



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
06.04.2022 Bulletin 2022/14

(51) International Patent Classification (IPC):
E21B 1/00 (2006.01) E21B 17/04 (2006.01)

(21) Application number: **20199285.6**

(52) Cooperative Patent Classification (CPC):
E21B 17/04; E21B 1/00

(22) Date of filing: **30.09.2020**

(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:
KH MA MD TN

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

(72) Inventors:
• **Kraft, Conny**
811 92 Sandviken (SE)
• **Jansson, Tomas**
811 81 Sandviken (SE)

(74) Representative: **Sandvik**
Sandvik Intellectual Property AB
811 81 Sandviken (SE)

(54) **LOW STRESS CAVITY FOR CONICALLY CONNECTING DRILL BITS**

(57) A percussive drill bit comprising a sleeve section and bit section having a longitudinal axis; wherein the sleeve section has an axial end at the opposing end of the drill bit compared to the bit section from which a generally conically shaped internal cavity extends from for receiving a conically shaped drill rod to form a conical frictional connection; wherein the cavity has a conical region nearest to the axial end and a cylindrical region nearest to the bit section; characterised in that: there is connection section joining the conical region to the cylindrical region; the conical region has a straight tapered region with a starting point adjacent to the connection region; wherein the connection section has at a first curved connection region having a first radius, CR_1 , wherein its tangent, CT_1 , is positioned at a first distance, CD_1 , from the taper region starting point.

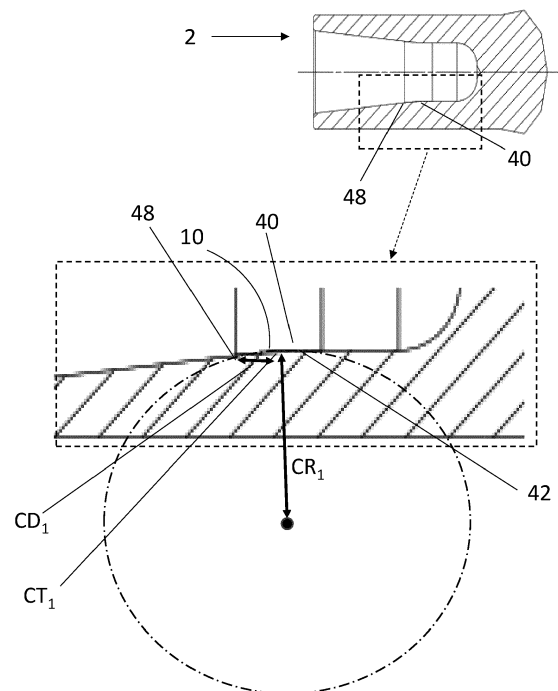


Fig. 2

Description

Technical field

[0001] The present invention relates to a rock drill and, more particularly, to a rock drill for use in percussion rock drilling comprising a drill bit having a first conical surface adapted for connection to a drill rod having a corresponding second conical surface.

Background

[0002] In percussive drilling, during drilling, drill bits are connected to a drill rod by means on a threaded connection or conical frictional connection. In the case of the conical frictional connection, otherwise known as a taper joint, the drill bit has a generally conical cavity which is terminated by a cup-shaped cylindrical region, while the end of the drill rod that should be received in the cavity is generally conical.

[0003] In known designs the conical section of the cavity connects directly to the cylindrical region. The problem with this sharp connection is that it results in high stresses being located inside the drill bit, which increases the risk of fracture of the drill bit in the region which consequently reduces the lifetime of the drill bit. If the drill bit fractures the percussive shock wave forces may no longer be transmitted to the rock but instead may loosen the firm connection between the drill bit and the drill rod, which could result in the drill bit spinning or even becoming detached and lost in the drill hole.

[0004] US20070175671A1, GB-658631A and GB-860768A show traditional conical frictional connections known in the prior art.

[0005] Therefore, the problem to be solved is how to reduce stress in the cavity of the drill bit.

Summary

[0006] It is an objective of this invention to provide a novel and improved design that reduces the stress in the drill bit in the region of the exit of the conical cavity in a taper joint. This objective is achieved by providing a percussive drill bit comprising a sleeve section and bit section having a longitudinal axis; wherein the sleeve section has an axial end at the opposing end of the drill bit compared to the bit section from which a generally conically shaped internal cavity extends from for receiving a conically shaped drill rod to form a conical frictional connection; wherein the cavity has a conical region nearest to the axial end and a cylindrical region nearest to the bit section; characterised in that: there is connection section joining the conical region to the cylindrical region; the conical region has a straight tapered region having a starting point adjacent to the connection region; wherein the connection section has at a first curved connection region having a first radius, CR_1 , wherein its tangent, CT_1 , is positioned at a first distance, CD_1 , from the taper

region starting point.

[0007] Advantageously, the inclusion of the curved transition section reduces the stress in the conical cavity of the drill bit. This means the drill bit is less likely to fracture, which reduces the risk of the frictional connection being loosened. Consequently, the lifetime of the drill bit is increased, the risk of the bit spinning with respect to the drill rod or becoming detached from the drill rod is reduced.

[0008] Optionally, the connection section additionally has a second curved connection region having a second radius, CR_2 , wherein its tangent, CT_2 , is positioned at a second distance, CD_2 , from the taper region starting point; wherein $CD_2 < CD_1$ and $CR_2 > CR_1$. Advantageously, the inclusion of two different radii provides a reduction in stress whilst maintaining sufficient contact between the conical rod and the conical cavity in the drill bit.

[0009] Preferably, CR_1 is between 1 - 160 mm, more preferably between 5 - 120 mm. Advantageously, this provides an optimal balance between providing a tight connection between the conical rod and the conical cavity of the drill bit and achieving a reduction in stress.

[0010] Optionally, the first curved connection region connects directly to the second curved connection region. Advantageously, this design has low levels of the stress in the region of the exit of the conical cavity of the drill bit.

[0011] Alternatively, the first curved region connects to the second curved region via an intermediate straight section. Advantageously, this design has low levels of the stress in the region of the exit of the conical cavity of the drill bit.

[0012] Optionally, the connection section further comprises a third curved connection region having a third radius, CR_3 , wherein its tangent, CT_3 , is positioned at a third distance, CD_3 , from the taper region starting point, wherein $CD_3 < CD_2$ and $CR_3 > CR_2$. Advantageously, this design has low levels of the stress in the region of the exit of the conical cavity of the drill bit.

[0013] Optionally, there is additionally a curved transition section positioned in-between the axial end of the drill bit and the straight tapered region of the conical region.

Brief description of the drawing

[0014] A specific implementation of the present invention will now be described, by way of example only, and with reference to the accompanying drawings:

Figure 1: Cross section of a drill bit having a conically shaped internal cavity.

Figure 2: Enlargement of the cross section of the connection section according to one embodiment wherein the connection section has a single radius.

Figure 3: Enlargement of the cross section of the connection section according to one embodiment wherein the connection section has two radii wherein the first curved connection region and the second curved connection region are directly connected.

Figure 4: Cross section of the connection section according to one embodiment wherein the connection section has two radii wherein the first curved connection region and the second curved connection region of the connection section are connected via an intermediate straight section.

Figure 5: Enlargement of the cross section of the connection section according to one embodiment wherein there is additionally a third curved connection region in the connection section.

Figure 6: Cross section of the connection section according to one embodiment wherein there is additionally a curved transition section between the straight tapered region and the cylindrical region.

Figure 7: Stress image of the conical region of the prior art drill bit.

Figure 8: Stress image of the conical region of an inventive drill bit.

Detailed description

[0015] Figure 1 shows a cross section of a drill bit 2 comprising a sleeve section 4 and a bit section 6 which are integrated together. The sleeve section 4 has an internal cavity 8, having a generally conical shape, for receiving a conically shaped drill rod (not shown). The drill bit 2 has a longitudinal axis 30. The cavity 8 opens from an axial end 18 of the drill bit 2, furthest from the bit section 6. The cavity 8 has the largest cross-sectional diameter at the axial end 18 of the drill bit 2. The cavity 8 comprises a conical region 14 that tapers inwardly from the open axial end 18 along a straight tapered region 26 to a cup-shaped cylindrical region 16 that terminates the cavity 8 and is positioned adjacent to the bit section 6. A connection region 40 joins the conical region 14 to the cylindrical region 16. The tapered region 26 has a taper region starting point 48 adjacent to the connection region 40.

[0016] Figure 2 shows an enlargement of the drill bit 2 in the area of the connection region 40 according to one embodiment of the present invention. In this embodiment the internal surface 10 of the connection region 40 has a first curved connection section 42 having a first radius, CR_1 , wherein its tangent CT_1 is positioned at a first distance, CD_1 , from the taper region starting point 48.

[0017] Figure 3 shows an alternative embodiment wherein the internal surface 10 of the connection section 40 has a first curved connection section 42 having a first radius, CR_1 , wherein its tangent CT_1 is positioned at a

first distance, CD_1 , from the taper region starting point 48 and a second curved connection region 44 having a second radius, CR_2 , wherein its tangent CT_2 is positioned a second distance, CD_2 , from the taper region starting point 48. In the present invention $CD_2 < CD_1$ and $CR_2 > CR_1$, in other words the curved connection section having the smaller radius is adjacent to the cylindrical region 16. CR_1 is between 1-160 mm, preferably between 5-120 mm. CR_2 is between $>1 - 160$ mm, preferably between 5 - 120 mm. In this embodiment the first curved connection section 42 is directly connected to the second curved connection section 44 and the second connection section 44 is directly connected to the straight tapered region 26.

[0018] Figure 4 shows an alternative embodiment, wherein the first curved connection section 42 is connected to the second curved connection section 44 via an intermediate straight section 34.

[0019] Figure 5 shows an alternative embodiment, wherein the connection section 40 additionally comprises a third curved connection section 46. The third curved connection section 46 has a third radius, CR_3 , wherein its tangent, CT_3 , is positioned at a third distance, CD_3 , from taper region start point 48, wherein $CD_3 < CD_2$. CR_3 will be different to CR_1 and CR_2 , preferably $CR_3 > CR_2$. Optionally, the connection section 40 could also comprise more than three curved connection sections, each having a different radius. Each of the curved connection sections could either be directly connected to each other or could be connected to each other via an intermediate straight section 34.

[0020] Figure 6 shows an alternative embodiment wherein there is additionally a curved transition section 32 that is positioned in-between the axial end 18 of the drill bit 2 and the straight tapered region 26.

[0021] Figure 7 shows the von Mises equivalent stress taken of the conical region 14 of a prior art drill bit, wherein there is no curved connection region. Figure 8 shows the von Mises equivalent stress taken of the conical region 14 for an inventive drill bit, wherein there is a first curved connection region. In the models one rod and one bit are included and the models are axi-symmetry. An axial load of 190 kN is applied on the end of the rod and the bit face is fully supported. An elastic material with Young's modulus of 206 GPa, Poisson's ratio of 0.3 and a volumetric mass density of 7800 kg/m³ were used. The implicit solver in LS-Dyna R10 were used to solve the models and the images of the von Mises equivalent stress were taken at the maximum load and HyperView 2019 were used as post-processor. It can be seen that the stress in cavity 8 of the drill bit 2 is reduced for the inventive drill bits compared to the prior art drill bit.

Claims

1. A percussive drill bit (2) comprising a sleeve section (4) and bit section (6) having a longitudinal axis (30);

wherein the sleeve section (4) has an axial end (18) at the opposing end of the drill bit (2) compared to the bit section (6) from which a generally conically shaped internal cavity (8) extends from for receiving a conically shaped drill rod to form a conical frictional connection; wherein the cavity (8) has a conical region (14) nearest to the axial end (18) and a cylindrical region (16) nearest to the bit section (6);

the axial end (18) of the drill bit (2) and the straight tapered region (26) of the conical region (14).

characterised in that:

there is connection section (40) joining the conical region (14) to the cylindrical region (16); the conical region (14) has a straight tapered region (26) having a starting point (48) adjacent to the connection region (40); wherein the connection section (40) has at a first curved connection region (42) having a first radius (CR_1) wherein its tangent (CT_1), is positioned at a first distance (CD_1) from the taper region starting point (48).

2. The percussive drill bit (2) according to claim 1 wherein the connection section (40) additionally has a second curved connection region (44) having a second radius (CR_2) wherein its tangent (CT_2) is positioned at a second distance (CD_2) from the taper region starting point (48); wherein $CD_2 < CD_1$ and $CR_2 > CR_1$.

4. The percussive drill bit (2) according to any of the previous claims, wherein CR_1 is between 1 - 160 mm.

5. The percussive drill bit (2) according to any of the previous claims, wherein CR_1 is between 5 - 120 mm.

6. The percussive drill bit (2) according to any of the proceeding claims, wherein the first curved connection region (42) connects directly to the second curved connection region (44).

7. The percussive drill bit (2) according to any of claims 1-5, wherein the first curved region (42) connects to the second curved region (44) via an intermediate straight section (34).

8. The percussive drill bit (2) according to any of the proceeding claims, wherein the connection section (40) further comprises a third curved connection region (46) having a third radius (CR_3) wherein its tangent (CT_3) is positioned at a third distance (CD_3) from the taper region starting point (48), wherein $CD_3 < CD_2$ and $CR_3 > CR_2$.

9. The percussive drill bit (2) according to any of the previous claims wherein additionally there is a curved transition section (32) positioned in-between

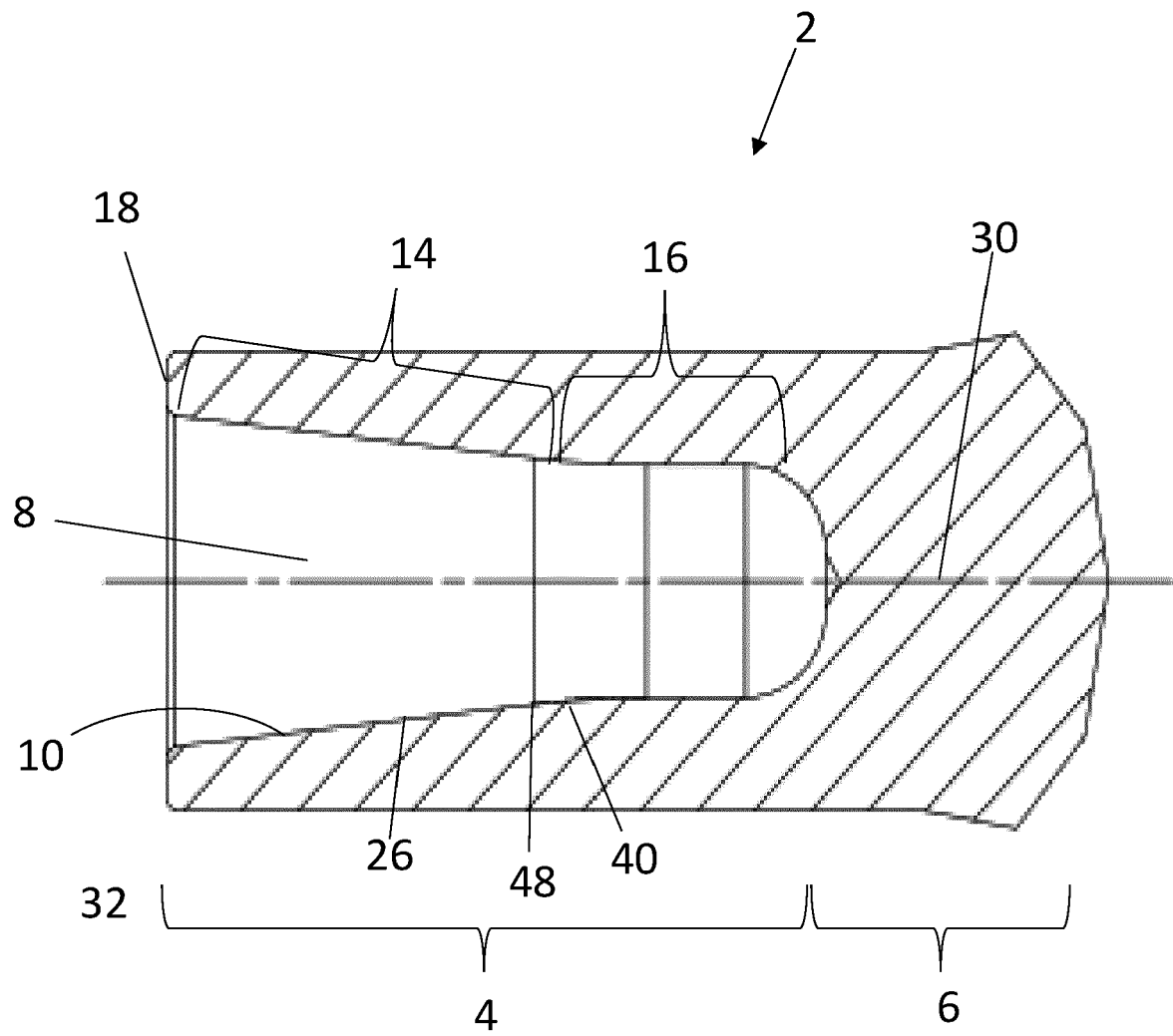


Fig. 1

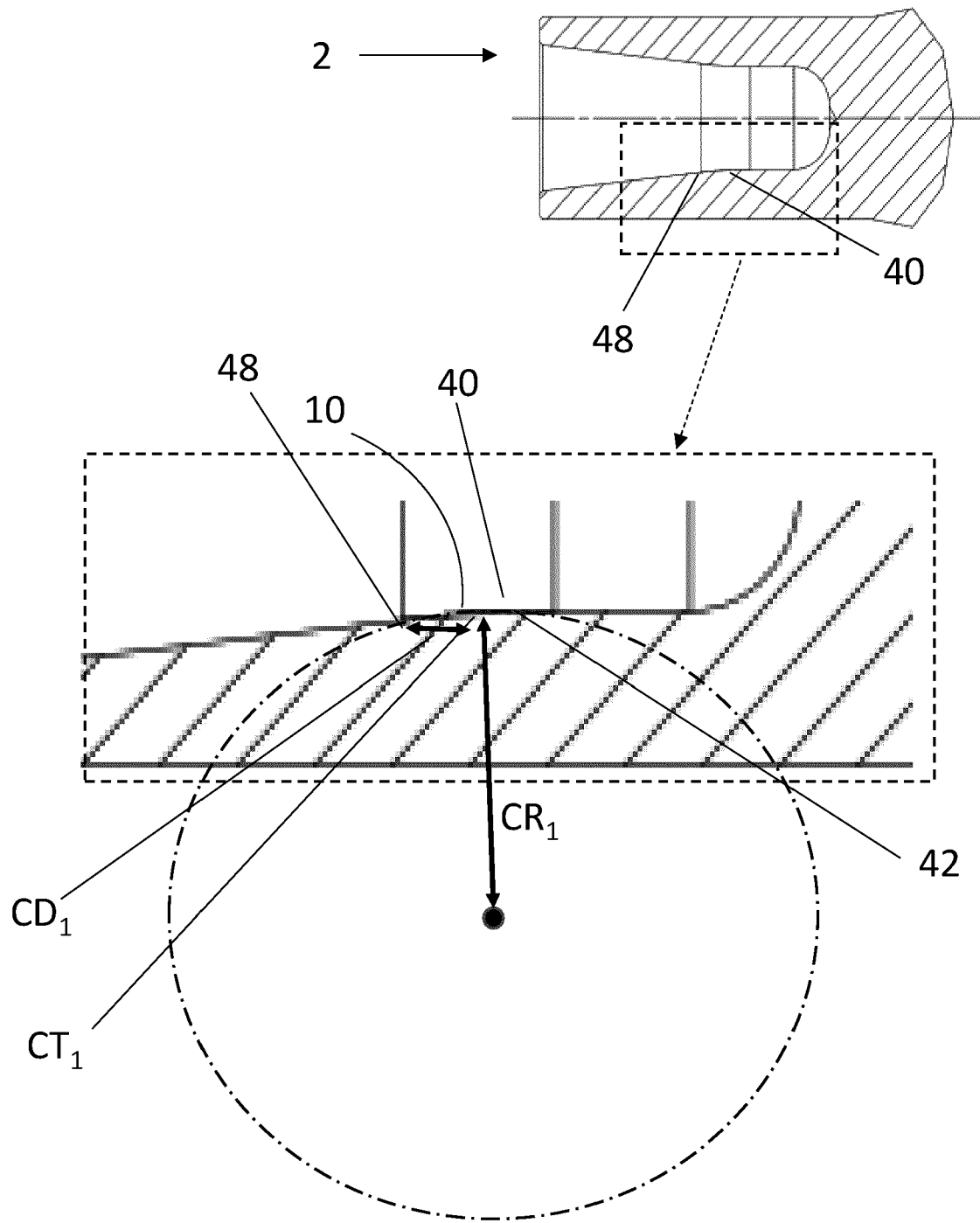


Fig. 2

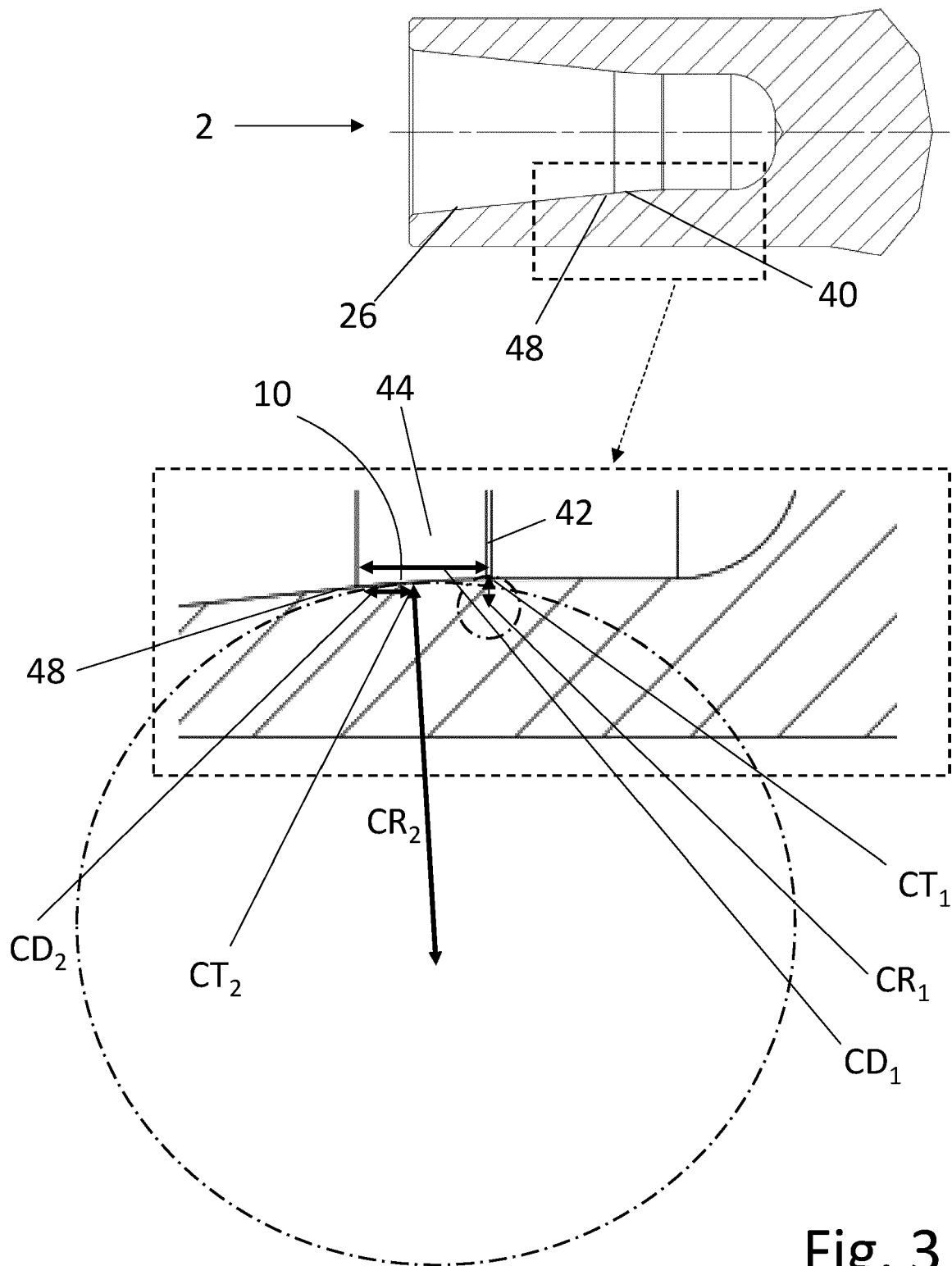


Fig. 3

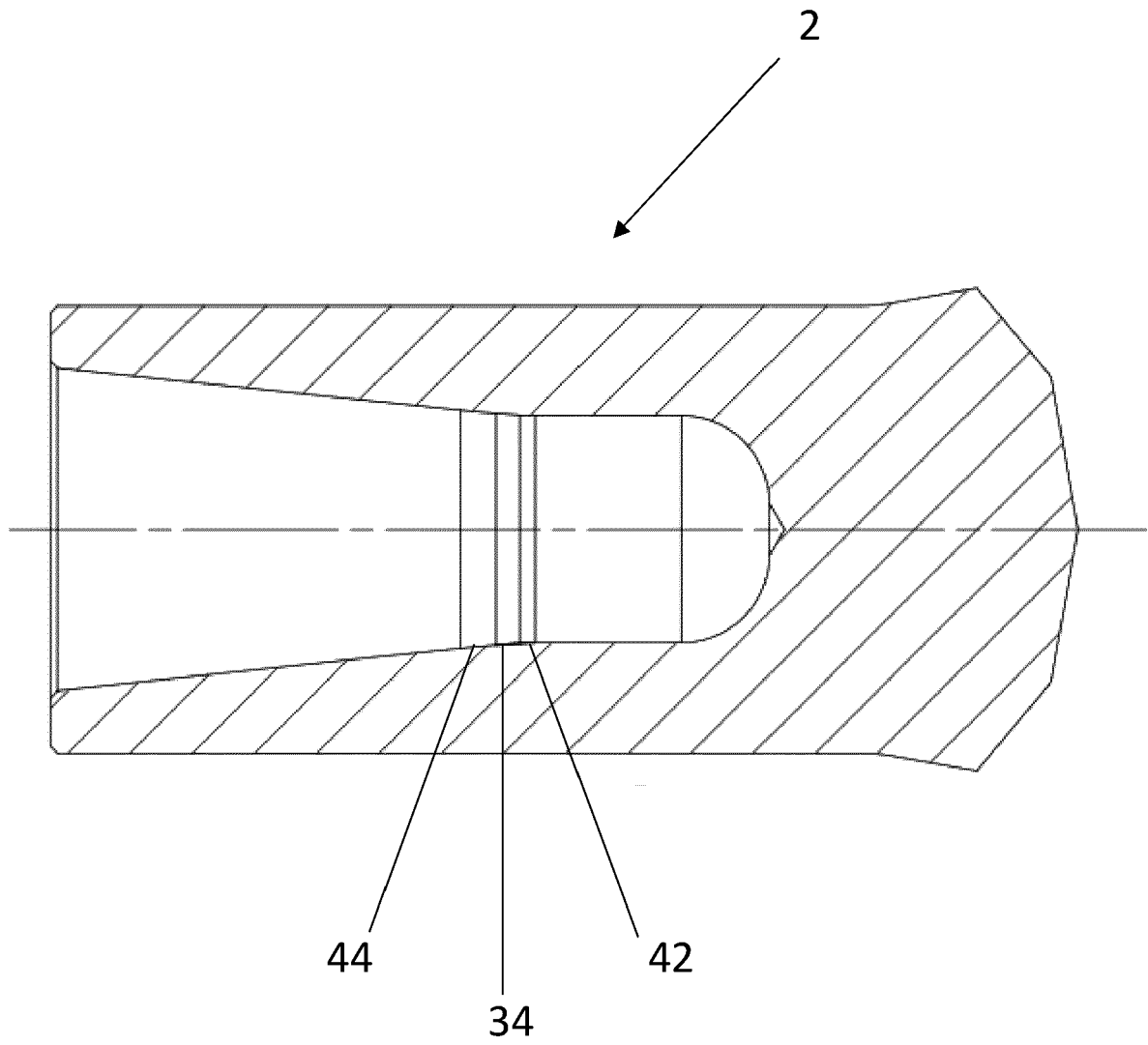


Fig. 4

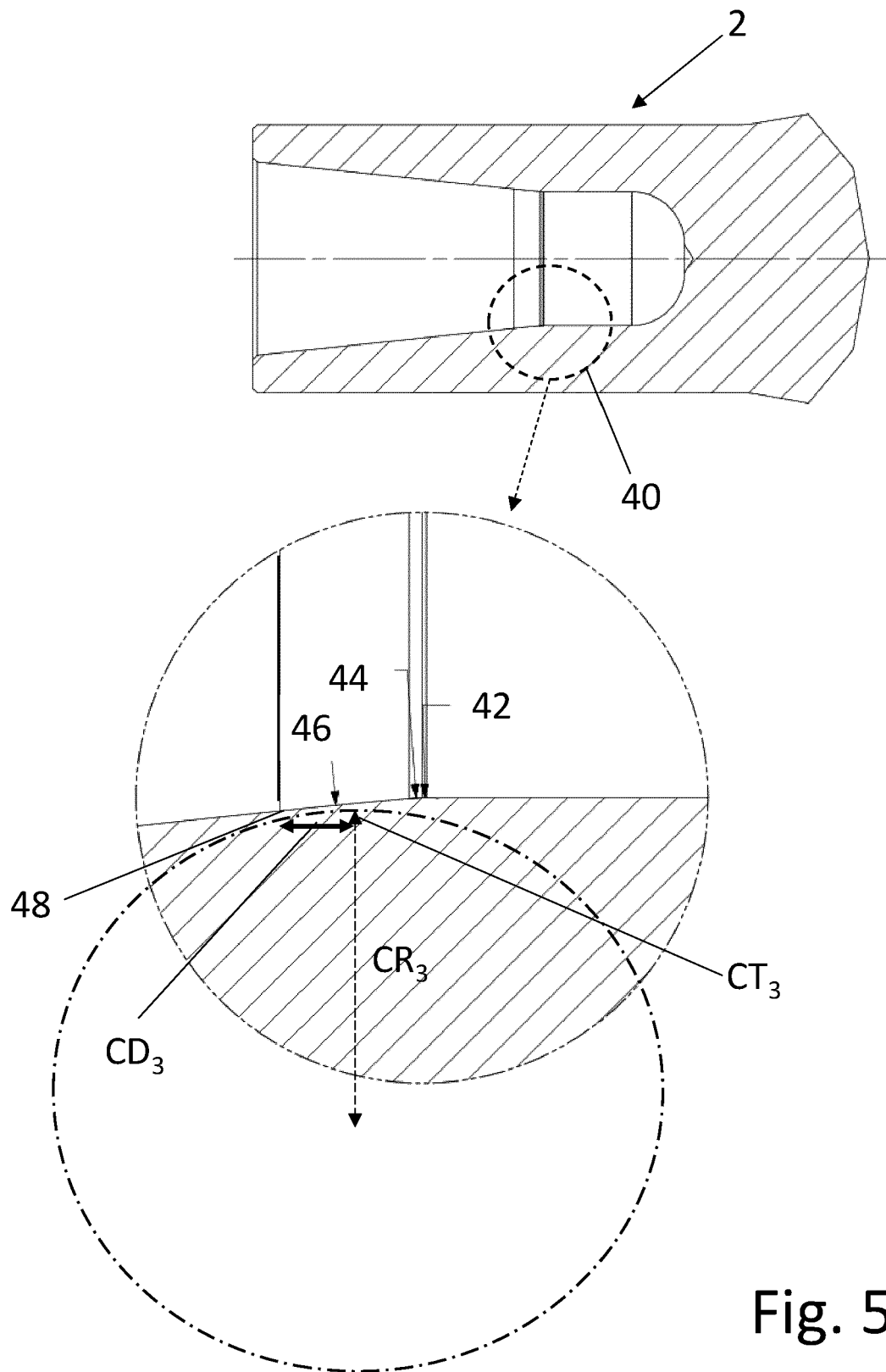


Fig. 5

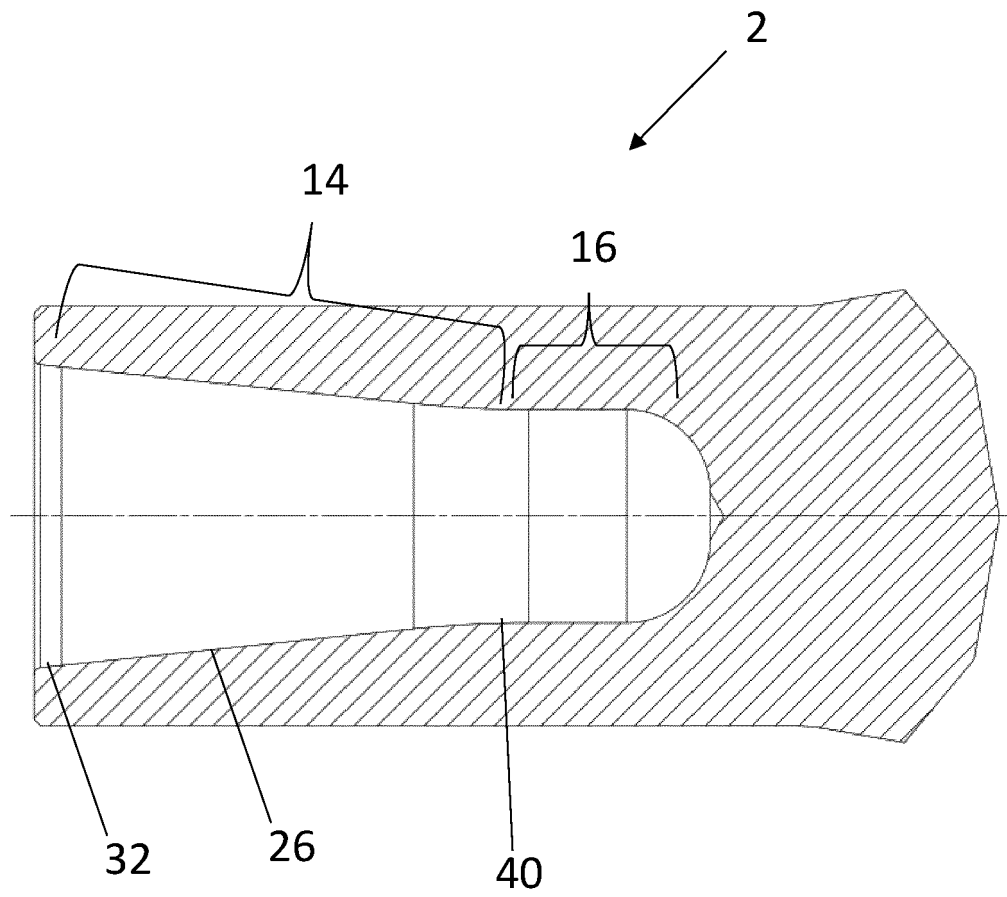


Fig. 6

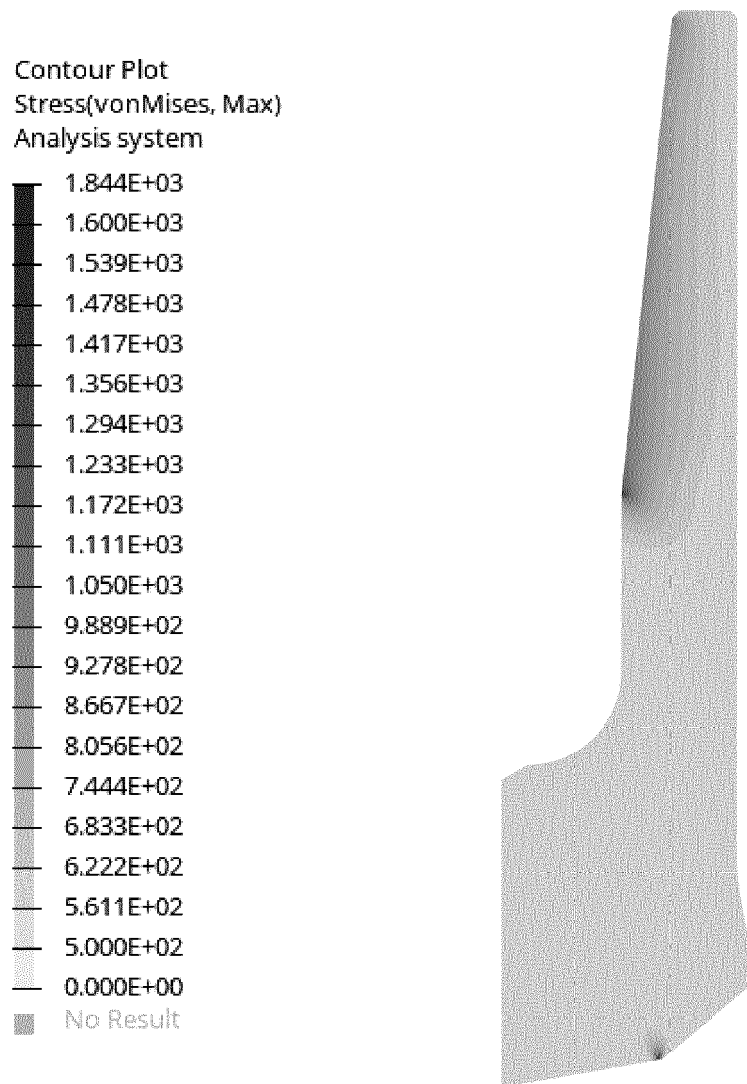


Fig. 7

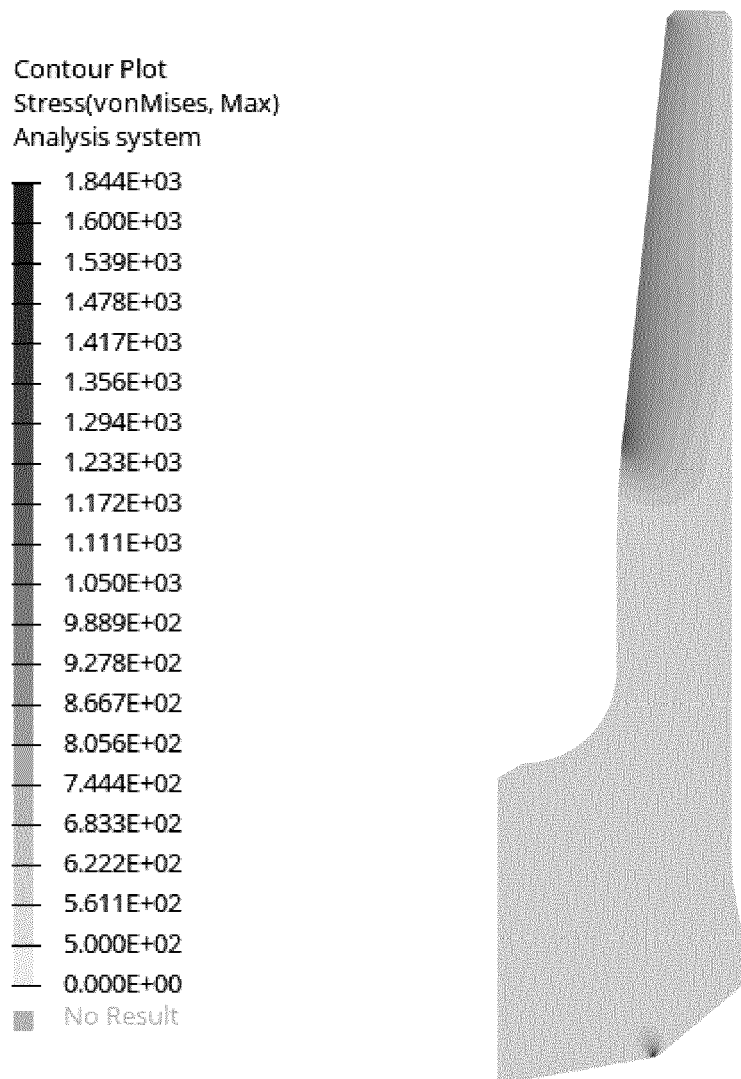


Fig. 8



EUROPEAN SEARCH REPORT

Application Number
EP 20 19 9285

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,D	GB 658 631 A (HALL & PICKLES LTD; ROBERT RUSSELL) 10 October 1951 (1951-10-10)	1,2,4-8	INV. E21B1/00 E21B17/04
Y	* the whole document *	9	
Y	GB 2 307 930 A (DREBO WERKZEUGFAB GMBH [DE]) 11 June 1997 (1997-06-11)	9	
A	* Description; figures 1,3 *	1,2,4-8	
A	US 5 685 381 A (KLOPPERS STEPHANUS FREDERICK [ZA] ET AL) 11 November 1997 (1997-11-11)	1,2,4-8	
A	US 3 336 081 A (ERICSSON SAMUEL S) 15 August 1967 (1967-08-15)	1,2,4-8	
			TECHNICAL FIELDS SEARCHED (IPC)
			E21B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 5 March 2021	Examiner Altamura, Alessandra
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

 1
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 20 19 9285

5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

05-03-2021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB 658631 A	10-10-1951	NONE	
GB 2307930 A	11-06-1997	DE 29519484 U1 GB 2307930 A	25-01-1996 11-06-1997
US 5685381 A	11-11-1997	NONE	
US 3336081 A	15-08-1967	NONE	

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 20070175671 A1 [0004]
- GB 658631 A [0004]
- GB 860768 A [0004]