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(71) Applicant: **Sandvik Mining and Construction Tools AB**
81181 Sandviken (SE)

(72) Inventor: **GHOLIOF, Hamidreza**
811 36 Sandviken (SE)

(74) Representative: **Sandvik**
Sandvik Mining and Construction Oy PL 100
Patent Department
33311 Tampere (FI)

(54) PERCUSSION DRILL BIT WITH WEAR INSERTS

(57) A percussion drill bit (1) with radial support means for guiding of the drill bit (1) within a bore of a formation. The drill bit (1) comprises a head (2) and a shaft (3) extending from the head (2) rearwards along a longitudinal axis (4) of the drill bit (1), wherein the head (2) is provided with drilling inserts (5), wherein the head (2) is shaped and sized to define a drilling diameter with a first radial distance (6) to the longitudinal axis (4) of the drill bit (1), wherein the shaft (3) is provided with a plurality of radially extending wear inserts (7) distributed around the circumference of the shaft (3), wherein the wear inserts (7) protrude equally far from the longitudinal axis (4) of the drill bit (1), and the second radial distance (8) is within the range of 93-97% of the first radial distance (6).

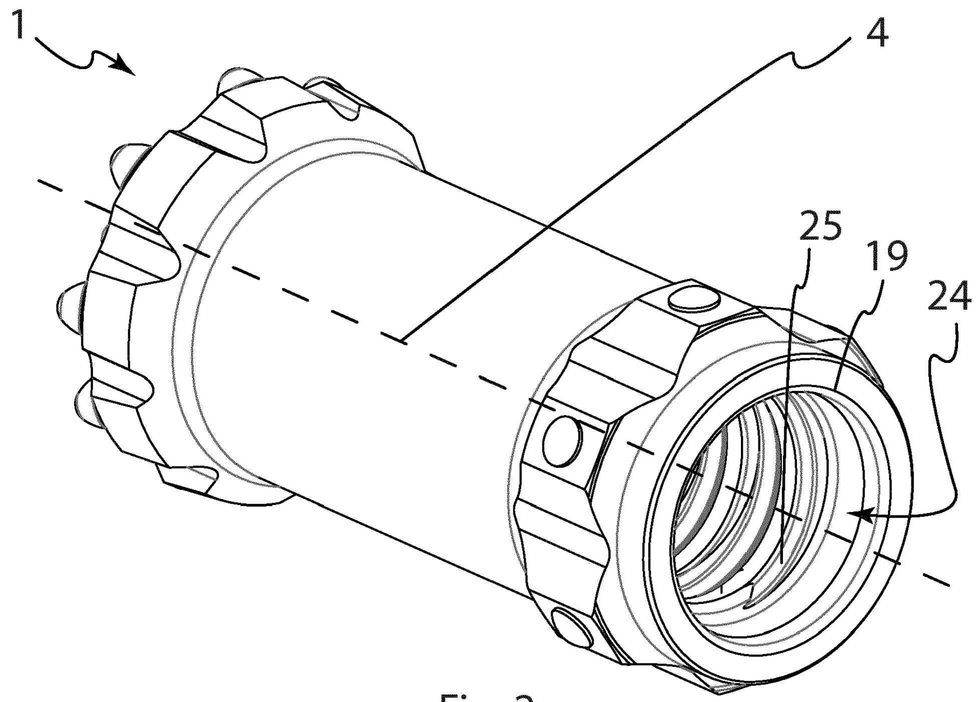

Fig. 2

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Description

Technical field

[0001] The present invention relates to a percussion rock drill bit and in particular, although not exclusively, to a drill bit with improved guide means for guiding the drill bit in a bore.

Background

[0002] Percussion drill bits are widely used both for drilling relatively shallow bores in hard rock and for creating deep boreholes. For the latter application, drill strings are typically used in which one or more rods are added to the string via male/female threads or coupling sleeves as the depth of the hole increases. A terrestrial machine is operative to transfer a combined impact and rotary drive motion to an upper end of the drill string whilst a drill bit positioned at the lower end is operative to crush the rock and form the boreholes. Fluid, such as air, is typically flushed through the drill string and exits at the base of the borehole via apertures in the drill head to flush the drill cuttings from the boring region to be conveyed backward and up through the bore around the outside of the drill string.

[0003] The drill bit typically comprises a drill head that mounts a plurality of hard drilling inserts, commonly referred to as cutting inserts or buttons. Such buttons comprise a carbide-based material to enhance the lifetime of the drill bit. The gauge buttons are configured to engage material to be crushed and to determine the diameter of the bore. The head may also mount a plurality of front buttons provided at a recessed front face of the drill head for engaging material to be crushed at the axial region immediately in front the drill head.

[0004] Typically, a plurality of flushing channels or grooves are recessed into the head to allow the flushing of fractured material rearwardly from the drill bit via the flushing fluid. However, some rocks are very fractured and this leads to large size cuttings which are too heavy to be flushed to the surface. Further, some conventional drill heads are disadvantageous in that large pieces of material cut from the seam cannot pass through the flushing grooves without being further crushed by the bit head. This reduces the effectiveness of the cutting bit to fracture and further penetrate the rock or seam face. It also leads to excessive wear at the rear end of the drill bit.

[0005] WO 2015/175285 A1 discloses a drill bit comprising a shaft provided with wear inserts.

[0006] Also, one often wants to quickly drill a straight hole. However, drill bits and associated equipment may suffer from not being able to drill straight enough and quick enough.

[0007] What is therefore required is improved drilling equipment configured to promote increased penetration rate, improved straightness and increased robustness of the drill bit.

Summary

[0008] Accordingly, an object of the present disclosure is to provide technology allowing for increased cutting action at rock drilling. A further object is to provide technology for promoting drilling of straight bores. These and other objects achieved by a percussion drill bit as defined in the appended independent claim with alternative embodiments set forth in the appended dependent claims. Specifically, these objects are achieved by a percussion drill bit comprising a head and a shaft extending from the head rearwards along a longitudinal axis of the drill bit. The head is provided with drilling inserts and shaped and sized to define a drilling diameter with a first radial distance to the longitudinal axis of the drill bit. Further, the shaft is provided with a plurality of radially extending wear inserts distributed around the circumference of the shaft, wherein each wear insert protrudes a second radial distance from the longitudinal axis of the drill bit. Thereby, the wear inserts jointly provide radial support at a second radial distance from the longitudinal axis. The second radial distance is within the range of 93-97% of the first radial distance.

[0009] At drilling, the wear inserts face the walls of the bore drilled, thereby preventing excessive radial displacement of the shaft away from the center of the bore. By configuring the wear inserts such that the second radial distance is within the range of 93-97% of the first radial distance, an improved balance between radial support performance, cooling performance and flushing performance is achieved. The space around the wear inserts prevents continuous contact between bore and drill bit such that wear on the drill bit and its wear inserts is reduced. Also, the space around the wear inserts is suitable for crushing drill cuttings between the wear bits and the surrounding bore, which leads to improved transport of drill cuttings away from the drill bit. Further, the use of wear inserts enables increase of the size of space between the wear inserts for the drill cuttings to move through, since the wear inserts are made of a hard material which provides the required resistance to wear in a small footprint. This leads to reduced risk of drill cutting getting stuck or moving slowly through the available space and thereby increases the rate at which drill cuttings are transported away from the drill bit, which in turn enables increased penetration rate. The wear inserts prevent the surrounding material from getting worn. Furthermore, if bending of the drill bit happens, the wear insert will touch the wall of the bore and will improve the straightness of the bore.

[0010] The wear inserts may be attached to the shaft by means of attachment protrusions extending radially from the shaft, wherein each attachment protrusion comprises an attachment recess for receiving a respective attachment portion of a wear insert. The attachment protrusions are distributed around the circumference of the shaft and are separated by flushing recesses for flushing of drill cuttings past the attachment protrusions. The attachment recess of each attachment protrusion provides an increased gripping area for holding each wear insert since each gripping area is permitted to extend further radially outwards rather than along the length or along the circumference of the shaft. Decreasing the footprint along the length of the shaft and/or along the circumference of the shaft enables increased flow of flushing fluid. Also, the provision of an attachment protrusion enables reduction of the main diameter or cross-sectional area of the shaft, i.e. of the shaft portion connecting the rear portion of the shaft with the head of the shaft, since the attachment protrusion provides the required gripping area for securely holding the wear insert.

[0011] Each attachment protrusion may comprise a plurality of wear inserts distributed along the length of the drill bit. By longitudinally distributing a plurality of wear inserts along each attachment protrusion rather than using only one wear insert per attachment protrusion, the wear inserts provide radial support at multiple depths of the bore such that the attachment protrusion can still radially support the drill bit despite recesses or cracks in the formation leaving some of the wear inserts without radial support/pressure from the bore formation. When longitudinally distributed but not circumferentially distributed, the wear inserts are effectively arranged in a straight line parallel to the longitudinal axis of the drill bit.

[0012] The plurality of attachment recesses of each attachment protrusion may also be circumferentially distributed with respect to the drill bit. By circumferentially distributing the wear inserts, they act over a widespread circumferential area or circle sector of the shaft to thereby enable support in several radial directions about the longitudinal axis of the drill bit, which in turn enables use of fewer attachment protrusions. When being both longitudinally and circumferentially distributed, the wear inserts are effectively diagonally arranged with respect to the longitudinal axis of the drill bit.

[0013] Each attachment protrusion may comprise a top surface in which the attachment recess is formed, and a curved or slanted front surface extending in front of each attachment protrusion from the top surface to surrounding surfaces of the shaft. The front surfaces provide a smooth transition in front of each attachment protrusion, between the top surface of each attachment protrusion and surrounding surfaces of the shaft. The smooth transition mitigates excessive turbulence of flushing fluid passing the attachment protrusion, and thereby improves overall flow and mitigates low-flow regions in which drill cuttings could deposit.

[0014] Each attachment protrusion may also comprise a first and a second curved or slanted side-surface, each side surface respectively extending from a respective opposite side of the top surface in opposite directions along the circumference of the shaft, to surrounding surfaces of the shaft. The side-surfaces provide a smooth sideways transition along the circumference of each attachment protrusion, between the top surface of each attachment protrusion and surrounding surfaces of the shaft. The smooth transition mitigates excessive turbulence of flushing fluid passing the attachment protrusion, and thereby mitigates low-flow regions in which drill cuttings could deposit. However, the drill bit may be provided with the curved or slanted first and second side surfaces even if the drill bit would not be provided with a slanted or curved front surface.

[0015] The wear inserts may be provided at a rear portion of the shaft. A specific amount of radial movement permitted for the wear inserts within the bore gives rise to a lower angular displacement of the drill bit when the wear inserts are provided at a rear portion of the shaft than what would have been the case if the same amount of radial movement would occur closer to the head of the drill bit, thereby increasing the directional stability of the drill bit within the bore.

[0016] The drill bit may comprise at least three of said wear inserts distributed around the circumference of the shaft. The provision of three wear inserts enables support by the wear inserts in all directions about the longitudinal axis of the drill bit.

[0017] The wear inserts may be evenly distributed around the circumference of the shaft. Such positioning of the wear insert provides for an even flow of flushing fluid. Also, such positioning mitigates vibrations since the same amount of support is provided in all directions.

[0018] The shaft may comprise a waist with a diameter smaller than the diameter defined by the second radial distance to the longitudinal axis, wherein the drill bit is provided with an inner channel extending through the shaft between an inlet opening at the rear portion of the drill bit, and one or more outlet openings at a front portion of the of the head, and wherein the head is provided with flushing passages fluidly connecting the front of the drill bit to a space around the shaft. At drilling, fluid may thus be flushed through a drill string or rod to which the drill bit is attached, into the inner channel and out through the head of the drill bit. From there, fluid flows through the flushing passages and further into the space around the shaft. From there, the fluid flows through the channels between the wear inserts and further out through the bore. The fluid thus flushes drill cuttings away from the drill bit and out of the bore. At the same time, the fluid acts to cool the bore and the drill bit. The waist portion with its smaller diameter promotes improved flushing.

[0019] The wear inserts may comprise tungsten carbide. Tungsten carbide is a material suitable for the intended use since it is very hard and resists wear better than steel.

[0020] Each wear insert may be provided with a respective rounded or semi-spherical outer tip. The rounded shape of the outer tip makes the wear insert robust by avoiding sharp edges prone to chipping. Also, the rounded shape provides a slanted surface for oncoming drill cuttings to glide along for being crushed between the wear insert and the surrounding bore formation. Further, the rounded or semi-spherical shape provides an increase in the height of the insert, and only a small area will be in contact with the rock, thereby increasing local stress achieved on the oncoming drill cuttings by each wear insert such that the wear inserts easier breaks drill cuttings. Also, the reduced contact surface results in less heat being produced.

[0021] Each wear insert may comprise a cylindrical attachment portion. The cylindrical attachment portion is advantageous since it enables firm grip of the wear insert by enabling distribution of forces applied to the wear insert in any radial direction of the cylindrical attachment portion, which in turn enables use of smaller wear inserts, which in turn enables improved flushing past the wear inserts.

Brief description of drawings

[0022]

Figs. 1-7 all relate to a drill bit according to a first embodiment.
Fig. 1 shows an elevated front perspective view of the drill bit.
Fig. 2 shows an elevated rear perspective view of the drill bit.
Fig. 3 shows a side view of the drill bit.
Fig. 4 shows a rear view of the drill bit.
Fig. 5 shows detail view A as defined in Fig. 4, which specifically marks the first and second radiuses.
Fig. 6 shows a side view of a wear insert used in the drill bit.
Fig. 7 shows an elevated side perspective view of the wear insert also shown in Fig. 6.

1	percussion drill bit	14	front surface
2	head	15	first side surface
3	shaft	16	second side surface
4	longitudinal axis	17	rear portion of shaft
5	drilling inserts	18	waist
6	first radial distance	19	inlet opening
7	wear inserts	20	outlet opening(s)
8	second radial distance	21	flushing passages
9	attachment protrusion	22	space around shaft
10	attachment recess	23	outer tip of wear insert
11	attachment portion of wear insert	24	central elongate recess
12	flushing recesses	25	thread
13	top surface		

Detailed description

[0023] A percussion drill bit according to a first embodiment of the invention will hereinafter be described with reference to Figs. 1-7.

[0024] The percussion drill bit 1 comprises a head 2 and a shaft 3 extending from the head 2 rearwards along a longitudinal axis 4 of the drill bit 1. An alternative word for the shaft is 'shank' and the wording 'shaft' is not to be construed as limited to cylindrical or axisymmetric shapes. The longitudinal axis 4 corresponds to the rotational axis of the drill bit 1. The head 2 and shaft 3 are made of steel but could in other embodiments alternatively be made of any other suitable material. Also, the head 2 and shaft 3 are made in one piece except for drilling inserts and wear inserts but could in other embodiments alternatively be made of multiple pieces joined temporarily or permanently to form the head 2 and shaft 3 of the drill bit 1. The head 2 is provided with drilling inserts 5 typically made from any suitable drilling insert material, such as tungsten carbide. The drilling inserts 5 are press-fitted within respective recesses (not illustrated) of the head 2. The head 2 is shaped and sized to define a drilling diameter with a first radial distance 6 to the longitudinal axis 4 of the drill bit 1. The shaft 3 is provided with a plurality of radially extending wear inserts 7 distributed around the circumference of the shaft 3. The wear inserts 7 protrude equally far from the longitudinal axis 4 of the drill bit 1. Thereby, the wear inserts jointly provide radial support at a second radial distance 8 from the longitudinal axis 4. The second radial distance 8 is within the range of 93-97% of the first radial distance 6.

[0025] The distance between the drilling inserts and the wear inserts is greater than 100 mm, preferably greater than 120 mm, and more preferably greater than 140 mm. However, in other embodiments, the distance between the drilling inserts and the wear inserts could alternatively be any other suitable distance, for example depending on the diameter of the bore to be drilled.

[0026] The wear inserts 7 are attached to the shaft 3 by means of attachment protrusions 9 extending radially from the shaft 3, wherein each attachment protrusion 9 comprises an attachment recess 10 for receiving a respective attachment portion 11 of a wear insert 7. There could be three, four, six or eight attachment protrusions 9, depending on the size of the drill bit. In other embodiments, the number of attachment protrusions may vary depending on the size of the bore to be drilled, so for larger sized drill bits the number of attachment protrusions may be ten or twelve. Each attachment protrusion may in other embodiments alternatively comprise more than one wear insert 7.

[0027] The attachment protrusions 9 are distributed around the circumference of the shaft 3, preferably with the same sizing of the attachment protrusions 9 and with the same spacing between the attachment protrusions 9. In other embodiments, the shape of the attachment protrusions 9 may vary.

[0028] The attachment protrusions 9 are separated by flushing recesses 12 which allow for efficient flushing of drill cuttings past the attachment protrusions 9.

[0029] As shown in fig. 3, each attachment protrusion 9 comprises a planar top surface 13 in which the attachment recess 10 is formed. A concavely curved front surface 14 extends in front of each attachment protrusion 9 from the top surface 13 to surrounding surfaces of the shaft 3. The front surfaces 14 provide a smooth transition in front of each attachment protrusion 9, between the top surface 13 of each attachment protrusion and surrounding surfaces of the shaft 3. The smooth transition mitigates excessive turbulence of flushing fluid, typically air, passing the attachment protrusion, and thereby mitigates low-flow regions in which drill cuttings could deposit. In this embodiment, the front surfaces are normally produced by turning, thereby generating double curved front surfaces 14. However, in other embodiments, the front surface may alternatively have other shapes, such as planar or single curved. The top surface 13 is planar but could in other embodiments alternatively have some other suitable shape such as single curved or double curved.

[0030] Each attachment protrusion 9 further comprises a first 15 and a second 16 slanted side-surface respectively extending from a respective opposite left and right side respectively of the top surface 13, in opposite directions along the circumference of the shaft 3, to surrounding surfaces of the shaft 3. The side-surfaces 15, 16 provide a smooth sideways transition along the circumference of each attachment protrusion 9, between the top surface 13 of each attachment protrusion 9 and surrounding surfaces of the shaft 3. The smooth transition mitigates excessive turbulence of flushing fluid passing the attachment protrusion and mitigates low-flow regions in which drill cuttings could deposit.

[0031] The wear inserts 7 are provided at a rear portion 17 of the shaft, said rear portion being defined as the rearmost 50% of the length of the drill bit 1, as indicated in fig. 3, but could in other embodiments alternatively be positioned further forward or backward along the shaft 3. The wear inserts 7 could be located at any point in a longitudinal direction in the rear portion 17. In one preferred embodiment the wear inserts 7 and the associated attachment protrusions 9 are located in the backward most rear portion of the shaft, such that the location is defined as the rearmost 25% of the length of the drill bit 1 The minimum distance between the wear inserts 7 and the drilling inserts 5 is 1.5 times the diameter of the drilled hole, i.e. three times the first radial distance.

[0032] The wear inserts 7 are evenly distributed around the circumference of the shaft 3 but could in other embodiments be differently positioned. When evenly distributing the wear inserts 7 will give the most optimal drilling. So, there will not be any issues with unbalance.

[0033] Between the head 2 and the wear inserts 7, the shaft 3 has a reduced cross-sectional area or diameter, such that drill cuttings can efficiently be flushed from the head 2 along the shaft 3 without getting stuck. The reduced cross-sectional area forms a waist 18 with a diameter smaller than the diameter defined by the second radial distance 8 to the longitudinal axis 4. In this embodiment, the waist 18 is cylindrical. In other embodiments the waist could have any other suitable diameter or cross-sectional shape and area.

[0034] As shown in figs. 1, 2 and 3, the drill 1 bit is provided with an inner channel extending through the shaft 3 between an inlet opening 19 at the rear portion of the drill bit 1, and one or more outlet openings 20 at a front portion of the head 2. The head 2 is provided with flushing passages 21 fluidly connecting the front of the drill bit 1 to a space 22 around the shaft 3.

[0035] At drilling, fluid may thus be flushed through a drill string or rod to which the drill bit 1 is attached, into the inner channel and out through the head 2 of the drill bit 1. From there, fluid flows through the flushing passages 21 and further into the space 22 around the shaft 3. From there, the fluid flows through the flushing recesses 12 between the wear inserts 7 and further out through the drill string, rod or bore. The fluid thus flushes drill cuttings away from the drill bit 1 and out of the bore. In other embodiments, the drill bit 1 may alternatively comprise one or more other fluid channels, or no fluid channels at all. However, the provision of a central fluid channel along the longitudinal axis 4 of the drill bit 1 is advantageous since it is easy to produce.

[0036] The head 2 and shaft 3 of the drill bit are made of steel but could in other embodiments be made of any other suitable material. The wear inserts 7 comprise tungsten carbide. Tungsten carbide is a material suitable for the intended use since it is very hard thus resists wear better than steel. In other embodiments, other suitable materials could alternatively be used instead of tungsten carbide, as long as they are tough and hard enough for the intended use.

[0037] Each wear insert 7 is provided with a respective rounded, or semi-spherical outer tip 23. The rounded shape of the outer tip 23 makes the wear insert robust by avoiding sharp edges prone to chipping. Also, the rounded shape provides a slanted surface for oncoming drill cuttings to glide along for being crushed between the wear insert and the surrounding bore formation. In other embodiments, the wear inserts could alternatively have other shapes, such as cylindrical or cuboid. However, should the wear inserts exhibit sharp corners, there is a risk of cutting and of chipping of the wear insert upon rotation of the drill bit 1 within a bore. In order to avoid cutting, the positioning of the wear insert 7 in the drill bit 1 may be changed such that any sharp edges are directed not to cut into the formation drilled, this being in accordance with an intended rotational direction of the drill bit.

[0038] Each wear insert 7 comprises a cylindrical attachment portion 11. The cylindrical attachment portion 11 is advantageous since it enables firm grip of the wear insert 7 by enabling distribution of forces applied to the wear insert 7 in any radial direction of the cylindrical attachment portion 11, which in turn enables use of smaller wear inserts 7, which in turn enables improved flushing past the wear inserts 7.

[0039] The shaft 3 is provided with rear connection means for attachment of the drill bit 1 to a drill string or a rod.

[0040] The rear connection means comprises a central elongate recess 24 provided with a thread 25. The central elongate recess enables receipt of an end portion of a drill string or rod and the thread of the recess enables threaded engagement between drill string/rod and drill bit to securely hold the parts together.

Claims

1. A percussion drill bit (1) comprising a head (2) and a shaft (3) extending from the head (2) rearwards along a longitudinal axis (4) of the drill bit (1),
   wherein the head (2) is provided with drilling inserts (5),
   wherein the head (2) is shaped and sized to define a drilling diameter with a first radial distance (6) to the longitudinal axis (4) of the drill bit (1),
   wherein the shaft (3) is provided with a plurality of radially extending wear inserts (7) distributed around the circumference of the shaft (3),
   wherein each wear insert (7) protrudes a second radial distance (8) from the longitudinal axis (4) of the drill bit (1),
   characterized in that the second radial distance (8) is within the range of 93-97% of the first radial distance (6).

2. A percussion drill bit (1) according to claim 1, wherein the wear inserts (7) are attached to the shaft (3) by means of attachment protrusions (9) extending radially from the shaft (3),
   wherein each attachment protrusion (9) comprises an attachment recess (10) for receiving a respective attachment portion (11) of a wear insert (7),
   wherein the attachment protrusions (9) are distributed around the circumference of the shaft (3), and
   wherein the attachment protrusions (9) are separated by flushing recesses (12) for flushing of drill cuttings past the attachment protrusions (9).

3. A percussion drill bit (1) according to claim 2,
   wherein each attachment protrusion (9) comprises a plurality of wear inserts (7) longitudinally distributed with respect to the drill bit (1).

4. A percussion drill bit (1) according to claim 3, wherein the plurality of attachment recesses (10) of each attachment protrusion (9) are also circumferentially distributed with respect to the drill bit (1).

5. A percussion drill bit (1) according to any one of claims 2 to 4,
   wherein each attachment protrusion (9) comprises a top surface (13) in which the attachment recess (10) is formed, and a curved or slanted front surface (14) extending in front of each attachment protrusion (9) from the top surface (13) to surrounding surfaces of the shaft (3).

6. A percussion drill bit (1) according to any one of the preceding claims, wherein each attachment protrusion (9)

comprises a top surface (13) in which the attachment recess (10) is formed, and a first (15) and a second (16) curved or slanted side-surface, each side surface (15, 16) respectively extending from a respective opposite side of the top surface (13) in opposite directions along the circumference of the shaft (3), to surrounding surfaces of the shaft (3).

7. A percussion drill bit (1) according to any one of the preceding claims, wherein the wear inserts (7) are provided at a rear portion (17) of the shaft.

8. A percussion drill bit (1) according to any one of the preceding claims, wherein the drill bit (1) comprises at least three wear inserts (7) distributed around the circumference of the shaft (3).

9. A percussion drill bit (1) according to any one of the preceding claims, wherein the wear inserts (7) are evenly distributed around the circumference of the shaft (3).

10. A percussion drill bit (1) according to any one of the preceding claims, wherein the wear inserts (7) comprise tungsten carbide.

11. A percussion drill bit (1) according to any one of the preceding claims, wherein each wear insert (7) is provided with a respective rounded or semi-spherical outer tip (23).

12. A percussion drill bit (1) according to claim 11, wherein each wear insert (7) comprises a cylindrical attachment portion (11).

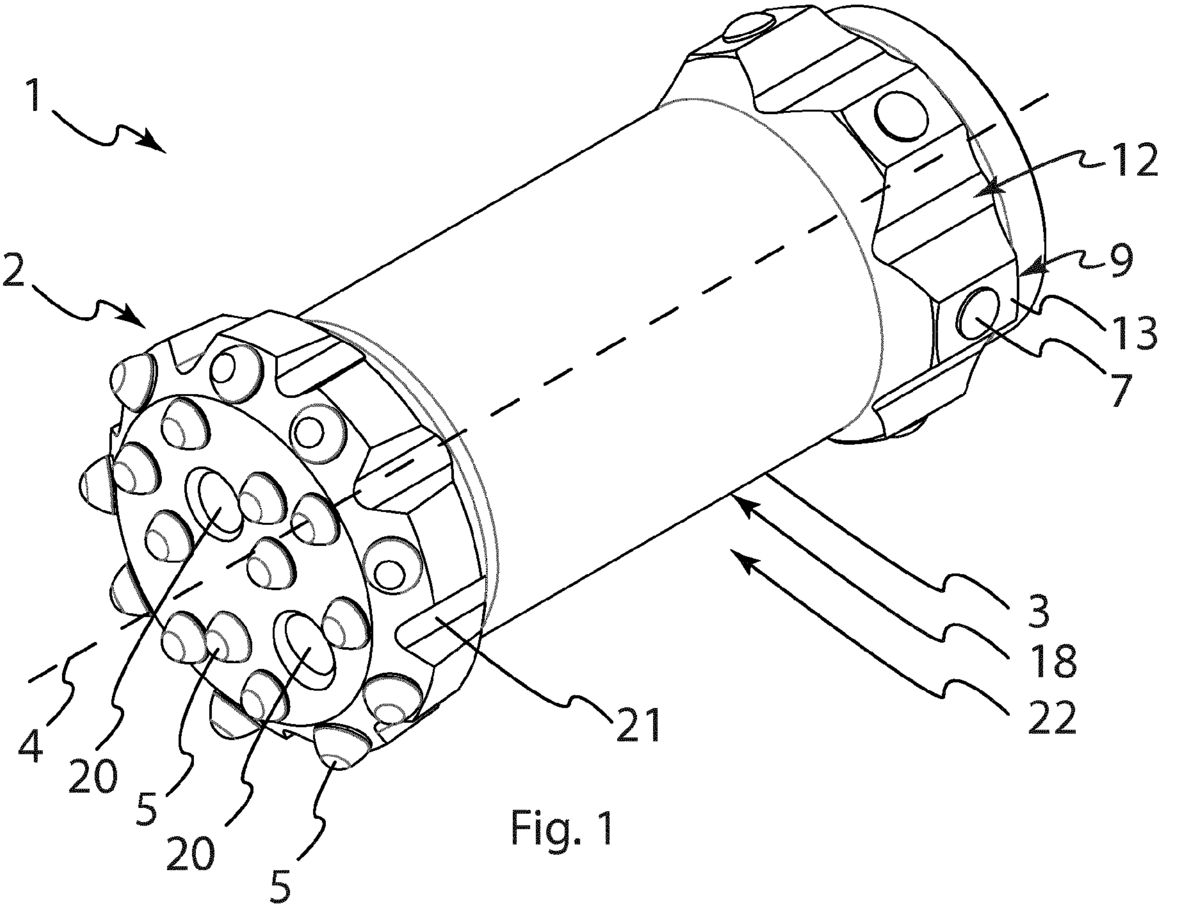

Fig. 1

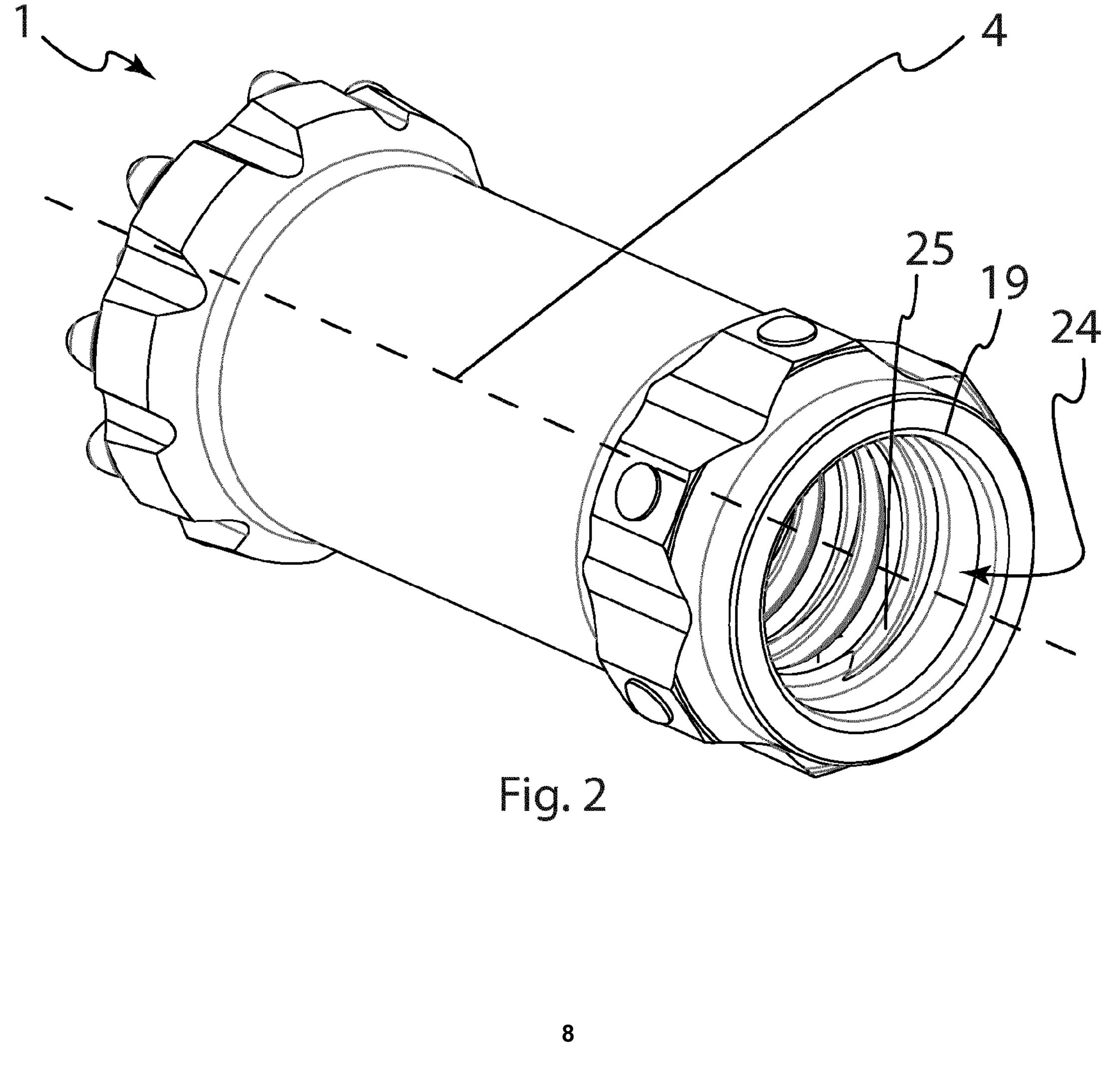

Fig. 2

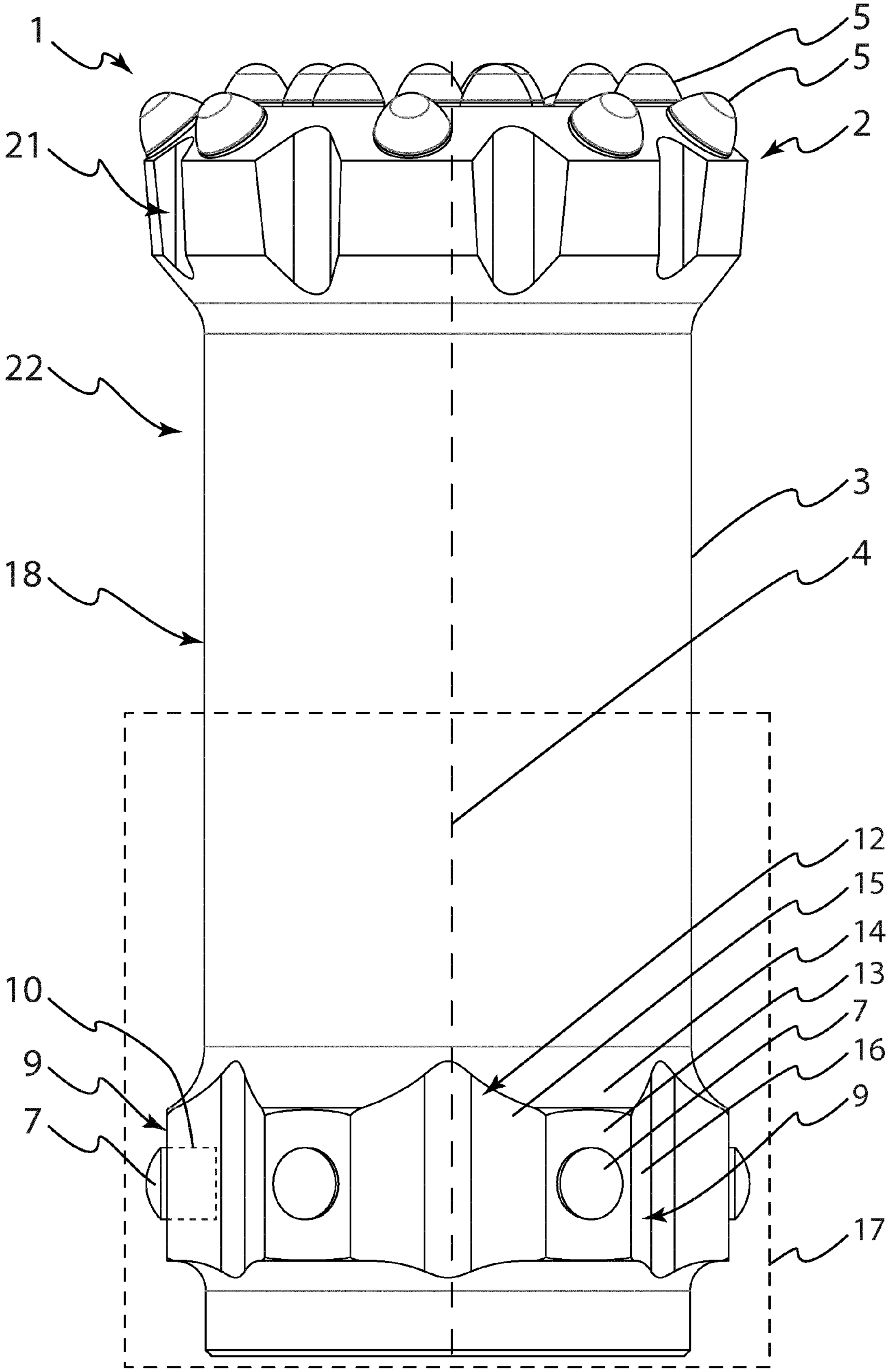

Fig. 3

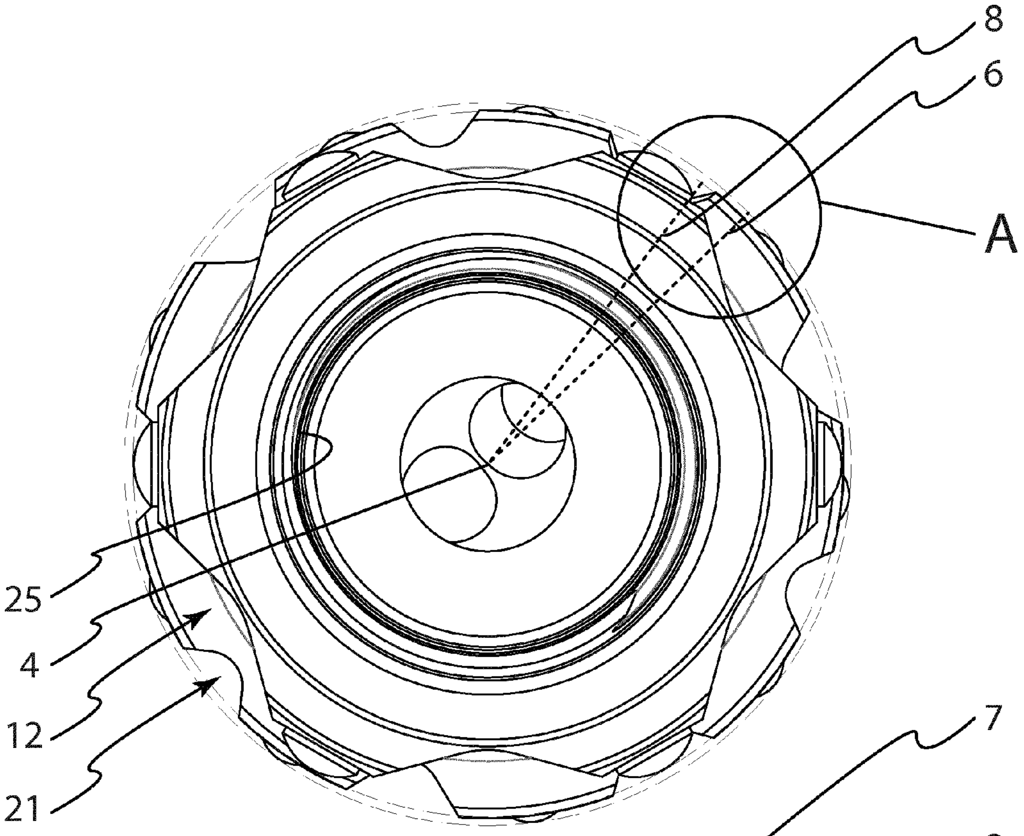

Fig. 4

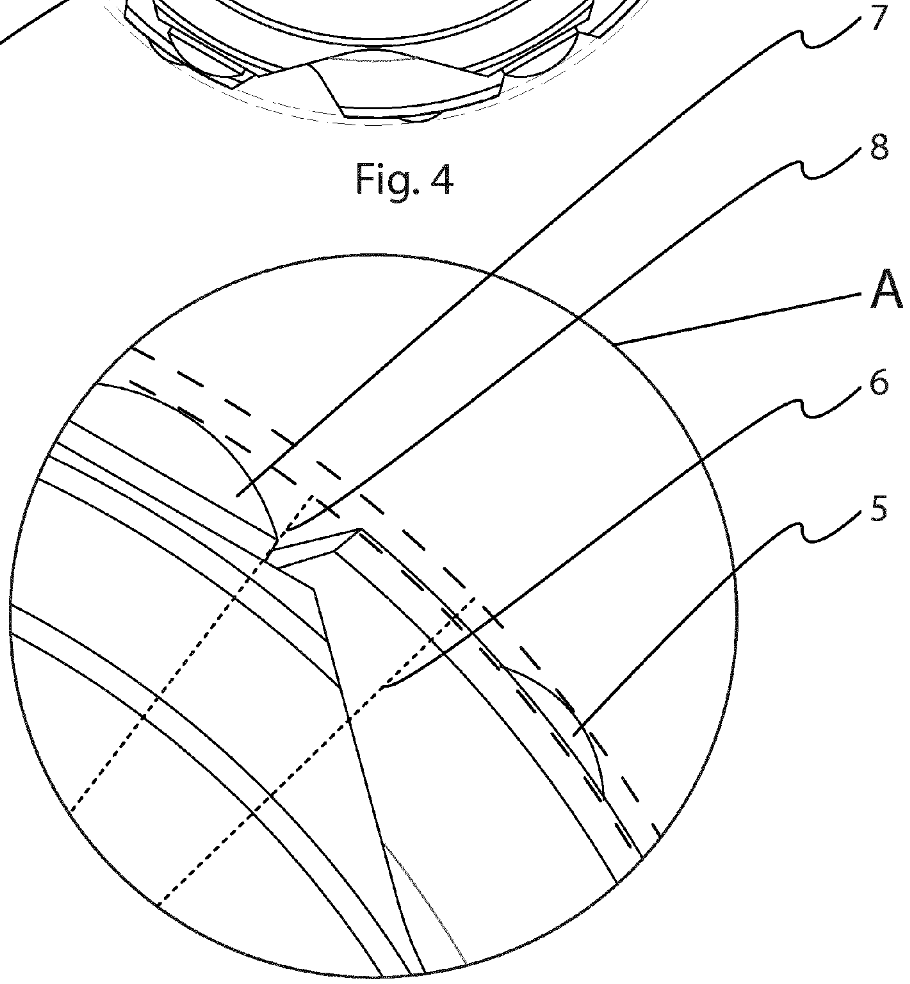

Fig. 5

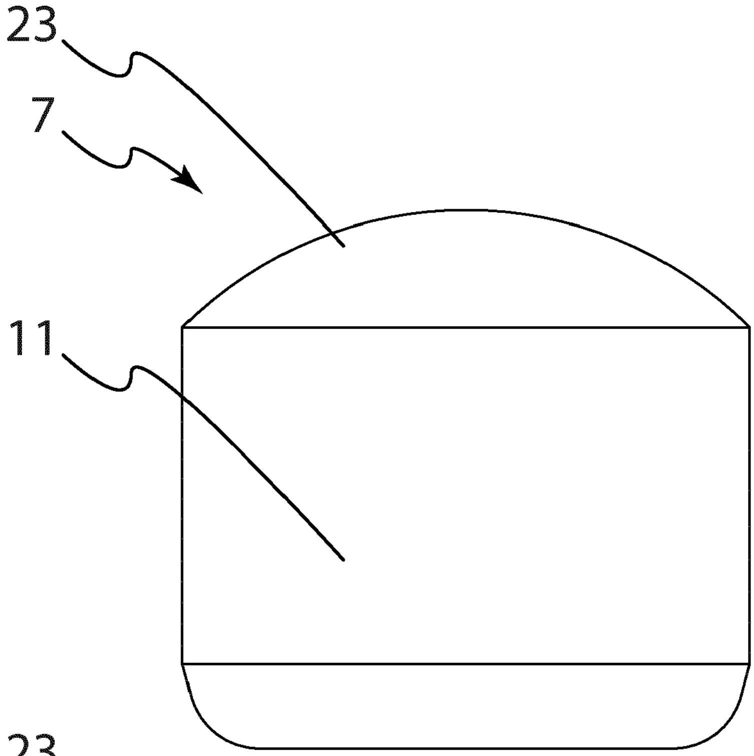

Fig. 6

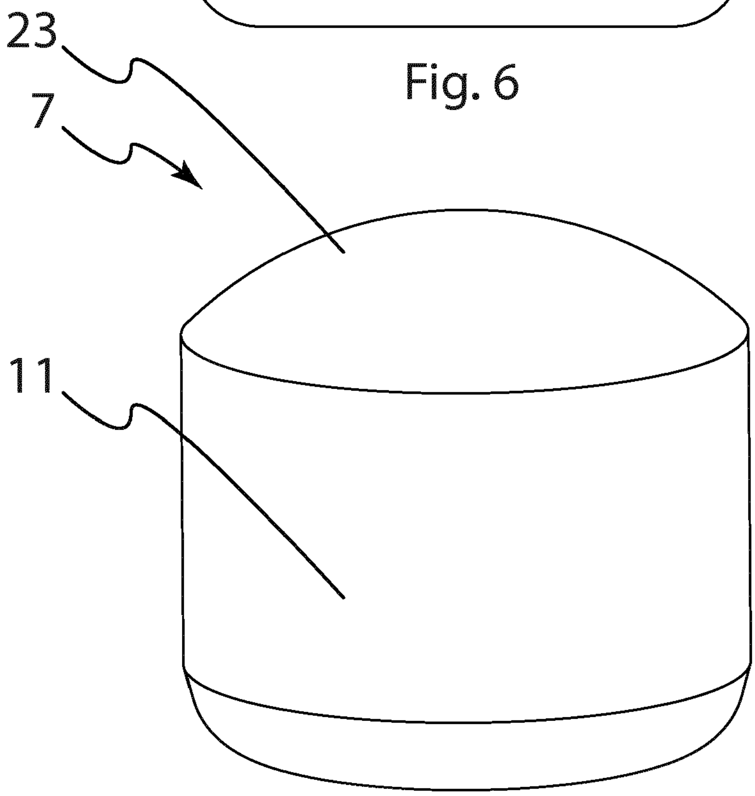

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 19 15 4474

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 4 106 578 A (BEYER LEAMAN REX) 15 August 1978 (1978-08-15) * column 2, line 51 - column 3, line 22 * -----	1-12	INV. E21B10/36 E21B17/042 E21B17/10
Y	WO 2006/054933 A1 (SANDVIK INTELLECTUAL PROPERTY [SE]; HADIN PER-OLA [SE]) 26 May 2006 (2006-05-26) * page 5, lines 6-11 * -----	1-12	
Y	US 2001/018990 A1 (ASBERG BENGT [SE] ET AL) 6 September 2001 (2001-09-06) * paragraphs [0018] - [0023] * -----	1-12	
Y	US 5 743 345 A (HOLLAR CHARLES D [US] ET AL) 28 April 1998 (1998-04-28) * column 3, lines 17-30 * -----	1-12	

TECHNICAL FIELDS SEARCHED (IPC)

E21B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	16 July 2019	Manolache, Iustin

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 15 4474

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16-07-2019

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 4106578	A	15-08-1978	NONE			
WO 2006054933	A1	26-05-2006	AU	2005307146	A1	26-05-2006
			CA	2585564	A1	26-05-2006
			CN	101061290	A	24-10-2007
			EP	1815103	A1	08-08-2007
			JP	4709226	B2	22-06-2011
			JP	2008520870	A	19-06-2008
			KR	20070086145	A	27-08-2007
			RU	2378480	C2	10-01-2010
			SE	0402806	A	18-05-2006
			US	2006162965	A1	27-07-2006
			WO	2006054933	A1	26-05-2006
			ZA	200703953	B	25-08-2010
US 2001018990	A1	06-09-2001	AU	778724	B2	16-12-2004
			BR	0108795	A	31-12-2002
			CA	2397146	A1	07-09-2001
			CN	1406309	A	26-03-2003
			EP	1259697	A1	27-11-2002
			JP	2003525372	A	26-08-2003
			MX	PA02008445	A	28-01-2003
			PL	357778	A1	26-07-2004
			SE	514931	C2	21-05-2001
			US	2001018990	A1	06-09-2001
			WO	0165051	A1	07-09-2001
			ZA	200205239	B	29-09-2003
US 5743345	A	28-04-1998	NONE			

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- WO 2015175285 A1 **[0005]**