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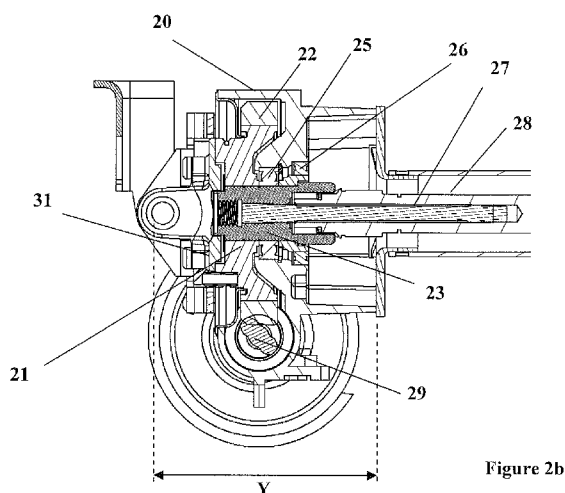


Figure 2b

(57) Abstract: A gearbox assembly for an electric power assisted steering assembly comprises a gearbox housing (20), an output shaft (23), a wheel gear assembly (22) comprising a hub (21) which is fixed to the output shaft by a locating means so as to prevent relative rotational and axial movement between the hub and the output shaft and a gear wheel fixed to the hub, at least one support bearing assembly (25,26) which supports the output shaft relative to the gearbox housing (20), a worm gear which engages the wheel gear (22), and a coupling for transmission of torque from the output shaft to an intermediate shaft that is external to the gearbox housing. The coupling includes a fixing part (31) which is fixed to the output shaft (23) through the gear assembly and the support bearing assembly is provided on the opposite side of the gear assembly (22) to the coupling (31) such that the gear assembly (22) is overhung from the portion of the output shaft supported by the bearings (25,26).

GEARBOX ASSEMBLY FOR ELECTRIC POWER STEERING SYSTEMS

This invention relates to improvements in gearbox assemblies for use in
5 an electric power assisted steering system.

Electric power assisted steering systems of the kind in which a motor is
connected to a part of the steering system through a reduction gearbox are
well known. The motor can be operated to apply an assistance torque to
10 the steering system which can help the driver to turn the wheel during
normal driving. The motor can also be used to apply a torque of the same
sense or of an opposite sense to that applied by the driver or passed back
from the road wheels of the vehicle in order to provide other forms of
driver assistance during abnormal operating conditions.

15

All currently mass-produced column drive (CD-EPS) systems use a worm-
and-wheel type of motor-speed reduction gearbox. The worm-wheel may
either be supported by one ball bearing on each side or it may be
“overhung” from a pair of adjacent ball bearings which are spaced apart
20 by several millimetres. An example of such a prior art gearbox is shown
in Figure 1 of the accompanying drawings for a column drive type
steering system. The gearwheel (2) is attached to an end part of an output
shaft (3), which in the example forms part of a steering shaft operatively
connected to a steering wheel. The motor (4) is connected to the worm
25 wheel (2) through a worm gear and both the worm and wheel are
contained within a housing (1). This housing also, conveniently, provides
a location for a torque sensor (5) which is used as part of the control
circuit for the motor(4). The wheel gear (2) is splined to the shaft (3) and
is supported on either side by bearings (7, 8) which support the output
30 shaft (3) relative to the gearbox housing (1).

The output shaft free end carries a detachable upper yoke (9) which is a splined fit to the end of the output shaft (3) and has a split collar which is compressed over the splined shaft portion, or an alternatively profiled shaft, by a high-tensile pinch bolt. The upper yoke and output shaft
5 therefore form one half of a Cardan joint, the other half being carried by an intermediate shaft, otherwise known as an I-shaft, which is connected to the output shaft for onwards transmission of torque to the roadwheels of the vehicle.

10 For a given overall column length and a given set of reach-adjustment and crash-collapse requirements, the Guide Length of the column is reduced by around 55 to 85 mm when a column-mounted Electric Power Steering device is installed compared with a non-assisted assembly. This can often mean a reduction in Guide Length of the order of 50%. The effect is to
15 make it difficult, in many instances, to devise upper steering column designs which have the desired stiffness, ease of adjustment and consistency in their collapse forces. The prior art form of attachment of the upper yoke contributes to this reduction.

20 According to a first aspect the invention provides a gearbox assembly for an electric power assisted steering assembly which comprises:

a gearbox housing,

an output shaft,

a wheel gear assembly comprising a hub which is fixed to the output shaft
25 by a locating means so as to prevent relative rotational and axial movement between the hub and the output shaft and a gear wheel fixed to the hub,

at least one support bearing assembly which support the output shaft relative to the gearbox housing,

30 a worm gear which engages the wheel gear, and

a coupling for transmission of torque from the output shaft to an intermediate shaft that is external to the gearbox housing;

characterised in that:

the coupling includes a fixing part which is fixed to the output shaft
5 through the gear assembly and the support bearing assembly is provided on the opposite side of the gear assembly to the coupling such that the gear assembly is overhung from the portion of the output shaft supported by the bearings.

10 By overhanging the gearbox from the bearing assembly located on the “input” side of a gear assembly the applicant has appreciated that access to the end face of the gear hub on the “output” side is provided which permits the coupling to be connected directly to the gear hub rather than directly to the end of the output shaft using a splined coupling as is
15 known in the prior art. The overall length of the gearbox can therefore be reduced.

The support bearing assembly may comprise two bearings spaced apart along the axis of the output shaft, both on the input side of the gearbox. It
20 may comprise only one bearing such as a so-called 4-point contact angular ball bearing or, alternatively, a significantly larger deep-groove ball bearing. In either case, it is preferred that the output shaft is not supported at all by any bearing assembly on the output side of the gearbox, i.e. the side of the hub to which the coupling is fastened.

25

The fixing part of the coupling may comprise a flange which abuts the gear assembly, and preferably abuts an end face of the gear hub on the output side of the gearbox.

30 The overall length reduction is slightly compromised by the need to have some unoccupied space between the Worm-Wheel support bearings which

is, in effect, “wasted” length. Increasingly, the said unoccupied space reduces the radial forces acting on the bearings which are due to shaft bending-moments. These bending moments partly derive from the effects of the helix angle of the gear teeth and partly derive from the kinematics
5 of any coupling used. The axial length of the said unoccupied space is much less than the reduction in overall length brought about by using the flanged coupling, directly driven from the Worm-Wheel.

An additional advantage of the overhung Worm-Wheel gear assembly is
10 that the Output Bearing Carrier which is shown in the Prior Art case in Fig. 1 is no longer necessary.

The open end of the gearbox housing on the coupling side of the gear assembly may be covered by a cover which co-operates with the gear hub
15 and/or the gearbox housing. This helps to retain the grease, where provided inside. The cover may be a light metal pressing. The sealing between the pressing and the gear wheel hub can either rely on having a small clearance with some labyrinthine geometry or may, alternatively, use a flexible rubbing seal.

20

The coupling flange may be attached directly to the hub of the EPS Worm-Wheel via one or more fasteners, such as screws, typically four.

The coupling may comprise an upper yoke which forms part of a Cardan
25 shaft connection. Of course, other forms of coupling may be provided within the scope of the invention, such as a constant velocity joint.

The coupling may form an integral part of the intermediate shaft, a so called I-shaft. The complete I shaft may therefore form an integral part of
30 the gearbox assembly.

The locating means by which the worm gear hub is fixed to the output shaft may comprise an interaction between part of the hub gear and part of the output shaft. For instance a bore may be provided through a central region of the hub gear which is a heavy press fit onto a portion of the output shaft.

Additionally, or in the alternative, the locating means may include spline teeth which are incorporated into either or both of the connecting surfaces of the hub gear and output shaft. For instance, the outside diameter of the shaft could have a “fine-tooth” spline form comprising a large number of small ridges extending axially over a part or the whole of the interface between the Worm-Wheel and the Output Shaft.

The fine tooth spline could be economically produced by a rolling process. The internal bore of the Worm-Wheel could be plain but have a diameter slightly smaller than the diameter of an imaginary circle enveloping the tips of the male spline on the shaft.

Alternately, the shaft could be made plain and spline teeth could be incorporated into the bore of the Worm-Wheel instead. In a further arrangement, matching spline teeth can be incorporated into both surfaces and designed so that they require a heavy press-fit for assembly by virtue of having interference between them.

The wheel hub may be fixed to the shaft so as to provide a combination of at least 400 Nm minimum rotational slip torque and at least 8kN minimum axial slip force.

In a preferred arrangement a secondary locating means is provided which ensures that in the event of at least one type of failure of the connection

between the hub and the output shaft the flanged coupling cannot rotate or move axially relative to the output shaft.

The applicant has appreciated that a “Disconnected Steering” occurrence
5 in service would be unacceptable, and has appreciated that it is possible to provide secondary retention means for securing the Worm-Wheel hub to the output shaft, both axially and rotationally, in the event that the press-fit between them would fail in either mode.

10 To provide rotational security, the secondary locating means may comprise a portion of the output shaft which has a non-round, for example square, profile in cross section which co-operates with corresponding non-round, for example square, hole formed in the centre of the flange. This ensures that the flange cannot rotate relative to the
15 output shaft, thus preventing the flange from rotating even if the hub gear is free to rotate. The effect is to ensure that the output and output shafts remain rotationally locked to permit torque to pass from one to the other at all times.

20 To provide an axial security a circlip may be provided which fits at least partially within a groove provided in the non-round part of the shaft and which prevents the Worm-Wheel from sliding off the shaft in the event that the fixing between hub and shaft fails.

25 Where the non-round part of the shaft has a square or polygonal section, the circlip may fit into one or more grooves that are provided in each corner of the shaft section. In order to ensure that relatively deep grooves can be employed in the shaft to provide a secure retention of the circlip, and to further aid security by having a solid clip rather than a split
30 device, the circlip may be designed to be slid over the non-round, e.g.

square, profile during assembly until it is level with the groove and then rotated into engagement in the manner of a “bayonet” fitting.

Where the circlip is rotated into position it may be prevented from rotating out of its installed position by one or more flexible fingers radiating from the periphery of the circlip which are arranged so as to engage with depressions formed in the adjacent side of the Worm-Wheel Hub into which they snap-fit on assembly and out of which they are prevented from subsequently disengaging by the presence of the flange once it is fixed to the hub.

In an alternative arrangement the rotational and axial back-up features may be combined into one component which resembles a grub screw and which engages with a hole half-formed as a semi-circular depression in the outside circumference of the output Shaft and half-formed as a semi-circular depression in the inside circumference of the gear hub. The former semi-circular depression having a thread form matching that of the grub screw while the latter semi-circular depression is plain.

The grub screw may be provided with a non-round head, such as a rectangular extension, at its accessible end which provides a means for screwing it into position in the half-threaded hole which is created by the two said semi-circular depressions. The non-round head may then engage with a slot in the circumference of the inner bore of the flange once the latter is fixed in position against the Worm-Wheel hub such that the interaction between the slot and the head prevents further rotation of the grub screw.

The grub screw is thereby prevented from rotating and therefore can not move along the threaded semi-circular depression in the outside circumference of the Output Shaft.

In use the non-accessible end of the grub screw may be located adjacent to an end wall of the semi-circular depression in the inside circumference of the hub and therefore prevents the hub from slipping along the shaft by
5 more than a fraction of a millimetre. In this manner the grub screw retains the hub on the shaft both rotationally and axially in the event that the press-fit between the hub and the shaft should fail and initiate some slip.

10 There will now be described, by way of example only, three embodiments of the present invention with reference to and as illustrated in the accompanying drawings of which:

Figure 1 is shows the cross-section through the worm-wheel axis for a
15 typical prior art Column-Drive EPS gearbox;

Figure 2 is a first embodiment of a gearbox assembly according to the present invention but omitting to show an I-shaft which forms part of the gearbox assembly;

20

Figure 3 is an illustration of the complete I-Shaft, with flanged upper yoke, separated from the EPS Gearbox for clarity;

Figure 4 is an illustration of an enhanced feature whereby an axial and
25 rotational back-up is provided by an additional secondary locating means in the form of a special circlip; and

Figure 5 is an alternative arrangement employing a grub screw as the additional secondary locating means to provide axial and rotational back-
30 up.

As shown in Figure 2, an embodiment of an electric power assisted steering assembly in accordance with the present invention comprises a gearbox housing (20) within which is located an output shaft (23). The output shaft (23) is connected to an input shaft (28) by an optional quill shaft (27) that is located within a bore in the output shaft and a bore in the input shaft on an "input" side of the gearbox housing (the right side as shown in Figure 2). The input shaft (28) forms part of a steering column and is operatively connected to a steering wheel of a vehicle. The quill shaft (27) is provided to increase the amount of rotation between the input and output shafts as the driver applies torque to the input shaft. This rotation is then detected by a torque sensor (not shown) located within the gearbox housing (20) on the input side used as part of the control circuit for an electric motor (also not shown).

As well as connecting to an input shaft on an "input" side of the gearbox, the output shaft (23) also forms a take off point for the transfer of torque out from the gearbox on an "output" side of the gearbox shown to the left in the Figure. The output shaft is operatively connected to the roadwheels of the vehicle via an intermediate I-shaft (32) shown in Figure 3. The manner in which the output shaft and the I-shaft shaft are connected is described hereinafter.

With the housing is a worm and wheel gearbox. The wheel forms part of a wheel gear assembly (22) and is fixed to a wheel gear assembly comprising a hub (21) which is fixed to the output shaft (23) by a locating means so as to prevent relative rotational and axial movement between the hub (21) and the output shaft (23) and a gear wheel (22) fixed to the hub. The locating means takes the form of a heavy press fit of the hub to the shaft.

The worm (29) forms part of a motor drive shaft which extends through the gearbox at right angles and offset from the output shaft so that the worm and wheel gear teeth mesh. The motor drive shaft is arranged such that it can be connected to a motor (not shown), rotation of the motor
5 causing the worm to rotate and it turn the wheel and hence the output shaft. The worm shaft is supported relative to the gearbox housing (20) by bearings (not shown).

The output shaft (23) is supported with the gearbox housing (20) by a pair
10 of bearing races (25, 26) which are spaced apart by a small distance. Each comprises an inner bearing race fixed to the output shaft, and outer race journaled to the gearbox housing, and a set of ball bearings between the inner and outer races. One of the bearings could be of the needle or roller type. Both bearings are provided on the input side of the gear
15 assembly such that the gear assembly is overhung, eg it is supported on the free end of the output shaft that protrudes beyond the bearings on the output side of the gearbox and is not supported by bearings on that output side.

20 Secured to the gearbox hub on the output side is a flange (31) which forms part of a universal coupling. The flange is fixed to the hub by four screws (33), and the outer yoke fixed to the flange (31) provides half of a Cardan type universal coupling, the other half being secured to an intermediate shaft to which the gearbox is to be connected. Once the
25 Cardan coupling is assemble there is a direct torque transmission path from the output shaft (23) through the coupling, the flange (31) and the gear hub to the I-shaft (32).

As shown in Fig. 2, the locating means for connecting the Worm-Wheel
30 (22) to the Output Shaft (23) comprises a heavy press-fit connection between part of the hub (21) and the shaft (23). Thus, the mechanical

connection between the steering wheel and the road wheels relies on this press-fit never slipping in service. Slippage of this connection could result in “Disconnected Steering”, which is an unacceptable failure mode. Note that the said press-fit provides both a vital rotational connection and a vital axial connection and the failure of either or both could cause “Disconnected Steering”. To improve the capacity of the connection to resist rotational slip, there is an option to incorporate spline teeth into either or both of the connecting surfaces. For instance, the outside diameter of the shaft also has a “fine-tooth” spline form comprising a large number of small ridges extending axially over a part or the whole of the interface between the Worm-Wheel and the Output Shaft. In this embodiment, the spline form and interference fit are chosen, together with the respective hardnesses of the Worm-Wheel and shaft materials, so as to provide a combination of 400 Nm minimum rotational slip torque and 8kN minimum axial slip force.

In the modified arrangement of Figure 4, an additional secondary locating means is provided whereby an additional connection is made between the flanged coupling and the output shaft to ensure they cannot be displaced rotationally or axially in the event that the press fit between the gear hub and the output shaft relaxes or an excessive load is applied.

A rotational back-up is ensured by the engagement of a square profile (42) which is formed at the end of the Output Shaft (23) with a corresponding square hole (43) formed in the centre of the I-Shaft Upper Yoke. It is worth noting that, under normal operation, torque which is transmitted by the press fit of the Worm-Wheel hub on the Output Shaft is only that which is applied by the driver to the Steering Wheel. The assistance torque generated by the electric motor and reduction gears is not transmitted by the said press-fit. This fact enhances the service life expectancy of the secondary retention means, should it be called into

play. Occasional sudden angular accelerations of the shafts caused by road wheel impacts, on the other hand, may result in larger levels of torque being briefly applied to the said press-fit due to the inertia of the steering wheel.

5

In the arrangement shown in Fig. 4, an axial back-up is provided by a special circlip (40) which is fitted into grooves at the corners of the said square part of the shaft and which prevents the Worm-Wheel from sliding off the shaft in the event that the original press-fit relaxes. In order to ensure that relatively deep grooves can be employed in the shaft to provide a secure retention of the circlip (40), and to further aid security by having a solid clip rather than the more usual split device, the special circlip is designed to be slid over the square profile (42) during assembly until it is level with the groove and then rotated into engagement in the manner of a “bayonet” fitting. It is preventing from rotating out of its installed position by the bent-over ends (41) of one or more flexible fingers radiating from the periphery of the circlip (40). These bent-over flexible fingers (41) engage with depressions formed in the adjacent side of the Worm-Wheel Hub into which they snap-fit on assembly and out of which they are prevented from subsequently disengaging by the presence of the Upper Yoke once it is fixed to the hub by, in this example, four screws.

In another embodiment shown in Figure 5, the rotational and axial back-up features are combined into one component which resembles a grub screw (50) and which engages with a hole half-formed as a semi-circular depression in the outside circumference of the Output Shaft and half-formed as a semi-circular depression in the inside circumference of the hub. The former semi-circular depression has a thread form matching that of the grub screw (50) while the latter semi-circular depression is plain. The grub screw has a rectangular extension at its accessible end which

provides a means for screwing it into position in the half-threaded hole which is created by the two said semi-circular depressions.

The rectangular extension of the grub screw (50) engages with a slot (51)
5 in the circumference of the inner bore of flanged yoke once the latter is fixed in position against the Worm-Wheel hub. The grub screw is thereby prevented from rotating and therefore can not move along the threaded semi-circular depression in the outside circumference of the Output Shaft. The non-accessible end of the grub screw is adjacent to the end wall of
10 the semi-circular depression in the inside circumference of the hub and therefore prevents the hub from slipping along the shaft by more than a fraction of a millimetre. It can be seen that the grub screw retains the hub on the shaft both rotationally and axially in the event that the press-fit between the hub and the shaft should fail and initiate some slip.

CLAIMS

1. A gearbox assembly for an electric power assisted steering assembly which comprises:

5 a gearbox housing,

an output shaft,

a wheel gear assembly comprising a hub which is fixed to the output shaft by a locating means so as to prevent relative rotational and axial movement between the hub and the output shaft and a gear wheel fixed to

10 the hub,

at least one support bearing assembly which support the output shaft relative to the gearbox housing,

a worm gear which engages the wheel gear, and

a coupling for transmission of torque from the output shaft to an

15 intermediate shaft that is external to the gearbox housing;

characterised in that:

the coupling includes a fixing part which is fixed to the output shaft through the gear assembly and the support bearing assembly is provided on the opposite side of the gear assembly to the coupling such that the

20 gear assembly is overhung from the portion of the output shaft supported by the bearings.

2. A gearbox assembly according to claim 1, in which the support bearing assembly comprises two bearings spaced apart along the axis of

25 the output shaft, both on the input side of the gearbox.

3. A gearbox assembly according to claim 1, in which the support bearing assembly comprises only one bearing such as a so-called 4-point contact angular ball bearing or, alternatively, a significantly larger deep-

30 groove ball bearing.

4. A gearbox assembly according to any preceding claim, in which the output shaft is not supported at all by any bearing assembly on the output side of the gearbox.
- 5 5. A gearbox assembly according to any preceding claim, in which the fixing part of the coupling comprises a flange which abuts the gear assembly, and abuts an end face of the gear hub on the output side of the gearbox.
- 10 6. A gearbox assembly according to any preceding claim, in which the open end of the gearbox housing on the coupling side of the gear assembly is covered by a cover which co-operates with the gear hub and/or the gearbox housing.
- 15 7. A gearbox assembly according to any preceding claim, in which the coupling flange is attached directly to the hub of the EPS Worm-Wheel via one or more fasteners.
8. A gearbox assembly according to any preceding claim, in which
20 the coupling comprises an upper yoke which forms part of a Cardan shaft connection.
9. A gearbox assembly according to any preceding claim, in which the coupling forms an integral part of the intermediate shaft, typically a
25 so called I-shaft.
10. A gearbox assembly according to claim 9, in which the complete I shaft forms an integral part of the gearbox assembly.
- 30 11. A gearbox assembly according to any preceding claim, in which the locating means by which the worm gear hub is fixed to the output

shaft comprises an interaction between part of the hub gear and part of the output shaft.

12. A gearbox assembly according to any preceding claim, in which
5 the locating means includes spline teeth which are incorporated into either or both of the connecting surfaces of the hub gear and output shaft.

13. A gearbox assembly according to any preceding claim, in which
the wheel hub is fixed to the shaft so as to provide a combination of at
10 least 400 Nm minimum rotational slip torque and at least 8kN minimum axial slip force.

14. A gearbox assembly according to any preceding claim, in which a
secondary locating means is provided which ensures that in the event of at
15 least one type of failure of the connection between the hub and the output shaft the flanged coupling cannot rotate or move axially relative to the output shaft.

15. A gearbox assembly according to claim 14, in which the secondary
20 locating means comprises a portion of the output shaft which has a non-round, for example square, profile in cross section which co-operates with corresponding non-round, for example square, hole formed in the centre of the flange.

25 16. A gearbox assembly according to claim 15, in which a circlip is provided which fits at least partially within a groove provided in the non-round part of the shaft and which prevents the Worm-Wheel from sliding off the shaft in the event that the fixing between hub and shaft fails.

30 17. A gearbox assembly according to claim 16, in which where the circlip is rotated into position it is prevented from rotating out of its

installed position by one or more flexible fingers radiating from the periphery of the circlip which are arranged so as to engage with depressions formed in the adjacent side of the Worm-Wheel Hub into which they snap-fit on assembly and out of which they are prevented from subsequently disengaging by the presence of the flange once it is fixed to the hub.

18. A gearbox assembly according to any preceding claim, in which rotational and axial back-up features are combined into one component which resembles a grub screw and which engages with a hole half-formed as a semi-circular depression in the outside circumference of the output Shaft and half-formed as a semi-circular depression in the inside circumference of the gear hub.

19. A gearbox assembly according to claim 18, in which the grub screw is provided with a non-round head, such as a rectangular extension, at its accessible end which provides a means for screwing it into position in the half-threaded hole which is created by the two said semi-circular depressions.

20

20. A gearbox assembly according to claim 19, in which the non-round head is engaged with a slot in the circumference of the inner bore of the flange once the latter is fixed in position against the Worm-Wheel hub such that the interaction between the slot and the head prevents further rotation of the grub screw.

25

21. A gearbox assembly according to any of claims 18 to 20, in which in use the non-accessible end of the grub screw is located adjacent to an end wall of the semi-circular depression in the inside circumference of the hub and therefore prevents the hub from slipping along the shaft by more than a fraction of a millimetre.

30

22. A gearbox assembly substantially as described herein with reference to and as illustrated in figures 2a, 2b, 3a, 3b, 4a, 4b, 5a, 5b, and 5c of the accompanying drawings.

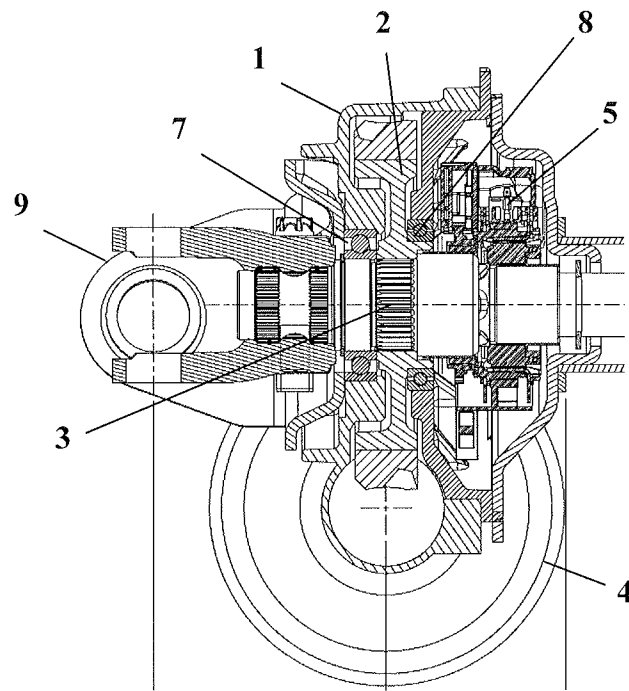


Figure 1. Prior Art

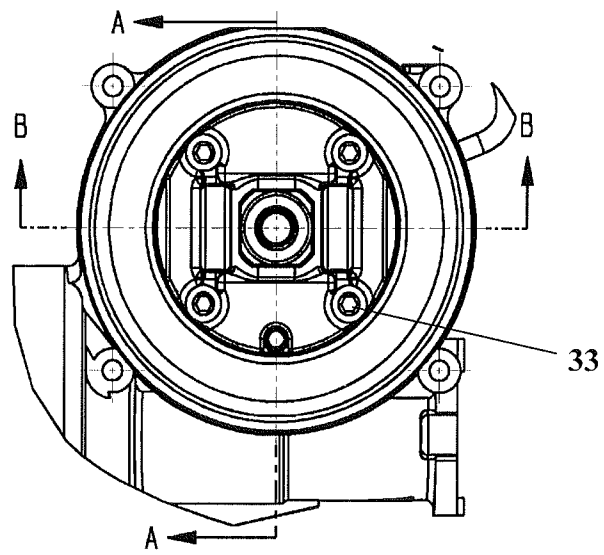


Figure 2a

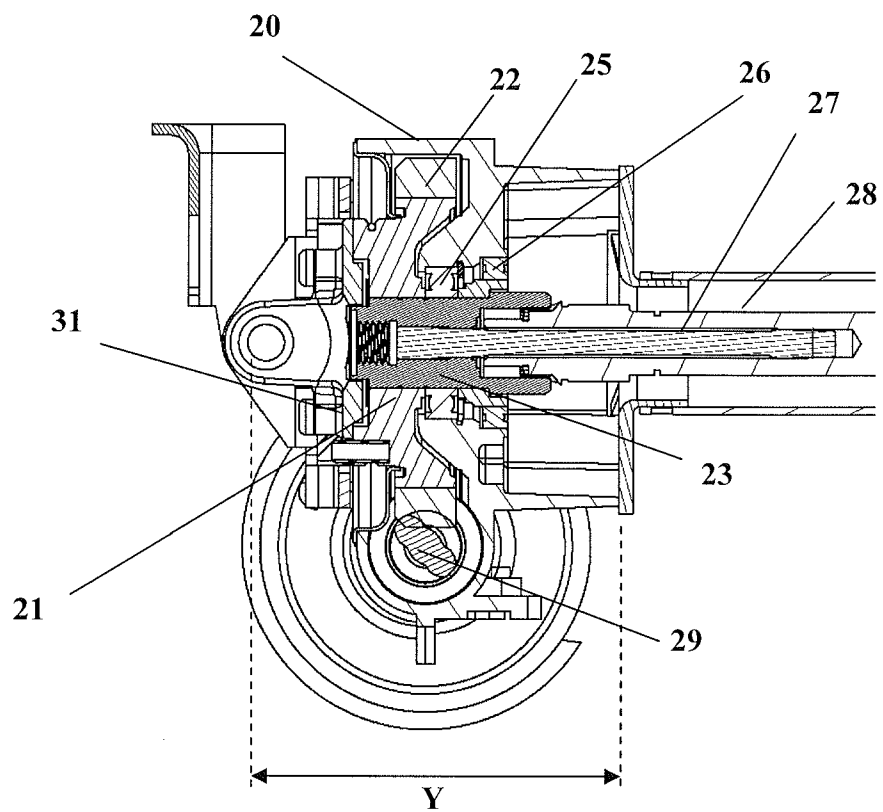


Figure 2b

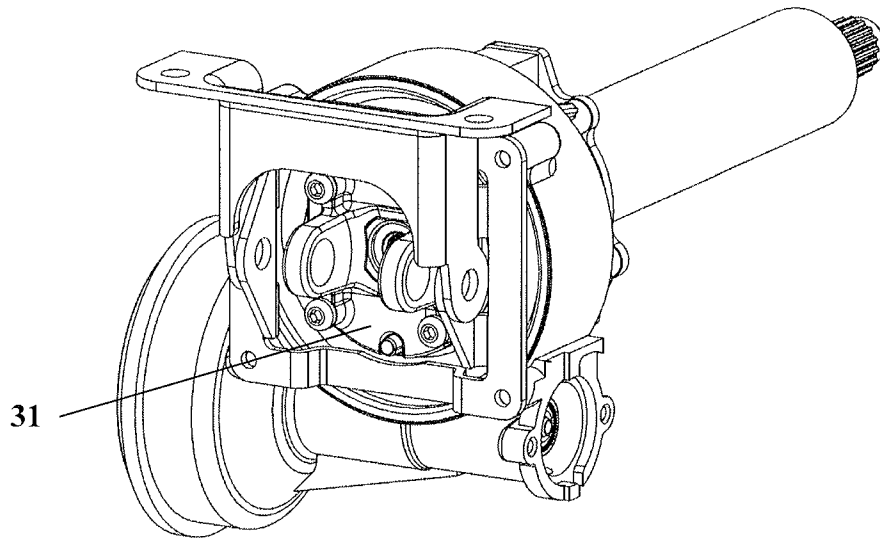


Figure 3a

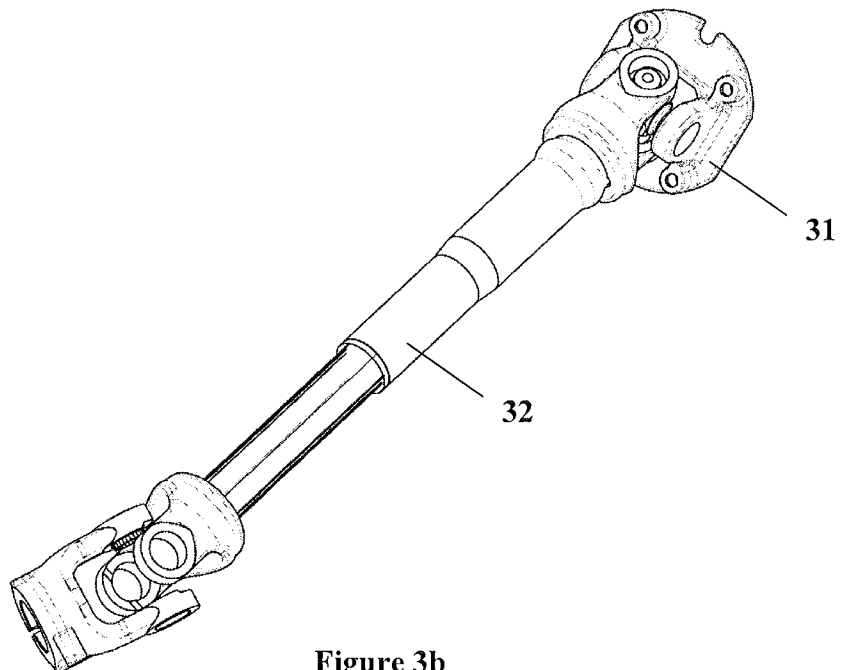


Figure 3b

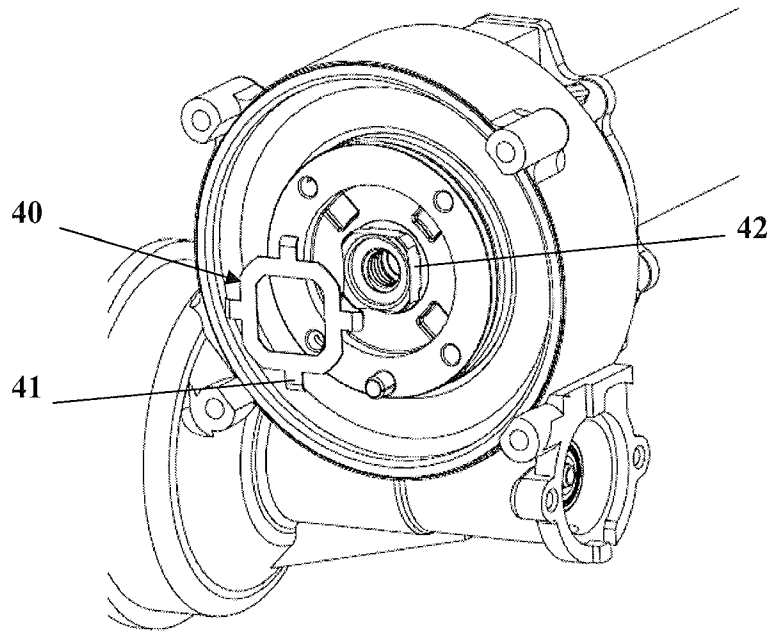


Figure 4a

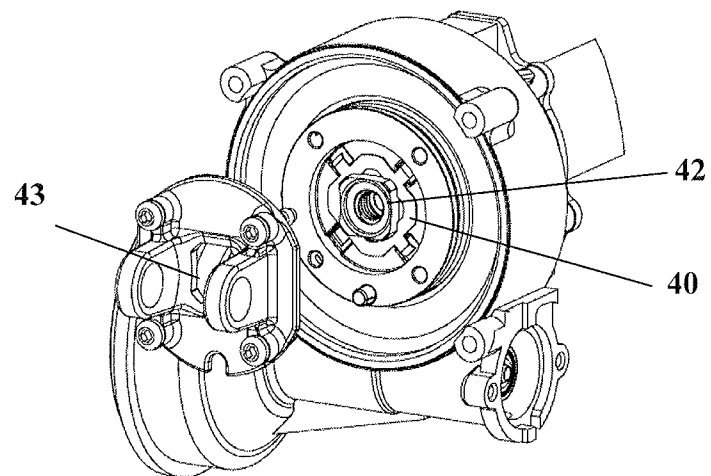


Figure 4b

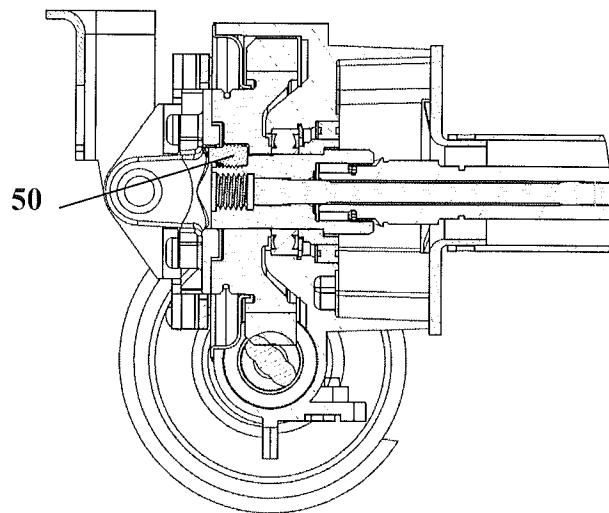


Figure 5a

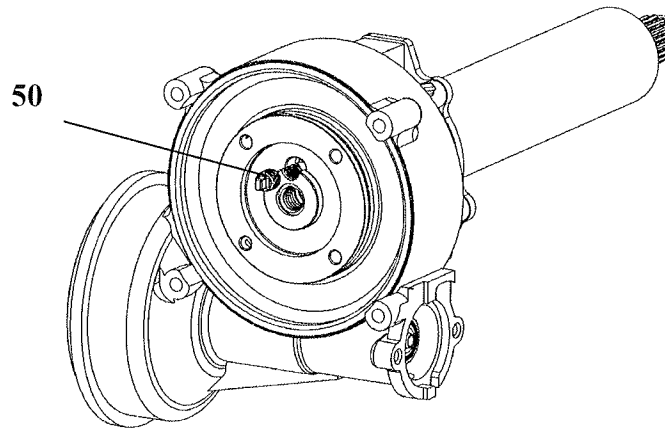


Figure 5b

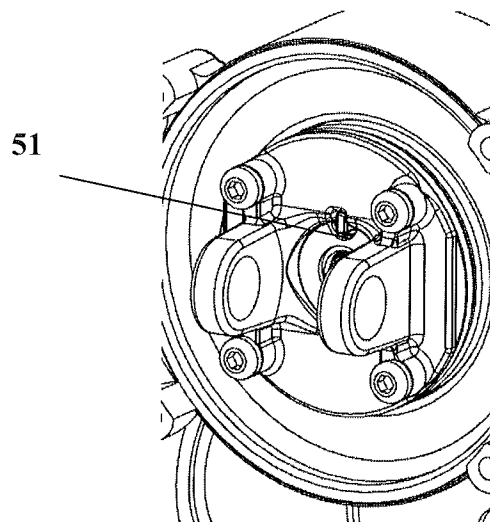


Figure 5c

INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2010/050492

A. CLASSIFICATION OF SUBJECT MATTER

INV. B62D5/04 B62D1/16 F16D3/38
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 F16H 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 practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 198 56 830 A1 (GEN MOTORS CORP [US]) 24 June 1999 (1999-06-24) column 2, line 16 - line 68; figures 1, 2 -----	1



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 document 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

26 August 2010

Date of mailing of the international search report

06/09/2010

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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Authorized officer

Kulozik, Ehrenfried

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2010/050492

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 22
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 22

Claim 22 solely relies on references to drawings. Therefore it is not allowed (Rule 6.2(a) PCT).

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2010/050492

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 19856830	A1	24-06-1999	NONE