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(54) **STARTER FOR AN INTERNAL COMBUSTION ENGINE**

(57) The present invention relates to a starter (1) for an internal combustion engine (2), comprising a housing (3), a drive shaft (4) which has a coupling member (5) for coupling to the internal combustion engine (2) and which is axially adjustable between a retracted passive position (PS) and an extended active position (AS), and an actuating drive (8) for axially adjusting the drive shaft (4), said actuating drive (8) having a drive lever (9), which is mounted in the housing (3) so as to be pivotable about a pivot axis (11) extending transversely to the longitudinal centre axis (10) of the drive shaft (4), and a drive ring (13), which coaxially encloses the drive shaft (4), which is connected in terms of drive to the drive lever (9), which is axially supported on an annular push face (14) in order to drive the drive shaft (4) into the active position (AS), and which is axially supported on an annular pull face (16) in order to drive the drive shaft (4) into the passive position (PS).

It is easier to produce the starter when the push face (14) is formed directly on a shaft flange (17) separate from the drive shaft (4), said shaft flange (17) coaxially enclosing the drive shaft (4) and being arranged in an axially fixed manner thereon so as to rotate therewith, and when the pull face (16) is formed directly on a cover ring (18) which coaxially encloses the drive shaft (4) and is arranged on the shaft flange (17) so as to rotate therewith.

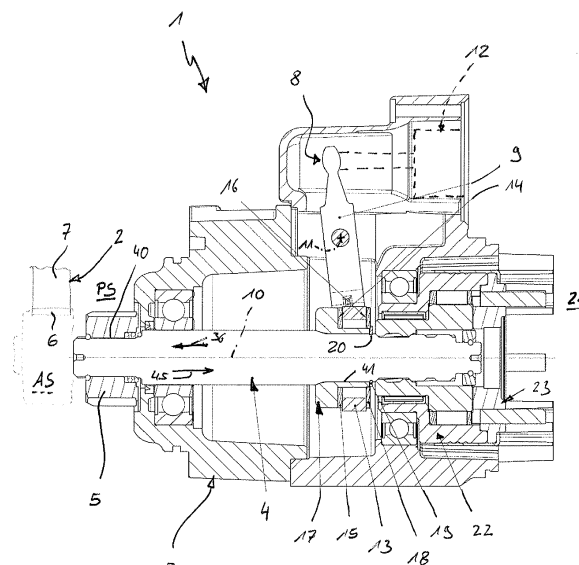


Fig. 1

Description

[0001] The present invention relates to a starter for an internal combustion engine according to the preamble of Claim 1.

[0002] A generic starter is known for example from US 8 776 752 B2. It comprises a housing by way of which the starter can be fastened to the internal combustion engine. The starter furthermore comprises a drive shaft which has a coupling member, for example a pinion, for coupling to the internal combustion engine, and which is axially adjustable between a retracted passive position and an extended active position. In the passive position, the coupling member is decoupled from the internal combustion engine. In the active position, the coupling member is coupled in terms of drive to the internal combustion engine such that a rotation of the drive shaft can be used to start the internal combustion engine. For example, the coupling member, which is in the form of a toothed wheel, engages with a complementary toothing on a flywheel of the internal combustion engine. Furthermore, the starter is equipped with an actuating drive for axially adjusting the drive shaft, said starter having a drive lever which is mounted in the housing so as to be pivotable about a pivot axis extending transversely to the longitudinal centre axis of the drive shaft, and a drive ring which coaxially encloses the drive shaft, which is connected in terms of drive to the drive lever, which is axially supported on a push face in order to drive the drive shaft into the active position, and which is axially supported on a pull face in order to drive the drive shaft into the passive position. In this known starter, the push face is formed on an annular collar of a sleeve which is placed on the drive shaft and is axially supported on the drive shaft against an annular step of the drive shaft. The pull face is formed on an annular disc which is placed on the drive shaft at an axial distance from the sleeve and is supported axially on a support ring which is axially fixed to the drive shaft by a securing ring. In the known starter, in order that the annular step can axially support the annular collar of the sleeve in a secure manner, the annular step has to have relatively large dimensions in the radial direction with regard to the drive shaft. In the case of a drive shaft produced by machining, this results in relative large material expenditure and material loss during the production of the drive shaft and thus of the starter.

[0003] The present invention deals with the problem of specifying an improved or at least a different embodiment for a starter of the type mentioned at the beginning, said embodiment being distinguished in particular by being easy and preferably inexpensive to produce.

[0004] This problem is solved according to the invention by the subject matter of the independent claim. Advantageous embodiments are the subject matter of the dependent claims.

[0005] The invention is based on the general idea of providing a shaft flange separate from the drive shaft, said shaft flange coaxially enclosing the drive shaft and

being arranged in an axially fixed manner thereon so as to rotate therewith. The push face is now formed directly on said shaft flange. The shaft flange is itself sufficiently rigid and stable that no additional support for stabilization is required. For example, the axial support of the shaft flange on the drive shaft can already be realized via a comparatively small form fit which is realizable on the drive shaft without great material expenditure. The pull face can now be formed directly on a cover ring which coaxially encloses the drive shaft and is arranged on the shaft flange so as to rotate therewith. As a result of the rotationally fixed coupling of the shaft flange to the drive shaft, the cover ring is connected indirectly to the drive shaft, so as to rotate therewith, via the shaft flange.

[0006] The shaft flange obtains particularly high rigidity and stability when an axial wall thickness of the shaft flange in the region of the push face is greater than 50% of a radial height of the encircling push face. In particular, the axial wall thickness of the shaft flange in the region of the push face is at least as great as the radial height of the encircling push face.

[0007] In a particular embodiment, the shaft flange has a flange ring having the push face, and a sleeve connected to the cover ring. Via said sleeve, an axial annular space is created between the push face on the flange ring and the pull face on the cover ring, the drive ring being arranged in said annular space. Furthermore, via the sleeve, the flange ring can be connected particularly easily to the cover so as to rotate therewith.

[0008] In this case, the radial height of the encircling push face corresponds to the distance between the outer side of the sleeve and the outer side of the flange ring, in each case at the push face. In other words, the radial height of the encircling push face is 50% of the difference between the outside diameter of the flange ring and the outside diameter of the sleeve.

[0009] According to one development, the sleeve may have, on its end face remote from the flange ring, at least one protrusion, which engages in a complementary depression or cutout formed in the cover ring in order in this way to connect the cover ring to the shaft flange so as to rotate therewith. Preferably, it is also possible for two or more such protrusions and associated depressions or cutouts to be provided, which are expediently arranged in a manner distributed regularly in the circumferential direction. An embodiment in which exactly two such protrusions are provided is preferred.

[0010] According to a particularly advantageous development, provision can be made for each particular depression to be formed only in that side of the cover ring that faces the flange ring, such that it does not pass axially through the cover ring. Thus, the cover ring can be formed for example in a completely planar and continuous manner on its side remote from the flange ring, in order to avoid disruptive contours on this side. Alternatively, the respective depression also can axially pass through the cover ring.

[0011] In another embodiment of the starter, the cover

ring is axially fixed to the shaft flange by means of a securing ring, wherein the securing ring engages in an annular groove formed in the drive shaft and is axially fixed directly to the drive shaft therein. As a result, reliable and secure axial positioning of the cover ring on the shaft flange and thus on the drive shaft can be realized.

[0012] According to one development, it is possible, with the aid of the securing ring, for the shaft flange to furthermore be axially fixed to the drive shaft in an axial direction leading away from the coupling member. In this case, the shaft flange is then supported axially on the drive shaft via the cover ring. As a result, the securing ring obtains an additional function.

[0013] In another embodiment, the shaft flange is axially fixed to the drive shaft by a form fit in an axial direction leading towards the coupling member. As mentioned, this form fit can already be realized by comparatively small radial variations in the dimensions of the external cross section of the drive shaft and internal cross section of the shaft flange, such that the corresponding contours on the drive shaft can be realized with little production outlay.

[0014] For example, the form fit may be formed by a supporting contour formed on the shaft flange and an abutment contour of complementary form that bears against said supporting contour and is formed directly on the drive shaft. This abutment contour does not require any substantial radial dimension. It can for example be smaller than a radial wall thickness of the sleeve of the shaft flange. Expediently, the supporting contour can widen radially in the direction of the coupling member, for example in the form of a cone or of a ring with a round, in particular circular or elliptical, cross section. At the drive shaft, the abutment contour creates a transition between a cylindrical shaft portion, onto which the shaft flange is axially plugged, and a further cylindrical portion that adjoins the shaft flange in the direction of the coupling member. The radii of the two cylindrical shaft portions that are connected together via the abutment contour are relatively close to one another, preferably such that a difference in the radii of the two cylindrical shaft portions is less than a radial wall thickness of the sleeve of the shaft flange.

[0015] Preferably, the shaft flange may be fixed to the drive shaft, so as to rotate therewith and preferably also in an axially fixed manner, in particular by means of a press fit. To this end, the shaft flange can be shrink-fitted onto the drive shaft during production. As a result, particularly efficient and inexpensive assembly is allowed. Alternatively, also a key dowel, a thread, a pin or something else can be used to block the relative rotation between a shaft and a shaft flange.

[0016] According to a preferred embodiment, an electric motor for driving the drive shaft for starting the internal combustion engine may furthermore be arranged in the housing of the starter. Furthermore, a clutch that connects the electric motor to the drive shaft may be arranged in an axially fixed manner in the housing. This means that when the drive shaft is adjusted between the

passive position and the active position, it is also adjusted axially relative to the clutch. The clutch can be configured as a freewheel clutch or overrunning clutch. Furthermore, a transmission may be arranged between the electric motor and clutch in the housing in order to transmit a rotational speed of the electric motor to a rotational speed of the drive shaft.

[0017] Further important features and advantages of the invention can be gathered from the dependent claims, from the drawings and from the associated description of the figures with reference to the drawings.

[0018] It goes without saying that the features mentioned above and those yet to be explained below are usable not only in the combination specified in each case but also in other combinations or on their own without departing from the scope of the present invention.

[0019] Preferred exemplary embodiments of the invention are illustrated in the drawings and described in more detail in the following description, wherein identical reference signs relate to identical or similar or functionally identical components.

[0020] In the drawings, in each case schematically,

Fig. 1 shows a longitudinal section through a starter,

Fig. 2 shows a side view of a drive shaft of the starter with the shaft flange in section,

Fig. 3 shows an axial view of the drive shaft with the shaft flange from a viewing direction III in Fig. 2,

Fig. 4 shows an axial view of the shaft flange,

Fig. 5 shows a longitudinal section of the shaft flange as per section lines V in Fig. 4,

Fig. 6 shows a side view of the shaft flange,

Fig. 7 shows a side view of the shaft flange as in Fig. 6, but rotated through 90°,

Fig. 8 shows a side view of the drive shaft with the shaft flange in section and the cover ring in section,

Fig. 9 shows an axial view of the drive shaft with the cover ring in a viewing direction IX in Fig. 8,

Fig. 10 shows an axial view of the cover ring in a viewing direction X in Fig. 8,

Fig. 11 shows a longitudinal section of the cover ring as per section lines XI in Fig. 10.

[0021] According to Fig. 1, a starter 1, which serves to start an internal combustion engine 2 (illustrated only in part here), comprises a housing 3, with the aid of which

the starter 1 can preferably be fastened to the internal combustion engine 2. The starter 1 furthermore comprises a drive shaft 4 which has a coupling member 5, arranged thereon so as to rotate therewith, for coupling to the internal combustion engine 2. The coupling member 5 is formed for example by a toothed wheel or a pinion. The drive shaft 4 is axially adjustable between a retracted passive position PS illustrated in Fig. 1 and an extended active position AS relative to the housing 3, which is indicated in Fig. 1 by a broken line only in the region of the coupling member 5. The active position AS serves for starting the internal combustion engine 2. In the active position AS, the coupling member 5 is coupled in terms of drive to the internal combustion engine 2. To this end, the coupling member 5 is suitably connected to the drive train of the internal combustion engine 2. For example, the coupling member 5 engages with a ring gear 6 of a flywheel 7 of the internal combustion engine 2. In the passive position PS, by contrast, the coupling member 5 is decoupled from the internal combustion engine 2. In particular, in this case, the coupling member 5 is no longer engaged with the drive train or with the ring gear 6.

[0022] In order to axially adjust the drive shaft 4, the starter 1 is equipped with an actuating drive 8. This actuating drive 8 has a drive lever 9 which is mounted in the housing 3 so as to be pivotable about a pivot axis 11 extending transversely to the longitudinal centre axis 10 of the drive shaft 4. This pivot axis 8 is perpendicular to the plane of the drawing in Fig. 1. The actuating drive 8 furthermore has an actuator 12 (indicated only by a broken line here) for pivoting the drive lever 9, which can be configured for example as a solenoid. The actuating drive 8 furthermore has a drive ring 13 which coaxially encloses the drive shaft 4 and is connected to the drive lever 9 in articulated manner such that the drive ring 13 can be adjusted axially, that is to say parallel to the longitudinal centre axis 10 of the drive shaft 4, relative to the housing 3 by the drive lever 9 being pivoted. In other words, the drive lever 9 is connected in terms of drive to the drive ring 13. In order to drive the drive shaft 4 into the active position AS, the drive ring 13 is supported axially on an annular push face 14. In the example in Fig. 1, this does not take place directly, but indirectly via a compensating disc 15. In order to drive the drive shaft 4 into the passive position PS, the drive ring 13 can be supported on an annular pull face 16. This takes place directly in the example in Fig. 1.

[0023] In the case of the starter 1 illustrated here, the push face 14 is formed directly on a shaft flange 17 which represents a separate component from the drive shaft 4, said component coaxially enclosing the drive shaft 4 and being arranged in an axially fixed manner on the drive shaft 4 so as to rotate therewith. In contrast, the pull face 16 is formed directly on a cover ring 18 which coaxially encloses the drive shaft 4 and is arranged on the shaft flange 17 so as to rotate therewith. The axial positioning, in particular also the axial fixing, of the cover ring 18 takes place in this case with the aid of a securing ring 19 which

engages in an annular groove 20 formed in the drive shaft 4. The securing ring 19 is axially fixed directly to the drive shaft 4 in the annular groove 20.

[0024] According to Fig. 1, the starter 1 in the housing 3 can furthermore have an electric motor 21 (indicated only symbolically here by way of its reference sign) for driving the drive shaft 4 for starting the internal combustion engine 2. In addition, a clutch 22 that connects the electric motor 21 to the drive shaft 4 can be arranged in an axially fixed manner in the housing 2. The clutch 22 is usually configured as a freewheel or overrunning clutch. Between the clutch 22 and the electric motor 21, it is furthermore usually possible for a transmission 23 to be arranged, which is only illustrated in part here.

[0025] According to Figs. 2 to 10, the shaft flange 17 can have a flange ring 24 and a sleeve 25. The flange ring 24 and sleeve 25 are preferably made in one piece. Accordingly, the sleeve 25 is formed integrally on the flange ring 24. The flange ring 24 has the push face 14. The cover ring 18 is connected to the sleeve 25 so as to rotate therewith.

[0026] As can be gathered from Figs. 2 and 5, the push face 14 has a radial height 26 which reaches in the radial direction from a radial outer side 27 of the sleeve 25 as far as a radial outer side 28 of the flange ring 24. Accordingly, it corresponds to the radial dimension of the flange ring 24, by which the flange ring 24 protrudes radially beyond the sleeve 25. The flange ring 24 has an axial wall thickness 29 which extends from the push face 14 to an end side 30, remote from the push face 14, of the flange ring 24. As can be seen in this example, the wall thickness 29 of the shaft flange 17 in the region of the push face 14 is now at least as large as the radial height 26 of the encircling push face 14. Furthermore, an axial extent 31 of the sleeve 25, by which the sleeve 25 projects axially from the flange ring 24, can be greater than the radial height 26 of the push face 14. These dimensions contribute towards high stability of the shaft flange 17.

[0027] On its end face 32 remote from the flange ring 17, the sleeve 25 can have at least one protrusion 33 which projects axially from the end face 32. In the example shown, exactly two such protrusions 33 are provided, which are located diametrically opposite one another. In the assembled state, each protrusion 33 engages in a complementary depression or cutout 34, which to this end is formed on the cover ring 18. As a result of this axial engagement of the protrusions 33 in the associated depressions or cutouts 34, a form-fitting and thus rotationally fixed connection is produced in the circumferential direction between the cover ring 18 and the sleeve 25 and thus the shaft flange 17. According to the example of Figs. 8 to 11, the depressions 34 are expediently dimensioned such that they are formed only on a side 35 facing the flange ring 24, or inner side 35. In other words, each particular depression 34 has an axial depth which is less than a wall thickness of the cover ring 18 such that the particular depression 34 does not pass axially through the cover ring 18. In this case, the inner side 35

forms the pull face 16. In another embodiment the depressions 34 or cutouts also can axially pass through the cover ring 18.

[0028] As can be gathered in particular from Figs. 2 and 8, the shaft flange 17 can be fixed axially to the drive shaft 4 by a form-fitting connection 37, or by a form fit 37, in an axial direction 36, indicated by an arrow in Figs. 1, 2 and 8, leading to the coupling member 5. The form fit 37 can be formed expediently by a supporting contour 38 formed on the shaft flange 17 and a complementary abutment contour 39 that bears against said supporting contour 38 and to this end is formed directly on the drive shaft 4. In the example, the supporting contour 38 and the abutment contour 39 are formed in a conical manner such that the supporting contour 38 widens in the direction of the coupling member 5. A toothing portion 40, onto which the coupling member 5 according to Fig. 1 is plugged and is thus connected to the drive shaft 4 so as to rotate therewith, can be seen in the lefthand end region of the drive shaft 4 in Figs. 2 and 8.

[0029] The shaft flange 17 is expediently fixed to the drive shaft 4, so as to rotate therewith, by means of a press fit 41.

[0030] According to Fig. 8, the flange ring 24 and the cover ring 18 define, in the state mounted on the shaft flange 17, a radially open annular space 42 for receiving the drive ring 13. The axial spacing that is produced in this case between the push face 14 and pull face 16 defines an axial width 43 of the annular space 42, which is generally greater than the axial height of the drive ring 13. The difference between the width 43 of the annular space 42 and the height of the drive ring 13 varies on account of tolerances and can be compensated for example by the correspondingly selected compensating disc 15.

[0031] In order to start the internal combustion engine 2, the actuator 12 for pivoting the drive lever 9 is actuated. At the same time, the electric motor 21 for driving the drive shaft 4 in rotation is actuated. As a result of the drive lever 9 being pivoted, the drive ring 13 is pushed axially against the push face 14 via the compensating disc 15. As a result, a driving-out axial force is transmitted to the shaft flange 17 and, by the latter, to the drive shaft 4 such that the latter can extend out of the housing 3. In this case, the drive shaft 4 is transferred from the passive position PS into the active position AS. In the process, comparatively large forces for extending the drive shaft 4 are transmitted via the push face 14.

[0032] Once a starting operation has been completed, the drive shaft 4 is adjusted back from the active position AS into the passive position PS. This can be supported by an oblique toothing 44, which is discernible in the right-hand end region of the drive shaft 4 in Figs. 2 and 8, and via which drive coupling between the drive shaft 4 and the clutch 22 takes place. Accordingly, the forces that are transmitted to the pull face 16 during the retraction of the drive shaft 4 are much lower than the forces that are transmitted to the push face 14 during extension.

Consequently, it is sufficient to realize the cover disc 18 with a relatively small wall thickness. Likewise, particularly stable axial support of the cover disc 18 via the securing ring 19 is also not necessary, and so the latter serves substantially only for axial positioning.

[0033] While the shaft flange 17 is axially supported on the drive shaft 4 via the form fit 37 in the axial direction 36 leading to the coupling member 5, in the opposite direction, that is to say in an axial direction 45 leading away from the coupling member 5, this being indicated by an arrow in Figs. 1, 2 and 8, the shaft flange 17 is fixed axially to the drive shaft 4. If the press fit 41 is used to fix the shaft flange 17 to the drive shaft 4, the securing ring 19 serves only for positioning or securing the cover ring 18 on the shaft flange 17.

Claims

1. Starter for an internal combustion engine (2),

- having a housing (3),
- having a drive shaft (4) which has a coupling member (5) for coupling to the internal combustion engine (2) and which is axially adjustable between a retracted passive position (PS), in which the coupling member (5) is decoupled from the internal combustion engine (2), and an extended active position (AS) for starting the internal combustion engine (2), in which the coupling member (5) is coupled to the internal combustion engine (2),
- having an actuating drive (8) for axially adjusting the drive shaft (4), said actuating drive (8) having a drive lever (9), which is mounted in the housing (3) so as to be pivotable about a pivot axis (11) extending transversely to the longitudinal centre axis (10) of the drive shaft (4), and a drive ring (13), which coaxially encloses the drive shaft (4), which is connected in terms of drive to the drive lever (9), which is axially supported on an annular push face (14) in order to drive the drive shaft (4) into the active position (AS), and which is axially supported on an annular pull face (16) in order to drive the drive shaft (4) into the passive position (PS),

characterized

- **in that** the push face (14) is formed directly on a shaft flange (17) separate from the drive shaft (4), said shaft flange (17) coaxially enclosing the drive shaft (4) and being arranged in an axially fixed manner thereon so as to rotate therewith,
- **in that** the pull face (16) is formed directly on a cover ring (18) which coaxially encloses the drive shaft (4) and is arranged on the shaft flange (17) so as to rotate therewith.

2. Starter according to Claim 1,
characterized
in that an axial wall thickness (29) of the shaft flange (17) in the region of the push face (14) is greater than 50% of a radial height (26) of the encircling push face (14). 5
3. Starter according to Claim 1 or 2,
characterized
in that the shaft flange (17) has a flange ring (24) having the push face (14), and a sleeve (25) connected to the cover ring (18). 10
4. Starter according to Claim 3,
characterized
in that the sleeve (25) defines or keeps an axial distance between the push face (14) and the pull face (16). 15
5. Starter according to Claim 3 or 4,
characterized
in that the sleeve (25) has, on its end face (32) remote from the flange ring (24), at least one protrusion (33), which engages in a complementary depression (34) or cutout (34) formed in the cover ring (18) in order to fix the cover ring (18) to the shaft flange (17) so as to rotate therewith. 20
6. Starter according to Claim 5,
characterized
in that each particular depression (34) is formed only in that side of the cover ring (18) that faces the flange ring (24). 25
7. Starter according to Claim 5,
characterized
in that each particular cutout (34) is axially passing through the cover ring (18). 30
8. Starter according to one of Claims 1 to 7,
characterized
in that the cover ring (18) is axially fixed to the shaft flange (17). 35
9. Starter according to one of Claims 1 to 7,
characterized
- **in that** the cover ring (18) is axially fixed to the shaft flange (17) by means of a securing ring (19), 40
- **in that** the securing ring (19) engages in an annular groove (20) formed in the drive shaft (4) and is axially fixed directly to the drive shaft (4) therein. 45
50
10. Starter according to one of Claims 1 to 9,
characterized
in that, by means of the securing ring (19) and/or 55
- the cover ring (18), the shaft flange (17) is furthermore axially secured to the drive shaft (4) in an axial direction (45) leading away from the coupling member (5).
11. Starter according to one of Claims 1 to 10,
characterized
in that the shaft flange (17) is axially fixed to the drive shaft (4) by a form fit (37) in an axial direction (36) leading towards the coupling member. 5
12. Starter according to Claim 11,
characterized
in that the form fit (37) is formed by a supporting contour (38) formed on the shaft flange (17) and a complementary abutment contour (39) that bears against said supporting contour (38) and is formed directly on the drive shaft (4). 10
13. Starter according to Claim 12,
characterized
in that the supporting contour (38) widens radially in the direction of the coupling member (5). 15
14. Starter according to one of Claims 1 to 13,
characterized
in that the shaft flange (17) is fixed to the drive shaft (4), so as to rotate therewith. 20
15. Starter according to one of Claims 1 to 14,
characterized
- **in that** an electric motor (21) for driving the drive shaft (4) for starting the internal combustion engine (2) is arranged in the housing (3),
- **in that** a clutch (22) that connects the electric motor (21) to the drive shaft (4) is arranged in the housing (3) in an axially fixed manner. 25

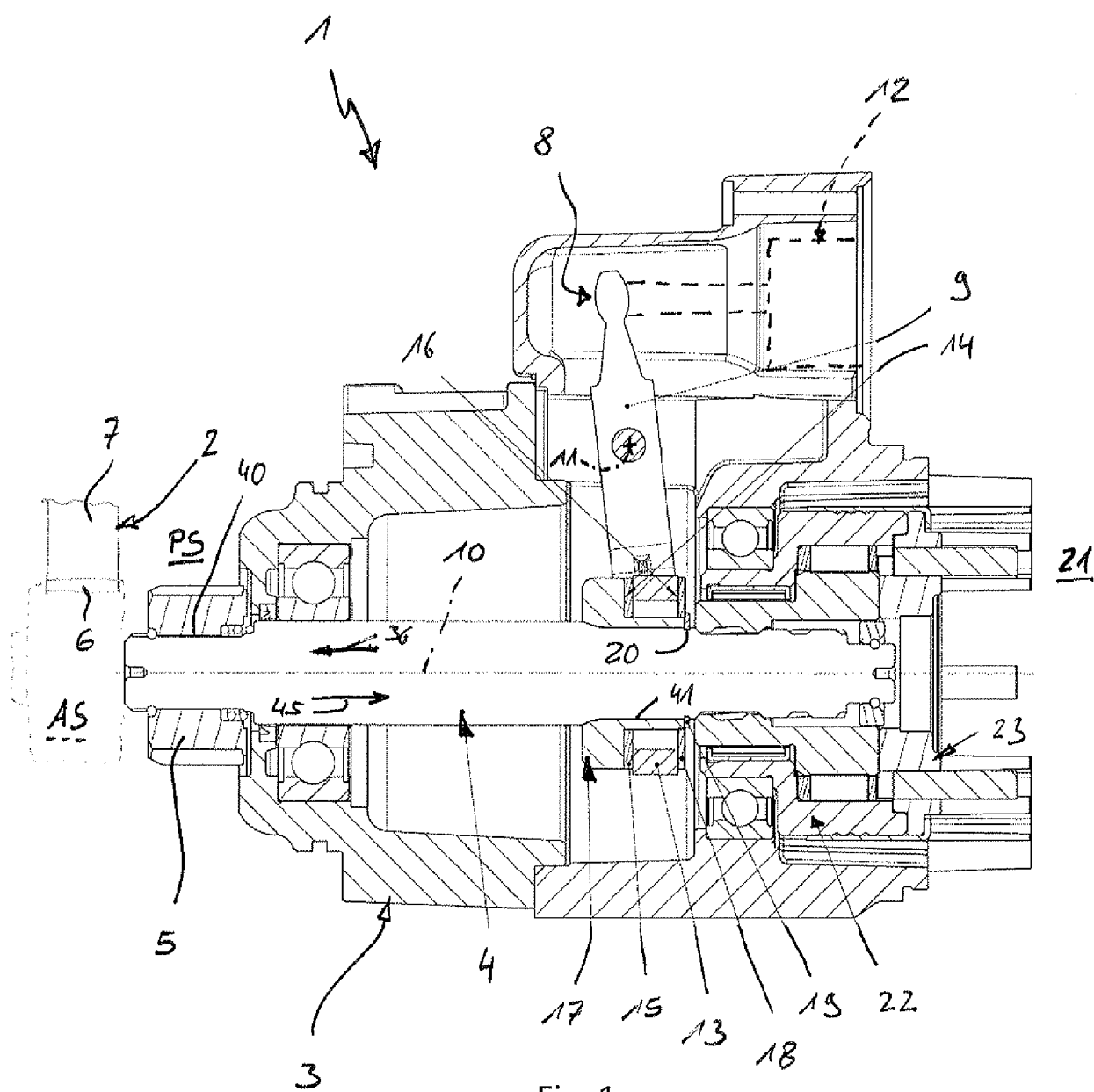
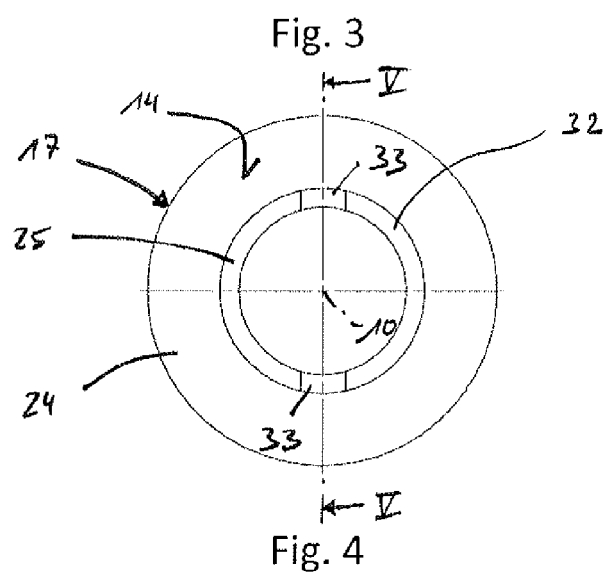
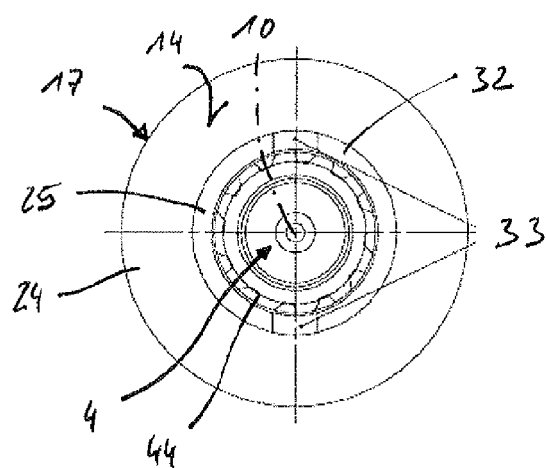
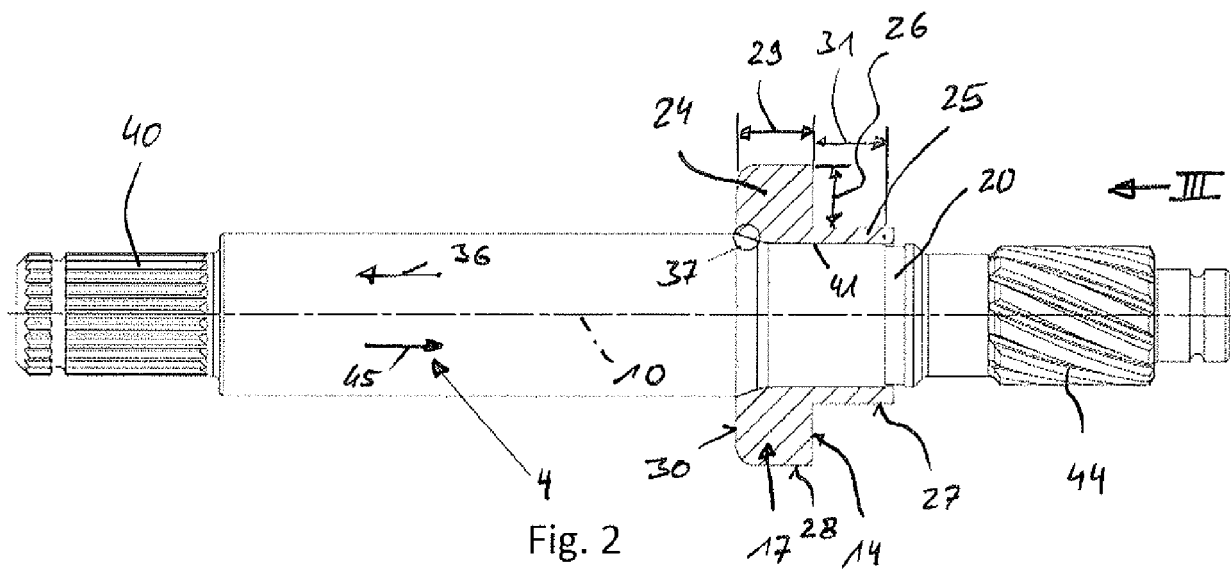
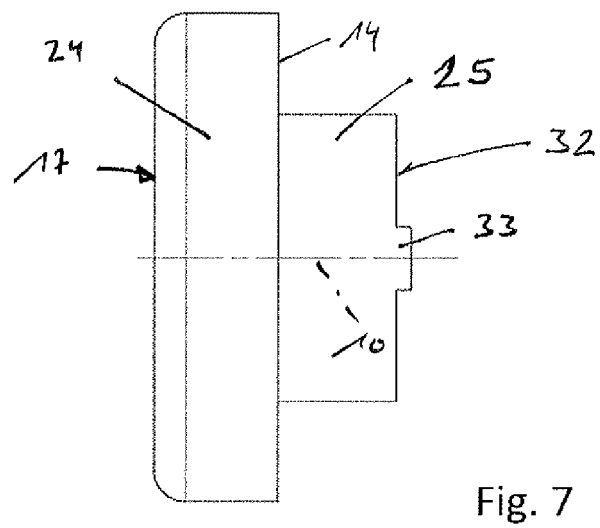
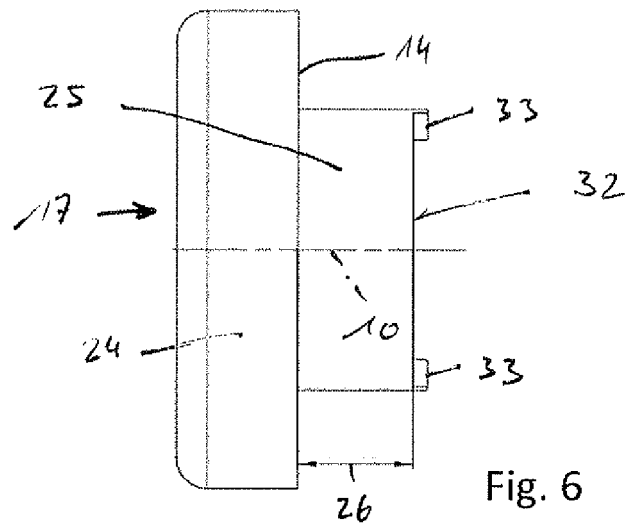
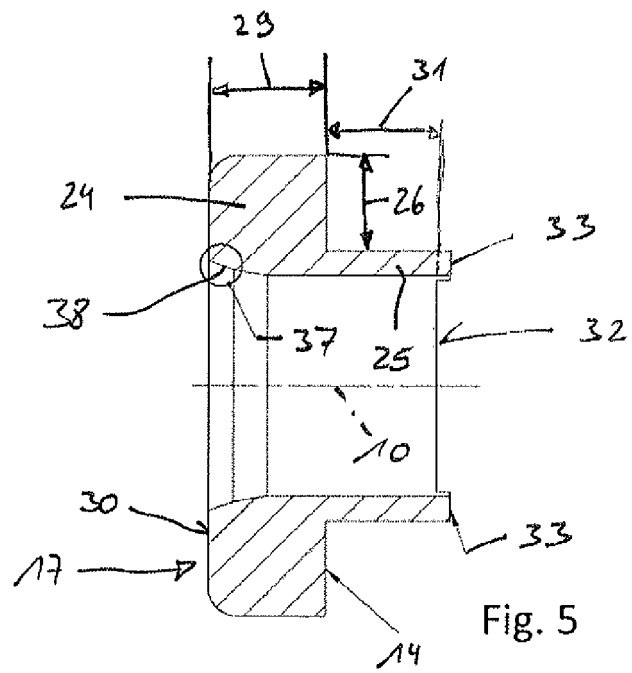


Fig. 1





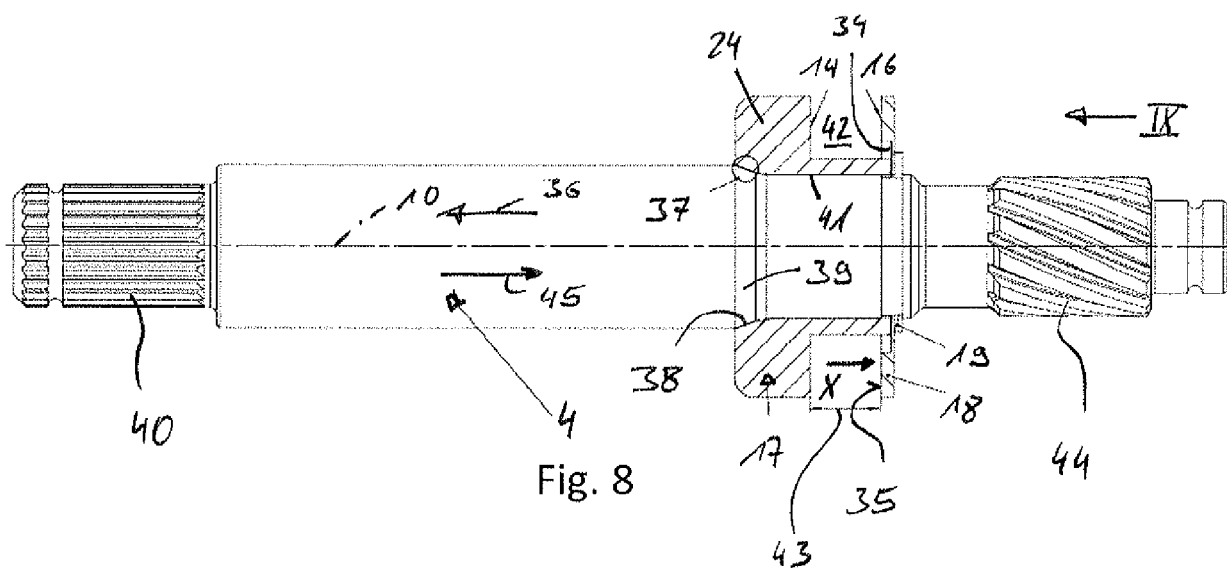


Fig. 8

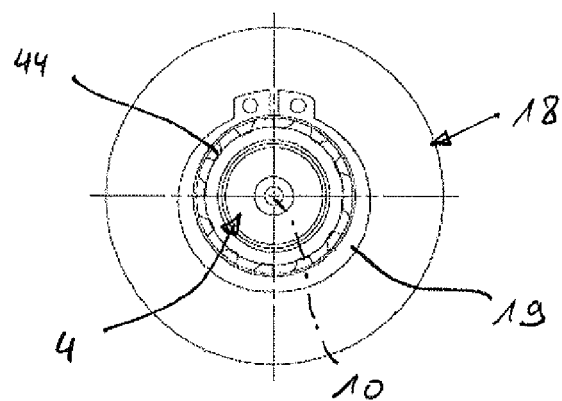


Fig. 9

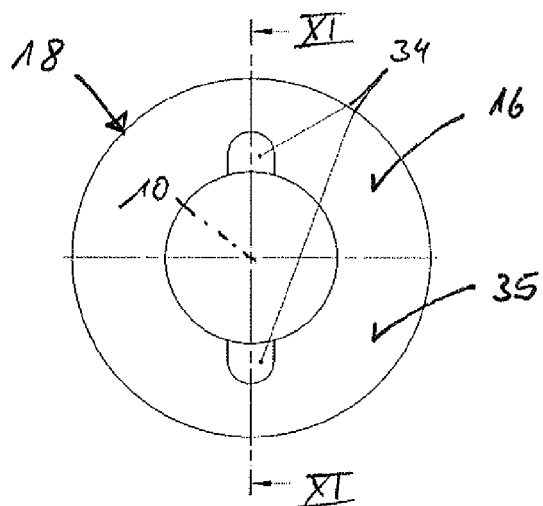


Fig. 10

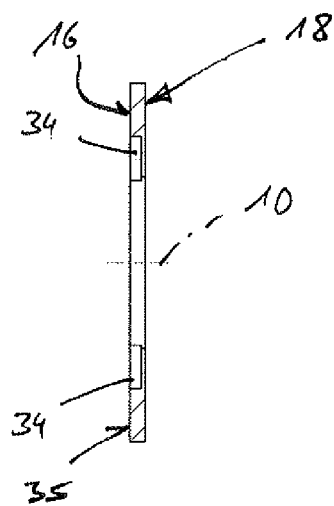


Fig. 11



EUROPEAN SEARCH REPORT

 Application Number
 EP 17 19 7562

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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	US 2012/234280 A1 (KIMURA MOTOAKI [JP]) 20 September 2012 (2012-09-20)	1,3,4, 8-10,14, 15	INV. F02N15/00 F02N15/02 F02N15/06 F02N15/08
A	* paragraph [0032] - paragraph [0045] * * figures *	2,5-7, 11-13	
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A	* paragraph [0030] - last paragraph * * figures *	2-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			F02N
The present search report has been drawn up for all claims			
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