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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 November 2012 (22.11.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/156418 A1

(51) International Patent Classification:
B60G 15/06 (2006.01) *B60G 17/027* (2006.01)

(21) International Application Number:
PCT/EP2012/059059

(22) International Filing Date:
15 May 2012 (15.05.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
TO2011A000434 16 May 2011 (16.05.2011) IT

(71) Applicant *(for all designated States except US)*: **SISTEMI SOSPENSIONI S.p.A.** [IT/IT]; Viale Aldo Borletti 61/63, I-20011 Corbetta (Milano) (IT).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **TRINCHERA, Massimo** [IT/IT]; Corso Gamba 36/M, I-10144 Torino (IT). **BRUNO, Walter** [IT/IT]; Via Cendola 2, I-14100 Asti (IT).

(74) Agents: **RONDANO, Davide** et al.; Jacobacci & Partners S.p.A., Corso Emilia 8, I-10152 Torino (IT).

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

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

[Continued on next page]

(54) Title: MACPHERSON VEHICLE SUSPENSION COMPRISING A DEVICE FOR ADJUSTING THE HEIGHT OF THE VEHICLE BODY FROM THE GROUND

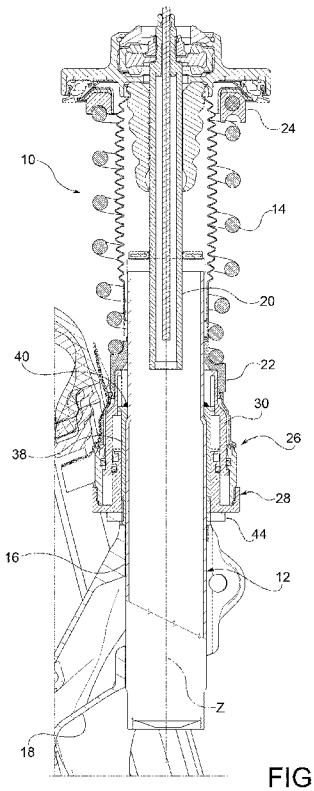

FIG. 1

(57) Abstract: The suspension comprises a damper and spring unit (10) with a damper (12), a spring (14) and an adjustment device (16) for adjusting the height of the vehicle from the ground. The adjustment device (26) is made as a hydraulic linear actuator and comprises a cylinder (28) and a plunger (30). The adjustment device (26) is interposed between the cylinder (16) of the damper (12) and the spring (14) to change in a controlled manner the linear position of the bottom end of the spring (14) relative to the cylinder (16) of the damper (12) along the axis (Z) of this latter. The adjustment device (26) further comprises a sleeve (38) which is firmly secured to the cylinder (16) of the damper (12) and on which the cylinder (28) of the adjustment device (26) is fitted. The adjustment device (26) further comprises anti-rotation means (48, 50) for preventing relative rotation of the sleeve (38) and of the plunger (30) of the adjustment device (26) about the axis (Z) of the cylinder (16) of the damper (12). These anti-rotation means (48, 50) are advantageously made as guide means adapted to allow the plunger (30) to slide relative to the sleeve (38) of the adjustment device (26) along the axis (Z) of the cylinder (16) of the damper (12).

WO 2012/156418 A1

TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *of inventorship (Rule 4.17(iv))*

Published:

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

MacPherson vehicle suspension comprising a device for adjusting the height of the vehicle body from the ground

The present invention relates in general to a MacPherson vehicle suspension, and more specifically to a damper and spring unit for a MacPherson vehicle suspension comprising an adjustment device for adjusting, i.e. for changing in a controlled manner, the height of the vehicle body from the ground, as specified in the preamble of independent claim 1.

The use on vehicle suspensions of adjustment devices for adjusting the height of the vehicle body from the ground is known. Such adjustment devices are used for instance on so-called SUVs (Sport Utility Vehicles), in order to allow the vehicle body to be at a higher level from the ground during off-road driving and at a lower level from the ground during on-road driving, in particular during high-speed driving. Such adjustment devices are also used on sport cars, whose height from the ground is usually reduced to ensure the best driving conditions at high speed, in order to allow to lift the vehicle body from the ground during special manoeuvres, for instance when entering or leaving areas delimited by steep ramps, as well as in order to allow the vehicle to drive on snowy roads or in any other driving condition for which it is preferable to have a higher level from the ground than the normal one.

An adjustment device of the above-identified type is typically made as a linear actuator, in particular as a single-effect hydraulic linear actuator, and is mounted on the suspension of each wheel of the vehicle so as to be vertically interposed either between a top end of the spring of the suspension and the vehicle body to change in a controlled manner the distance between the top end of the spring and the vehicle body, or between a part of the suspension drivingly connected to the wheel-carrier and a bottom end of the spring of the suspension to change in a controlled manner the distance between the axis of the wheel and the bottom end of the spring, and hence between the axis of the wheel and the vehicle body. In this second arrangement, one of the two parts which are movable relative to each other and which form the linear actuator acting as adjustment device is secured to the cylinder of the damper and the other is secured to a bottom plate which bears the bottom end of the spring or directly forms this bottom plate. In case of a hydraulic linear actuator, the

first one of the two parts of the actuator mentioned above corresponds to the cylinder, whereas the second one corresponds to the plunger.

A device for adjusting the height of the vehicle body from the ground which is made as a hydraulic linear actuator and is interposed between a part of the suspension drivingly connected to the wheel-carrier and a bottom end of the spring of the suspension has the advantage that it does not increase the vertical size of the suspension, but suffers from the drawback that it cannot be used on MacPherson suspensions for steering wheels, since the two parts of the hydraulic linear actuator, namely the cylinder and the plunger, are free to rotate relative to each other about the axis of the actuator.

It is therefore an object of the present invention to allow the use, on a MacPherson suspension for steering wheel, of an adjustment device for adjusting the height of the vehicle body from the ground, wherein the device is made as a hydraulic linear actuator.

This and other objects are fully achieved according to the invention by virtue of a damper and spring unit for a MacPherson vehicle suspension provided with an adjustment device for adjusting the height of the vehicle body from the ground having the features set forth in the characterizing part of the enclosed independent claim 1.

Advantageous embodiments of the invention are specified in the dependent claims, the content of which is to be regarded as an integral and integrating part of the following description.

The features and the advantages of the present invention will appear more clearly from the following detailed description, given purely by way of non-limiting example with reference to the appended drawings, in which:

Figure 1 is an axial section view of a damper and spring unit for a MacPherson vehicle suspension provided with an adjustment device for adjusting the height of the vehicle body from the ground according to a preferred embodiment of the present invention;

Figures 2 and 3 are axial section views showing in detail the adjustment device mounted between the damper and the spring of the damper and spring unit of Figure 1, in

the position of maximum height and in the position of minimum height of the vehicle body from the ground, respectively; and

Figure 4 is a section view of the adjustment device taken through section line IV-IV of Figure 3.

In the following description and claims, terms such as "upper" and "lower", "vertical" and "horizontal" and the like are to be intended as referred to the normal condition of mounting of the MacPherson suspension on the vehicle. Moreover, the terms "axial" and "longitudinal" are used herein to identify the direction of the axis of the hydraulic jack acting as adjustment device, which axis coincides, in the mounted condition of the adjustment device on a MacPherson suspension, with the axis of the damper, whereas the terms "radial" and "transverse" are used to identify a direction laying in a plane perpendicular to that axis.

With reference first to Figure 1, a damper and spring unit for a MacPherson suspension for a steering wheel of a vehicle is generally indicated 10 and comprises a damper 12 and a spring 14, both of per-se-known type. The damper 12 comprises a cylinder 16 rigidly connected to a wheel-carrying strut 18 (only partially shown), and a piston which is slidable inside the cylinder 16 and has a rod 20 projecting from the top end of the cylinder 16 and extending coaxially to this latter. The axis of the cylinder 16 is indicated Z and coincides with the direction of the extension and retraction movement of the rod 20 relative to the cylinder 16. The rod 20 is attached at its top end to the vehicle body. The spring 14 is made as a helical spring and is wound about the rod 20 of the damper 12, coaxially thereto. The spring 14 rests at its bottom end against a bottom spring plate 22 and at its top end against a top spring plate 24.

An adjustment device 26 for adjusting the height of the vehicle body from the ground is associated to the damper and spring unit 10. The adjustment device 26 is made as a hydraulic linear actuator and is interposed between the cylinder 16 of the damper 12 and the bottom spring plate 22 so as to allow to adjust the position of the bottom end of the spring 14 (and hence the position of the vehicle body) relative to the cylinder 16 of the damper 12 (and hence relative to the axis of the wheel, i.e. relative to the ground) along the axis Z. The adjustment device 26 basically comprises a cylinder 28 and a plunger 30, which are mounted

so as to be drivingly connected for axial translation the one with the cylinder 16 of the damper and the other with the bottom spring plate 22.

With reference in particular to Figures 2 and 3, the cylinder 28 of the adjustment device 26 comprises an inner cylinder element 32 and an outer cylinder element 34 which are arranged coaxially to each other so as to enclose an annular chamber 36. The annular chamber 36 acts as pressure chamber and for this purpose it is connected, in a manner which is per-se-known and not shown, to a source of fluid under pressure. The inner cylinder element 32 is fitted on a sleeve 38 which is firmly secured to the cylinder 16 of the damper 12, for instance by means of welding 40. The sleeve 38 has an externally threaded lower portion 42 on which a locking nut 44 is screwed. The bottom face of the cylinder 28 of the adjustment device 26, in particular the bottom face of the inner cylinder element 32, rests against the top face of the locking nut 44. The plunger 30 of the adjustment device 26 is made as a hollow cylindrical body and is slidably arranged, with a lower tubular portion 45 thereof, in the annular chamber 36. Seal members 46 of per-se-known type are arranged between the bottom end portion of the plunger 30 and the inner and outer cylinder elements 32 and 34 of the cylinder 28 to ensure tightness of the annular chamber 36. By feeding the annular chamber 36 with fluid under pressure, the plunger 30 is extended (lifted) from the cylinder 28 of the adjustment device 26, and hence both the spring 14 and the vehicle body are lifted. In this connection, Figure 2 shows the adjustment device 26 in the position of maximum extension of the plunger 30, corresponding to the condition of maximum height of the vehicle body from the ground. By discharging the annular chamber 36 of the adjustment device 26, the plunger 30 is retracted (lowered) into the cylinder 28, and hence both the spring 14 and the vehicle body are moved downwards. In this connection, Figure 3 shows the adjustment device 26 in the position of maximum retraction of the plunger 30, corresponding to the condition of minimum height of the vehicle body from the ground.

With reference now to Figure 4 as well, according to the invention the plunger 30 of the adjustment device 26 is prevented from rotating relative to the cylinder 28 (i.e. relative to the sleeve 38) of the adjustment device itself, and hence relative to the cylinder 16 of the damper 12, by virtue of anti-rotation means which are advantageously made as guide

means adapted to allow the plunger 30 to slide relative to the cylinder 28 (i.e. relative to the sleeve 38). In this connection, in the proposed embodiment these anti-rotation means are formed by a pair of prismatic guides provided on diametrically opposite sides between the plunger 30 and the sleeve 38. More specifically, each guide consists of a radial tooth 48 formed by the sleeve 38, preferably at the top end of this latter, and of a guide groove 50, which extends parallel to the axis Z and is formed on an inner cylindrical surface of the plunger 30 which is always placed outside the cylinder 28. In the illustrated embodiment, the guide groove 50 is formed on the inner cylindrical surface of an upper tubular portion 52 of the plunger 30 on which the top spring plate 24 is mounted. The width of the radial teeth 48 and that of the associated guide grooves 50 are selected so as to allow each radial tooth to slide along the associated guide groove, but to prevent each radial tooth (and hence the plunger 30) from rotating relative to the associated guide groove (and hence relative to the sleeve 38). Naturally, the arrangement of the radial teeth and of the guide grooves could be inverted with respect to the one shown in the drawings, in that the radial teeth could be formed by the plunger 30 and the guide grooves could be formed in the sleeve 38. Moreover, the number of guides could also be different from the one envisaged in the proposed embodiment.

With reference still to Figure 4, anti-rotation means are also provided between the plunger 30 of the adjustment device 26 and the bottom spring plate 22 for preventing these components from rotating relative to each other. More specifically, in the proposed embodiment these anti-rotation means comprise a pair of radial projections 54, which are formed by the plunger 30 and extend radially outwards from diametrically opposite sides, and a pair of recesses 56, which are provided on the inner cylindrical surface of a tubular portion 58 of the bottom spring plate 22 and in each of which a respective radial projection 54 of the plunger 30 engages. Also in this case, the arrangement of the radial projections and of the recesses could be inverted with respect to the one shown in the drawings, in that the radial projections could be formed by the bottom spring plate 22 and the recesses could be formed in the plunger 30. Moreover, the number of radial projections, and hence of recesses, could also be different from the one envisaged in the proposed embodiment. The anti-rotation means arranged to prevent the bottom spring plate 22 from rotating relative to the plunger 30 of the adjustment device 26 can also be made in a way other than the en-

gagement of projections in associated radial recesses.

By virtue of the provision of anti-rotation means between the sleeve 38 and the plunger 30 of the adjustment device 26, as well as between the plunger 30 of the adjustment device 26 and the bottom spring plate 22, the bottom spring plate 22 is prevented from rotating relative to the damper 12. The adjustment device according to the invention can thus be used also on a MacPherson suspension for a steering wheel.

Naturally, the principle of the invention remaining unchanged, the embodiments and the constructional details may vary widely from those described and illustrated purely by way of non-limiting example.

CLAIMS

1. Damper and spring unit (10) for a MacPherson vehicle suspension, the damper and spring unit (10) comprising a damper (12) and a spring (14),
wherein the damper (12) includes a cylinder (16) intended to be rigidly connected to a wheel-carrying member (18) and a rod (20) projecting from the top end of the cylinder (16) and movable along an axis (Z) of the cylinder (16),
wherein the spring (14) extends coaxially to the rod (20) of the damper (12), and
wherein the damper and spring unit (10) is provided with an adjustment device (16) for adjusting the height of the vehicle from the ground, the adjustment device (26) being made as a hydraulic linear actuator and comprising a cylinder (28) and a plunger (30),
characterized
in that the adjustment device (26) is interposed between the cylinder (16) of the damper (12) and the spring (14) to change in a controlled manner the linear position of the bottom end of the spring (14) relative to the cylinder (16) of the damper (12) along the axis (Z) of this latter,
in that the adjustment device (26) further comprises a sleeve (38) which is firmly secured to the cylinder (16) of the damper (12) and on which the cylinder (28) of the adjustment device (26) is fitted, and
in that the adjustment device (26) further comprises first anti-rotation means (48, 50) for preventing relative rotation of the sleeve (38) and of the plunger (30) of the adjustment device (26) about the axis (Z) of the cylinder (16) of the damper (12).

2. Damper and spring unit (10) according to claim 1, wherein said first anti-rotation means (48, 50) are made as guide means adapted to allow the plunger (30) to slide relative to the sleeve (38) of the adjustment device (26) along said axis (Z).

3. Damper and spring unit (10) according to claim 2, wherein said first anti-rotation means (48, 50) comprise at least one prismatic guide between the sleeve (38) and the plunger (30) of the adjustment device (26).

4. Damper and spring unit (10) according to claim 3, wherein said first anti-rotation

means (48, 50) comprise a pair of prismatic guides provided on diametrically opposite sides between the sleeve (38) and the plunger (30) of the adjustment device (26).

5. Damper and spring unit (10) according to any of claims 2 to 4, wherein said guide means (48, 50) comprise at least one radial tooth (48) formed by the sleeve (38) and at least one guide groove (50) extending parallel to said axis (Z), and wherein said at least one radial tooth (48) engages slidably, but non-rotatably, in said at least one guide groove (50) with respect to said axis (Z).

6. Damper and spring unit (10) according to claim 5, wherein the plunger (30) of the adjustment device (26) comprises an upper tubular portion (52) which is arranged outside the cylinder (28) of the adjustment device (26), and wherein said at least one guide groove (50) is formed on the inner cylindrical surface of said upper tubular portion (52).

7. Damper and spring unit (10) according to any of the preceding claims, further comprising a bottom spring plate (22) which is drivingly connected for axial translation with the plunger (30) of the adjustment device (26) and against which the bottom end of the spring (14) rests.

8. Damper and spring unit (10) according to claim 7, further comprising second anti-rotation means (54, 56) for preventing relative rotation of the plunger (30) of the adjustment device (26) and of the bottom spring plate (22) about said axis (Z).

9. Damper and spring unit (10) according to claim 8, wherein said second anti-rotation means (54, 56) comprise at least one radial projection (54) formed by the plunger (30) of the adjustment device (26) or by the bottom spring plate (22) and at least one recess (56) formed on the bottom spring plate (22) or on the plunger (30) of the adjustment device (26), respectively.

10. MacPherson vehicle suspension, comprising a damper and spring unit (10) according to any of the preceding claims.

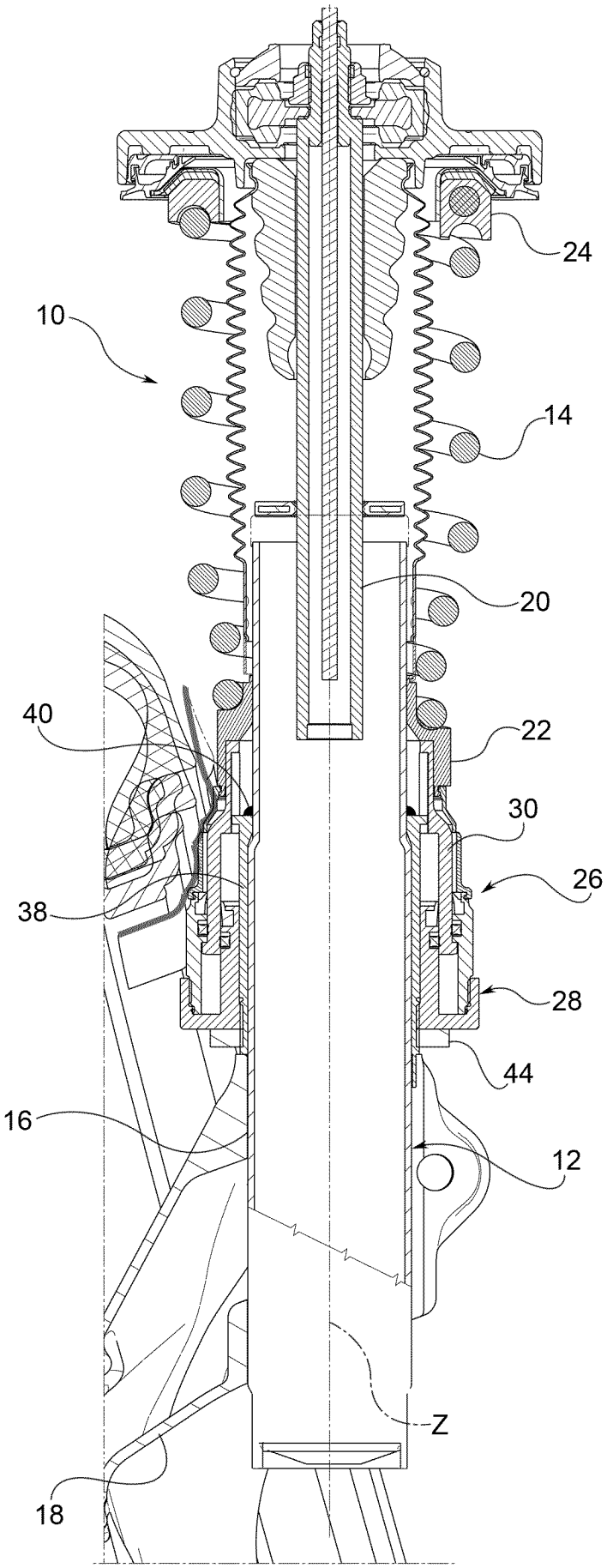

FIG. 1

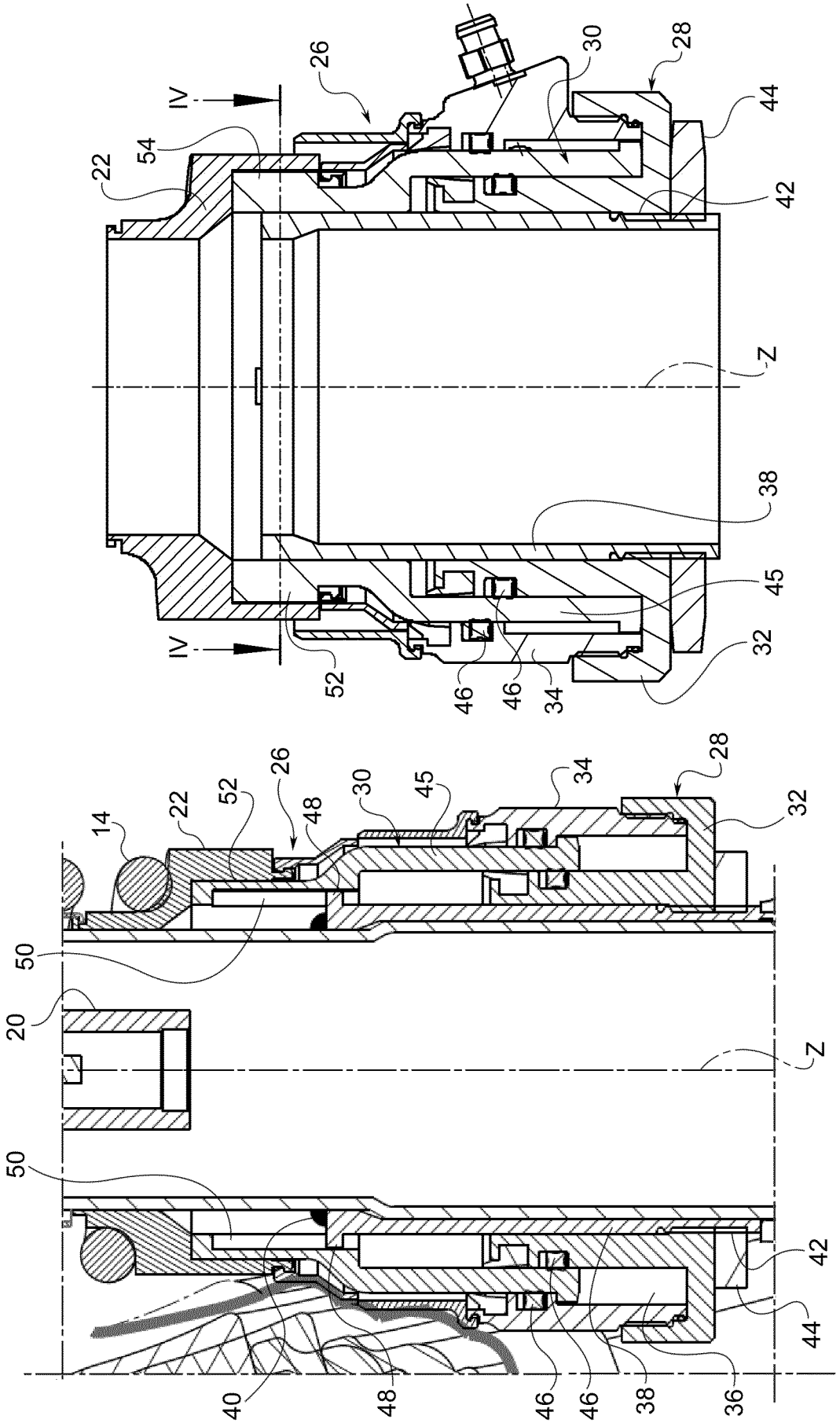
IV
IV
26
30
28
44
54
22
42
Z
38
45
32
52
46
46
34
14
22
52
26
48
30
45
34
28
32
50
20
Z
50
42
44
40
48
46
46
38
36

FIG. 3

FIG. 2

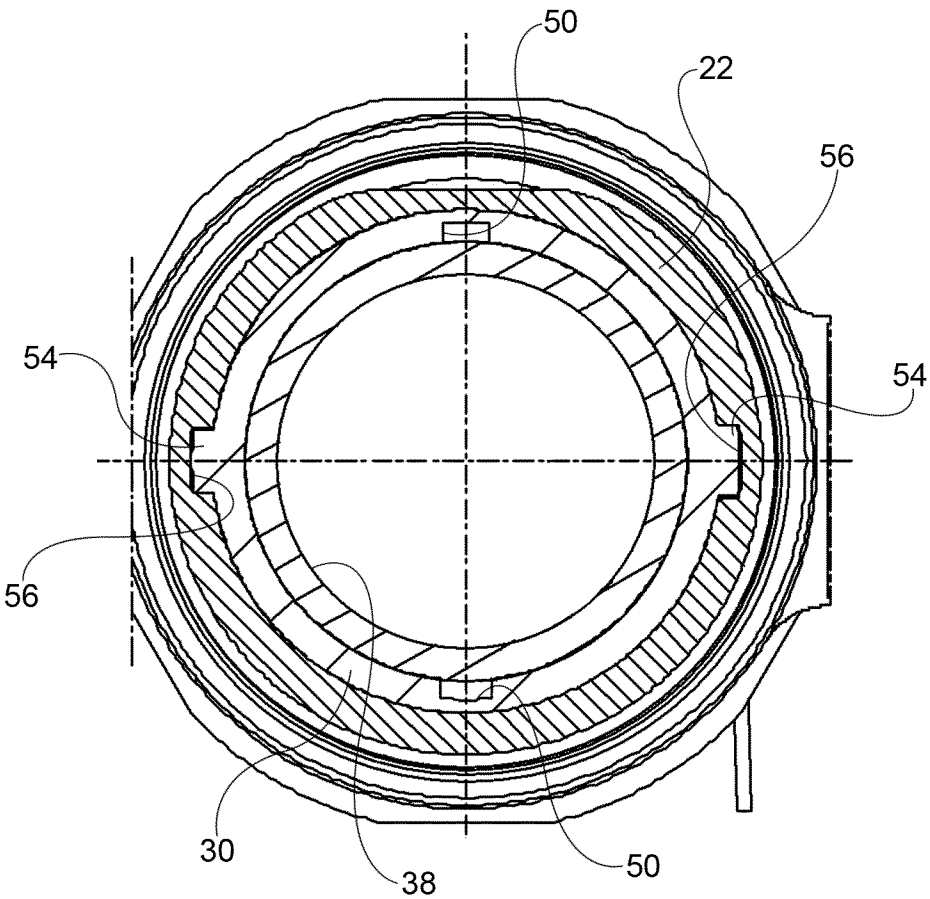

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/059059

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60G15/06 B60G17/027
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)
B60G

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/159993 A1 (MILLER ALEXANDER [DE] ET AL) 19 August 2004 (2004-08-19) paragraphs [0006], [0020], [0021], [0033], [0035]; figures 1,3	1-10
X	US 2004/163909 A1 (MILLER ALEXANDER [DE] ET AL) 26 August 2004 (2004-08-26) paragraphs [0006] - [0009], [0021], [0026] - [0027], [0031]; figures 1-3	1,7-10
A	DE 10 2007 044538 A1 (WOHLFARTH KLAUS [DE]) 12 March 2009 (2009-03-12) paragraphs [0023] - [0026], [0037] - [0038]; claim 13; figures 1-4	1-10
A	DE 101 44 242 A1 (WOHLFARTH KLAUS [DE]) 27 March 2003 (2003-03-27) paragraphs [0002], [0006], [0025], [0032]; figures 1-5	1-10

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

☒ See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 June 2012	21/06/2012

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

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2012/059059

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2004159993 A1	19-08-2004	AT 330801 T	15-07-2006
		DE 10256407 B3	29-04-2004
		EP 1426206 A2	09-06-2004
		ES 2265086 T3	01-02-2007
		JP 3936932 B2	27-06-2007
		JP 2004183891 A	02-07-2004
		KR 20040048299 A	07-06-2004
		US 2004159993 A1	19-08-2004
US 2004163909 A1	26-08-2004	DE 10301546 B3	06-05-2004
		FR 2850148 A1	23-07-2004
		US 2004163909 A1	26-08-2004
DE 102007044538 A1	12-03-2009	DE 102007044538 A1	12-03-2009
		EP 2197696 A1	23-06-2010
		WO 2009033985 A1	19-03-2009
DE 10144242 A1	27-03-2003	DE 10144242 A1	27-03-2003
		WO 03022607 A1	20-03-2003