(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 November 2020 (12.11.2020)

WIPO | PCT

(10) International Publication Number
WO 2020/224988 A1

(51) International Patent Classification:
B62D 7/18 (2006.01)

(21) International Application Number:
PCT/EP2020/061409

(22) International Filing Date:
24 April 2020 (24.04.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
201941018218 07 May 2019 (07.05.2019) IN

(71) Applicant: **VOLVO TRUCK CORPORATION** [SE/SE]; 405 08 GÖTEBORG (SE).

(72) Inventors: **GOWDA, Jithendra**; 442/2, 5th cross, Samanyu nilaya, near Tatsherwood apts, Vibhuthipura mai, BANGALORE 560037 (IN). **SIVANKUTTY, Anish**; Flat Number 404, Landstar Pinnacle, Hirandahalli Village, Bidarahalli Hobli, Rampura Main road, BANGALORE 560049 (IN). **BUE, Emmanuel**; 44 cours Tolstoï, 69100 VILLEURBANNE (FR). **LÖFSTRÖM, Christoffer**; Knaståsvägen 137, 439 93 ONSALA (SE).

(74) Agent: **KRANSELL & WENNBORG KB**; P.O. Box 2096, 403 12 GÖTEBORG (SE).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,

(54) Title: STEERING AXLE ASSEMBLY FOR A VEHICLE

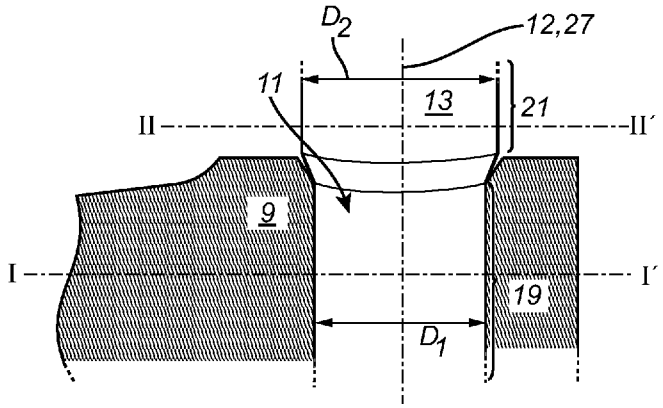

Fig. 3B

(57) Abstract: The invention relates to a steering axle assembly (7) for a vehicle (1), comprising: an axle beam (9) having an axle beam bore (11) with a bore axis (12), exhibiting a minimum cross-section (23); and a king pin (13), in interference fit with the axle beam bore (11), including: a first king pin portion (19) arranged inside the axle beam bore (11), the first king pin portion (19) having a first cross-section (24) in a first plane (I-I') perpendicular to the bore axis (12), the first cross-section (24) being in interference fit with the minimum cross-section (23) of the axle beam bore (11); and second king pin portion (21) arranged at a higher vertical level than the first king pin portion (19) when the steering axle assembly (7) is arranged in the vehicle (1), the second king pin portion (21) having a second cross-section (25) in a second plane (II-II') perpendicular to the bore axis (12), a projection along the bore axis (12) of the second cross-section (25) in the first plane (I-I') perpendicular to the bore axis (12) at least partly extending outside the minimum cross- section (23) of the axle beam bore (11).

WO 2020/224988 A1

[Continued on next page]

EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

Steering axle assembly for a vehicle

TECHNICAL FIELD

The invention relates to a steering axle assembly for a vehicle, to a vehicle comprising such a steering axle assembly, and to an assembly method.

The invention can be applied in heavy-duty vehicles, such as trucks, buses and construction equipment. Although the invention will be described with respect to a truck, the invention is not restricted to this particular vehicle, but may also be used in other vehicles, for instance buses or various kinds of working vehicles, such as wheel loaders, excavators, or articulated haulers etc.

BACKGROUND

The steering axle assembly on a vehicle is crucial for safe operation of the vehicle. Although a steering axle configuration with interference fit between the axle bore and the king pin is robust and reliable, it would be desirable to provide for improved functionality and safety over the service life of the steering axle assembly.

SUMMARY

An object of the invention is to provide for improved functionality and safety over the service life of the steering axle assembly.

According to a first aspect of the invention, this object is achieved by a steering axle assembly for a vehicle, comprising: an axle beam having an axle beam bore with a bore axis, exhibiting a minimum cross-section; and a king pin, in interference fit with the axle beam bore, including: a first king pin portion arranged inside the axle beam bore, the first king pin portion having a first cross-section in a first plane perpendicular to the bore axis, the first cross-section being in interference fit with the minimum cross-section of the axle beam bore; and a second king pin portion arranged at a higher vertical level than the first king pin portion when the steering axle assembly is arranged in the vehicle, the second king pin portion having a second cross-section in a second plane perpendicular to the bore axis, a projection along the bore axis of the second cross-section in the first plane

perpendicular to the bore axis at least partly extending outside the minimum cross-section of the axle beam bore.

The present invention is based on the observation that a king pin in interference fit with the axle bore in a steering axle assembly may loosen in certain use cases with heavy loads and frequent braking. The present inventors have realized that the king pin can be modified to radially protrude above the axle bore, so that the effects of a loosening interference fit between the king pin and the axle bore can be mitigated through interaction between such a radial protrusion and the axle bore. Hereby, the potential consequences of loosening of the king pin can be mitigated, while retaining the advantages of an interference fit configuration.

The axle beam bore may be cylindrical, having the same diameter along substantially the entire axle beam bore.

The first king pin portion may be cylindrical.

The first cross-section of the first king pin portion may have a circular perimeter.

The second cross-section of the second king pin portion may have a circular perimeter.

According to embodiments, the first king pin portion may be completely inserted, in interference fit, in the axle bore.

According to embodiments, there may be a clearance between the axle bore and the second king pin portion when the king pin is in its intended mounting position in the axle bore. In these embodiments, the connection between axle bore and king pin will thus be pure interference fit, except in failure condition. This provides for a connection with a minimum of play in normal operation, and added safety in failure conditions involving loosening of the first king pin portion from the axle bore.

According to embodiments, the axle bore may have a first diameter at a first vertical level and a second diameter, greater than the first diameter, at a second vertical level, higher than the first vertical level; and the second king pin portion may be at least partly inserted in the axle bore, at least to the second vertical level.

The steering axle assembly according to embodiments of the present invention may advantageously be included in a vehicle, further comprising a vehicle body; and a wheel coupled to the steering axle assembly. The steering axle assembly may be arranged to allow the wheel to be turned in relation to the vehicle body.

According to a second aspect of the present invention, there is provided an assembly method for a steering axle assembly, comprising the steps of: providing an axle beam having an axle beam bore with a bore axis, exhibiting a minimum cross-section; providing a king pin having a king pin axis, the king pin including: a first king pin portion a having a first cross-section in a first plane perpendicular to the king pin axis, the first cross-section being dimensioned to be in interference fit with the minimum cross-section of the axle beam bore; and a second king pin portion having a second cross-section in a second plane perpendicular to the king pin axis, a projection of the second cross-section in the first plane perpendicular to the king pin axis at least partly extending outside the first cross-section of the king pin; and pressing the king pin through the axle beam bore in such a way that the first king pin portion becomes in interference fit with the axle beam bore.

According to embodiments, the axle bore may have a cylindrical first bore portion with a first bore diameter; and the first king pin portion may be cylindrical with a first king pin portion diameter dimensioned for interference fit with the first bore diameter of the first bore portion.

BRIEF DESCRIPTION OF THE DRAWINGS

With reference to the appended drawings, below follows a more detailed description of embodiments of the invention cited as examples.

In the drawings:

Fig. 1 is a side view of a vehicle according to an embodiment of the present invention, in the form of a truck having a steering axle assembly according to an embodiment of the invention.

Fig. 2 is a schematic section view of a steering axle assembly according to an exemplary embodiment of the invention.

Figs. 3A-C schematically illustrate different exemplary configurations of the steering axle assembly according to embodiments of the invention.

Figs. 4A-C schematically illustrate different exemplary configurations of the steering axle assembly according to embodiments of the invention.

Fig. 5 is a flow-chart schematically illustrating an example embodiment of the method according to the present invention.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS OF THE INVENTION

Fig 1 schematically shows a vehicle, here in the form of a truck 1, comprising a vehicle body 3 and wheels 5. In the exemplary truck 1 in fig 1, at least the front wheels 5 are steerable, and are therefore mounted on a steering axle assembly 7, which is indicated but not visible in fig 1.

Fig. 2 is a schematic cross-section view of an exemplary steering axle assembly 7 arranged to accommodate the front wheel 5 of the truck 1 in fig 1, to allow the front wheel 5 to be turned in relation to the vehicle body 3. Referring to fig 2, the steering axle assembly 7 comprises an axle beam 9 with an axle beam bore 11, a king pin 13, a knuckle 15, and upper 17a and lower 17b bearings. The axle beam bore 11 has a bore axis 12, and the king pin 13 has a king pin axis 27.

The king pin 13 is in interference fit with the axle beam bore 11, and the bearings 17a-b are provided between the king pin 13 and the knuckle 15, to allow the knuckle 15, and thereby the wheel 5, to swivel around the king pin 13.

As can be seen in the enlarged portion of fig 2, the king pin 13 has a first king pin portion 19 and a second king pin portion 21. The first king pin portion 19 is arranged inside the axle beam bore 11 and in interference fit with the axle beam bore 11. The second king pin portion 21 is not in contact with the axle beam 9 when the king pin 13 is in its intended mounting position in the axle beam bore 11. In other words, there is a clearance between the axle beam 9 and the second king pin portion 21 when the truck 1 is new and/or in

good working condition. In the event that the king pin 13 slides downwards in the axle beam bore 11 due to, for example, extreme longitudinal forces acting on the king pin 13, any such downward movement is effectively stopped by interaction between the second king pin portion 21 and the axle beam 9, as the second king pin portion 21 protrudes radially outside the axle beam bore 11. This will allow safe continued operation of the truck 1.

Further example configurations of the steering axle assembly 7 according to embodiments of the present invention will now be descried in greater detail with reference to figs 3A-C.

A first example configuration, schematically shown in fig 3A, corresponds to the configuration described above with reference to fig 2. In this first example configuration, the first king pin portion 19 is cylindrical, and the second king pin portion 21 is provided as a rotationally symmetrical protrusion arranged with a clearance in respect of the axle beam 9 when the king pin 13 is in its intended mounting position in the axle beam bore 11 as described above. As is schematically indicated in fig 3A, the first king pin portion 19 has a first cross-section in a first plane I-I' perpendicular to the bore axis 12 and the king pin axis 27, and the second king pin portion 21 has a second cross-section in a second plane II-II' perpendicular to the bore axis 12 and the king pin axis 27. The first cross-section of the first king pin portion 19 is in interference fit with a minimum cross-section of the axle beam bore 11, and a projection along the bore axis 12 of the second cross-section of the second king pin portion 21 extends outside the minimum cross-section of the axle beam bore 11. This will be described in greater detail further below with reference to figs 4A-C.

In a second example configuration, schematically shown in fig 3B, the first king pin portion 19 is cylindrical with a first diameter d1, and the second king pin portion 21 is provided as a second cylindrical king pin portion with a second diameter d2, greater than the first diameter d1. Again, there is a clearance between the second king pin portion 21 and the axle beam 9 when the king pin 13 is in its intended mounting position in the axle beam bore 11 as described above. As is schematically indicated in fig 3B, the first king pin portion 19 has a first cross-section in a first plane I-I' perpendicular to the bore axis 12 and the king pin axis 27, and the second king pin portion 21 has a second cross-section in a second plane II-II' perpendicular to the bore axis 12 and the king pin axis 27. The first cross-section of the first king pin portion 19 is in interference fit with a minimum cross-

section of the axle beam bore 11, and a projection along the bore axis 12 of the second cross-section of the second king pin portion 21 extends outside the minimum cross-section of the axle beam bore 11. This will be described in greater detail further below with reference to figs 4A-C.

In a third example configuration, schematically shown in fig 3C, the first king pin portion 19 is again cylindrical with a first diameter d1, and the second king pin portion 21 is provided as a second cylindrical king pin portion with a second diameter d2, greater than the first diameter d1. Above the second king pin portion 21, the king pin is cylindrical with the first diameter d1. The king pin diameters d1 and d2 are not indicated in the drawing to avoid cluttering the drawing. This third example configuration mainly differs from the above-described first and second configurations in that the axle beam bore 11 has a first diameter D1 at a first vertical level and a second diameter D2, greater than the first diameter D1 at a second vertical level, higher than the first vertical level. As is schematically shown in fig 3C, the second king pin portion 21 is at least partly inserted in the axle beam bore 11. The second diameter d2 of the second king pin portion 21 may be dimensioned to be in interference fit with the axle beam bore 11 at the second vertical level, or there may be a clearance fit between the second king pin portion 21 and the axle beam bore 11. Obviously, the second cross-section of the second king pin portion 21 extends outside the minimum cross-section of the axle beam bore 11. This will be described in greater detail further below with reference to figs 4A-C.

In the example configurations described so far, both the first king pin portion 19 and the second king portion 21 have been rotationally symmetrical in respect of the king pin axis 27. This configuration is schematically illustrated in fig 4A in a view taken along the bore axis 12/the king pin axis 27. As can be seen in fig 4A, the minimum cross-section 23 of the axle beam bore 11 coincides with the first cross-section 24 of the first king pin portion 19, since the first king pin portion 19 is in interference fit with the minimum cross-section 23 of the axle beam bore 11. Fig 4A also illustrates the second cross-section 25 of the second king pin portion 21, and as is evident from fig 4A, the projection along the bore axis 12 of the second cross-section extends outside the minimum cross-section 23 of the axle beam bore 11, so that the second king pin portion 21 cannot pass through the axle beam bore 11.

Figs 4B-C schematically illustrate other example configurations in which the second king pin portion 21 is not rotationally symmetrical in respect of the king pin axis 27, but still exhibit second cross-sections 25 extending outside the minimum cross-section 23 of the axle beam bore 11.

Fig. 5 is a flow-chart schematically illustrating an example embodiment of the method according to the present invention. In a first step 101, an axle beam 9 is provided. The axle beam 9 has an axle beam bore 11 with a bore axis 12, and exhibits a minimum cross-section 23. In the subsequent step 102 a king pin 13 is provided. The king pin 13 has a king pin axis 27, and comprises a first king pin portion 19 and a second king pin portion 21. The first king pin portion 19 has a first cross-section 24 in a first plane I-I' perpendicular to the king pin axis 27, the first cross-section 24 being dimensioned to be in interference fit with the minimum cross-section 23 of the axle beam bore 11. The second king pin portion 21 has a second cross-section 25 in a second plane II-II' perpendicular to the king pin axis 27. A projection of the second cross-section 25 in the first plane I-I' perpendicular to the king pin axis 27 at least partly extends outside the first cross-section 24 of the king pin 13. In the next step 103 the king pin 13 is pressed through the axle beam bore 11 in such a way that the first king pin portion 19 becomes in interference fit with the axle beam bore 11. Thereafter, bearings 17a-b and any other parts of the steering axle assembly 7 may be mounted using, *per se*, known methods.

It is to be understood that the present invention is not limited to the embodiments described above and illustrated in the drawings; rather, the skilled person will recognize that many changes and modifications may be made within the scope of the appended claims.

CLAIMS

1. A steering axle assembly (7) for a vehicle (1), comprising:

an axle beam (9) having an axle beam bore (11) with a bore axis (12), exhibiting a minimum cross-section (23); and

a king pin (13), in interference fit with the axle beam bore (11), including:

a first king pin portion (19) arranged inside the axle beam bore (11), the first king pin portion (19) having a first cross-section (24) in a first plane (I-I') perpendicular to the bore axis (12), the first cross-section (24) being in interference fit with the minimum cross-section (23) of the axle beam bore (11); and

a second king pin portion (21) arranged at a higher vertical level than the first king pin portion (19) when the steering axle assembly (7) is arranged in the vehicle (1), the second king pin portion (21) having a second cross-section (25) in a second plane (II-II') perpendicular to the bore axis (12), a projection along the bore axis (12) of the second cross-section (25) in the first plane (I-I') perpendicular to the bore axis (12) at least partly extending outside the minimum cross-section (23) of the axle beam bore (11).

2. The steering axle assembly (7) according to claim 1, wherein the axle beam bore (11) is cylindrical.

3. The steering axle assembly (7) according to claim 1 or 2, wherein the first king pin portion (19) is cylindrical.

4. The steering axle assembly (7) according to any one of the preceding claims, wherein the first cross-section (24) of the first king pin portion (19) has a circular perimeter.

5. The steering axle assembly (7) according to any one of the preceding claims, wherein the second cross-section (25) of the second king pin portion (21) has a circular perimeter.

6. The steering axle assembly (7) according to any one of the preceding claims, wherein the first king pin portion (19) is completely inserted in the axle beam bore (11).

7. The steering axle assembly (7) according to any one of the preceding claims, wherein there is a clearance between the axle beam (9) and the second king pin portion (21) when the king pin (9) is in its intended mounting position in the axle beam bore (11).

8. The steering axle assembly (7) according to any one of the preceding claims, wherein:

the axle beam bore (11) has a first diameter (D_1) at a first vertical level and a second diameter (D_2), greater than the first diameter (D_1), at a second vertical level, higher than the first vertical level; and

the second king pin portion (21) is at least partly inserted in the axle beam bore (11), at least to the second vertical level.

9. A vehicle (1) comprising:

a vehicle body (3);

a wheel (5); and

the steering axle assembly (7) according to any one of the preceding claims coupled to the wheel (5) to allow the wheel (5) to be turned in relation to the vehicle body (3).

10. An assembly method for a steering axle assembly (7), comprising the steps of:

providing (101) an axle beam (9) having an axle beam bore (11) with a bore axis (12), exhibiting a minimum cross-section (23);

providing (102) a king pin (13) having a king pin axis (27), the king pin (13) including:

a first king pin portion (19) a having a first cross-section (24) in a first plane (I-I') perpendicular to the king pin axis (27), the first cross-section (24) being dimensioned to be in interference fit with the minimum cross-section (23) of the axle beam bore (11); and

a second king pin portion (21) having a second cross-section (25) in a second plane (II-II') perpendicular to the king pin axis (27), a projection of the second cross-section (25) in the first plane (I-I') perpendicular to the king pin axis (27) at least partly extending outside the first cross-section (24) of the king pin (13); and

pressing (103) the king pin (13) through the axle beam bore (11) in such a way that the first king pin portion (19) becomes in interference fit with the axle beam bore (11).

11. The assembly method according to claim 10, wherein:

the axle beam bore (11) has a cylindrical first bore portion (29) with a first bore diameter; and

the first king pin portion (19) is cylindrical with a first king pin portion diameter dimensioned for interference fit with the first bore diameter of the first bore portion (29).

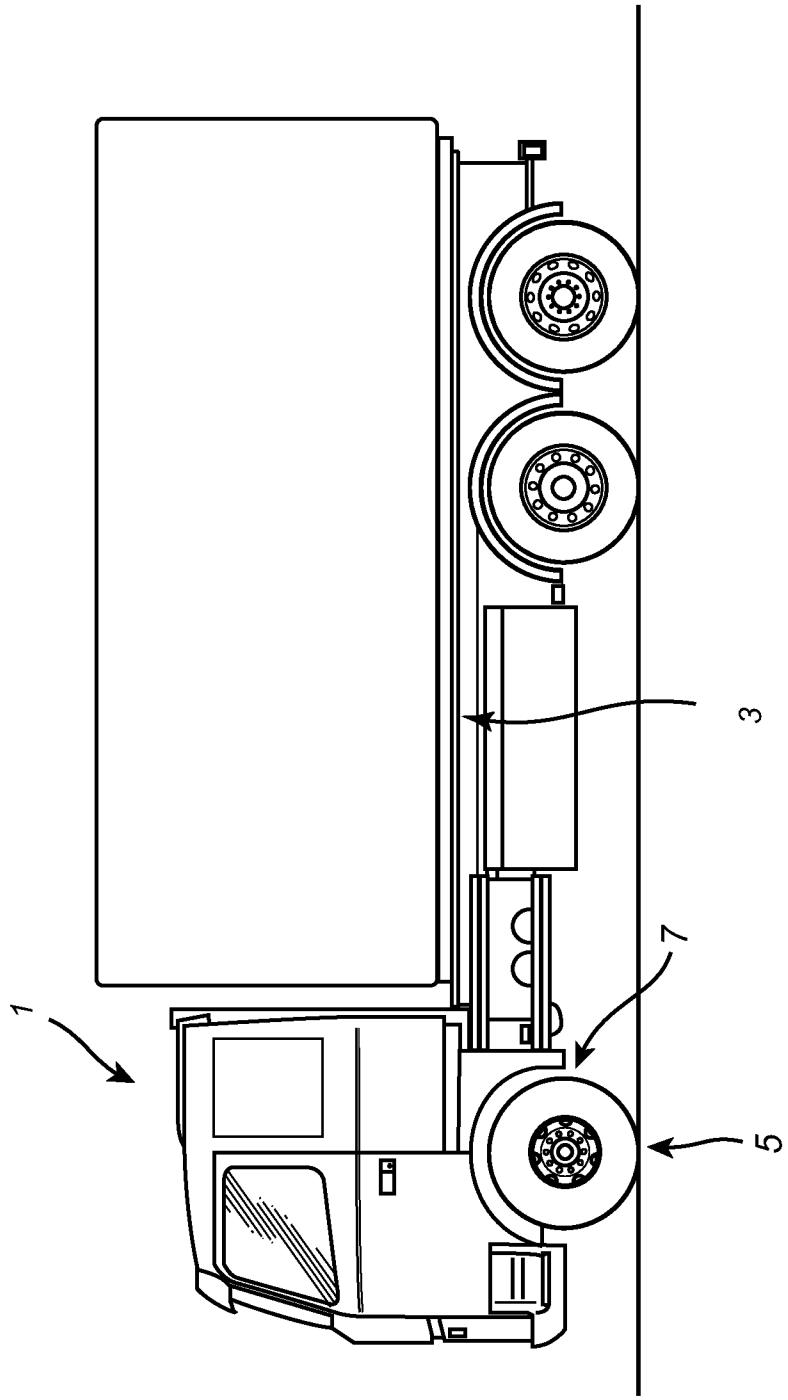

Fig. 1

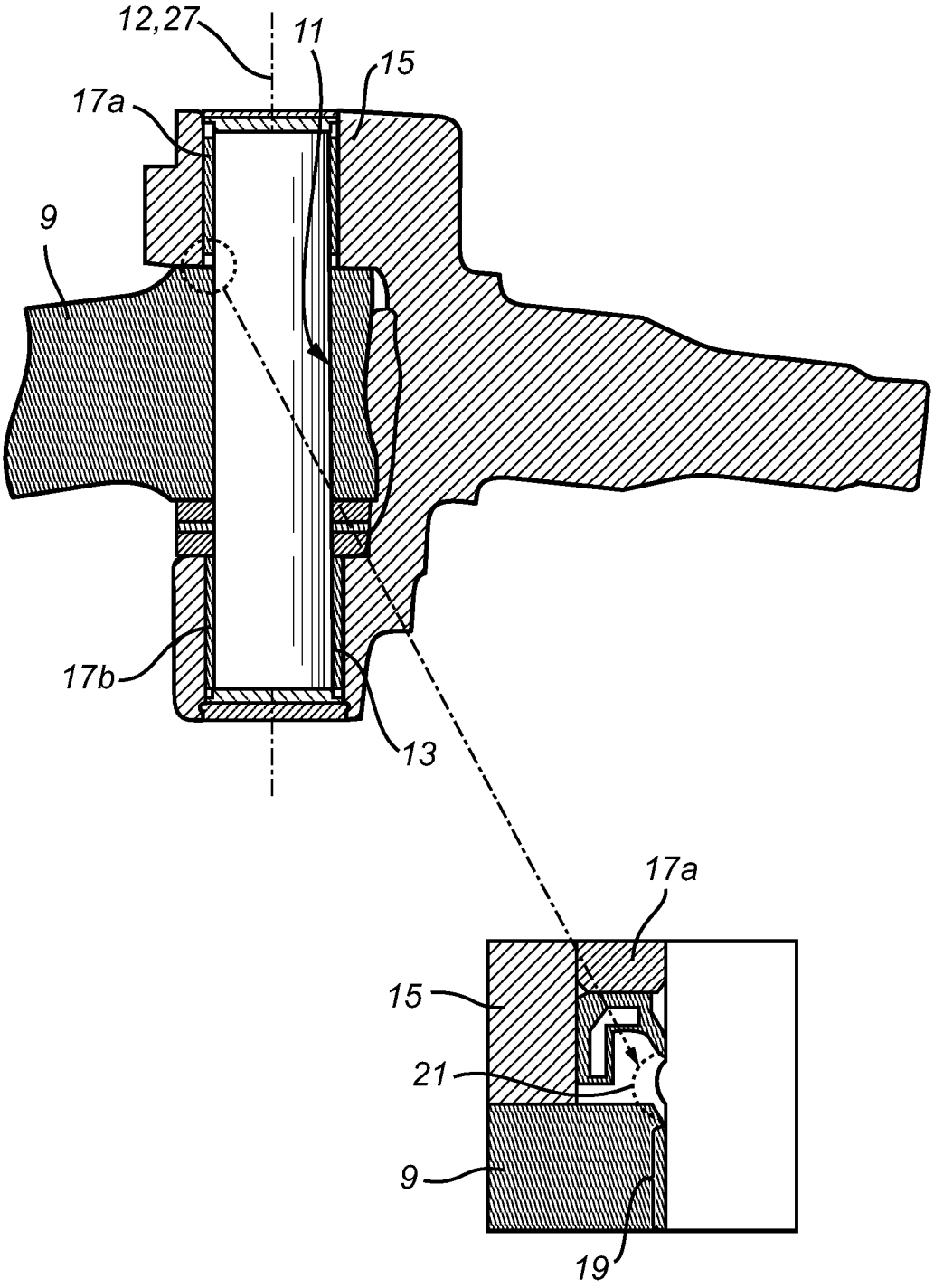

Fig. 2

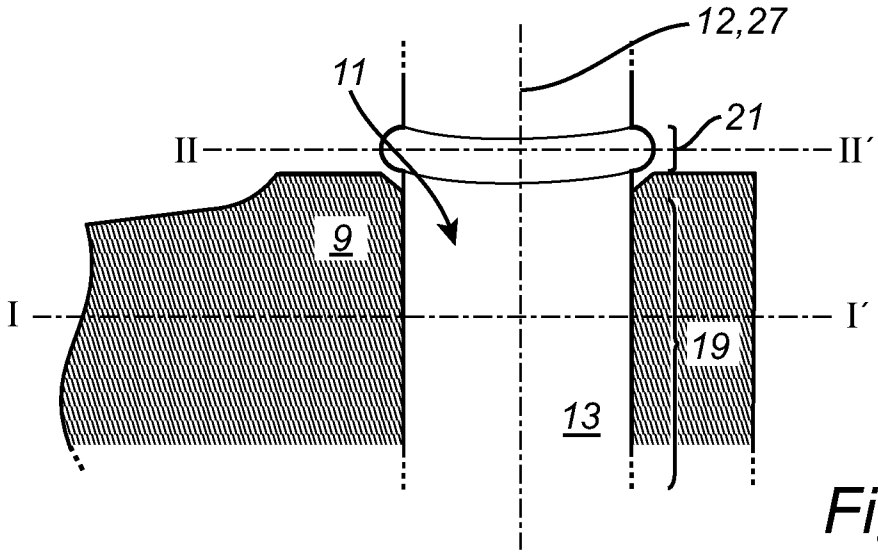

Fig. 3A

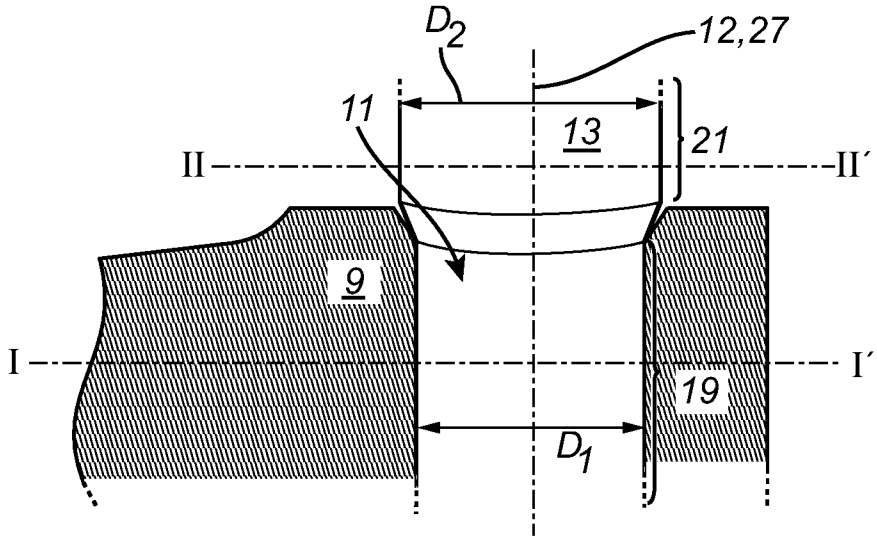

Fig. 3B

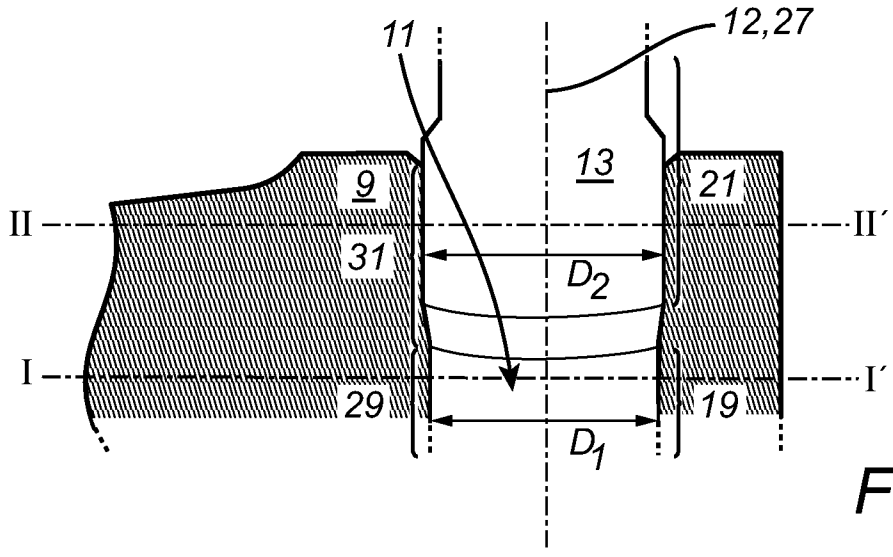

Fig. 3C

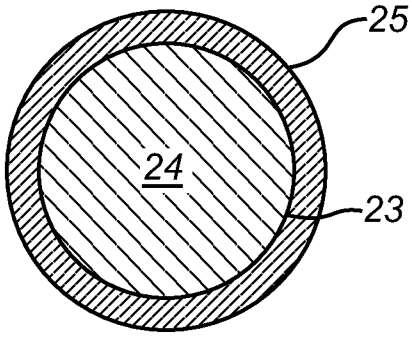

Fig. 4A

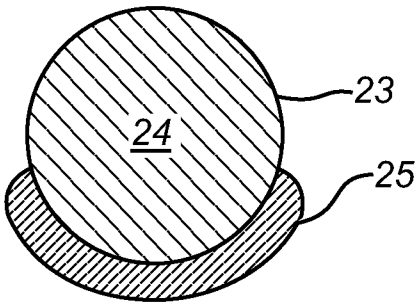

Fig. 4B

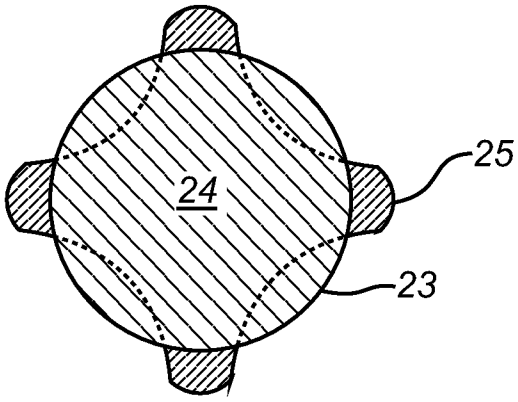

Fig. 4C

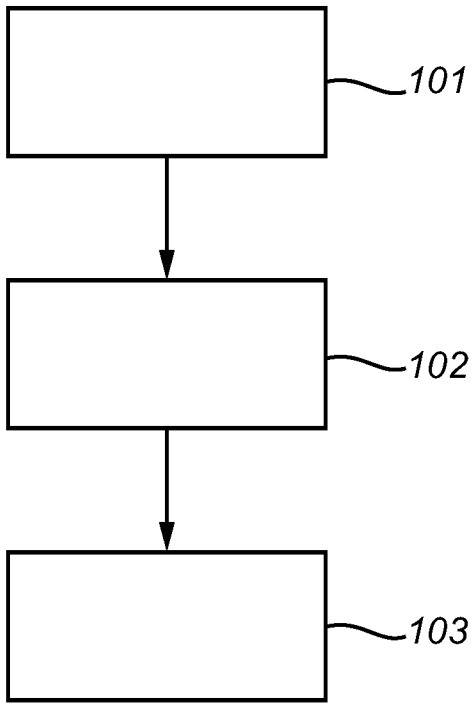

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/061409

A. CLASSIFICATION OF SUBJECT MATTER
INV. B62D7/18
ADD.

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)
B62D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 28 47 035 A1 (DAIMLER BENZ AG) 30 April 1980 (1980-04-30) the whole document -----	1-11

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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
2 July 2020	10/07/2020

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Areal Calama, A

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2020/061409

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 2847035 A1	30-04-1980	NONE	