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(54) INTERNAL COMBUSTION ENGINE

VERBRENNUNGSMOTOR

MOTEUR À COMBUSTION INTERNE

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(73) Proprietor: **Mahle International GmbH**
70376 Stuttgart (DE)

(72) Inventor: **PADOVAN, Dominik**
5000 Nova Gorica (SI)

(74) Representative: **BRP Renaud & Partner mbB**
Rechtsanwälte Patentanwälte
Steuerberater
Königstraße 28
70173 Stuttgart (DE)

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Description

[0001] The present invention relates to an internal combustion engine having a starter motor with a drive pinion according to the preamble of Claim 1. In addition, the invention relates to a starter motor for such an internal combustion engine and to a drive pinion for such a starter motor.

[0002] In order to start internal combustion engines, electric starter motors comprising a drive pinion are usually employed, which drive pinion for starting the internal combustion engine is moved in the axial direction and intermeshed with a toothing and thus drive-connected to a shaft of the internal combustion engine. To this end, a first gear ring with first teeth located outside on the lateral surface is usually provided on the drive pinion of the starter motor, wherein the shaft of the internal combustion engine comprises a second gear ring with second teeth located outside on the lateral surface. The first and second teeth are designed in such a manner that in operative connection they mesh with one another. For starting the internal combustion engine, the drive pinion with its first teeth is thus adjusted in the axial direction toward the shaft with its second teeth and thereby brought into operative connection. An operative connection in this case is only possible however provided that the first teeth of the drive pinion mesh with the second teeth of the shaft of the internal combustion engine.

[0003] From JP 2009-168230 an internal combustion engine is known, having a starter motor with a drive pinion, which when starting the internal combustion engine is drive-connectable to a shaft of the internal combustion engine, wherein the drive pinion comprises a first gear ring with first teeth located outside on the lateral surface and a first front side and is adjustable in the axial direction toward the shaft, wherein the first front side faces the shaft and wherein the shaft of the internal combustion engine comprises a second gear ring with second teeth located outside on the lateral surface. The first gear ring and the second gear ring are designed in such a manner that upon an axial adjusting of the drive pinion toward the shaft a first engagement situation arises, in which exclusively a first tooth engages between two second teeth or a second tooth engages between two first teeth.

[0004] From GB 256,089 A and from US 1,979,869 A further drive pinions are known.

[0005] Often, the drive pinion however strikes with a first front side against an associated front side of the shaft and has to be rotated in order to be able to bring about introducing the first teeth of the drive pinion between the second teeth of the internal combustion engine.

[0006] Here it is disadvantageous that when the drive pinion is not fed toward the shaft in an accurately fitting manner the first front side of the drive pinion lies against the associated front side of the shaft where it rubs, which does not only create comparatively high frictional forces but also unnecessarily increases a wear.

[0007] The present invention therefore deals with the problem of stating an improved or at least an alternative embodiment for an internal combustion engine of the generic type, which overcomes the disadvantages known from the prior art.

[0008] According to the invention, this problem is solved through the subject of the independent Claim 1. Advantageous embodiments are subject of the dependent claims.

[0009] The present invention is based on the general idea of forming a drive pinion with a first gear ring with first teeth located outside on the lateral surface or a first front side of the same or a shaft of an internal combustion engine with a second gear ring with second teeth located outside on the lateral surface, in such a manner that upon an axial adjusting of the drive pinion toward the shaft a first engagement situation arises, in which exclusively a first tooth engages between two second teeth or a second tooth engages between two first teeth, as a result of which a friction and thus also a wear can be significantly reduced since, in the past, with drive pinions known from the prior art, usually three teeth of the first gear ring of the drive pinion lie and rub against three associated teeth of the second gear ring of the shaft. The internal combustion engine according to the invention comprises a starter motor with the previously described drive pinion which when starting the internal combustion engine is drive-connectable to the shaft of the internal combustion engine. The drive pinion has a first gear ring with first teeth located outside on the lateral surface and a first front side and is adjustable in the axial direction toward the shaft of the internal combustion engine, wherein the first front side of the drive pinion faces the shaft. The shaft of the internal combustion engine in turn comprises a second gear ring with second teeth located outside on the lateral surface, which are usually formed complementarily to the first teeth of the drive pinion and because of this can mesh with the latter. According to the invention, the first gear ring and the second gear ring are now designed in such a manner that upon the axial adjusting of the drive pinion toward the shaft the above-described first engagement situation arises, in which exclusively a first tooth engages between two second teeth or a second tooth engages between two first teeth. Upon a further axial adjusting of the drive pinion toward the shaft a further engagement situation arises, in which at least one further first tooth engages between two further second teeth or a further second tooth engages between two further first teeth. In this way, it is possible in particular for a contact area between the two front faces of the gear rings upon a non-meshing movement into one another to be reduced. Obviously, this case occurs only provided that the first teeth of the drive pinion are not already aligned relative to the second teeth of the second gear ring on the shaft in such a manner that a direct sliding into one another is possible. Through the drive pinion according to the invention and the internal combustion engine according to the invention, starting of the same can thus be made significantly lower in friction and in

addition significantly lower in wear.

[0010] According to the invention the first gear ring located outside on the lateral surface or the second gear ring located outside on the lateral surface has a foot circle diameter d_f and a useful tip circle diameter d_a, wherein the first front side or the second front side between the useful tip circle diameter d_a and a radial region B about the foot circle diameter d_f between d_f - 6mm < B < d_f + 3mm is rounded out with a radius R and because of this has a convex shape in this region. By way of this special embodiment, a front-side contact between the first front side of the drive pinion and an associated front side of the shaft located opposite can be limited to a maximum of two first teeth on the first gear ring of the drive pinion, wherein at the same time, because of the convexly rounded-out radial region B, only a comparatively small contact area is also present on the first teeth that are in contact. Thus, this is entirely different than with drive pinions known from the prior art in the past, which merely had a bevel on each tooth located outside on the front side. With such drive pinions, three teeth on the first gear ring usually entered into front-side contact with three associated teeth on the second gear ring of the shaft, as a result of which a significantly increased friction took place.

[0011] Also according to the invention an axial depth h between the first front side of the drive pinion or the second front side on the shaft and the useful tip circle diameter d_a amounts to between 1mm < h < 5mm. Because of this, it is possible to react individually to the configuration of the second gear ring on the shaft and for example minimize a friction and a wear.

[0012] In a further advantageous embodiment of the solution according to the invention, the first front side or the second front side between the useful tip circle diameter d_a and the foot circle diameter d_f is rounded out with a radius R and because of this has a convex shape in this region. In this concrete exemplary embodiment, the convex shape is thus delimited in radial direction to the inside by the foot circle diameter d_f and to the outside by the useful tip circle diameter d_a. Because of this, a particularly light and low-friction intermeshing of the drive pinion with the associated shaft of the internal combustion engine and thus a particularly low-friction and low-wear starting of the internal combustion engine can be achieved.

[0013] Practically, the drive pinion comprises a hub aperture with an internal toothing, as a result of which a rotationally fixed and at the same time extremely simple connection with a driveshaft, for example an electric motor, which is part of a starter motor, becomes possible. The drive pinion itself can be produced for example by means of cold extrusion, wherein such a cold extrusion makes possible a high-quality forming that is at the same time simple and cost-effective from a production point of view.

[0014] Furthermore, the present invention is based on the general idea of specifying a starter motor for an internal combustion engine described in the preceding paragraphs, having a drive pinion, which comprises a first gear ring with first teeth located outside on the lateral surface and a first front side. The first gear ring located outside on the lateral surface in this case has a foot circle diameter d_f and a tip circle diameter d_a, wherein the first front side between the useful tip circle diameter d_a and a radial region B about the foot circle diameter d_f between d_f - 6mm < B < d_f + 3 mm is rounded out with a radius R and because of this has a convex shape in this region. Such a starter motor makes possible a low-friction and simultaneously a low-wear starting of the internal combustion engine since when the drive pinion is operationally connected to the shaft of the internal combustion engine, which takes place for example by axially adjusting the drive pinion toward the shaft, when the first front side of the drive pinion lies against an associated front side of the shaft a contact exclusively takes place via a single first tooth of the first gear ring with a second tooth of the second gear ring and not via three teeth as was usual in the past. An axial depth h between the first front side of the drive pinion or the second front side on the shaft and the useful tip circle diameter d_a amounts to between 1mm < h < 5mm.

[0015] Furthermore, the present invention is based on the general idea of specifying a drive pinion for a starter motor described in the aforementioned paragraph, which comprises a first gear ring with first teeth located outside on the lateral surface and a first front side, wherein the first gear ring located outside on the lateral side has a foot circle diameter d_f and a useful tip circle diameter d_a and wherein the first front side between the useful tip circle diameter d_a and a radial region B about the foot circle diameter d_f between d_f - 6mm < B < d_f + 3mm is rounded out with a radius R and because of this has a convex shape in this region. Such a drive pinion, which can be produced for example cost-effectively and with a high quality at the same time by means of cold extrusion, makes possible in particular also a retrofitting of a previously installed starter motor or a previously installed internal combustion engine, as a result of which with comparatively little monetary expenditure the friction and the wear can be significantly reduced. An axial depth h between the first front side of the drive pinion or the second front side on the shaft and the useful tip circle diameter d_a amounts to between 1mm < h < 5mm.

[0016] It is of course also possible for the second gear ring of the shaft of the internal combustion engine to be configured analogously to the first gear ring of the drive pinion described in the preceding paragraph.

[0017] Further important features and advantages of the invention are obtained from the subclaims, from the drawings and from the associated figure description by way of the drawings.

[0018] It is to be understood that the features mentioned above and still to be explained in the following can be used not only in the respective combination stated but also in other combinations or by themselves without leaving the scope of the present invention, as defined in the

appended claims.

[0019] Preferred exemplary embodiments of the invention are shown in the drawings and are explained in more detail in the following description, wherein same reference characters relate to same or similar or functionally same components. There,

Fig. 1a schematically shows a front view of a starter motor with a drive pinion according to the prior art,

Fig. 1b schematically shows a representation as in Fig. 1a, however with a drive pinion according to the invention,

Fig. 2a schematically shows a lateral representation of the drive pinion and of a shaft according to Fig. 1a according to the prior art,

Fig. 2b schematically shows a representation as in Fig. 2a, however with the drive pinion according to the invention according to Fig. 1b,

Fig. 3a schematically shows an oblique view from the direction A according to Fig. 2a,

Fig. 3b schematically shows an oblique view from the direction A with the drive pinion and the shaft according to Fig. 2b,

Fig. 4 schematically shows a drive pinion according to the invention in a front view and a sectional representation along the section plane A-A,

Fig. 5 schematically shows an oblique view of an internal combustion engine according to the invention in a first engagement situation,

Fig. 6a schematically shows a side view of a drive pinion and of a shaft in a first engagement situation in the case of a correspondingly formed first gear ring on the drive pinion,

Fig. 6b schematically shows a representation as in Fig. 6a, but in the case of a correspondingly formed second gear ring on the shaft,

Fig. 7a schematically shows a representation as in Fig. 6a, but in a second engagement situation,

Fig. 7b schematically shows a representation as in Fig. 7a, but in a second engagement situation.

[0020] According to Fig. 1b to 3b and 5 to 7, an internal combustion engine 1 according to the invention comprises a starter motor 2 according to the invention with a drive pinion 3 likewise according to the invention, which during the starting of the internal combustion engine 1 is drive connectable to a shaft 4 of the internal combustion engine 1. According to Figures 1b to 3b as well as 5, 6a and 7a, the drive pinion 3 according to the invention comprises a first gear ring 5 with first teeth 6 located outside on the lateral surface and a first front side 7 (see Fig. 2b) and is adjustable in the axial direction 8, which according to Fig. 1b runs perpendicularly to the figure plane, toward the shaft 4, wherein the first front side 7 of the drive pinion 3 faces an associated, in particular second, front side 9 of the shaft 4. Similarly, the internal combustion engine 1' known from the prior art is formed according to Fig. 1a, 2a and 3a, wherein the same reference characters here relate to the corresponding components merely distinguished by an apostrophe. In addition, the shaft 4 of the internal combustion engine 1 has a second gear ring 10 with second teeth 11 located outside on the lateral surface. In order to be able to rotate the shaft 4 via the drive pinion 3 of the starter motor 2 and thus start the internal combustion engine 1, the drive pinion 3 is thus pushed in the axial direction 8 toward the shaft 4 until the first teeth 6 of the first gear ring 5 of the drive pinion 3 mesh with the second teeth 11 of the second gear ring 10 of the shaft 4. However, when the first and second teeth 6, 11 are arranged aligned relative to one another in the axial direction 8, these contact one another at contact points 12. Looking at the internal combustion engine 1' according to Fig. 3a it is evident that when the drive pinion 3' is moved in the axial direction 8' toward the shaft 4' and simultaneously aligned teeth 6', 11', there is a total of three contact points 12', with this being accompanied not only by a high friction force but additionally also by a comparatively major wear.

[0021] Looking at Fig. 1a, 2a and 3a further, which each show a drive pinion 3' according to the prior art, it is evident that these, on the first front side 7', have an associated elongated bevel 16' on each first tooth 6', wherein this bevel 16' with the drive pinion 3 according to the invention is formed as rounded-out bevel 16 according to Fig. 1b, 2b, 3b and 4.

[0022] An axial adjustment of the drive pinion 3 in this case is effected for example using an electromagnetic actuator.

[0023] Looking at the drive pinion 3 according to the invention according to Fig. 1b, 2b and 3b as well as 4, 5, 6a and 7a it is evident, by contrast, that the first gear ring 5 is formed in such a manner that the first gear ring 5 and the second gear ring 10 are formed in such a manner that upon an axial adjusting of the drive pinion 3 toward the shaft 4, a first engagement situation arises, in which exclusively a first tooth 6 engages between two second teeth 11. The special gear ring form according to the invention may of course additionally or alternatively also be formed on the second gear ring 10, such that upon an axial adjusting of the drive pinion 3 toward the shaft 4 a first engagement situation arises, in which exclusively a second tooth 11 engages between two first teeth 6. In this way, it is additionally achieved that when adjusting the drive pinion 3 in the axial direction 8 toward the shaft

4 a front-side contact takes place between the drive pinion 3 and the shaft 4 exclusively at a maximum of two contact points 12, which means that merely a maximum of two first teeth 6 of the drive pinion 3 enter into contact with two associated second teeth 11 of the shaft 4 and the owing to the bevel 16 also only on a greatly reduced surface, as a result of which the wear and the friction can be substantially reduced.

[0024] According to an advantageous further development of the solution according to the invention, the first gear ring 5 located outside on the lateral surface (see Fig. 2b, 3b, 4, 5, 6a, 7a) has a foot circle diameter d_f (see Fig. 4) and a useful tip circle diameter d_a, wherein the first front side 7 between the useful tip circle diameter d_a and a radial region B about the foot circle diameter d_f between d_f - 6mm < B < d_f + 3mm is rounded out with a radius R and because of this has a convex shape in this region, as is clearly evident in particular from the sectional representation A-A from Fig. 4. Analogously or alternatively, the second gear ring 10 located outside on the lateral surface (see Fig. 6b, 7b) may also have a foot circle diameter d_f (see Fig. 4) and a useful tip circle diameter d_a on, wherein the second front side 9 between the useful tip circle diameter d_a and a radial region B about the foot circle diameter d_f between d_f - 6 mm < B < d_f + 3 mm is rounded out with a radius R and because of this has a convex shape in this region, as is clearly evident, analogously to the sectional representation A-A, from Fig. 4. The bevel 16 is thus delimited radially to the outside by the useful tip circle diameter d_a and radially to the inside by the foot circle diameter d_f, wherein the foot circle diameter d_f may vary in a range d_f - 6 mm < B < d_f + 3 mm. It can be achieved in this way that upon an axial adjusting of the drive pinion 3 toward the shaft 4 a first engagement situation arises, in which exclusively a first tooth 6 engages between two second teeth 11 (see Fig. 6a) or a second tooth 11 engages between two first teeth 6 (see Fig. 6b).

[0025] Here, the first front side 7 or the second front side 9 is rounded out with a radius R between the useful tip circle diameter d_a and the foot circle diameter d_f in a particularly preferred exemplary embodiment and in this case has a convex shape in this region.

[0026] An axial depth H between the first front side 7 or the second front side 9 and the useful tip circle diameter d_a preferentially amounts to between 1 and 5mm.

[0027] Looking at Fig. 1b, 3b, 4 and 5 further, it is evident that the drive pinion 3 has a hub aperture 13 with internal splines 14, via which it makes possible a rotationally fixed contact with a shaft 15 of the starter motor 2, for example of an electric motor. Here, the drive pinion 3 can be produced for example by way of cold extrusion.

[0028] Generally, a front-side friction during the starting of the internal combustion engine 1 can be significantly reduced with the drive pinion 3 according to the invention and the starter motor 2 according to the invention, as a result of which a wear can be minimized at the same time.

[0029] According to the invention, also a drive pinion 3 on which a radial region B starts in between d_f - 6mm and d_f +3 mm and ends at d_a. Blend depth (axial depth) h is in between 1 and 5 mm. Radius R is any value that is possible to connect the start and the end radius point.

[0030] When symmetry lines of a first tooth 6 of the drive pinion 3 (first gear ring 5) and a second tooth 11 of the second gear ring 10 tooth are collinear only one tooth touch (one contact point 12) is possible. The main advantage of the gear pinions 3 shape is that it smoothly slides on a new or worn out ring gear 10 head face (front side) 9. Because of this characteristic shape, it reduces the possibility of jamming. Jamming means to stuck/stop the drive pinion 3 resp. the first gear ring 5 on the beginning of its travel into/through the second ring gear 10. Less force and torque is needed to engage gear rings 5 and 10 and furthermore less wear on a ring gear 5, 10 is caused by innovative drive pinion 3. This inventive design allows engaging force and torque reduction which was not possible with previous designs. Previous designs start to get stuck (jamming) on a ring gear teeth if force and torque were reduced too much.

Claims

1. Internal combustion engine (1) having a starter motor (2) with a drive pinion (3), which when starting the internal combustion engine (1) is drive-connectable to a shaft (4) of the internal combustion engine (1),

   - wherein the drive pinion (3) comprises a first gear ring (5) with first teeth (6) located outside on the lateral surface and a first front side (7) and is adjustable in the axial direction (8) toward the shaft (4), wherein the first front side (7) faces the shaft (4),
   - wherein the shaft (4) of the internal combustion engine (1) comprises a second gear ring (10) with second teeth (11) located outside on the lateral surface and a second front side (9),
   - wherein the first gear ring (5) and the second gear ring (10) are designed in such a manner that upon an axial adjusting of the drive pinion (3) toward the shaft (4) a first engagement situation arises, in which exclusively a first tooth (6) engages between two second teeth (11) or a second tooth (11) engages between two first teeth (6),
   - the first gear ring (5) located outside on the lateral surface or the second gear ring (10) located outside on the lateral surface has a foot circle diameter d_f and a useful tip circle diameter d_a, the internal combustion engine (1) **characterised**
   - **in that** the first front side (7) or the second front side (9) between the useful tip circle diameter d_a and a radial region B about the foot circle

diameter d_f between d_f - 6mm < B < d_f + 3mm is rounded out with a radius R and because of this has a convex bevel (16) in this region
- **in that** an axial depth h between the first front side (7) or the second front side (9) and the useful tip circle diameter d_a amounts to between 1mm < h < 5mm.

2. Internal combustion engine according to Claim 1, wherein the first front side (7) or the second front side (9) between the useful tip circle diameter d_a and the foot circle diameter d_f is rounded out with a radius R and because of this has a convex bevel (16) in this region.

3. Internal combustion engine according to any one of the preceding claims, wherein

- the drive pinion (3) comprises a hub aperture (13) with an internal toothing (14), and/or
- the drive pinion (3) is produced by means of cold extrusion.

4. Starter motor (2) for an internal combustion engine (1) according to Claim 1, having a drive pinion (3), which comprises a first gear ring (5) with first teeth (6) located outside on the lateral surface and a first front side (7),

- wherein the first gear ring (5) located outside on the lateral surface has a foot circle diameter d_f and a useful tip circle diameter d_a, **characterised in that**
- the first front side (7) between the useful tip circle diameter d_a and a radial region B about the foot circle diameter d_f between d_f - 6mm < B < d_f + 3mm is rounded out with a radius R and because of this has a convex bevel (16) in this region, and
- an axial depth h between the first front side (7) and the useful tip circle diameter d_a amounts to between 1mm < h < 5mm.

5. Starter motor according to Claim 4, wherein the first front side (7) between the useful tip circle diameter d_a and the foot circle diameter d_f is rounded out with a radius R and because of this has a convex bevel (16) in this region.

6. Starter motor according to any one of the Claims 4 or 5, wherein

- the drive pinion (3) comprises a hub aperture (13) with an internal toothing (14), and/or
- the drive pinion (3) is produced by means of cold extrusion.

7. Drive pinion (3) for a starter motor (2) according to Claim 4, which comprises a first gear ring (5) with first teeth (6) located outside on the lateral surface and a first front side (7),

- wherein the first gear ring (5) located outside on the lateral surface has a foot circle diameter d_f and a useful tip circle diameter d_a, **characterised in that**
- the first front side (7) between the useful tip circle diameter d_a and a radial region B about the foot circle diameter d_f between d_f - 6mm < B < d_f + 3mm is rounded out with a radius R and because of this has a convex bevel (16) in this region,
- an axial depth h between the first front side (7) and the useful tip circle diameter d_a amounts to between 1mm < h < 5mm.

8. Drive pinion according to Claim 7, wherein the first front side (7) between the useful tip circle diameter d_a and the foot circle diameter d_f is rounded out with a radius R and because of this has a convex bevel (16) in this region.

9. Drive pinion according to any one of the Claims 7 or 8, wherein

- the drive pinion (3) has a hub aperture (13) with internal splines (14), and/or
- the drive pinion (3) is produced by means of cold extrusion.

Patentansprüche

1. Brennkraftmaschine (1), die einen Startermotor (2) mit einem Antriebsritzel (3) aufweist, das, wenn es die Brennkraftmaschine (1) startet, mit einer Welle (4) der Brennkraftmaschine (1) angetrieben verbindbar ist,

- wobei das Antriebsritzel (3) einen ersten Getriebering (5) mit ersten Zähnen (6), die außen an der Seitenoberfläche liegen, und einer ersten Vorderseite (7) umfasst und in der Achsrichtung (8) zu der Welle (4) einstellbar ist, wobei die erste Vorderseite (7) zu der Welle (4) zeigt,
- wobei die Welle (4) der Brennkraftmaschine (1) einen zweiten Getriebering (10) mit zweiten Zähnen (11), die außen an der Seitenoberfläche liegen, und einer zweiten Vorderseite (9) umfasst,
- wobei der erste Getriebering (5) und der zweite Getriebering (10) derart gestaltet sind, dass bei einer axialen Einstellung des Antriebsritzels (3) zu der Welle (4) eine erste Eingriffssituation entsteht, in der ausschließlich ein erster Zahn (6) zwischen zwei zweiten Zähnen (11) eingreift

oder ein zweiter Zahn (11) zwischen zwei ersten Zähnen (6) eingreift,
- wobei der erste Getriebering (5), der außen an der Seitenoberfläche liegt, oder der zweite Getriebering (10), der außen an der Seitenoberfläche liegt, einen ersten Fußkreisdurchmesser d_f und einen nutzbaren Spitzenkreisdurchmesser d_a aufweist, wobei die Brennkraftmaschine (1) **dadurch gekennzeichnet ist,**
- **dass** die erste Vorderseite (7) oder die zweite Vorderseite (9) zwischen dem nutzbaren Spitzenkreisdurchmesser d_a und einem Radialbereich B um den Fußkreisdurchmesser d_f zwischen d_f - 6mm < B < d_f + 3mm mit einem Radius R abgerundet ist und deswegen in diesem Bereich eine konvexe Schrägung (16) aufweist,
- **dass** eine Achstiefe h zwischen der ersten Vorderseite (7) oder der zweiten Vorderseite (9) und dem nutzbaren Spitzenkreisdurchmesser d_a zwischen 1mm < h < 5mm beträgt.

2. Brennkraftmaschine nach Anspruch 1, wobei die erste Vorderseite (7) oder die zweite Vorderseite (9) zwischen dem nutzbaren Spitzenkreisdurchmesser d_a und dem Fußkreisdurchmesser d_f mit einem Radius R abgerundet ist und deswegen in diesem Bereich eine konvexe Schrägung (16) aufweist.

3. Brennkraftmaschine nach einem der vorstehenden Ansprüche, wobei

- das Antriebsritzel (3) eine Nabenöffnung (13) mit einer Innenzahnung (14) umfasst, und/oder
- das Antriebsritzel (3) mittels Kaltextrusion hergestellt ist.

4. Startermotor (2) für eine Brennkraftmaschine (1) nach Anspruch 1, der ein Antriebsritzel (3) aufweist, das einen ersten Getriebering (5) mit ersten Zähnen (6), die außen an der Seitenoberfläche liegen, und einer ersten Vorderseite (7) umfasst,

- wobei der erste Getriebering (5), der außen an der Seitenoberfläche liegt, einen Fußkreisdurchmesser d_f und einen nutzbaren Spitzenkreisdurchmesser d_a aufweist, **dadurch gekennzeichnet, dass**
- die erste Vorderseite (7) zwischen dem nutzbaren Spitzenkreisdurchmesser d_a und einem radialen Bereich B um den Fußkreisdurchmesser d_f zwischen d_f - 6mm < B < d_f + 3mm mit einem Radius R abgerundet ist und deswegen in diesem Bereich eine konvexe Schrägung (16) aufweist, und
- eine axiale Tiefe h zwischen der ersten Vorderseite (7) und dem nutzbaren Spitzenkreisdurchmesser d_a zwischen 1mm < h < 5mm beträgt.

5. Startermotor nach Anspruch 4, wobei die erste Vorderseite (7) zwischen dem nutzbaren Spitzenkreisdurchmesser d_a und dem Fußkreisdurchmesser d_f mit einem Radius R abgerundet ist und deswegen in diesem Bereich eine konvexe Schrägung (16) aufweist.

6. Startermotor nach einem der Ansprüche 4 oder 5, wobei

- das Antriebsritzel (3) eine Nabenöffnung (13) mit einer Innenzahnung (14) umfasst, und/oder
- das Antriebsritzel (3) mittels Kaltextrusion hergestellt ist.

7. Antriebsritzel (3) für einen Startermotor (2) nach Anspruch 4, das einen ersten Getriebering (5) mit ersten Zähnen (6), die außen an der Seitenoberfläche liegen, und einer ersten Vorderseite (7) umfasst,

- wobei der erste Getriebering (5), der außen an der Seitenoberfläche liegt, einen Fußkreisdurchmesser d_f und einen nutzbaren Spitzenkreisdurchmesser d_a aufweist, **dadurch gekennzeichnet, dass**
- die erste Vorderseite (7) zwischen dem nutzbaren Spitzenkreisdurchmesser d_a und einem radialen Bereich B um den Fußkreisdurchmesser d_f zwischen d_f - 6mm < B < d_f + 3mm mit einem Radius R abgerundet ist und deswegen in diesem Bereich eine konvexe Schrägung (16) aufweist,
- eine axiale Tiefe h zwischen der ersten Vorderseite (7) und dem nutzbaren Spitzenkreisdurchmesser d_a zwischen 1mm < h < 5mm beträgt.

8. Antriebsritzel nach Anspruch 7, wobei die erste Vorderseite (7) zwischen dem nutzbaren Spitzenkreisdurchmesser d_a und dem Fußkreisdurchmesser d_f mit einem Radius R abgerundet ist und deswegen in diesem Bereich eine konvexe Schrägung (16) aufweist.

9. Antriebsritzel nach einem der Ansprüche 7 oder 8, wobei

- das Antriebsritzel (3) eine Nabenöffnung (13) mit Innenkeilen (14) aufweist, und/oder
- das Antriebsritzel (3) mittels Kaltextrusion hergestellt ist.

Revendications

1. Moteur à combustion interne (1) présentant un démarreur (2) avec un pignon d'entraînement (3), qui, lors du démarrage du moteur à combustion interne

(1) peut être raccordé pour entraînement à un arbre (4) du moteur à combustion interne (1),

- dans lequel le pignon d'entraînement (3) comprend une première couronne dentée (5) avec des premières dents (6) situées à l'extérieur sur la surface latérale et une première face avant (7) et est réglable dans la direction axiale (8) vers l'arbre (4), dans lequel la première face avant (7) fait face à l'arbre (4),
- dans lequel l'arbre (4) du moteur à combustion interne (1) comprend une seconde couronne dentée (10) avec des secondes dents (11) situées à l'extérieur sur la surface latérale et une seconde face avant (9),
- dans lequel la première couronne dentée (5) et la seconde couronne dentée (10) sont conçues de telle manière que lors d'un réglage axial du pignon d'entraînement (3) vers l'arbre (4) une première situation de mise en prise se produit, dans laquelle exclusivement une première dent (6) se met en prise entre deux secondes dents (11) ou une seconde dent (11) se met en prise entre deux premières dents (6),
- la première couronne dentée (5) située à l'extérieur sur la surface latérale ou la seconde couronne dentée (10) située à l'extérieur sur la surface latérale présente un diamètre de cercle de pied d_f et un diamètre de cercle de tête utile d_a, le moteur à combustion interne (1) étant **caractérisé**
- **en ce que** la première face avant (7) ou la seconde face avant (9) entre le diamètre de cercle de tête utile d_a et une région radiale B autour du diamètre de cercle de pied d_f entre d_f - 6 mm < B < d_f + 3 mm est arrondie avec un rayon R et de ce fait, présente un chanfrein convexe (16) dans cette région
- **en ce qu'**une profondeur axiale h entre la première face avant (7) ou la seconde face avant (9) et le diamètre de cercle de tête utile d_a s'élève entre 1 mm < h < 5 mm.

2. Moteur à combustion interne selon la revendication 1,
dans lequel
la première face avant (7) ou la seconde face avant (9) entre le diamètre de cercle de tête utile d_a et le diamètre de cercle de pied d_f est arrondie avec un rayon R et de ce fait, présente un chanfrein convexe (16) dans cette région.

3. Moteur à combustion interne selon l'une quelconque des revendications précédentes, dans lequel

- le pignon d'entraînement (3) comprend une ouverture de moyeu (13) avec une denture interne (14), et/ou
- le pignon d'entraînement (3) est produit au moyen d'une extrusion à froid.

4. Démarreur (2) pour un moteur à combustion interne (1) selon la revendication 1, présentant un pignon d'entraînement (3), qui comprend une première couronne dentée (5) avec des premières dents (6) situées à l'extérieur sur la surface latérale et une première face avant (7),

- dans lequel la première couronne dentée (5) située à l'extérieur sur la surface latérale présente un diamètre de cercle de pied d_f et un diamètre de cercle de tête utile d_a, **caractérisé en ce que**
- la première face avant (7) entre le diamètre de cercle de tête utile d_a et une région radiale B autour du diamètre de cercle de pied d_f entre d_f - 6 mm < B < d_f + 3 mm est arrondie avec un rayon R et de ce fait, présente un chanfrein convexe (16) dans cette région, et
- une profondeur axiale h entre la première face avant (7) et le diamètre de cercle de tête utile d_a s'élève entre 1 mm < h < 5 mm.

5. Démarreur selon la revendication 4,
dans lequel
la première face avant (7) entre le diamètre de cercle de tête utile d_a et le diamètre de cercle de pied d_f est arrondie avec un rayon R et de ce fait, présente un chanfrein convexe (16) dans cette région.

6. Démarreur selon l'une quelconque des revendications 4 ou 5,
dans lequel

- le pignon d'entraînement (3) comprend une ouverture de moyeu (13) avec une denture interne (14), et/ou
- le pignon d'entraînement (3) est produit au moyen d'une extrusion à froid.

7. Pignon d'entraînement (3) pour un démarreur (2) selon la revendication 4, qui comprend une première couronne dentée (5) avec des premières dents (6) situées à l'extérieur sur la surface latérale et une première face avant (7),

- dans lequel la première couronne dentée (5) située à l'extérieur sur la surface latérale présente un diamètre de cercle de pied d_f et un diamètre de cercle de tête utile d_a, **caractérisé en ce que**
- la première face avant (7) entre le diamètre de cercle de tête utile d_a et une région radiale B autour du diamètre de cercle de pied d_f entre d_f - 6 mm < B < d_f + 3 mm est arrondie avec un rayon R et de ce fait, présente un chanfrein con-

vexe (16) dans cette région,
- une profondeur axiale h entre le premier côté avant (7) et le diamètre de cercle de tête utile d_a s'élève entre 1 mm < h < 5 mm.

8. Pignon d'entraînement selon la revendication 7, dans lequel
la première face avant (7) entre le diamètre de cercle de tête utile d_a et le diamètre de cercle de pied d_f est arrondie avec un rayon R et de ce fait, présente un chanfrein convexe (16) dans cette région.

9. Pignon d'entraînement selon l'une quelconque des revendications 7 ou 8,
dans lequel

- le pignon d'entraînement (3) présente une ouverture de moyeu (13) avec des cannelures internes (14), et/ou
- le pignon d'entraînement (3) est produit au moyen d'une extrusion à froid.

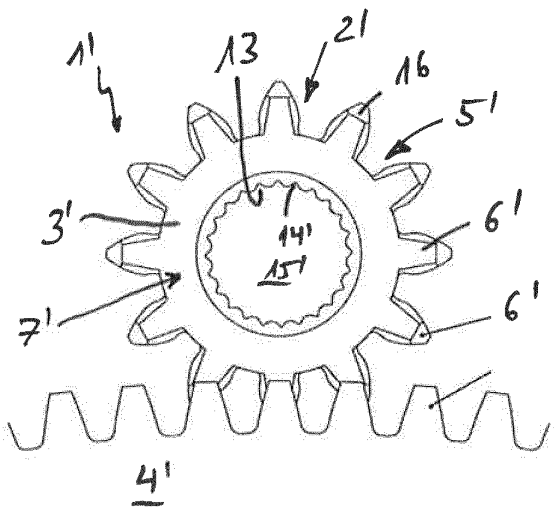


Fig. 1a

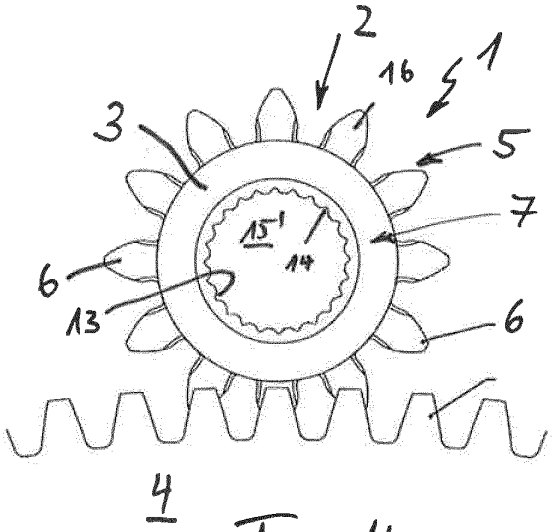


Fig. 1b

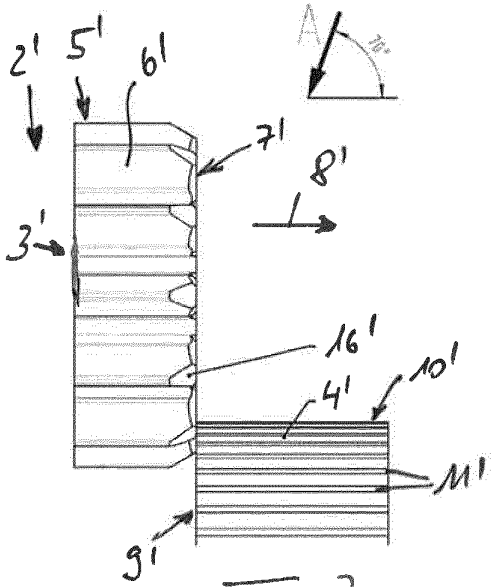


Fig. 2a

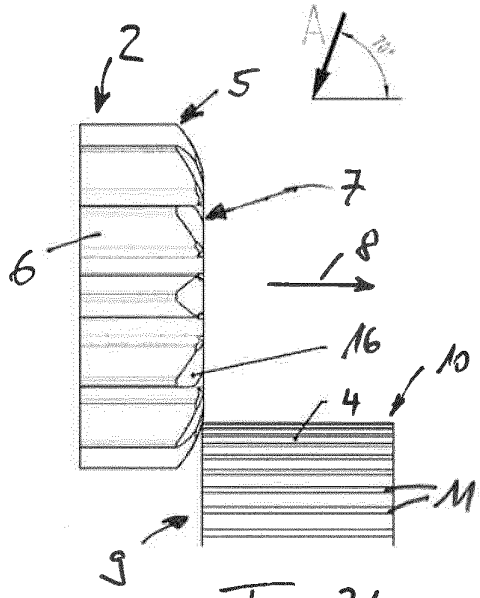


Fig. 2b

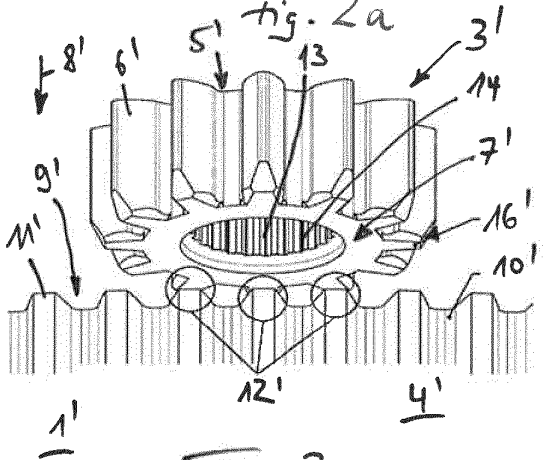


Fig. 3a

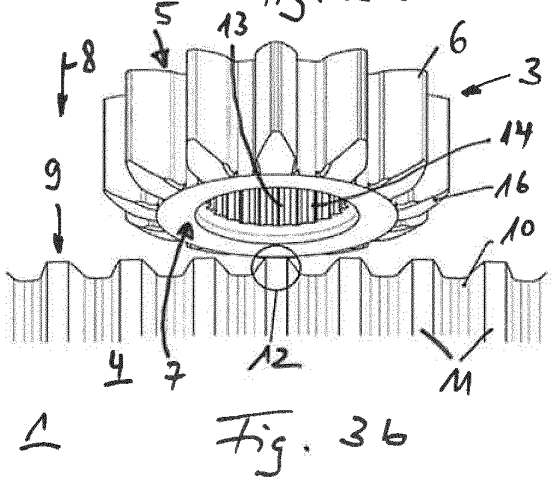


Fig. 3b

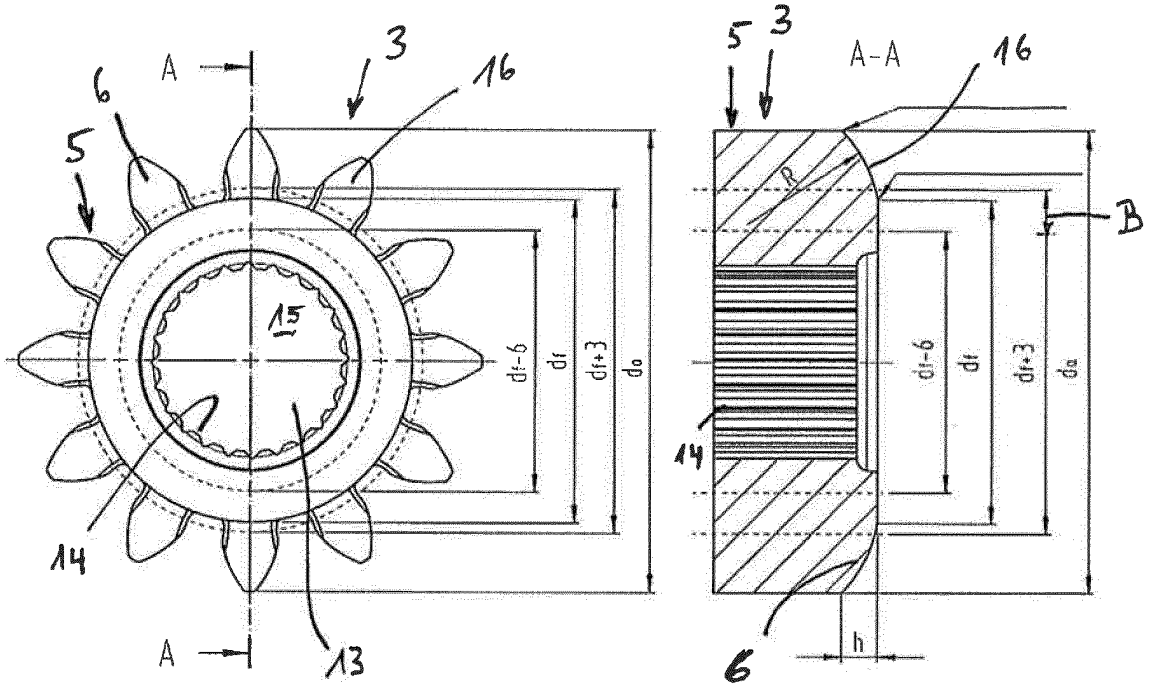
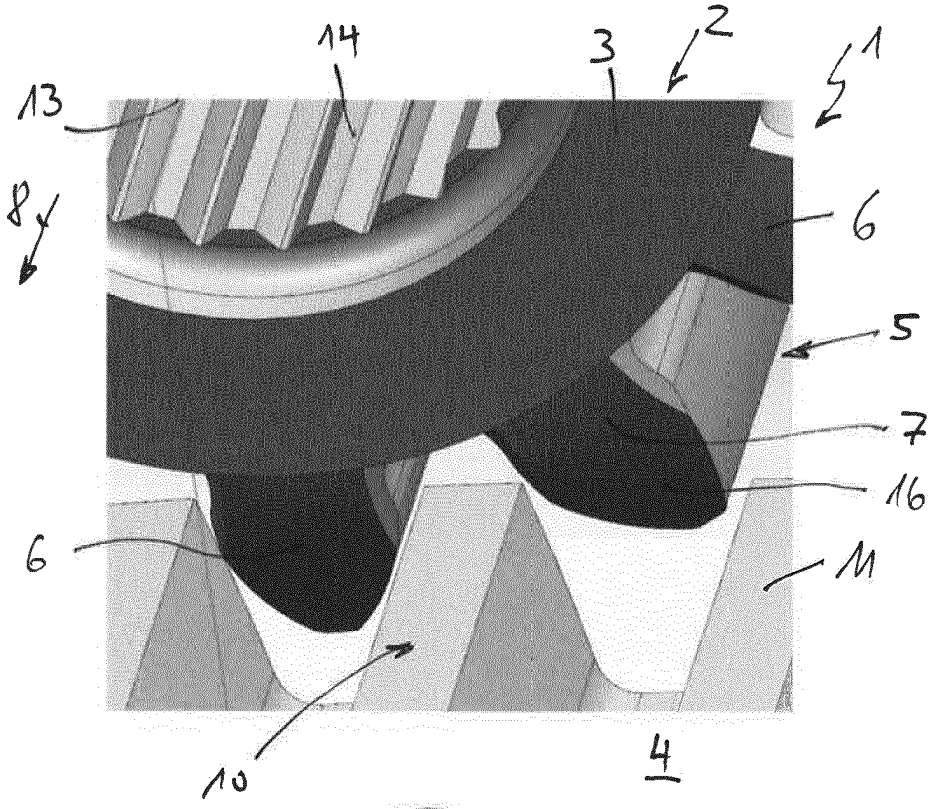

A
3
16
6
5
15
14
13
A
df-6
df
df+3
da
A-A
5
3
16
B
R
14
6
h

Fig. 4


14
3
2
1
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8
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16
6
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10
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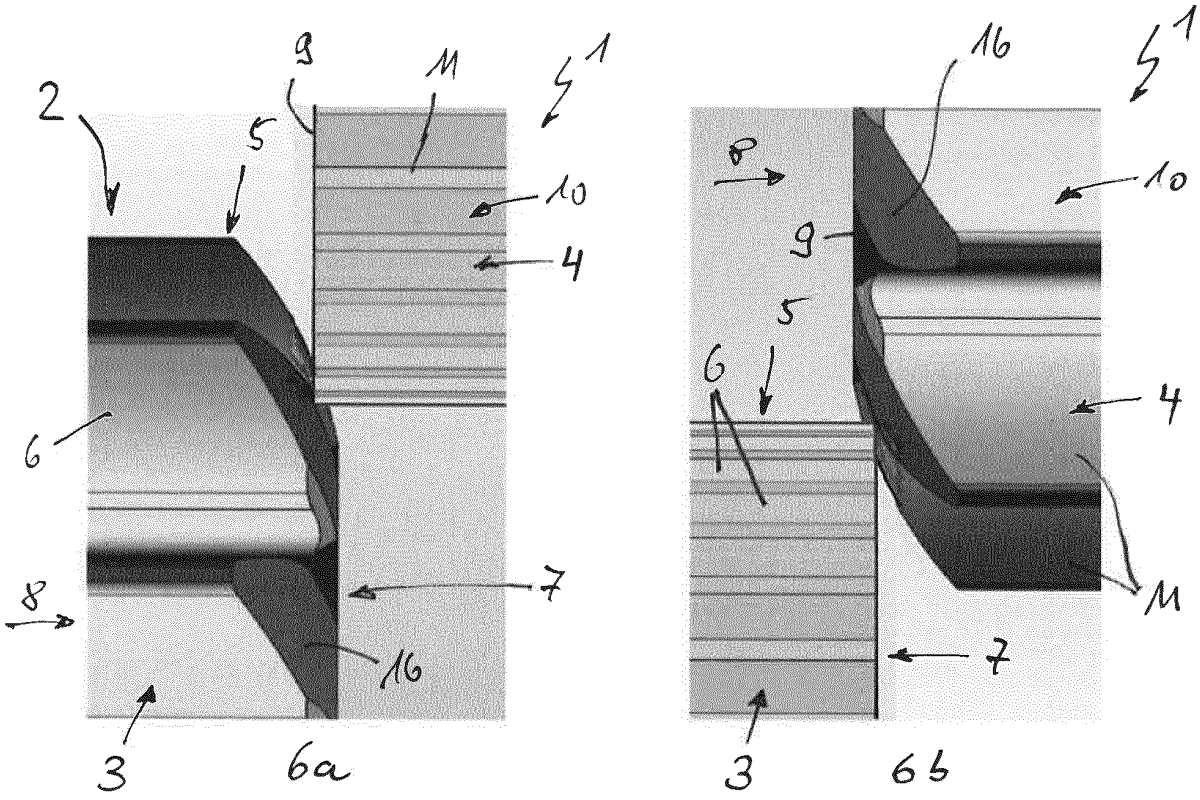
Fig. 5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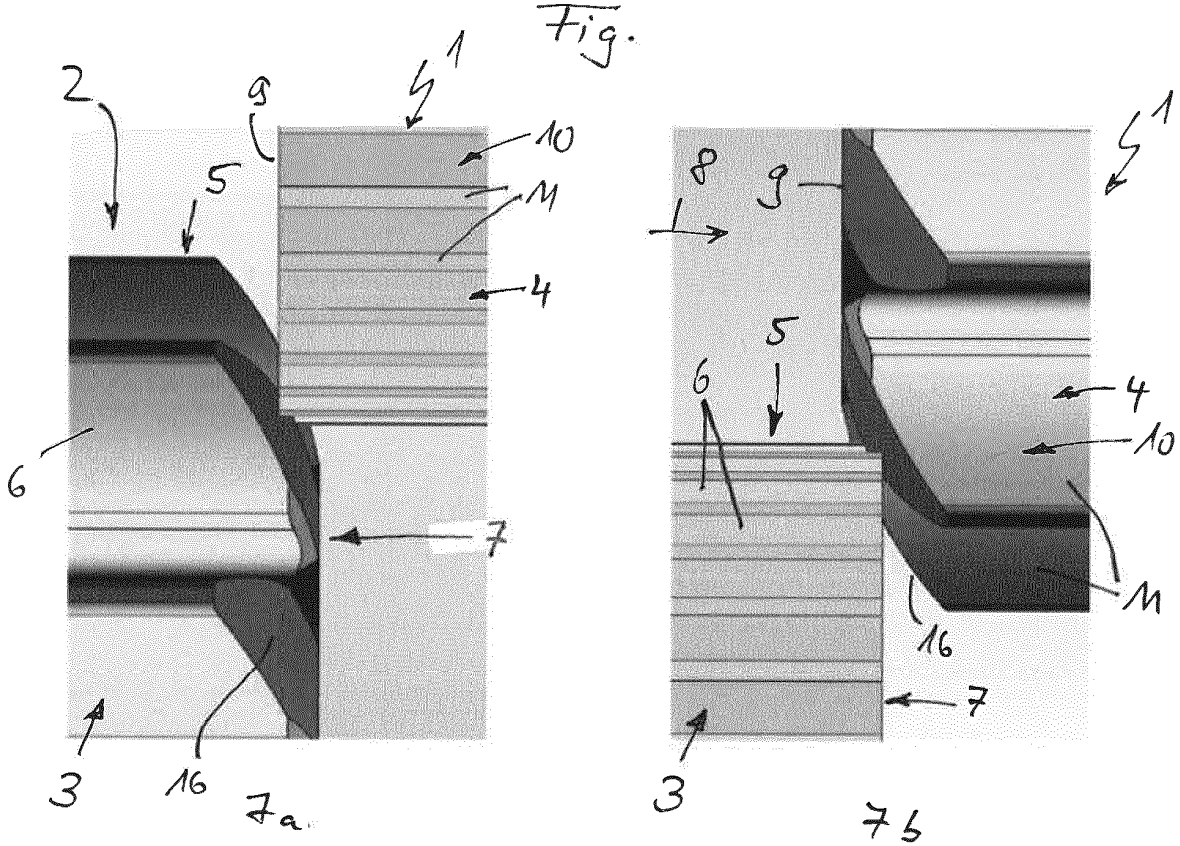
6b

Fig.


2
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16
7
3
7b

fig.

REFERENCES CITED IN THE DESCRIPTION

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