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(54) Title: JOINT-SITE DESIGN COMPRISING A HUB AND A SHAFT OR A GEAR BEING FRICTION WELDED

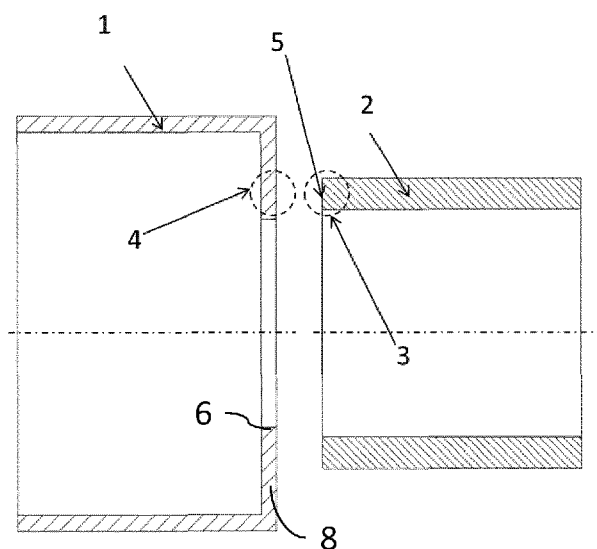


Fig.1

(57) Abstract: The present invention relates to a joint site design having a shaft (2) and a hub (1), for friction welding of the shaft (2) of a hard material with the hub (1) consisting of softer material, wherein the shaft (2) has a tubular shape with an end face (5) being joined to the hub having a connection area (4) with a flat shape formed by a radial shoulder (8) of the hub (1).



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JOINT-SITE DESIGN COMPRISING A HUB AND A SHAFT OR A GEAR BEING FRICTION WELDED

- 5 The invention relates to a joint site design for friction welding of a shaft of a hard material with a hub consisting of softer material.

State of the art

- 10 In vehicle construction, composite workpieces which are composed of a shaft and an essentially rotationally symmetrical hub part are used in numerous applications. Examples of hubs are transmission and clutch parts or also disk-shaped blanks which are still to be mechanically processed.
- 15 It is known to join a shaft and hub part in a connection region by friction welding. In this case, an end face of the shaft is joined to an end face of the hub part in a conventional manner. Alternatively, the shaft and hub part can be joined by means of overlap friction welding; this involves a variant of pressure welding in which, in contrast to conventional end-face
- 20 friction welding, the surfaces to be joined are arranged at the circumference of the components. In this case, for example, a shaft is welded to a hub part with overlap by one of the two components being set in rotation and being pressed onto the other stationary counterpart. The welding process starts at the contact surfaces of the components. After the plasti-
- 25 cization of the material located there by the friction heat, a permanent joint is obtained after the end of the rotary movement.
- Shown in DE 199 34 855 C1 is a friction-welded shaft/disk composite workpiece which is assembled from a disk having a through-hole and from

a shaft by means of overlap friction welding. During the welding of shaft and disk, annular connection sections are produced, between which annular cavities are formed. A reduction in the weight of the entire part is achieved by the joint sites offset from one another radially and axially, it
5 being possible for the cavities to be used, for example, for directing oil.

In the state of the art shafts and hubs for a composite clutch are connected by a intermeshing toothing between the components to achieve a frictional or positive fitting connection. The use of the clutches is mainly in
10 transfer cases and automatic transmission applications.

Known applications have a so called "tube to tube" joint design. This means that friction welding takes place between two end faces which have a pipe shape. In comparison to the pipe shaped end face of the softer part
15 the harder part has a larger or equal pipe outside diameter and a smaller or equal pipe inside diameter. With other words the harder part has an equal or larger end face than the soft part. This guarantees that the end face of the softer part will always fully touch the end face of the harder part. The harder side keeps being pipe shaped in the joining location, but
20 the softer part has a flat surface in the joining location. This means that the softer part has the larger joining surface ("end face"). This has major advantages in terms of packaging and cost. The end face of the harder part is designed in a way that it is guaranteed that the typical material squeezing out can take place in order to create an atomic bond.

25

The object of the invention is to specify a novel design of the joint site for a shaft-hub composite workpiece for a clutch, with which design the mechanical strength properties of the joint are increased.

The object is to find a joint design for friction welding of a harder material (higher melting point) with a softer material (lower melting point) with the challenge of having a simple and cheap part preparation and with the target of meeting lowest package specifications.

5

The object is achieved according to the invention by the features of independent claim. Advantageous configurations can be gathered from the subclaims.

According to the invention the joint design for friction welding of a harder
10 with a significant softer material comprises a tubular shape on the harder and a flat shape on the softer side. This means the joint design is adapted to weld a material with a higher melting temperature with a material with significant lower melting temperature, where the side with higher melting
15 temperature has a tubular shape and the side with lower melting temperature has a flat shape.

According to the invention, the joint-site structure of a shaft-hub composite work piece, in particular for joining a shaft to a connection area of a hub part of a clutch by means of friction welding, is designed in such a way that connection area of a hub part is located a defined distance apart
20 the inner circumference of the hub part and the spread of the material softened during the friction welding is not flowing up to the edge of the hub part component.

The advantage is a reduction in manufacturing costs for the softer part.
25 The variation of the friction welding shortening decreases significantly. The invention reduces package space compared to state of the art friction welding joints. The invention allows the usage of low weighted materials for clutches replacing actual common designs.

To reduce weight of a vehicle all part has to be as light as constructional possible and the invention opens a way to design a clutch with low weight material.

- 5 The projection or protrusion on account of the forced-out material at the joint site is preferably machined after the friction welding in order to obtain a rounded portion.

- 10 In an advantageous configuration of the invention, a plurality of joint sites axially offset from one another are provided between shaft and hub part. In this case, it is advantageous for the self-centering and relative axial orientation of the joining members during the friction welding to offset the joint sites of the joining members axially and radially relative to one another in such a way that the joint sites of the joining members on the
- 15 composite workpiece, after the welding, are arranged at an angle of between 10[deg.] to 20[deg.], preferably 15[deg.], to one another. The composite workpiece produced is then cylindrically symmetric.

- 20 This end-face friction welding of the shaft to the hub part avoids conical distortion of the hub part occurring due to asymmetrical shrinkage of the hub part after the friction welding. The method according to the invention is not associated with any conical distortion of the joining members at all; the original cylindrical symmetry of the two joining members is thus retained in the composite workpiece with high accuracy.

25

The shaft and hub part may be made of different materials. In particular, a hardened shaft may be used, and/or the hub part may be finish-machined (hardened, ground, etc.).

Short description of Invention

The invention is described below with reference to an exemplary embodiment shown in the schematic drawings. The drawings, the description and
5 the claims contain numerous features in combination. The person skilled in the art will also expediently consider the features individually and form appropriate further combinations therefrom.

FIGS. 1 show a shaft hub composite work piece

10 FIGS. 2a, 2b, 2c 2d show the structure of the joint site

According to FIG. 1, a shaft 2, e.g. an input shaft of a clutch, is joined to a hub part 1 of a clutch having a connection area 4.

The connection area 4 is formed at the surface of a radial shoulder 8 of
15 the hub that forms a rim with a 90° angle between hub and shoulder. The radial shoulder must have a dimension that allows the shaft to contact the end faces 5 to a flat area.

At the shaft the joining area 3 is finally in contact with connection area 4.

The end face 5 of the shaft 2 is shown in details in figures 2a, 2b, 2c and
20 2d. The end face as shown in 2a is a flat end face. The position of the end face in relation to the hub 1 and the inner opening circumference 6 is shown in this figure. The shaft end face 5 is placed a distance d1 away from inner circumference 6.

The shaft material will be steel and the hub will be made of aluminium or
25 another low weight metal or alloy.

Due to the friction welding, the heated, soft material escapes from the joining area 3 and forms a projection 7 of material around the shaft's end

face 5. The joining area is allocated in a way to avoid that the melted material flow to the edge of the hub. The distance d_2 between the inner circumference 6 and the end position of the melted material is at least 1 mm to maintain dimension and structure of the hub 1. So the joining area 3 is
5 allocated so that $d_1 > d_2$ is realized, wherein d_2 is approximately between 1 to 5 mm.

A projection or protrusion 7 of the material of the joint site is obtained after the friction welding, and this projection or protrusion 7 can be machined, for example, after the friction welding in order to obtain a rounded
10 portion 7.

The face end 5 of the shaft can be optimized or the welding process and the joint. Alternative solutions are shown in the figures 2. Fig. 2a shows a flat end face parallel to the flat area 4 of the hub and perpendicular to the
15 long axis of the shaft. Figure 2b and 2 d show inclined faces 5 that result in asymmetric joints. The solution of figure 2c shows a curved or convex end face of the shaft 2.

To produce a composite work piece of a shaft 2 for a clutch having a connection area 4 of a hub part, first of all a one-piece hub unit-comprising the hub part and the connection area-is produced. Then hub and shaft
20 are connected by friction welding.

Figure 3 shows a further embodiment of the invention. The shaft 2 – the
25 harder part - is a shaft of a clutch. The hub 1 – the softer part - is a clutch hub. The connection area 4 is formed as a tubular end fitting formed in the radial shoulder 8 of the hub 1. This tubular end fitting has an end face which is normal to the axis of the hub 1, the shaft 2. The connection

area 3 of the harder part - the shaft 2 – is arranged at a saucer-shaped end piece and formed at its border area. The connection area is flat shaped – normal to the axis of the shaft 2.

- 5 Figure 4 shows an enlarged view of the connection between the hub 1 and the shaft 2 with the displaced material 7 - the protrusion – made by friction welding.

- Figure 5 shows an embodiment of the invention with two friction welding joints. A softer part – hub 1 – is connected with a harder part – a shaft 2.
10 This joining location is tubular shaped – the shaft 2 has a saucer-shaped end piece and is connected with the radial shoulder of the hub 1.

- A second hub or a housing 1a – a soft or a hard part – is connected with
15 the hub 1 in a further joining location 10 with flat shape – concentric to the inner joining location 9 between the shaft 2 and the hub 1. Figure 6 is an enlarged view of the two joining locations 9, 10 between the shaft 2 and the hub 1 or between the hub 1 and the hub 1a. As shown the end face design of the tubular side can differ from a flat design.

20

Figure 7 shows an embodiment of the invention – a connection between a hub 1 and a gear 2. The end face design of the tubular side 3 can differ from a flat design 4 of the hub.

25

References

- 1 Hub
- 2 Shaft or gear
- 3 Joining area with tubular shape
- 4 Joining area with flat shape
- 5 5 End face of shaft
- 6 Inner circumference
- 7 Protrusion
- 8 radial shoulder
- d1,d2 distance
- 10 1a Hub or housing
- 9 Joining Location
- 10 Joining Location

Claims

1. A joint site design for friction welding of a shaft (2) or a gear of a hard material with a hub (1) consisting of softer material, characterized in that the shaft (2) or the gear has a tubular shape with an end face (5) being joined to the hub (1) having connection area (4) with a flat shape formed by a radial shoulder (8) of the hub (1).
2. A joint site design for friction welding according claim 1 characterized in that connection area (4) of a hub part is located at a defined distance (d1) apart the inner circumference (6) of the hub part
3. A joint site design for friction welding according claim 2 characterized in that the distance (d1) is more than the thickness of protrusion (7) by melted material.
4. A joint site design for friction welding according claim 3 characterized in that a distance (d2) is remaining between protrusion (7) by melted material and the inner circumference (6) of the hub.
5. A joint site design for friction welding according claim 2 characterized in that the distance (d1) is more than the remaining distance (d2).
6. A joint site design for friction welding according claim 1 characterized in that the end face (5) of the shaft (2) is flat and perpendicular to the shaft long axis.
7. A joint site design for friction welding according claim 1 characterized in that the end face (5) of the shaft (2) is flat inclined versus the shaft long axis.

8. A joint site design for friction welding according claim 1 characterized in that the end face (5) of the shaft (2) is conical shaped

.

5 9. A joint site design for friction welding according claim 1 characterized in that joint sites of the joining members on the composite workpiece, after the welding, are arranged at an angle of between 10[deg.] to 20[deg.], preferably 15[deg.], to one another.

10 10. A joint site design for friction welding according claim 1 characterized in that the hub and the shaft are parts of a clutch.

11. A joint site design for friction welding according one of the former claims characterized in that joint sites are optimized to be used in transfer cases and automatic transmissions.

15

12. A joint site design for friction welding according one of the former claims characterized in that the hub (1) has a connection area (4) with a flat shape which is formed as a tubular end fitting
20 formed in the radial shoulder (8) of the hub (1).

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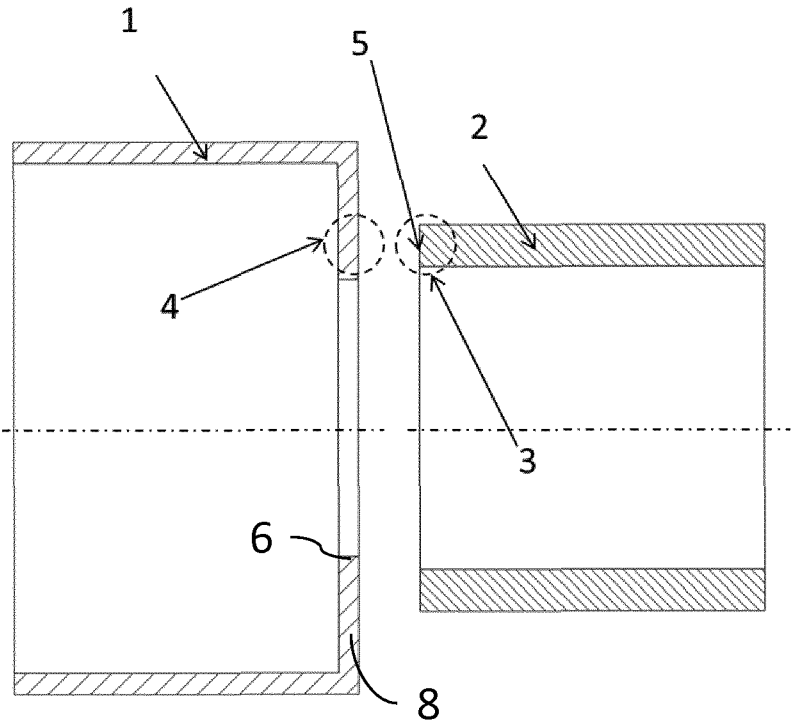


Fig.1

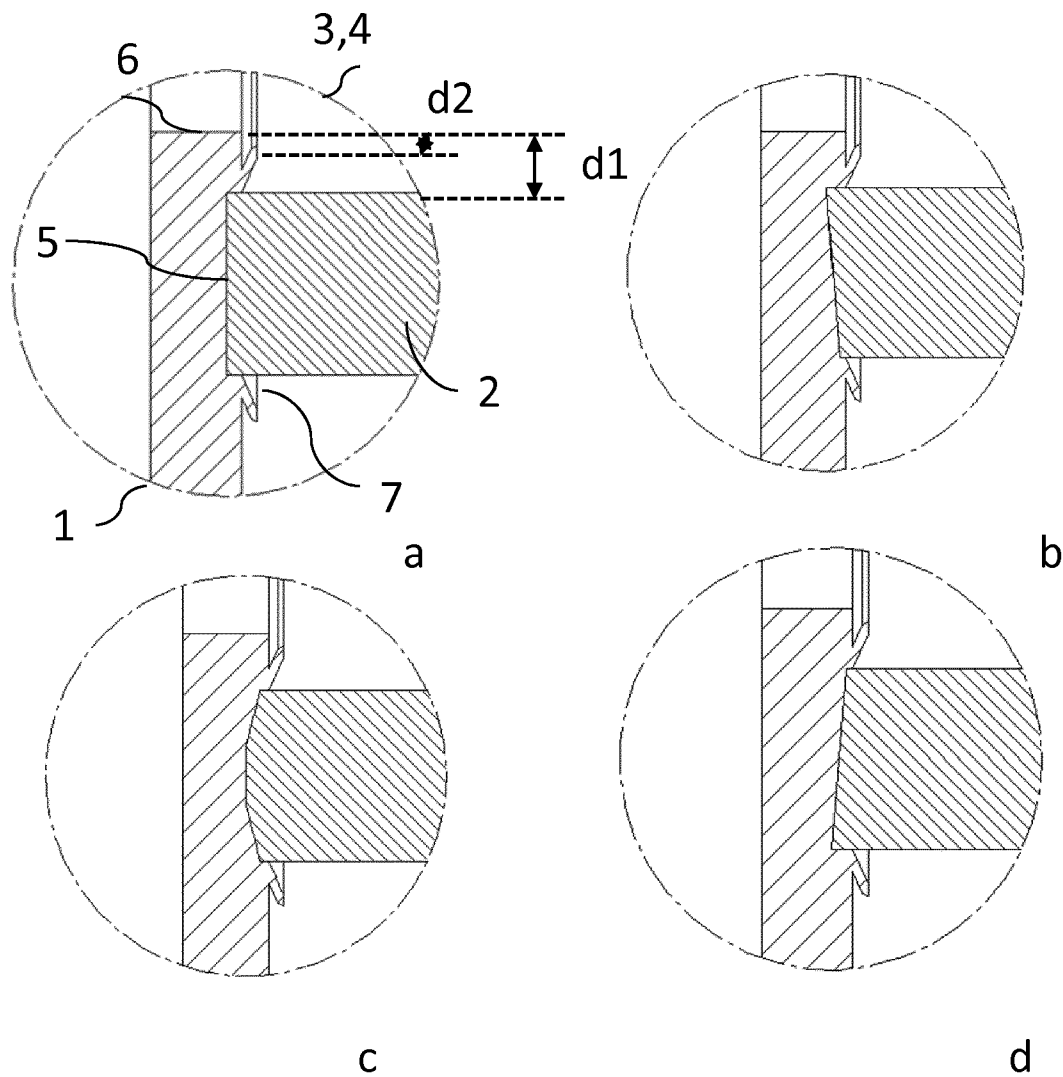
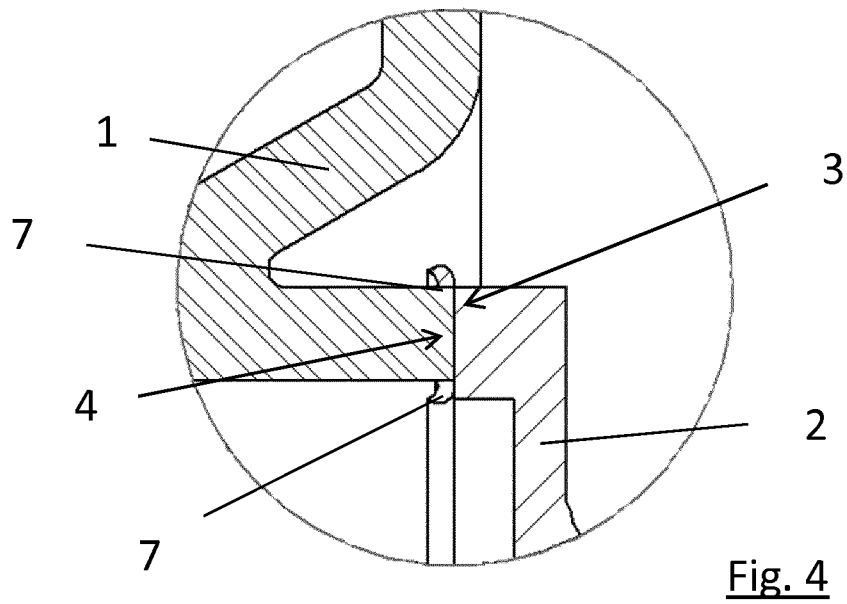
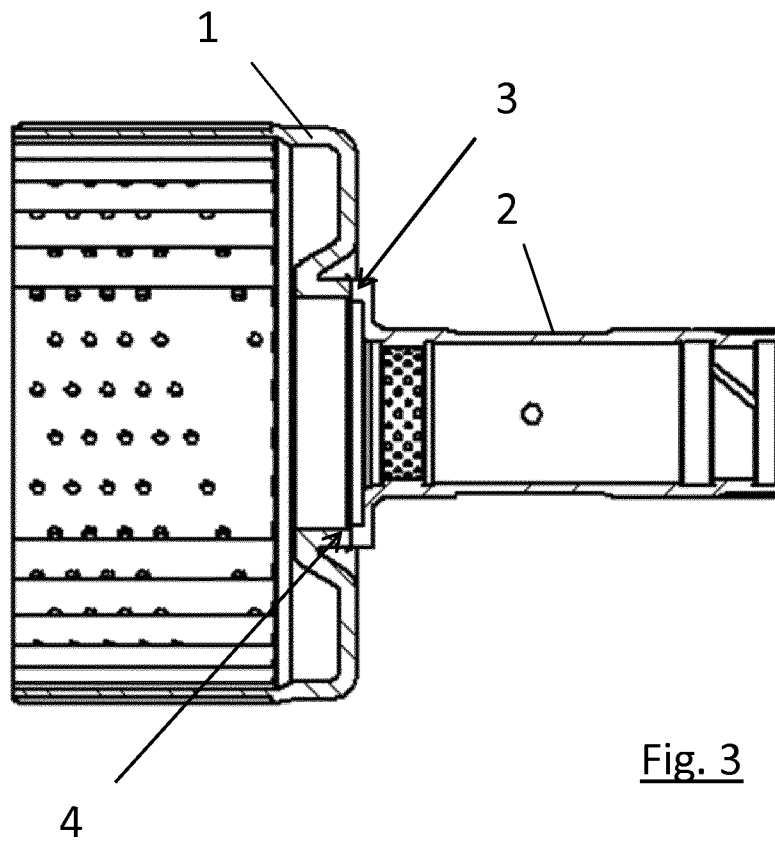
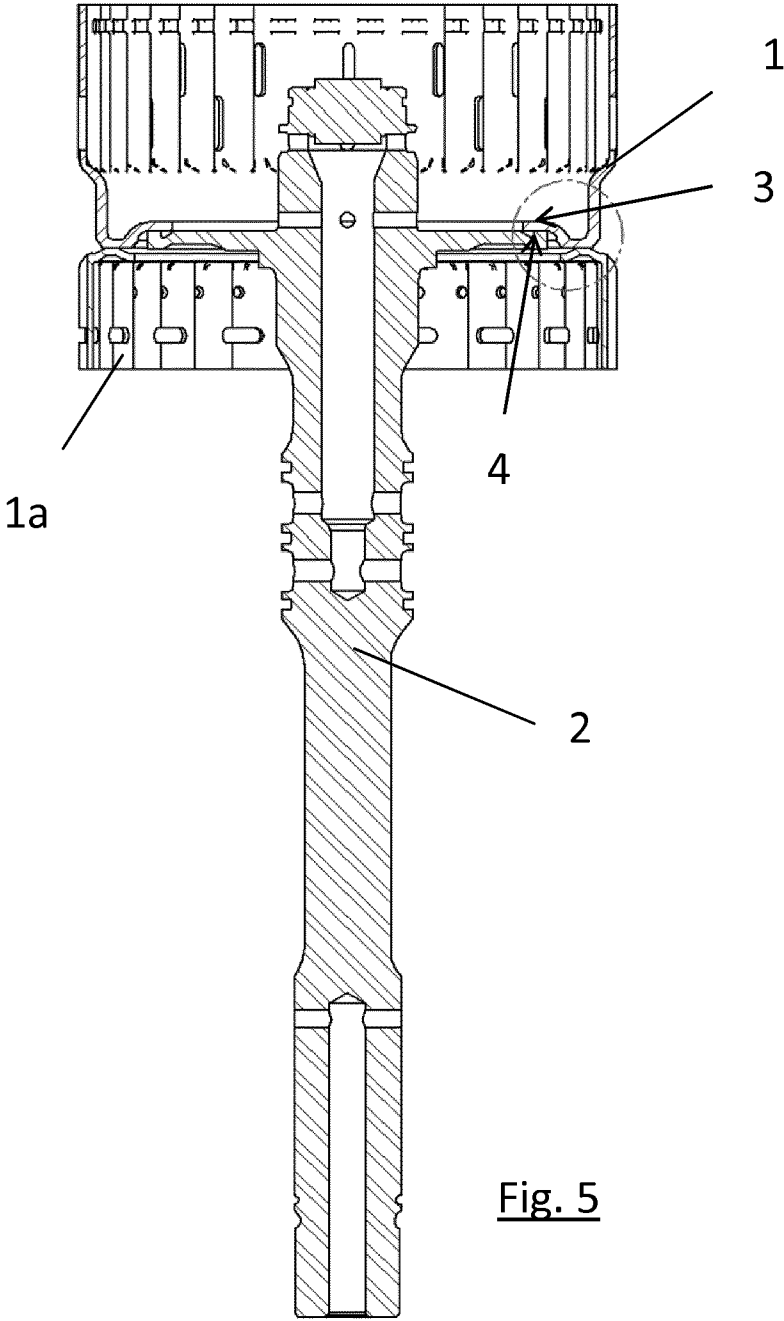


Fig.2

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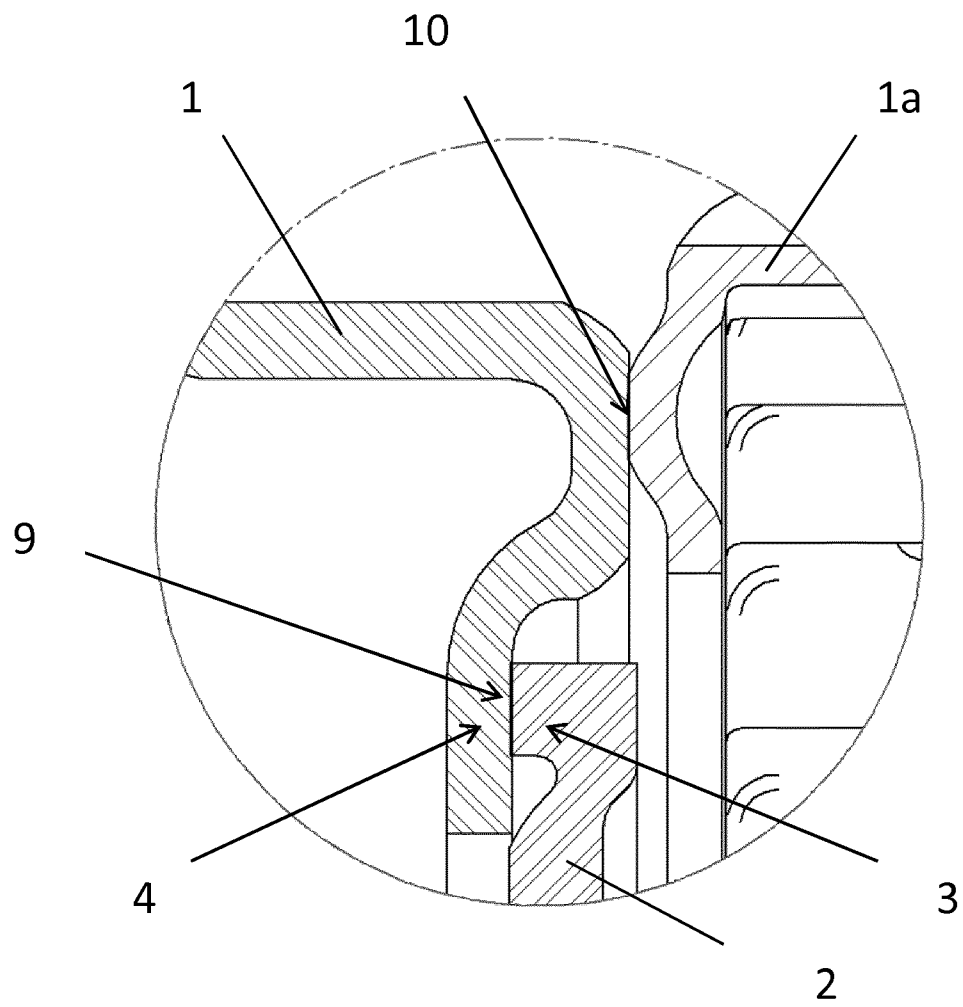


Fig. 6

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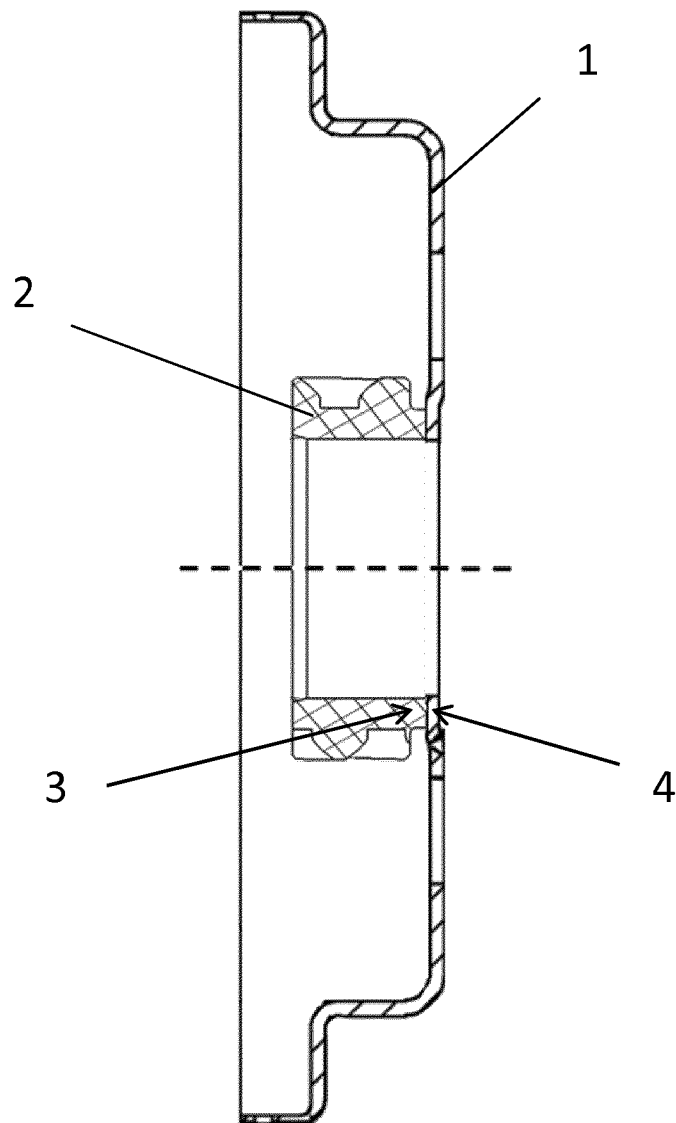


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2014/050790

A. CLASSIFICATION OF SUBJECT MATTER
INV. B23K20/12 B23K33/00 F16D1/068
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)
B23K F16D

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.
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Y	column 2, lines 22-49; figures -----	10,11
A	WO 2012/047562 A2 (NAT OILWELL VARCO LP ; J. F. HUGGHINS) 12 April 2012 (2012-04-12) abstract; figures -----	7,8
Y	DE 199 34 855 C1 (DAIMLER CHRYSLER AG) 9 November 2000 (2000-11-09) cited in the application column 1, lines 6-12; figures -----	10,11
X	JP H06 109101 A (HITACHI LTD) 19 April 1994 (1994-04-19) abstract; figures -----	1-5,10, 12



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"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

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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

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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