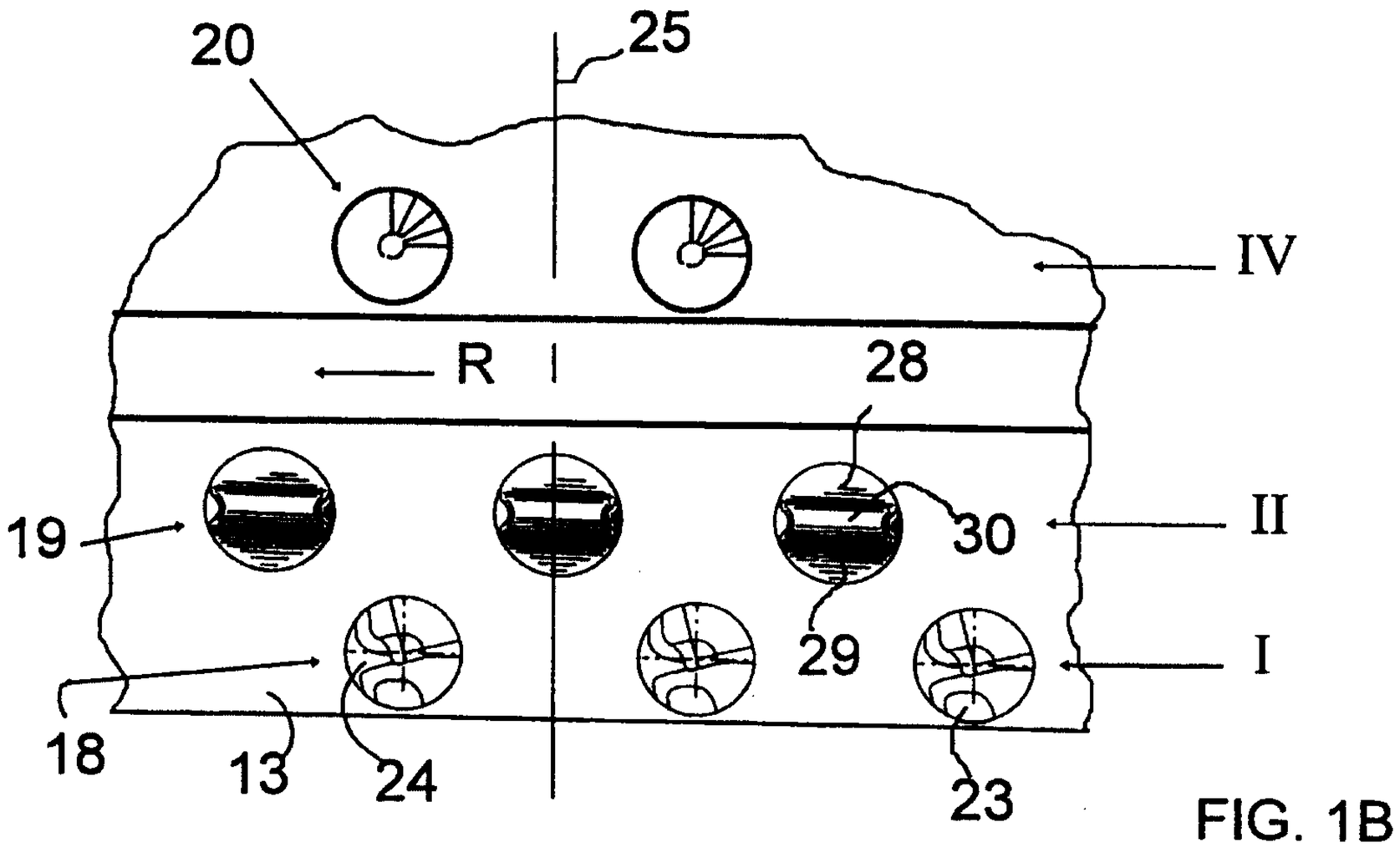


FIG. 1B

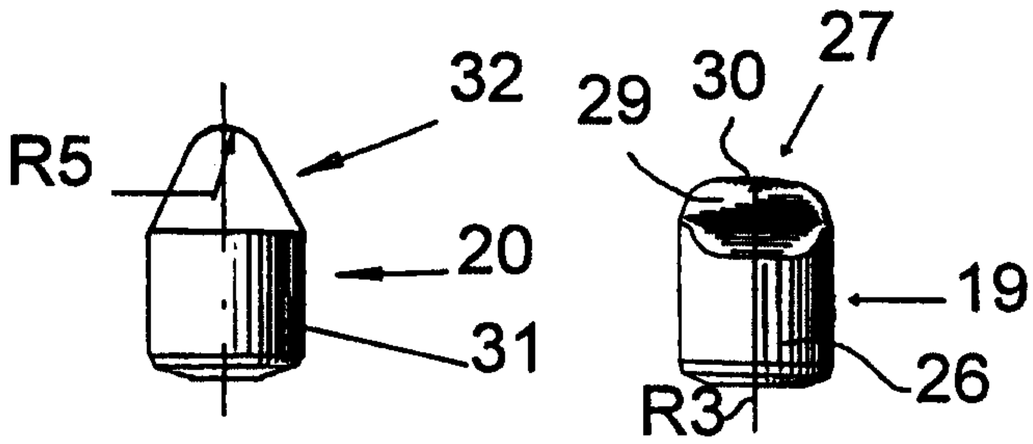


FIG. 1C

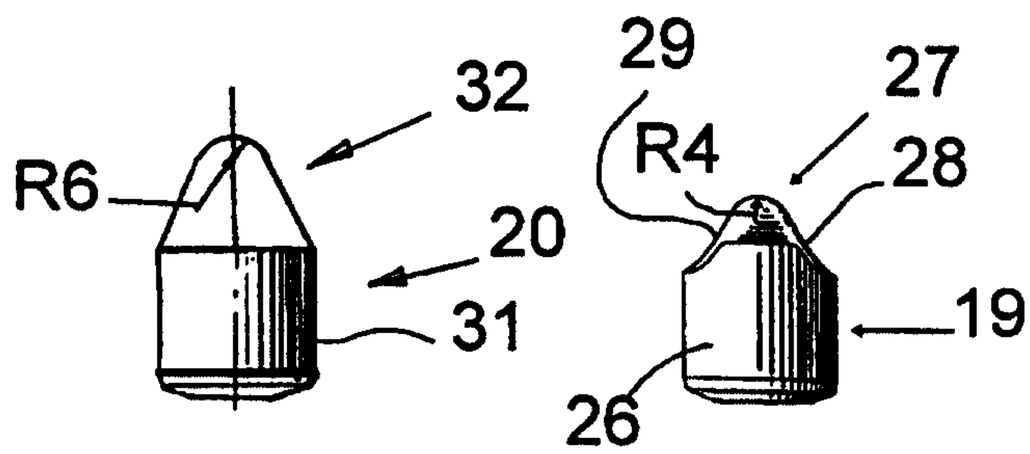


FIG. 1D

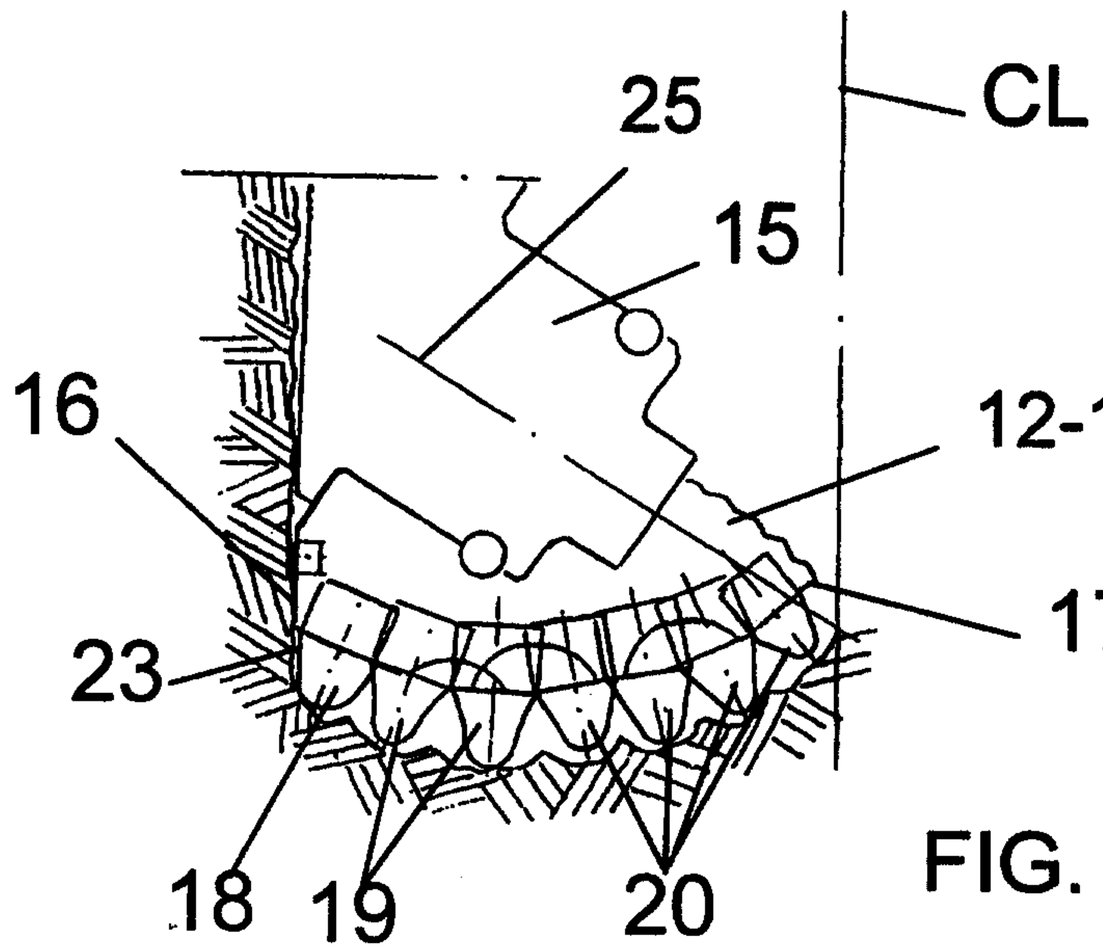


FIG. 3

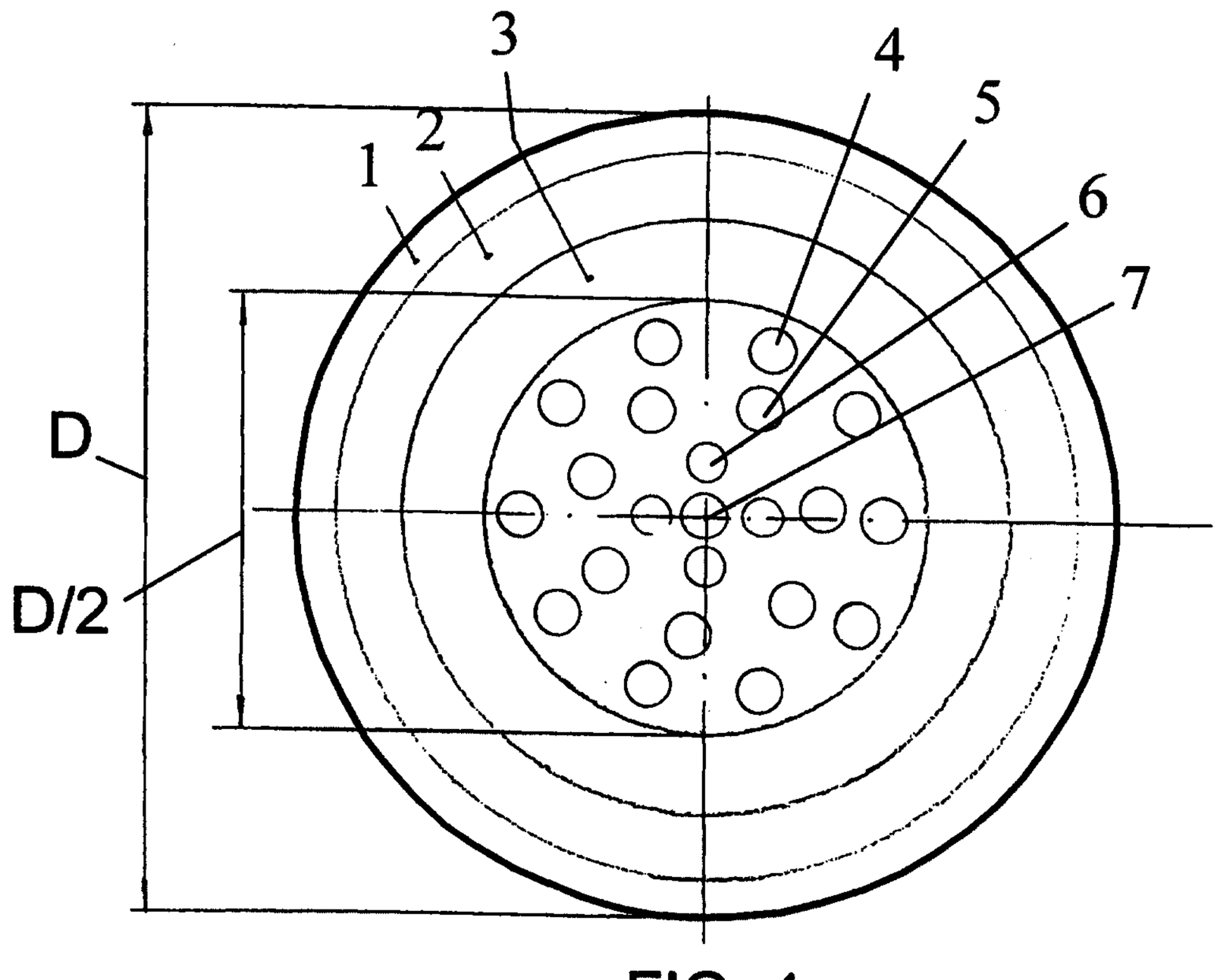
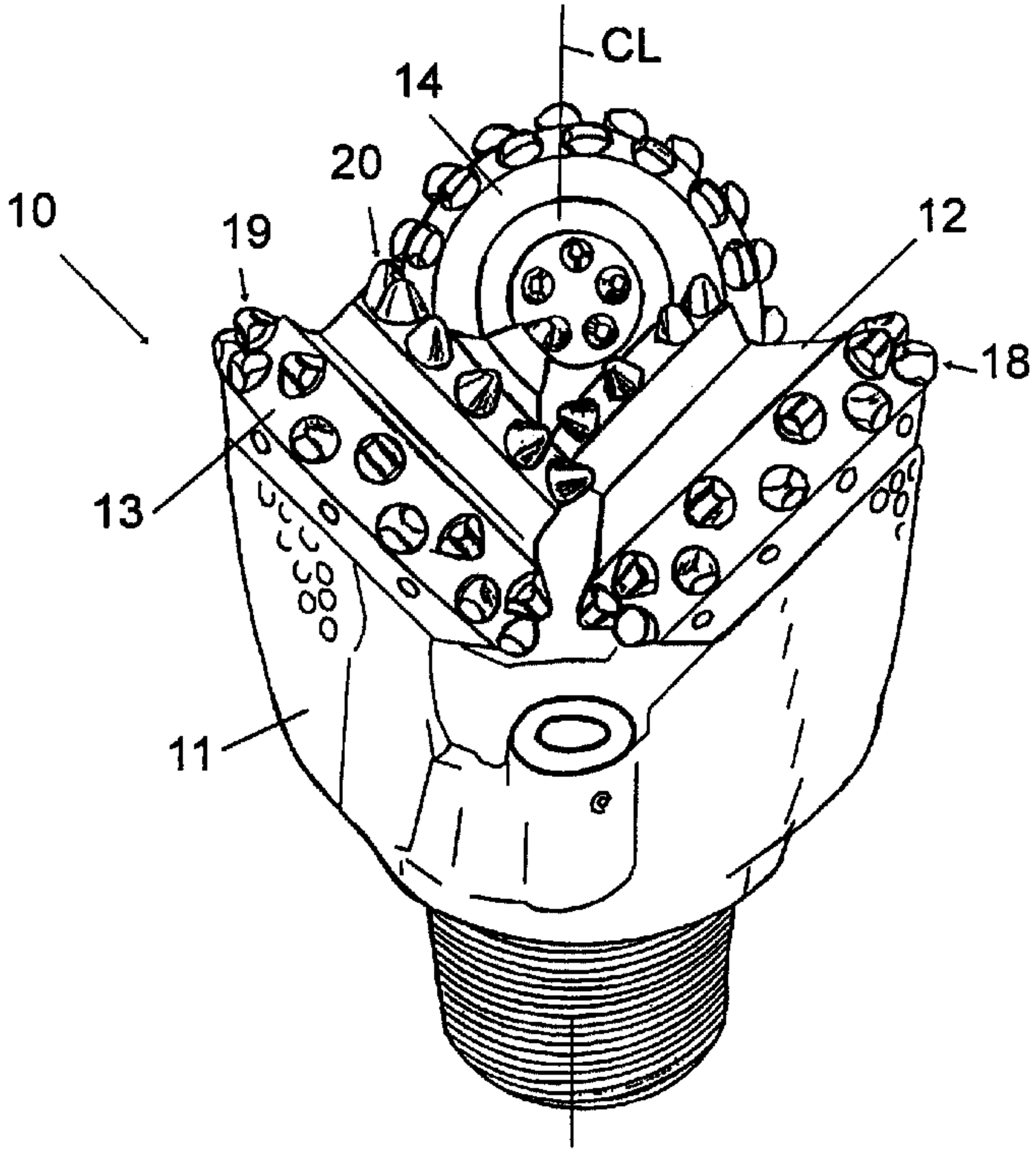


FIG. 4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