(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 184 729 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
28.06.2017 Bulletin 2017/26

(21) Application number: **15833073.8**

(22) Date of filing: **11.08.2015**

(51) Int Cl.:
E21B 10/32 *(2006.01)*

(86) International application number:
PCT/JP2015/072799

(87) International publication number:
WO 2016/027739 (25.02.2016 Gazette 2016/08)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA

(30) Priority: **20.08.2014 JP 2014167602**

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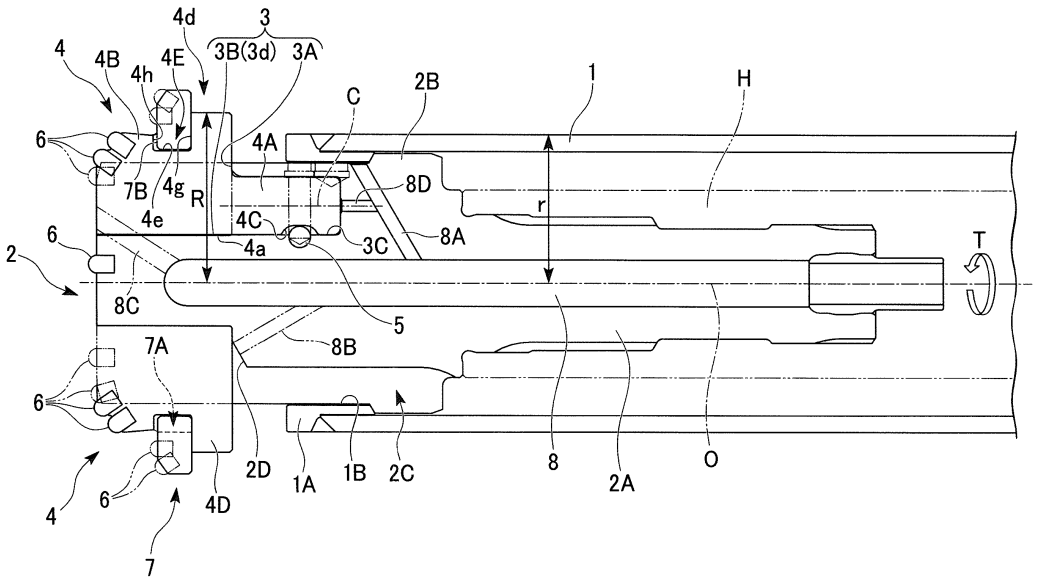
(54) EXCAVATION TOOL

(57) A drilling tool of the present invention includes: a casing pipe; a ring bit having a larger diameter and disposed coaxially on a tip side of the casing pipe; and a pilot bit inserted into the ring bit through the inside of the casing pipe. An outer peripheral part at a tip of the pilot bit is provided with a bit head which is extended when rotated in a tool rotation direction during drilling. The ring bit is provided with a part to be engaged that is engaged with the extended bit head in the tool rotation direction, and a first abutting part capable of abutting against the extended bit head in a direction of an axis.

FIG. 1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a so-called double pipe type drilling tool that performs drilling using a ring bit disposed on a tip side of a casing pipe, and a pilot bit inserted into the casing pipe.

[0002] Priority is claimed on Japanese Patent Application No. 2014-167602, filed August 20,2014, the content of which is incorporated herein by reference.

BACKGROUND ART

[0003] As such a double pipe type drilling tool, PTL 1 suggests a drilling tool in which a ring bit is rotatably inserted into a tip part of a casing pipe with their inner and outer periphery surfaces being made to face each other; an inner bit is attached to a tip of a transmission member inserted into the casing pipe; striking force and impelling force are transmitted to the casing pipe and rotating force in addition thereto are transmitted to the ring bit via this inner bit so as to perform drilling; and after a borehole having a predetermined depth is formed, the ring bit be removed from the casing pipe and left in the borehole.

[0004] PTL 2 describes a so-called under-reaming bit in which an extendable bit is attached to an outer periphery of a tip part of a shank device rotated around an axis; a borehole having a predetermined internal diameter is formed while the extendable bit is positioned in a extending state and protrudes to a tip of a casing pipe during drilling; and after the end of the drilling, the extendable bit is shrunk and then is recovered with the shank device through the inside of the casing pipe.

CITATION LIST

PATENT LITERATURE

[0005]

[PTL 1] Japanese Patent No. 4887857
[PTL 2] Japanese Patent No. 4501407

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0006] In recent years, in specific drilling works using such drilling tools, there have been increasing numbers of cases in which a borehole is formed with a greater internal diameter than an internal diameter sufficient enough to insert the casing pipe itself. For example, in a case where a steel-pipe diaphragm wall is buried, a casing pipe in which a joint is provided at an outer peripheral part of a steel pipe is inserted into a borehole. Further, in a case where the casing pipe is connected by a coupling having a greater external diameter than the external diameter of the steel pipe, this coupling is inserted into the borehole, and therefore, a borehole with an internal diameter for which the external diameter to the joint or the coupling is taken into consideration must be formed. Moreover, also in a case where the periphery of the steel pipe is cemented at a water well or the like for water stoppage, and a borehole with a greater internal diameter than the external diameter of the steel pipe is required.

[0007] In a case where such a borehole with a greater internal diameter is formed by the double pipe type drilling tool described in PTL 1, the external diameter of the ring bit is increased. However, as described above, the ring bit is rotatably inserted with the outer peripheral surface of the posterior end part thereof being made to face the inner peripheral surface of the casing pipe. Therefore, the internal diameter of the ring bit does not change and the size in the radial direction of the ring bit becomes larger. Since this ring bit is finally left in the borehole without being recovered, an increase in construction cost is caused. Further, since the rotating force is transmitted to the ring bit via the inner bit inserted into the ring bit through the inside of the casing pipe, sufficient rotating force cannot be transmitted if the external diameter of the ring bit becomes larger, and also there is a concern that drilling performance may degrade.

[0008] In a case where a borehole with a greater internal diameter is formed using the under-reaming bit described in PTL 2, the radius of the extendable bit from the axis in the extending state is increased. However, there is also a limitation to enlarge the extendable bit in order to shrink the extendable bit and recover it with the shank device after the end of the drilling. Moreover, in forming a borehole having a greater internal diameter, load becomes larger. As a result, there is also a concern that damage may occur on a shaft that rotatably supports the extendable bit. Further, there is also a limitation to the number of drilling tips disposed on the extendable bit, and drilling performance degrades as the diameter of a borehole becomes larger.

[0009] The present invention has been made in view of such a background, and the objective thereof is to provide a borehole that can prevent degradation of drilling performance, occurrence of damage, and an increase in construction cost, in a case where a borehole with a greater internal diameter than the external diameter of a casing pipe is drilled.

SOLUTION TO PROBLEM

[0010] In order to solve the above problems and achieve the objective, the present invention provides a drilling tool including: a cylindrical casing pipe centered on an axis; an annular ring bit that is coaxially disposed on a tip side of the casing pipe and has a greater external diameter than the casing pipe; and a pilot bit that is inserted into an inner peripheral part of the ring bit through the inside of the casing pipe. The pilot bit is rotatable around the axis and a bit head is provided at an outer

peripheral part of a tip of the pilot bit. The bit head is rotatable around a centerline eccentric from the axis, and is configured that when the pilot bit is rotated in a tool rotation direction during drilling, the bit head is extended such that a radius of the bit head from the axis is enlarged and thereby is supported by the pilot bit. The ring bit is provided with: a part to be engaged that is configured to be engaged with the extended bit head in the tool rotation direction during drilling; and a first abutting part capable of abutting against the tip side of the extended bit head in a direction of the axis.

[0011] In this drilling tool, the bit head provided at the outer peripheral part of the tip of the pilot bit is extended during drilling, and the first abutting part provided at the ring bit abuts against the tip side of the extended bit head in the direction of the axis. Thus, the ring bit can be prevented from coming off to the tip side thereof. Also, since the part to be engaged of this ring bit is engaged with the extended bit head in the tool rotation direction during drilling, rotating force can be transmitted from the pilot bit via the bit head to the ring bit.

[0012] Therefore, even if the external diameter of the ring bit is made to be greater than the external diameter of the casing pipe, via the extended bit head of which the radius from the axis is enlarged, sufficient rotating force can be transmitted to the ring bit, and drilling performance can be guaranteed. Additionally, when the part to be engaged of the ring bit is engaged with the extended bit head in the tool rotation direction during drilling, in this way, the need for making an outer peripheral surface of a posterior end part of the ring bit face an inner peripheral surface of the casing pipe to allow the posterior end part to be rotatably inserted into the casing pipe is also eliminated. Therefore, the internal diameter of the ring bit can be increased, that is, a required material can be reduced by making the volume of the ring bit small. Thus, even in a case where after the end of drilling, the bit head is rotated in a direction opposite to the direction during drilling and the ring bit is left in a borehole, construction cost can be prevented from increasing.

[0013] In contrast, in the pilot bit, even if the radius of the extended bit head from the axis is not made as large as the radius of the borehole, a borehole with a large internal diameter can be formed by the ring bit, and damage or the like to the bit head can be prevented without exerting an excessive load. Additionally, the number of the drilling tip disposed on the annular ring bit that drills the outer peripheral side of the borehole can be relatively freely set, and it is also possible to prevent degradation of drilling performance resulting from shortage of chips.

[0014] Here, when a recessed portion that is recessed to an outer peripheral side is formed at the inner peripheral part of the ring bit, and the recessed portion serves as the part to be engaged, the volume of the ring bit can be further reduced, and construction cost can be further reduced. In addition, in this case, a tip surface of the ring bit adjacent to the recessed portion may serve as the first abutting part, and a bottom surface that faces the tip side in the direction of the axis may be formed in the recessed portion so as to serve as the first abutting part.

[0015] In addition, in building the casing pipe in a borehole with the striking force and the impelling force to the tip side in the direction of the axis to be applied to the pilot bit, as in the drilling tools described in PTLs 1 and 2, a smaller-diameter part of which an internal diameter is one step smaller may be formed at an inner peripheral part of a tip of the casing pipe, and a second abutting part like a stepped part capable of abutting against the smaller-diameter part from a posterior end side in the direction of the axis may be formed at an outer peripheral part of a posterior end of the pilot bit so as to transmit the striking force and the impelling force. In this case, by making the internal diameter of the ring bit equal to or greater than the internal diameter of the smaller-diameter part, the volume of the ring bit can be made small as described above, and construction cost can be reliably reduced.

[0016] In transmitting the striking force and the impelling force to the tip side in the direction of the axis to the ring bit, the striking force and the impelling force may be directly transmitted to the ring bit from the pilot bit as in the drilling tool described in PTL 1. However, in that case, when the smaller-diameter part is formed at the inner peripheral part of the tip of the casing pipe and is made to be capable of abutting against the stepped part of the pilot bit as described above, a smaller-diameter part of which the internal diameter is further smaller than the smaller-diameter part of the casing pipe must be formed at the ring bit to abut against the pilot bit, and consequently, there is a concern that it becomes difficult to make the internal diameter of the ring bit small as described above to reduce construction cost.

[0017] Thus, particularly in such a case, by providing the bit head with a third abutting part which is capable of abutting against a surface of the ring bit that faces a posterior end side in the direction of the axis in a state where the bit head is extended, it becomes unnecessary to form a smaller-diameter part having a smaller internal diameter than the smaller-diameter part of the casing pipe in the ring bit, construction cost can be much more reliably reduced, and it is possible to reliably transmit the striking force and the impelling force from the pilot bit to the tip side in the direction of the axis to the ring bit via the third abutting part of the bit head.

[0018] Moreover, in this case, by making the greatest radius of the third abutting part of the extended bit head from the axis greater than a radius of an outer peripheral part of the tip of the casing pipe from the axis, the striking force and the impelling force can be transmitted to the outer peripheral side of the ring bit where drilling is performed. In a case where a borehole with a greater internal diameter than the external diameter of the casing pipe is formed, it is possible to perform even more efficient drilling, the thickness of the ring bit in the direction of the axis can also be made small, and much more construction cost reduction can be achieved.

ADVANTAGEOUS EFFECTS OF INVENTION

[0019] As described above, according to the present invention, even in a case where a borehole with a greater internal diameter than the external diameter of the casing pipe is formed, it is possible to transmit sufficient rotating force to the ring bit and to perform efficient drilling, without causing degradation of drilling performance, an increase in construction cost, or damage to the tool.

BRIEF DESCRIPTION OF DRAWINGS

[0020]

FIG. 1 is a cross-sectional view showing a state where a bit head is extended in one embodiment of the present invention.

FIG. 2 is an enlarged front view when the embodiment shown in FIG. 1 in a state where the bit head is retracted is seen from a tip side in a direction of an axis (illustration of a casing pipe and a casing top is omitted).

FIG. 3 is an enlarged front view when the embodiment shown in FIG. 1 in a state where the bit head is extended is seen from the tip side in the direction of the axis (illustration of the casing pipe and the casing top is omitted).

FIG. 4 is an enlarged front view when the ring bit of the embodiment shown in FIG. 1 is seen from the tip side in the direction of the axis.

FIG. 5 is Z-Z sectional view in FIG. 4.

DESCRIPTION OF EMBODIMENTS

[0021] FIGS. 1 to 5 show one embodiment of a drilling tool of the present invention. In the present embodiment, a casing pipe 1 is formed in a cylindrical shape centered on an axis O using metallic materials, such as a steel material, and a casing top 1A formed in a multi-stage cylindrical shape using metallic materials, such as a steel material, is attached to a tip part (left side in FIG. 1) of the casing pipe 1.

[0022] In the casing top 1A, the internal diameter thereof is a constant internal diameter that is one step smaller than the internal diameter of the casing pipe 1, the external diameter of a tip part is the same diameter as the casing pipe 1, and the external diameter of a posterior end part is of a size such that the posterior end part can be inserted and fitted into the casing pipe 1. The posterior end part of the casing top 1A is inserted and fitted into the casing pipe 1 from a tip side of the casing pipe 1 and then jointed by welding or the like, whereby the casing top 1A is coaxially integrated with the casing pipe 1.

[0023] By attaching the casing top 1A in this way, a smaller-diameter part 1B of which the internal diameter is one step smaller is formed at an inner peripheral part of the tip of the casing pipe 1. In addition, a posterior end surface of the smaller-diameter part 1B is formed in the shape of a concave conical surface which is centered on the axis O and tilts toward an inner peripheral side so as to become slightly closer to the tip side.

[0024] A pilot bit 2 is inserted into the casing pipe 1 from a posterior end side thereof (right side in FIG. 1). The pilot bit 2 is made of metallic materials such as a steel material and has an outer shape that is also formed in a multi-stage columnar shape, and a posterior end part thereof is made into a smaller-diameter shank part 2A. Striking force directed to the tip side in the direction of the axis O is transmitted to the pilot bit 2 from a down-the-hole hammer H attached to the shank part 2A.

[0025] Additionally, a drill rod (not shown) is added if necessary and is coupled to the posterior end side of the down-the-hole hammer H, and a drill rod disposed at the most posterior end is attached to a drilling device. The impelling force directed to the tip side in the direction of the axis O and the rotating force directed in a tool rotation direction T during drilling are transmitted to the pilot bit 2 from the drilling device via the drill rod and the down-the-hole hammer H. In addition, the casing pipe 1 is also added to the posterior end side if necessary and is inserted into a borehole.

[0026] A stepped part of which the external diameter becomes a maximum is formed at an outer periphery of the pilot bit 2 at a position closer to the tip side than the shank part 2A, and serves as a second abutting part 2B of the present embodiment. The external diameter of the second abutting part 2B is slightly smaller than the internal diameter of the casing pipe 1 and greater than the internal diameter of the smaller-diameter part 1B formed by the casing top 1A. Moreover, a tip surface of the second abutting part 2B is formed in the shape of a convex conical surface which tilts toward the inner peripheral side so as to become slightly closer to the tip side, and the tilt angle thereof is equal to the tilt angle of the posterior end surface of the smaller-diameter part 1B that forms the concave conical surface shape.

[0027] Therefore, the pilot bit 2 is coaxial with the casing pipe 1 and the casing top 1 A movable integrally with the casing pipe 1 and the casing top 1A to the tip side in the direction of the axis O, and rotatable around the axis O relative to the casing pipe 1 and the casing top 1A, in a place where the pilot bit 2 is inserted into the casing pipe 1 from the posterior end side thereof and the second abutting part 2B abuts against the smaller-diameter part 1B. Additionally, the external diameter of the pilot bit 2 at a position closer to the tip side than the second abutting part 2B is a constant external diameter slightly smaller than the internal diameter of the smaller-diameter part 1B formed by the casing top 1A, and thus a tip part of the pilot bit 2 is formed so as to protrude greatly from the tip of the casing top 1A in a state where the second abutting part 2B abuts against the smaller-diameter part 1B.

[0028] A housing recess 3 is formed at an outer periphery of the tip part of the pilot bit 2 protruding from the tip of the casing top 1A so as to be located closer to the tip side than the casing top 1A. The housing recess 3

includes: a bottom surface 3A that is located closer to the tip side than the casing top 1 A, faces the tip side, and is perpendicular to the axis O; and a wall surface 3B that extends to tip side in parallel with the axis O from an inner peripheral edge of the bottom surface 3A and reaches a tip surface of the pilot bit 2. The housing recess 3 is formed so as to be open to an outer peripheral surface and a tip surface of the tip part of the pilot bit 2. In the present embodiment, a plurality of (three) such housing recesses 3 having the same form and the same size are formed at equal intervals in a circumferential direction.

[0029] A wall surface 3B of each housing recess 3 includes: a first wall part 3a that is a plane facing an outer peripheral side of the pilot bit 2; a second wall part 3b that is a plane located on a side opposite to the first wall part 3a in the tool rotation direction T and facing the tool rotation direction T; and a third wall part 3c that is a plane located on the same side as the first wall part 3a in the tool rotation direction T and facing the side opposite to the tool rotation direction T. The second and third wall parts 3b and 3c are formed such that a gap therebetween in the circumferential direction becomes greater toward the outer peripheral side, and the second wall part 3b out of these wall parts extends toward the outer peripheral side so as to tilt to the tool rotation direction T.

[0030] Additionally, a fourth wall part 3d and a fifth wall part 3e are formed in the shape of a concave cylindrical surface centered on a straight line parallel to the axis O at a boundary part between the first and second wall parts 3a and 3b and a boundary part between the first and third wall parts 3a and 3c, respectively. The fourth wall part 3d connects with the first and second wall parts 3a and 3b, and the fifth wall part 3e connects with the first and third wall parts 3a and 3c. The radius of the concave cylindrical surface as the fourth wall part 3d formed at the boundary part between the first and second wall part 3a and 3b is greater than the radius of the concave cylindrical surface as the fifth wall part 3e formed at the boundary part between the first and third wall parts 3a and 3c.

[0031] Moreover, a discharge groove 2C for cuttings is formed which extends toward the posterior end side in parallel with the axis O from the tool rotation direction T side of the bottom surface 3A of each housing recess 3 and reaches an outer peripheral side of the shank part 2A beyond the second abutting part 2B. Each discharge groove 2C forms a substantially rectangular shape in a cross-section perpendicular to the axis O and is open to an outer peripheral surface of the tip part of the pilot bit 2. A bottom surface of each discharge groove 2C which faces the outer peripheral side of the pilot bit 2 forms a recessed curved shape and is slightly swept toward the outer peripheral side in a place where the bottom surface reaches a posterior end of the second abutting part 2B. A portion where this bottom surface and the bottom surface 3A of the housing recess 3 intersect each other is chamfered by an inclined surface 2D that intersects with both the bottom surfaces at an obtuse angle.

[0032] On the other hand, a fitting hole 3C that has a centerline C parallel to the axis O and has a circular cross-sectional shape is formed on the side opposite to the bottom surface 3A of each housing recess 3 in the tool rotation direction T. The centerline C of the fitting hole 3C coincides with the centerline of the concave cylindrical surface as the fourth wall part 3d formed at the boundary part between the first and second wall parts 3a and 3b, and is eccentric to the outer peripheral side of the axis O. Additionally, the internal diameter (radius) of the fitting hole 3C is approximately equal to or slightly smaller than the radius of the concave cylindrical surface as the fourth wall part 3d.

[0033] A bit head 4 is attached to each of the housing recesses 3 of the pilot bit 2. In the bit head 4, a columnar shaft part 4A to be inserted and slidably fitted into the fitting hole 3C and a head main body 4B provided on the tip side of the shaft part 4A are integrally formed using metallic materials, such as a steel material. The bit head 4 is attached so as to be rotatable around the centerline C. The bit head 4 is positioned in a state where as shown in FIG. 2, the head main body 4B abuts against the first wall part 3a and is housed within the housing recess 3 and the radius thereof from the axis O is reduced, or is positioned in a state where as shown in FIG. 3, the head main body 4B abuts against the second wall part 3b and the radius thereof from the axis O is enlarged. A posterior end surface of the head main body 4B is a plane perpendicular to the centerline C.

[0034] A cutout 4C is formed at an outer periphery of the shaft part 4A such that the cutout 4C forms a semi-oval shape as shown in FIG. 1 in a cross-section along the centerline C and extends to form a substantial L-shape as shown in FIGS. 2 and 3 in a section perpendicular to the centerline C. A pin 5 is driven into the tip part of the pilot bit 2 in a tangential direction of the fitting hole 3C in the cross-section orthogonal to the axis O, at a position that faces the cutout 4C in the direction of the axis O in a state where the shaft part 4A is inserted into the fitting hole 3C, a posterior end surface of the shaft part 4A is made to abut against the bottom surface of the fitting hole 3C, and a posterior end surface of the head main body 4B is made to abut against the bottom surface 3A of the housing recessed portion 3. A peripheral surface of each pin 5 is exposed inside the fitting hole 3C and is engaged with the cutout 4C, and thereby the bit head 4 is prevented from coming off to the tip side while being made to be rotatable around the centerline C.

[0035] Additionally, a first side surface 4a, which is located on an extension of an outer peripheral surface of the shaft part 4A among side surfaces of the head main body 4B, is formed in the shape of a convex cylindrical surface centered on the centerline C which flushes with this outer peripheral surface of the shaft part 4A or has an external diameter slightly greater than that of the outer peripheral surface of the shaft part 4A. The first side surface 4a is made to be slidable on the fourth wall part 3d of the wall surface 3B of the housing recess 3. Moreover,

second and third side surfaces 4b and 4c that sandwich the first side surface 4a therebetween are formed in a planar shape. As shown in FIG. 2, in a state where the bit head 4 is retracted, the second side surface 4b out of these side surfaces is made to abut against the first wall part 3a of the wall surface 3B of the housing recess 3 while the third side surface 4c faces the outer peripheral side of the pilot bit 2. In a state where the bit head 4 is extended, the third side surface 4c is made to abut against the second wall part 3b while the second side surface 4b is directed to the tool rotation direction T.

[0036] Moreover, a fourth side surface 4d, which is located between the second and third side surfaces 4b and 4c on a side opposite to the first side surface 4a, is formed so as to protrude to the outer periphery of the pilot bit 2 and be located on a cylindrical surface centered on the axis O, as shown in FIG. 3 in a state where the bit head 4 is extended. In addition, an intersecting ridgeline part between the fourth side surface 4d and the third side surface 4c is formed so as to be chamfered by a cylindrical surface that has a diameter slightly smaller than the external diameter of the tip part of the pilot bit 2 and is centered on the axis O in a state where the bit head 4 is retracted as shown in FIG. 2. Accordingly, the head main body 4B retracted and housed in the housing recess 3 is located inside a cylindrical surface of the outer peripheral surface of the tip part of the pilot bit 2.

[0037] Additionally, the fourth side surface 4d is formed in a multi-stage (three-stage in the present embodiment) shape that becomes concave and convex to the inner and outer peripheral sides with respect to the axis O toward the direction of the centerline C as shown in FIG. 1. A stage at the most posterior end among these stages is made to protrude to the outermost peripheral side from the axis O, and a portion in which the stage at the most posterior end is formed serves as a third abutting part 4D in the present embodiment. The third abutting part 4D has a surface thereof facing the tip side which is a flat surface perpendicular to the centerline C, and a greatest radius R of the third abutting part 4D from the axis O is greater than a radius r of the outer peripheral parts of the tips of the casing pipe 1 and the casing top 1A from the axis O in a state where the bit head 4 is extended as shown in FIG. 1.

[0038] In addition, an intersecting ridgeline part between the fourth side surface 4d and the second side surface 4b in which the third abutting part 4D is formed is chamfered in the shape of a convex cylindrical surface with a radius approximately equal to a concave cylindrical surface as the fifth wall part 3e of the housing recess 3, and as shown in FIG. 2, is made to abut against the fifth wall part 3e in a state where the bit head 4 is retracted. Additionally, a stage at a foremost end of the fourth side surface 4d slightly tilts toward the posterior end side so as to become closer to the inner peripheral side in a stage where the bit head 4 is extended.

[0039] Moreover, at a middle stage located between the stage at the foremost end and a stage at a most posterior end in which the third abutting part 4D is formed, the fourth side surface 4d is formed so as to extend in parallel with the axis O. Furthermore, an engaging part 4E is formed at a corner part where that the fourth side surface 4d the second side surface 4b intersect with each other in this middle stage, such that the engaging part 4E cuts out the corner part in a substantial L-shape in a section orthogonal to the centerline C.

[0040] The engaging part 4E has a first wall surface 4e facing the outer peripheral side and a second wall surface 4f facing the tool rotation direction T, in a state where the bit head 4 is extended, a bottom surface 4g that is made to be flush with a surface of the third abutting part 4D which faces the tip side, and a ceiling surface 4h that faces the bottom surface 4g in parallel therewith and faces the posterior end side.

[0041] Similarly, in a state where the bit head 4 is extended, the first wall surface 4e is located on a cylindrical surface that has a slightly greater external diameter than the second abutting part 2B of the pilot bit 2 and is centered on the axis O, and the second wall surface 4f is formed such that the second wall surface 4f extends toward the outer peripheral side so as to slightly tilt to the tool rotation direction T.

[0042] Moreover, an intersecting ridgeline part between a stage at a foremost end of the fourth side surface 4d and a tip surface of the head main body 4B is formed as an inclined surface that extends toward the centerline C so as to become closer the tip side in such a manner the surface forms a truncated conical surface shape centered on the axis O in a state where the bit head 4 is extended. Additionally, an intersecting ridgeline part between the tip surface and the outer peripheral surface in the pilot bit 2 is also formed as an inclined surface that similarly forms a truncated conical surface shape centered on the axis O and tilts toward the inner peripheral side so as to become closer the tip side, except for the portion cutout by the housing recess 3.

[0043] Furthermore, the tip surface of the pilot bit 2 and the tip surface of the head main body 4B of the bit head 4 except the portions made to have these inclined surfaces are respectively flat surfaces perpendicular to the axis O and the centerline C.

[0044] Additionally, the length of the head main body 4B in the direction of the centerline C is equal to the depth from the bottom surface 3A of the housing recess 3 to the tip surface of the pilot bit 2. Therefore, the tip surfaces of the pilot bit 2 and the head main body 4B become flush with each other in a state where the bit head 4 is housed in the housing recess 3.

[0045] The tip surfaces and the respective inclined surfaces of the pilot bit 2 and the head main body 4B of the bit head 4 are provided with a plurality (large number) of drilling tips 6 made of cemented carbide or the like which is harder than a steel material or the like that forms the pilot bit 2 and the bit head 4. Each of the drilling tips 6 is one in which, for example, hemispherical head part protruding from the tip surfaces and the inclined surfaces

and columnar trunk part which are integrally formed, and is fixed by press-fitting, hot-shrink fitting, cold-shrink fitting, or brazing the trunk parts into each of circular holes formed perpendicularly to the tip surfaces and the inclined surfaces.

[0046] Moreover, an annular ring bit 7 is disposed coaxially with the axis O on the tip side of the casing pipe 1. The ring bit 7 is also formed in an annular plate shape using metallic materials, such as a steel material, and a tip surface and a posterior end surface thereof that face the direction of the axis O are perpendicular to the axis O. However, the intersecting ridgeline part between the tip surface and the outer peripheral surface is made to be a truncated cone-shaped inclined surface centered on the axis O. The drilling tips 6 made of hard materials, such as cemented carbide, are also provided on the inclined surface and the outer peripheral part of the tip surface so as to protrude perpendicularly thereto, similar to the pilot bit 2 and the bit head 4.

[0047] Additionally, the external diameter of the ring bit 7 is greater than the external diameter of the casing pipe 1 and the casing top 1A and greater than the external diameter of the extended bit head 4. Further, the internal diameter of the ring bit 7 is slightly greater than the external diameter of the second abutting part 2B of the pilot bit 2 and therefore greater than the internal diameter of the smaller-diameter part 1 B formed within the casing pipe 1 by the casing top 1A. The internal diameter of the ring bit 7 is smaller than the external diameter of the extended bit head 4 and is of such a size that the first wall surface 4e of the engaging part 4E is fittable. Additionally, the thickness of the ring bit 7 in the direction of the axis O is smaller than the width between the external and internal diameters of the ring bit 7, and is slightly smaller than a gap between the bottom surface 4g and the ceiling surface 4h of the engaging part 4E.

[0048] Moreover, three recessed portions that are recessed to the outer peripheral side and are of the same number as that of the bit heads 4 are formed at equal intervals in the circumferential direction at the inner peripheral part of the ring bit 7, and as shown in FIG. 3, each of the recessed portions serves as a part 7A to be engaged that is engaged with the engaging part 4E of each bit head 4 in the tool rotation direction T during drilling.

[0049] The part 7A to be engaged includes a first wall surface 7a that recedes by one step from the inner peripheral part of the ring bit 7 to the outer peripheral side and then faces the inner peripheral side, a second wall surface 7b facing the side opposite to the tool rotation direction T and a third wall surface 7c facing the tool rotation direction T which extend from the first wall surface 7a to the inner peripheral part. In the present embodiment, the part 7A to be engaged is formed so as to pass through the ring bit 7 in the direction of the axis O.

[0050] The first wall surface 7a among these surfaces is located on the cylindrical surface centered on the axis O. The radius of the first wall surface 7a from the axis O is slightly greater than the radius of the stage at the foremost end and the middle stage from the axis O in the fourth side surface 4d of the extended bit head 4 which faces the outer peripheral side and is smaller than the radius R of the third abutting part 4D. Further, the circumferential length of the first wall surface 7a is slightly greater than a length except the engaging part 4E in the circumferential length of the middle stage of the fourth side surface 4d.

[0051] Additionally, the second and third wall surfaces 7b and 7c extend toward the outer peripheral side so as to tilt to the tool rotation direction T, and an angle that the second wall surface 7b out of these wall surfaces makes with respect to a radial direction with respect to the axis O is equal to an angle that the second wall surface 4f in the engaging part 4E of the extended bit head 4 makes with the radial direction with respect to the axis O. Further, as shown in FIG. 3, the third wall surface 7c is formed in a concave cylindrical surface shape centered on the centerline C of the fitting hole 3C in the housing recess 3 of the pilot bit 2, in a state where the part 7A to be engaged is engaged with the engaging part 4E.

[0052] In addition, in the pilot bit 2, a bottomed supply hole 8 is drilled from a posterior end of the shank part 2A along the axis O to the vicinity of a central part of the housing recess 3 in the direction of the axis O so as to be capable of supplying compressed air therethrough from the down-the-hole hammer H side. First to third blow holes 8A to 8C, which are three for each and have a smaller diameter than the supply hole 8, branch obliquely from the supply hole 8 and extend toward the outer peripheral side so as to tilt to the tip side.

[0053] Each first blow hole 8A is open to the tip side of the second abutting part 2B in the outer peripheral surface of the tip part of the pilot bit 2. A fourth blow hole 8D with a much smaller diameter branches from each first blow hole 8A in parallel with the axis O and is open to the center of the bottom surface of the fitting hole 3C. Further, each second blow hole 8B branches from the supply hole 8 at a position closer to the tip side than each first blow hole 8A, and is open substantially perpendicularly to the inclined surface 2D between the bottom surface of each discharge groove 2C for cuttings and the bottom surface 3A of each housing recess 3. Moreover, each third blow hole 8C has a greater diameter than the first and second blow holes 8A and 8B, branches at the tip of the supply hole 8, and is open to the fifth wall part 3e side of the first wall part 3a of the housing recess 3.

[0054] In this drilling tool, the pilot bit 2 is inserted from the posterior end side of the casing pipe 1 in a state where the bit head 4 is retracted and the head main body 4B is housed in the housing recess 3, and is positioned in the direction of the axis O in a place where the second abutting part 2B abuts against the posterior end surface of the casing top 1A. Next, with the head main body 4B being housed, as shown in FIG. 2, a circumferential position of the part 7A to be engaged is aligned with the housing recess 3, and the ring bit 7 is inserted into the

tip part of the pilot bit 2 from the tip side and is disposed at the position of the engaging part 4E of the head main body 4B in the direction of the axis O.

[0055] When, from this state, the ring bit 7 is relatively rotated to the side opposite to the tool rotation direction T during drilling while the bit head 4 is being extended, as shown in FIG. 3, the second wall surface 4f in the engaging part 4E of the extended bit head 4 comes in close contact with and abuts against the second wall surface 7b in the part 7A to engaged of the ring bit 7 and thereby is engaged with the part 7A to be engaged, and the third side surface 4c in the head main body 4B abuts against the second wall part 3b of the housing recess 3 and is supported by the housing recess 3. Thereby, the ring bit 7 becomes integrally rotatable with respect to the pilot bit 2 and the bit head 4 in the tool rotation direction T.

[0056] Additionally, in the direction of the axis O, as shown in FIGS. 1 and 3, when the portion of the part 7A to be engaged on the tool rotation direction T side in the tip surface of the ring bit 7 faces the ceiling surface 4h of the engaging part 4E with a slight gap therefrom and is abuttable against the ceiling surface 4h, the ring bit 7 is prevented from coming off to the tip side. That is, in the present embodiment, the portion of the part 7A to be engaged on the tool rotation direction T side in the tip surface of the ring bit 7 serves as a first abutting part 7B that is abuttable against the extended bit head 4, on the tip side in the direction of the axis O. Moreover, the bottom surface 4g of the engaging part 4E and the surface of the third abutting part 4D flush with the bottom surface 4g which faces the tip side abut against the posterior end surface of the ring bit 7, and support the ring bit 7 on the tip side thereof. Thereby, the casing pipe 1 and the ring bit 7 are made to be movable to the tip side in the direction of the axis O integrally with the pilot bit 2 and the bit head 4.

[0057] Therefore, when, from this state, the striking force directed to the tip side in the direction of the axis O is transmitted to the pilot bit 2 and the bit head 4 and to the ring bit 7 via the third abutting part 4D by the down-the-hole hammer H and the impelling force, and the rotating force directed in the tool rotation direction T are transmitted from the drilling device, drilling work is performed by the drilling tips 6 provided on the pilot bit 2, the bit head 4, and the tip surface of the ring bit 7, and the casing pipe 1 is inserted into the formed borehole. In addition, compressed air is blown off from the supply hole 8 via the first to fourth blow holes 8A to 8D during drilling. Thereby, cuttings generated by the drilling tip 6 are discharged through the inside of the casing pipe 1 from the discharge groove 2C, and biting of the cuttings into the fitting hole 3C or the smaller-diameter part 1B is prevented.

[0058] After the borehole is formed up to a predetermined depth in this way, in the drilling tool of the above configuration, the pilot bit 2 is rotated to the side opposite to the tool rotation direction T during drilling by the drilling device. Then, the head main body 4B of the bit head 4 is guided by friction with the borehole and by the third wall surface 7c of the part 7A to be engaged, and thereby the bit head 4 is retracted as shown in FIG. 2. Thus, the pilot bit 2 and the bit heads 4 can be recovered with the ring bit 7 being left in the borehole by pulling out the pilot bit 2 together with the down-the-hole hammer H as it is from the casing pipe 1.

[0059] In this way, according to the drilling tool of the above configuration, the rotating force in the tool rotation direction T is transmitted from the head main body 4B of the extended bit head 4 to the part 7A to be engaged of the ring bit 7. Thus, the rotating force can be efficiently transmitted at a position farther from the axis O which becomes the rotation center of the pilot bit 2 and the bit head 4. Accordingly, even in a case where a borehole with a greater internal diameter than the external diameter of the casing pipe 1 is formed, sufficient rotating force can be transmitted to the ring bit 7, and drilling performance can be guaranteed.

[0060] Moreover, in the present embodiment, the pilot bit 2 and the bit head 4 protrude by one step to the tip side of the ring bit 7 as shown in FIG. 1. Therefore, the drilling tips 6 on the ring bit 7 drill an outer peripheral part of the borehole of which an inner peripheral part is drilled by the drilling tips 6 on the pilot bit 2 and the bit head 4, and becomes apt to be crushed. For this reason, the load to the ring bit 7 can be reduced, and more efficient drilling can be performed. Here the tip surfaces of the pilot bit 2 and the bit head 4 may be made to be flush with the tip surface of a ring bit 7, and the tip surface of the ring bit 7 may protrude from the tip surfaces of the pilot bit 2 and the bit head 4.

[0061] Additionally, since the outer peripheral side of the borehole is drilled by the ring bit 7, in the pilot bit 2 and the bit head 4, it is not necessary to make the radius of the extended head main body 4B from the axis O as large as the internal diameter of the borehole. For this reason, a burden to the shaft part 4A of the bit head 4 or the like can be reduced, and damage can be prevented. Moreover, since the ring bit 7 forms an annular shape, the number and positions of the drilling tips 6 can be relatively freely set, for example, like the drilling tips 6 being disposed in ranges other than a range in the circumferential direction where the extended bit head 4 as shown in FIG. 3 is located. Therefore, degradation of the drilling performance resulting from partial insufficiency of the drilling tips 6 can also be prevented.

[0062] In the ring bit 7, the part 7A to be engaged is engaged with the extended bit head 4 as described above, while the ring bit 7 is supported by the bit head 4 so as to be rotatable integrally therewith in the tool rotation direction T and the rotating force is transmitted to the ring bit 7. Thus, it becomes unnecessary to support the ring bit 7 with the casing pipe 1, and the internal diameter of the ring bit 7 can be increased. For this reason, required materials such as a steel material can be reduced by making the volume of the ring bit 7 small, and even in a case where the ring bit 7 is left in a borehole

after the end of drilling, an increase in construction cost can be suppressed.

[0063] Additionally, as described above, the inner peripheral part of the borehole is drilled by the drilling tips 6 on the pilot bit 2 and the bit head 4. Thus, in the present embodiment, it is not necessary to provide the ring bit 7 with the drilling tip 6, as shown in FIGS. 1 and 3, in a range where the drilling tips are provided on the tip surface of the head main body 4B of the extended bit head 4 in the radial direction from the axis O. For this reason, it is possible to avoid providing more drilling tips 6 made of expensive cemented carbide than needed in the ring bit 7 left in the borehole, and cost reduction can be achieved.

[0064] Moreover, in the present embodiment, a recessed portion that is recessed toward the outer peripheral side is formed in the inner peripheral part of the ring bit 7, and serves as the part 7A to be engaged. In this regard, for example, it is also possible to form a protrusion on the tip surface of the ring bit 7 as a part to be engaged to engage the head main body 4B of the extended bit head 4 with this protrusion in the tool rotation direction T. However, in that case, there is a concern that the load resulting from the rotating force may be concentrated on the protrusion to cause damage, and the volume of the ring bit 7 may also become as great as the protrusion and material cost may increase. In contrast, in the present embodiment, it is possible to receive the rotating force with a main body itself of the annular ring bit 7, and the volume and cost of the ring bit 7 can be further reduced.

[0065] In addition, in the present embodiment, the portion adjacent to the part 7A to be engaged at the tool rotation direction T side thereof which is formed as the recessed portion recessed from the inner peripheral part toward the outer peripheral side in this way in the tip surface of the ring bit 7 faces the ceiling surface 4h of the engaging part 4E, and serves as the first abutting part 7B abuttable against the ceiling surface 4h of the engaging part 4E on the tip side in the direction of the axis O. For example, even if the ring bit 7 collides against the ceiling surface 4h with the striking force transmitted via the bit head 4 from the pilot bit 2, a shock can be received over the overall thickness of the ring bit 7, and occurrence of damage or the like can be prevented. However, the bottom surface that faces the tip side may be formed in this recessed portion so as to face the ceiling surface 4h, and may be used as the first abutting part 7B.

[0066] Also in the present embodiment, in inserting the casing pipe 1 into a borehole with the striking force and the impelling force to the tip side to be applied to the pilot bit 2, similar to the drilling tools described in PTLs 1 and 2, the casing top 1A is attached to the tip part of the casing pipe 1 to form the smaller-diameter part 1 B, and the second abutting part 2B of the pilot bit 2 is made to abut against the smaller-diameter part 1B so as to transmit the striking force and the impelling force. However, in the present embodiment, the internal diameter of the ring bit 7 is increased with respect to the internal diameter of this smaller-diameter part 1B. Thus, as described above, construction cost can be reliably reduced compared to the drilling tool described in PTL 1 in which the internal diameter of the ring bit has to be made smaller. In addition, the internal diameter of the ring bit 7 may be equal to the smaller-diameter part 1B.

[0067] Furthermore, in the present embodiment, the striking force and the impelling force are transmitted by providing the casing pipe 1 with the smaller-diameter part 1 B in this way. In contrast, in transmitting the striking force and the impelling force from the pilot bit 2 to the ring bit 7, the striking force and the impelling force are not directly transmitted from the pilot bit 2 unlike the drilling tool described in PTL 1, but the bit head 4 is provided with the third abutting part 4D that is abuttable against the posterior end surface of the ring bit 7 in an extended state so as to transmit the striking force and the impelling force from the third abutting part 4D. For this reason, in a case where the smaller-diameter part 1B is provided as described above, it is unnecessary to make the internal diameter of the ring bit 7 still smaller, and it is possible to reduce construction cost even more reliably.

[0068] Moreover, in the present embodiment, in a case where the striking force and the impelling force are transmitted from the third abutting part 4D provided in the bit head 4 in this way to the ring bit 7, the greatest radius R of the third abutting part 4D of the extended bit head 4 from the axis O is greater than the radius r of the outer peripheral part of the tip of the casing pipe 1 from the axis O, that is, the radius of the casing top 1A. For this reason, the striking force and the impelling force can be more reliably transmitted to the ring bit 7 on the outer peripheral side where drilling is performed, and even in a case where a borehole with a greater internal diameter than the external diameter of the casing pipe 1 as in the present embodiment is formed, it is possible to perform drilling much more efficiently.

[0069] Then, in a case where the striking force and impelling force are transmitted from the third abutting part 4D that is enlarged and has the larger radius R than the radius r of the outer peripheral part of the tip of the casing pipe 1 to the ring bit 7 in this way, it is possible to reliably form a borehole with a large internal diameter without impairing the strength or rigidity of the ring bit 7 even if the thickness of the ring bit 7 in the direction of the axis O is smaller than the width between the external and internal diameters of the ring bit 7 like, for example, the present embodiment. Therefore, according to the present embodiment, the volume of the ring bit 7 can be further reduced, and a much greater reduction of construction cost can be achieved.

INDUSTRIAL APPLICABILITY

[0070] As described above, according to the drilling tool of the present invention, even in a case where a borehole with a greater internal diameter than the external diameter of the casing pipe is formed, it is possible

to transmit sufficient rotating force, striking force, and impelling force to the ring bit and to perform efficient drilling, without causing degradation of drilling performance, an increase in construction cost, or damage to the tool. Therefore, the present invention can be industrially applied.

REFERENCE SIGNS LIST

[0071]

1: CASING PIPE
1A: CASING TOP
1B: SMALLER-DIAMETER PART
2: PILOT BIT
2B: SECOND ABUTTING PART
2C: DISCHARGE GROOVE
3: HOUSING RECESS
3C: FITTING HOLE
4: BIT HEAD
4A: SHAFT PART
4B: HEAD MAIN BODY
4D: THIRD ABUTTING PART
4E: ENGAGING PART
5: PIN
6: DRILLING TIP
7: RING BIT
7A: PART TO BE ENGAGED
7B: FIRST ABUTTING PART
8: SUPPLY HOLE
O: AXIS OF CASING PIPE 1
T: TOOL ROTATION DIRECTION DURING DRILLING
C: CENTERLINE OF FITTING HOLE 3C
H: DOWN-THE-HOLE HAMMER
R: GREATEST RADIUS OF THIRD ABUTTING PART 4D OF EXTENDED BIT HEAD 4 FROM AXIS O
r: RADIUS OF OUTER PERIPHERAL PART OF TIP OF CASING PIPE 1 FROM AXIS O

Claims

1. A drilling tool, comprising:

a cylindrical casing pipe centered on an axis;
an annular ring bit that is coaxially disposed on a tip side of the casing pipe and has a greater external diameter than the casing pipe; and
a pilot bit that is inserted into an inner peripheral part of the ring bit through an inside of the casing pipe,
wherein the pilot bit is rotatable around the axis and a bit head is provided at an outer peripheral part of a tip of the pilot bit,
wherein the bit head is rotatable around a centerline eccentric from the axis, and is configured that when the pilot bit is rotated in a tool rotation direction during drilling, the bit head is extended such that a radius of the bit head from the axis is enlarged and thereby is supported by the pilot bit, and
wherein the ring bit is provided with: a part to be engaged that is configured to be engaged with the extended bit head in the tool rotation direction during drilling; and a first abutting part capable of abutting against the tip side of the extended bit head in a direction of the axis.

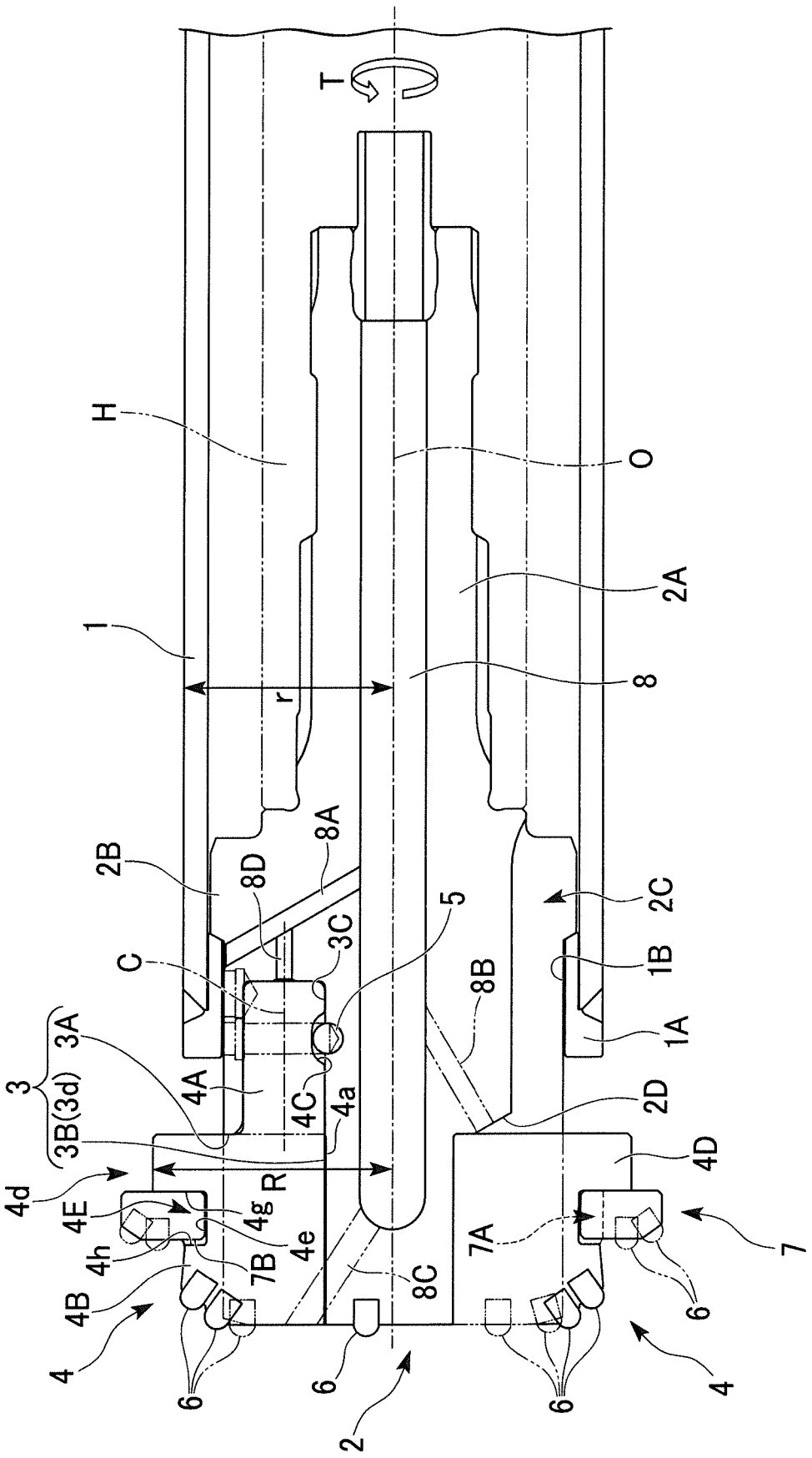
2. The drilling tool according to Claim 1,
wherein a recessed portion that is recessed to an outer peripheral side is formed at the inner peripheral part of the ring bit, and the recessed portion serves as the part to be engaged.

3. The drilling tool according to Claim 1 or 2,
wherein a smaller-diameter part of which an internal diameter is one step smaller is formed at an inner peripheral part of a tip of the casing pipe; a second abutting part capable of abutting against the smaller-diameter part from a posterior end side in the direction of the axis is formed at an outer peripheral part of a posterior end of the pilot bit; and an internal diameter of the ring bit is equal to or greater than the internal diameter of the smaller-diameter part.

4. The drilling tool according to any one of Claims 1 to 3,
wherein the bit head is provided with a third abutting part which is capable of abutting against a surface of the ring bit that faces a posterior end side in the direction of the axis in a state where the bit head is extended.

5. The drilling tool according to Claim 4,
wherein the greatest radius of the third abutting part of the extended bit head from the axis is greater than a radius of an outer peripheral part of the tip of the casing pipe from the axis.

FIG. 1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H
O
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2A
r
8
2B
8D
8A
2C
C
3C
5
1B
8B
3
3A
3B(3d)
4A
4C
4a
1A
2D
4d
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4D
4g
4h
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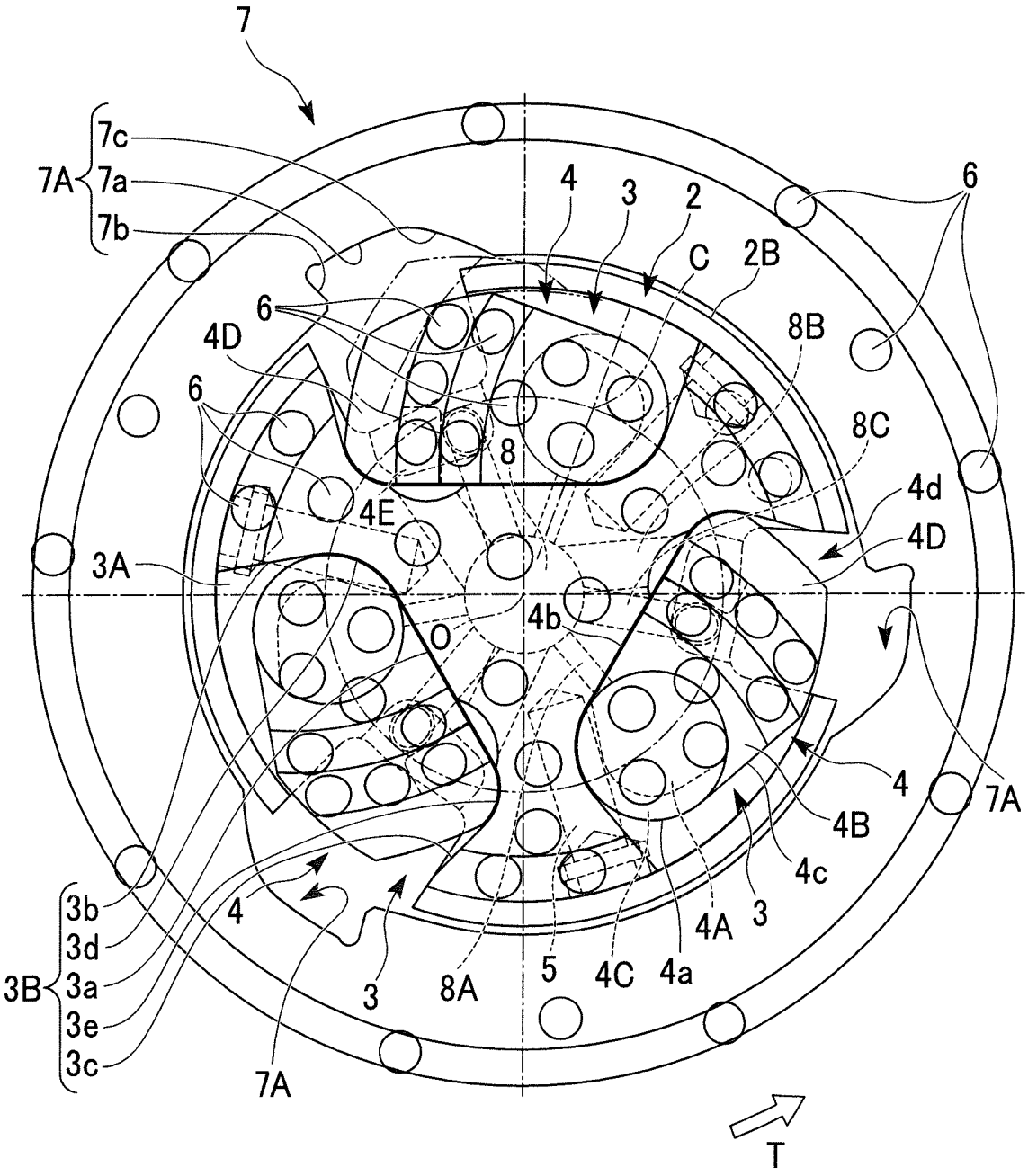
6
4
2

FIG. 2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4b
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7A
4B
4c
3
4A
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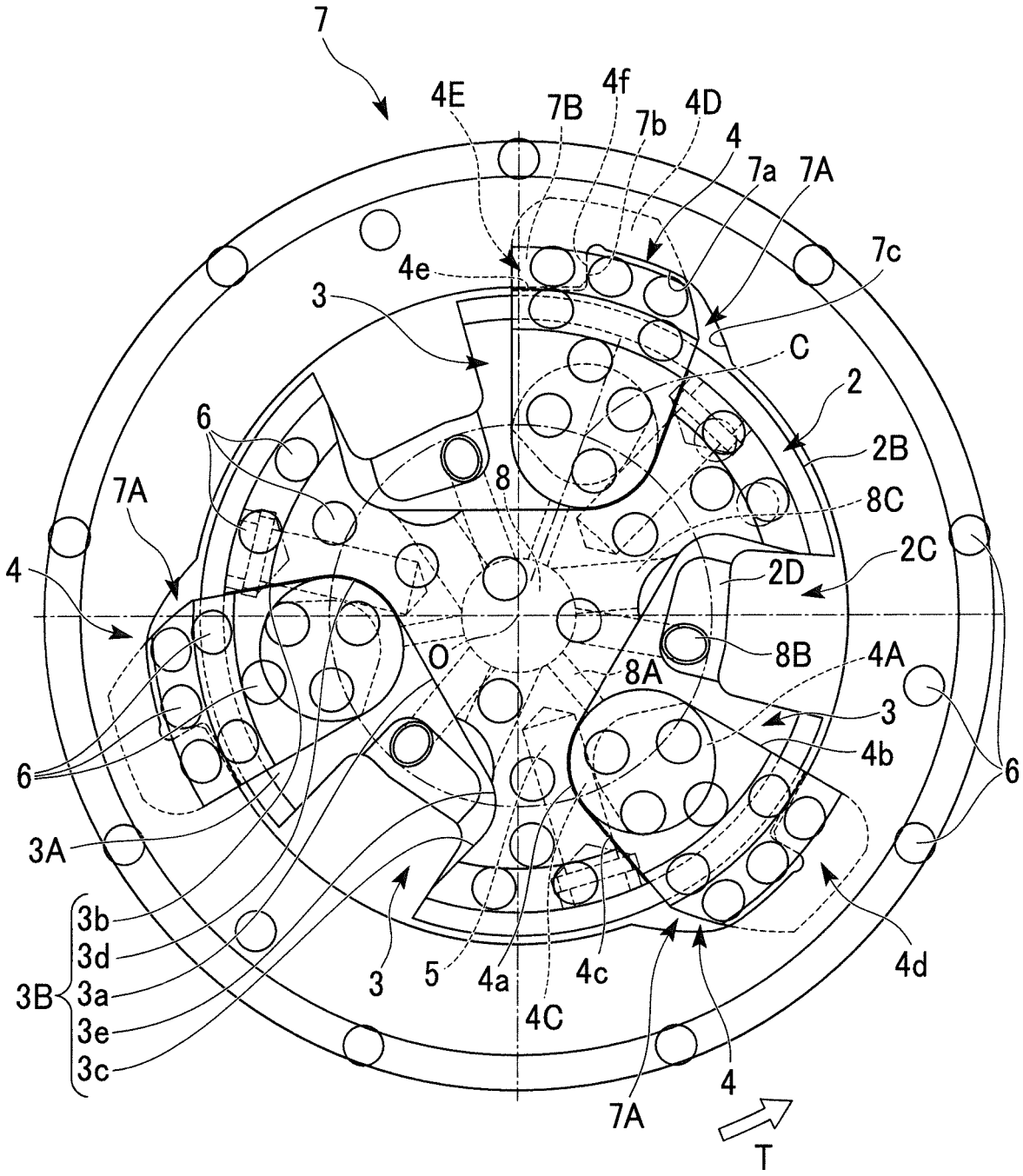
FIG. 3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4D
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7c
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FIG. 4

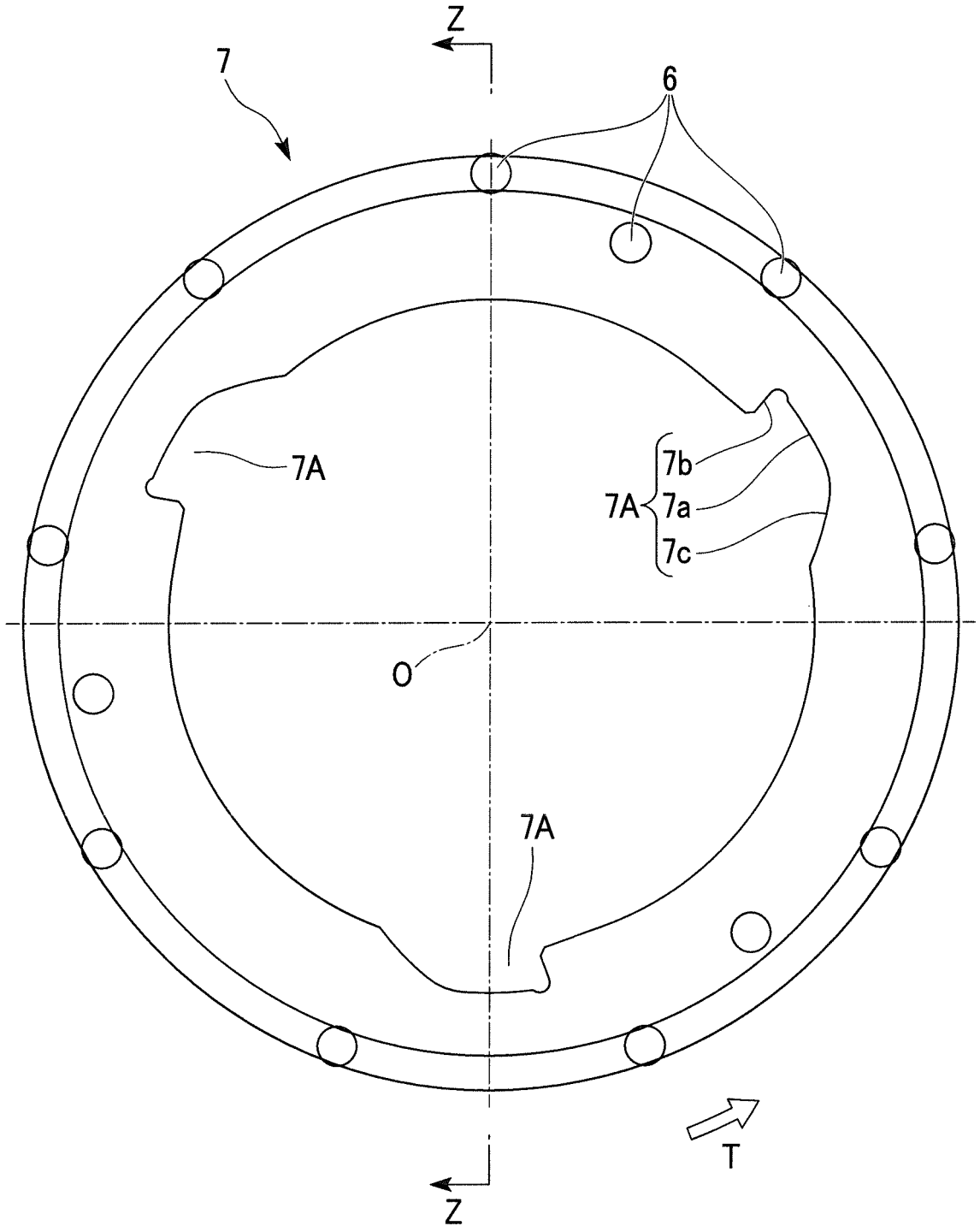
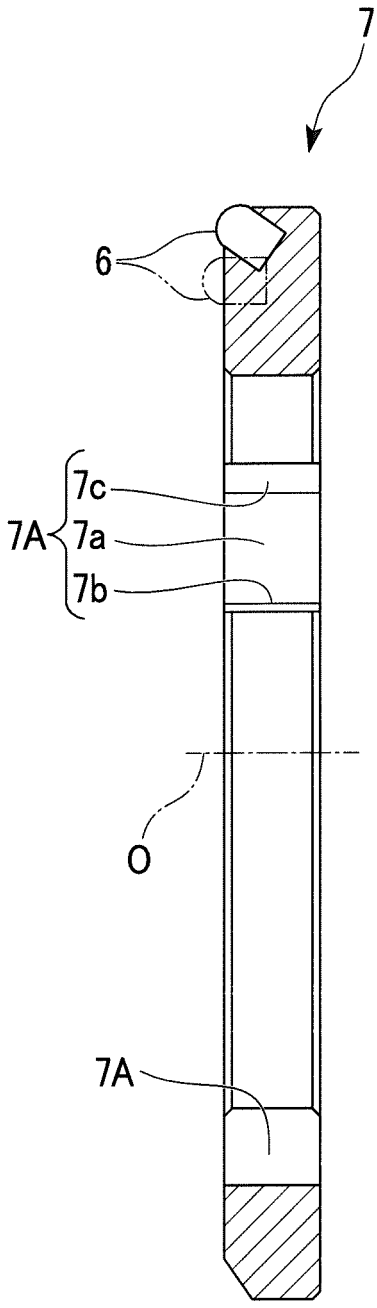


FIG. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/072799

A. CLASSIFICATION OF SUBJECT MATTER
E21B10/32(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E21B10/32

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2015
Kokai Jitsuyo Shinan Koho 1971-2015 Toroku Jitsuyo Shinan Koho 1994-2015

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2013-122112 A (Mitsubishi Materials Corp.), 20 June 2013 (20.06.2013), paragraphs [0018] to [0024]; fig. 1, 11 & EP 2789789 A1 paragraphs [0020] to [0026]; fig. 1, 11 & WO 2013/084994 A1 & AU 2012349363 A & CN 103958815 A & KR 10-2014-0096336 A & HK 1198196 A	1-5
A	JP 2008-038444 A (Mitsubishi Materials Corp.), 21 February 2008 (21.02.2008), paragraphs [0015] to [0048]; fig. 1 to 5 (Family: none)	1-5

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 October 2015 (21.10.15)	02 November 2015 (02.11.15)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2015/072799

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2001-146886 A (Mitsubishi Materials Corp.), 29 May 2001 (29.05.2001), paragraphs [0009] to [0027]; fig. 1 to 5 (Family: none)	1-5

Form PCT/ISA/210 (continuation of second sheet) (July 2009)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2014167602 A **[0002]**
- JP 4887857 B **[0005]**
- JP 4501407 B **[0005]**