



(51) International Patent Classification:

F16C 17/26 (2006.01)

B60G 7/02 (2006.01)

F16C 11/06 (2006.01)

(21) International Application Number:

PCT/US2019/022438

(22) International Filing Date:

15 March 2019 (15.03.2019)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/643,954

16 March 2018 (16.03.2018)

US

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(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, BN, BR, BW, BY, BZ,

CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, 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, ST, 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, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

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

(54) Title: IMPROVED PIVOT JOINT ASSEMBLY

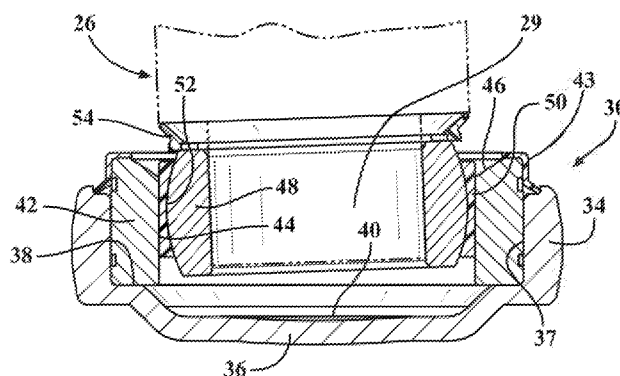


FIG. 7

(57) Abstract: The pivot joint assembly includes a housing (34) with an opening which extends along an axis. A bearing (50) is received in the opening and which has a cylindrical outer surface that is in slidable contact with another surface so that the bearing can slide in an axial direction relative to the housing. The bearing has a curved inner bearing surface (52). The pivot joint assembly also includes an inner ring (48) with a curved outer surface that is in slidable contact with the curved inner bearing surface of the bearing so that the inner ring can rotate and articulate relative to the housing.



IMPROVED PIVOT JOINT ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Patent Application Serial No. 62/643,954, filed March 16, 2018, entitled “IMPROVED PIVOT JOINT ASSEMBLY,” the entire disclosure of the application being considered part of the disclosure of this application and hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention is related, generally, to a pivot joint for pivotably attaching a pivot support with a steering knuckle in a vehicle steering and suspension system.

2. Related Art

[0003] Pivot joints are commonly found in vehicle suspension assemblies for operably attaching a knuckle with a pair of control arms in order to allow the knuckle and control arms to rotate and articulate relative to one another during operation of the vehicle. Such pivot joints could take a range of different configurations including configurations with and without ball studs. There is a continuing need for improved pivot joints which can be installed in a vehicle more easily, can be manufactured more cost effectively, and which offer improved durability.

SUMMARY OF THE INVENTION AND ADVANTAGES

[0004] One aspect of the present invention is related to a pivot joint assembly that includes a housing and wherein the housing has an opening which extends along an axis. The pivot joint assembly also includes a bearing which is received in the opening of the housing and which has a cylindrical outer surface that is in slidable contact with another surface so that the bearing can slide in an axial direction relative to the housing. The bearing has a curved inner bearing surface. The pivot joint assembly also includes an inner ring with a curved outer

surface that is in slidable contact with the curved inner bearing surface of the bearing so that the inner ring can rotate and articulate relative to the housing.

[0005] According to another aspect of the present invention, an outer ring is received in the opening of the housing and has a cylindrical inner surface and wherein the surface that is in slidable contact with the cylindrical outer surface of the bearing is the cylindrical inner surface of the outer ring.

[0006] According to yet another aspect of the present invention, the bearing is made as a monolithic piece of a material which consists of 8-12 wt% Polytetrafluoroethylene (PTFE), 2-6 wt% carbon fibers, and the remainder is of polyoxymethylene (POM).

[0007] According to still another aspect of the present invention, the housing has a bottom wall.

[0008] According to a further aspect of the present invention, the bottom wall has a raised portion which has an annular shape and which surrounds a recessed portion that is recessed relative to the raised portion.

[0009] According to yet a further aspect of the present invention, the bearing can slide in the axial direction until a portion of the bearing is axially located between the raised portion and the recessed portion and can slide such that the bearing is entirely located on an opposite side of the raised portion from the recessed portion.

[0010] According to still a further aspect of the present invention, the housing is made as a monolithic piece of metal.

[0011] According to another aspect of the present invention, the housing presents at least three bolt openings which are separate from the opening that extends along the axis.

[0012] According to yet another aspect of the present invention, the bearing includes a plurality of slits which are circumferentially spaced from one another by fingers and wherein the fingers are flexible in a radial direction for receiving and capturing the inner ring.

[0013] Another aspect of the present invention is related to a vehicle suspension system. The vehicle suspension system includes a knuckle, a control arm, and a joint assembly. The joint assembly operably connects the knuckle with the control arm while providing the knuckle with three rotational degrees of freedom and one translational degree of freedom for moving relative to the control arm. The joint assembly includes a housing which is fixedly attached with the control arm. The housing has an opening which extends along an axis. A bearing is received in the opening of the housing. The bearing has a cylindrical outer surface that is in slidable contact with another surface so that the bearing can slide in an axial direction relative to the housing. The bearing has a curved inner bearing surface. The joint assembly further includes an inner ring that has a curved outer bearing surface that is in slidable contact with the curved inner bearing surface of the bearing so that the inner ring can rotate and articulate relative to the housing. The inner ring is fixedly attached with the knuckle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] These and other features and advantages of the present invention will be readily appreciated, as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0015] Figure 1 is a perspective view of an exemplary suspension assembly and showing a knuckle being separated therefrom;

[0016] Figure 2 is another perspective view of the exemplary suspension assembly and illustrating movement of the control arms and knuckle in a vertical direction;

[0017] Figure 3 is another perspective view of the exemplary suspension assembly and illustrating movement of the knuckle in a rotating direction about a vertical axis;

[0018] Figure 4 is a perspective and exploded view of an exemplary pivot joint assembly for the suspension assembly of Figures 1-3;

[0019] Figure 5 is a cross-sectional view of the pivot joint in one configuration;

[0020] Figure 6 is a cross-sectional view of the pivot joint assembly in another configuration;

[0021] Figure 7 is a cross-sectional view of the pivot joint assembly in yet another configuration; and

[0022] Figure 8 is a cross-sectional view of the pivot joint assembly in still another configuration.

DETAILED DESCRIPTION OF THE ENABLING EMBODIMENT

[0023] Referring to the Figures, wherein like numerals indicate corresponding parts throughout the several views, a vehicle suspension system **20** is generally shown in Figures 1-3. The exemplary suspension system **20** includes a pair of vertically spaced apart control arms **22** and a single-piece pivot support **24** which extends between and is operatively attached with the control arms **22**. A knuckle **26** is operably attached with the pivot support **24** via a pair of joints **28, 30**, namely an upper joint **28** and a lower joint **30**. As shown in Figure 2, as the control arms **22** pivot in sync with one another up and down, the pivot support **24** and the knuckle **26** translate with generally fixed orientations so that a wheel which is operably connected with the knuckle **26** does not pivot.

[0024] The upper joint **28** has the form of a ball joint which has a ball joint housing that is received in an opening in the pivot support **24**. The upper joint **28** also has a ball stud which extends downwardly for attachment with the knuckle **26**. The lower joint **30** is a pivot joint which has an opening that receives a downwardly extending post **29** (shown in Figures 5-8) in the knuckle **26**. The ball stud of the upper joint **28** and a central location of the opening of the lower joint **30** are aligned with one another about a common central axis **A**. As

shown in Figure 3, the axial alignment of the upper and lower joints **28, 30** allows the knuckle **26** and a wheel (not shown) attached thereto to pivot about the central axis **A** in response to steering input from a tie rod **32** that is attached with the knuckle **24**.

[0025] Referring now to Figure 4, the lower joint **30** has a housing **34** with a cup-shaped opening which is defined by a bottom wall **36** and a side wall **37**. The opening extends along the central axis **A** from the bottom wall **36** at a closed first end to an open second end. The bottom wall **36** has an annular raised portion **38** which surrounds a recessed central portion **40**. The central axis **A** extends through the recessed central portion **40**. The annular raised portion **38** is planar and extends to a bottom end of the side wall **37**.

[0026] The housing **34** is preferably made of a single, monolithic piece of metal, such as steel or an alloy steel, and is preferably shaped through forging or casting and then machining to establish the final form of the cup-shaped opening. In the exemplary embodiment, the housing **34** has three bolt openings which receive bolts to fixedly attach the housing **34** with the pivot support **24**. However, it should be appreciated that the housing **34** could take other shapes and configurations and may be fixedly attached with the pivot support **24** through any suitable fastening means.

[0027] An outer ring **42** is fixedly received in the cup-shaped opening of the housing **34** and abuts the raised portion **38** of the bottom wall **36** of the housing **34**. In the Exemplary embodiment, the outer ring **42** is press fit into the opening of the housing **34** such that, once installed, the outer ring **42** remains in a fixed location within the opening of the housing **34**. A cap **43** is also fixed with the housing **34** and the outer ring **42** to fixedly attach these components together. When in an assembled position, the outer ring **42** projects out of the cup-shaped opening of the housing **34** in an axial direction. The outer ring **42** has an inner surface which has a major portion **44** with a generally constant diameter. The major portion **44** extends axially from adjacent the bottom wall **36** of the housing **34** to a tapered portion **46**

which tapers radially outwardly and which is located, axially, outside of the cup-shaped opening of the housing **34**. The outer ring **42** may be made of metal or plastic and may be shaped through any suitable operation.

[0028] The lower joint **30** further includes an inner ring **48** that has a through opening which is shaped to receive the post **29** of the knuckle **26** and includes a plastic bearing **50** which is disposed between the outer and inner rings **42, 48**. In the exemplary embodiment, the inner ring **48** is press-fit onto the post **29** such that, once attached, these components move with one another. The inner ring **48** is preferably made of metal, such as steel, and has a semi-spherically curved outer face.

[0029] A bearing **50** is disposed in the opening of the housing between the outer and inner rings **42, 48** for allowing these components to freely rotate relative to one another during operation of the vehicle suspension system **20**. Specifically, the bearing **50** is made of a low-friction material and has a semi-spherically curved inner face **52** that is in slidable contact with the curved outer face of the inner ring **48** to allow the inner ring **48** and the knuckle **26** to freely rotate about the central axis **A** (as shown in Figure 3) and to freely articulate, or pivot, relative to the outer ring **42**. For example, Figure 7 shows the inner ring **48** as being articulated relative to the bearing **50** and to the housing **34**. In other words, the slidable relationship between the inner ring **48** and the bearing **50** gives the knuckle **26** three rotational degrees of freedom by allowing it to rotate and articulate relative to the housing **34** and to the control arm **22** (shown in Figure 1) affixed thereto and vice versa. As discussed in further detail below, the bearing **50** is preferably made of a low friction plastic material and is preferably shaped through an injection molding operation.

[0030] The bearing **50** has an axial length which is less than an axial lengths of the outer and inner rings **42, 48**. In operation, an outer surface of the plastic bearing **50** can slide axially along the inner surface of the outer ring **42**. As shown in Figure 8, the slidable

relationship between bearing **50** and the outer ring **42** in combination with the configuration of the recessed portion **40** of the bottom wall **36** allows the inner ring **48** and the plastic bearing **50** to slide axially downwardly until both the inner ring **48** and the plastic bearing **50** are partially below the outer ring **42**. In other words, the slidable relationship between the plastic bearing **50** and the outer ring **48** provides the knuckle **26** with one translational degree of freedom by allowing it to translate relative to the control arm **22** (shown in Figure 1) and vice versa.

[0031] As shown in Figure 4, the bearing **50** has a plurality of circumferentially spaced apart and axially extending slots **56** formed therein. The slots **56** extend to one axial end of the bearing **50** and separate a plurality of fingers which can flex radially outwardly in an elastic manner when inserting the inner ring **48** into a cavity defined by the inner face **52** of the bearing **50**. Once a maximum outer diameter of the inner ring **48** clears the distal ends of the fingers, the fingers snap radially inwardly to capture the inner ring **48** within the bearing **50** while still allowing these components to rotate and articulate relative to one another.

[0032] The bearing **50** is preferably made of a material which consists of: 8-12 wt% Polytetrafluoroethylene (PTFE), 2-6 wt% carbon fibers, and the remainder is of polyoxymethylene (POM). This material has been found to provide the bearing **50** with low friction; sufficient strength to transfer forces between the outer and inner rings **42, 48** without damage; and sufficient elasticity to deflect when receiving the inner ring **48** therein during assembly of the lower joint **30**.

[0033] The lower joint **30** further includes a dust boot **54** which is sealed against the inner ring **48** and is sealable against the knuckle **26** for maintaining a lubricant within and keeping contaminants out of the lower joint **30**. The dust boot **54** may be fixedly attached with the inner ring **48** through any suitable means including, e.g., an adhesive.

[0034] Obviously, many modifications and variations of the present invention are possible in light of the above teachings and may be practiced otherwise than as specifically described while within the scope of the appended claims. Additionally, it is to be understood that all features of all claims and all embodiments can be combined with each other, as long as they do not contradict each other.

CLAIMS

What is claimed is:

1. A pivot joint assembly, comprising:
a housing with an opening which extends along an axis;
a bearing received in said opening of said housing and having a cylindrical outer surface that is in slidable contact with another surface so that said bearing can slide in an axial direction relative to said housing;
said bearing having a curved inner bearing surface; and
an inner ring having a curved outer bearing surface that is in slidable contact with said curved inner bearing surface of said bearing so that said inner ring can rotate and articulate relative to said housing.
2. The pivot joint assembly as set forth in claim 1 further including an outer ring which is received in said opening of said housing and which has a cylindrical inner surface and wherein said surface that is in slidable contact with said cylindrical outer surface of said bearing is said cylindrical inner surface of said outer ring.
3. The pivot joint as set forth in claim 1 wherein said bearing is made as a monolithic piece of a material which consists of 8-12 wt% Polytetrafluoroethylene (PTFE), 2-6 wt% carbon fibers, and the remainder is of polyoxymethylene (POM).
4. The pivot joint as set forth in claim 1 wherein said housing has a bottom wall.

5. The pivot joint as set forth in claim 4 wherein said bottom wall has a raised portion which has an annular shape and which surrounds a recessed portion that is recessed relative to said raised portion.

6. The pivot joint as set forth in claim 5 wherein said bearing can slide in said axial direction until a portion of said bearing is axially located between said raised portion and said recessed portion and can slide such that said bearing is entirely located on an opposite side of said raised portion from said recessed portion.

7. The pivot joint as set forth in claim 1 wherein said housing is made as a monolithic piece of metal.

8. The pivot joint as set forth in claim 7 wherein said housing presents at least three bolt openings which are separate from said opening that extends along said axis.

9. The pivot pin as set forth in claim 1 wherein said bearing includes a plurality of slots which are spaced circumferentially from one another by fingers and wherein said fingers are flexible in a radial direction for receiving and capturing said inner ring.

10. A vehicle suspension system, comprising:

a knuckle;

a control arm;

a joint assembly operably connecting said knuckle with said control arm while providing said knuckle with three rotational degrees of freedom and one translational degree of freedom for moving relative to said control arm, said joint assembly comprising;

a housing fixedly attached with said control arm;

a housing with an opening which extends along an axis;

a bearing received in said opening of said housing and having a cylindrical outer surface that is in slidable contact with another surface so that said bearing can slide in an axial direction relative to said housing;

said bearing having a curved inner bearing surface;

an inner ring having a curved outer bearing surface that is in slidable contact with said curved inner bearing surface of said bearing so that said inner ring can rotate and articulate relative to said housing; and

said inner ring being fixedly attached with said knuckle.

11. The vehicle suspension system as set forth in claim 10 further including an outer ring which is received in said opening of said housing and which has a cylindrical inner surface and wherein said surface that is in slidable contact with said cylindrical outer surface of said bearing is said cylindrical inner surface of said outer ring.

12. The vehicle suspension system as set forth in claim 10 wherein said bearing is made as a monolithic piece of a material which consists of 8-12 wt% Polytetrafluoroethylene (PTFE), 2-6 wt% carbon fibers, and the remainder is of polyoxymethylene (POM).

13. The vehicle suspension system as set forth in claim 10 wherein said housing has a bottom wall.

14. The vehicle suspension system as set forth in claim 13 wherein said bottom wall has a raised portion which has an annular shape and which surrounds a recessed portion that is recessed relative to said raised portion.

15. The vehicle suspension system as set forth in claim 14 wherein said bearing can slide in said axial direction until a portion of said bearing is axially located between said raised portion and said recessed portion and can slide such that said bearing is entirely located on an opposite side of said raised portion from said recessed portion.

FIG. 1

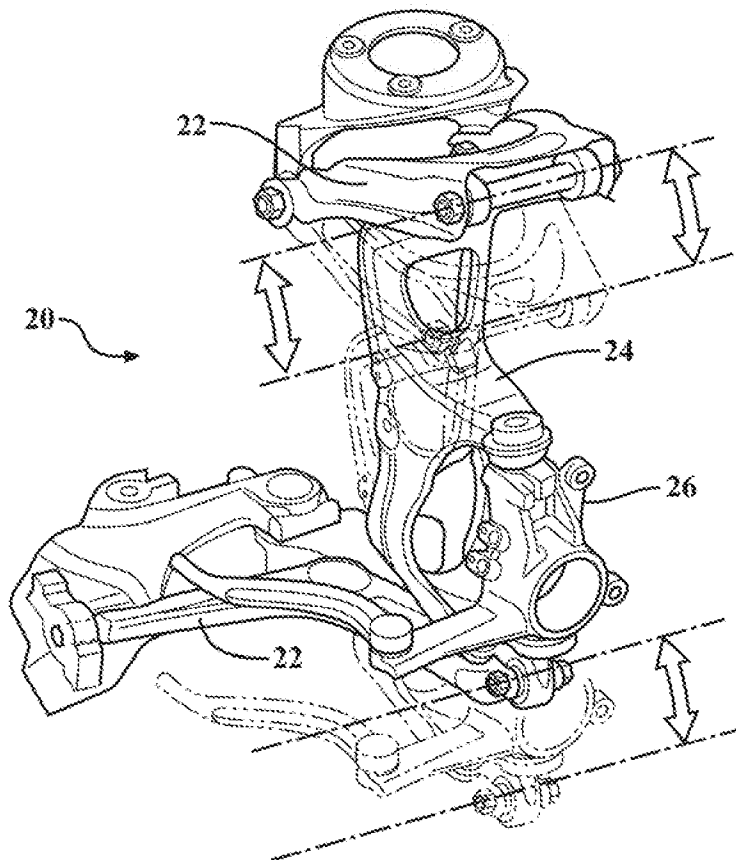
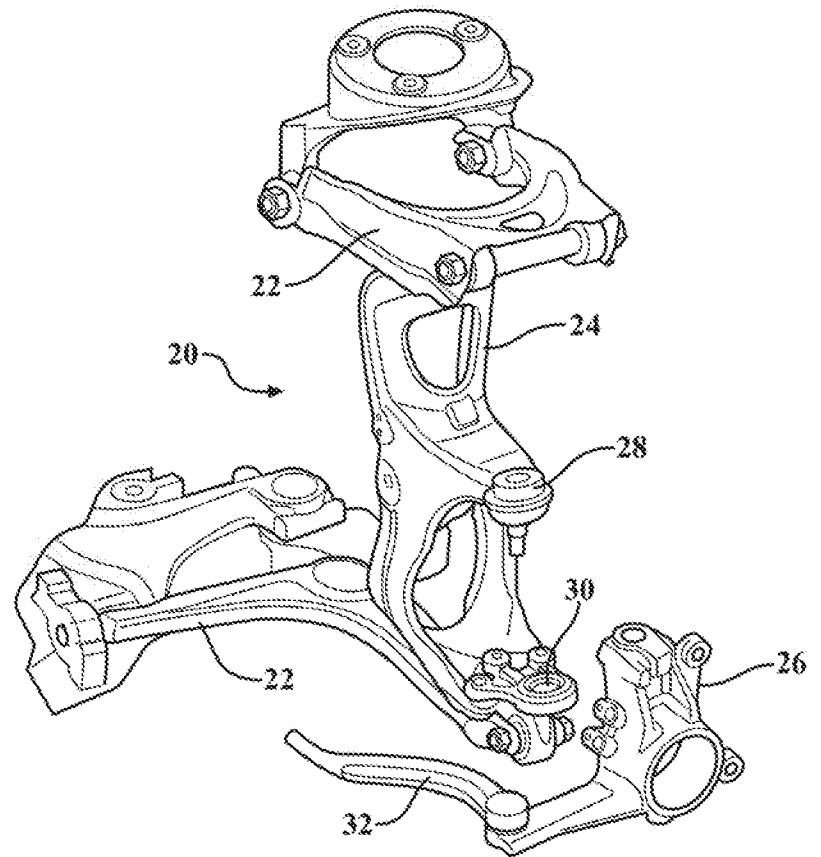


FIG. 2

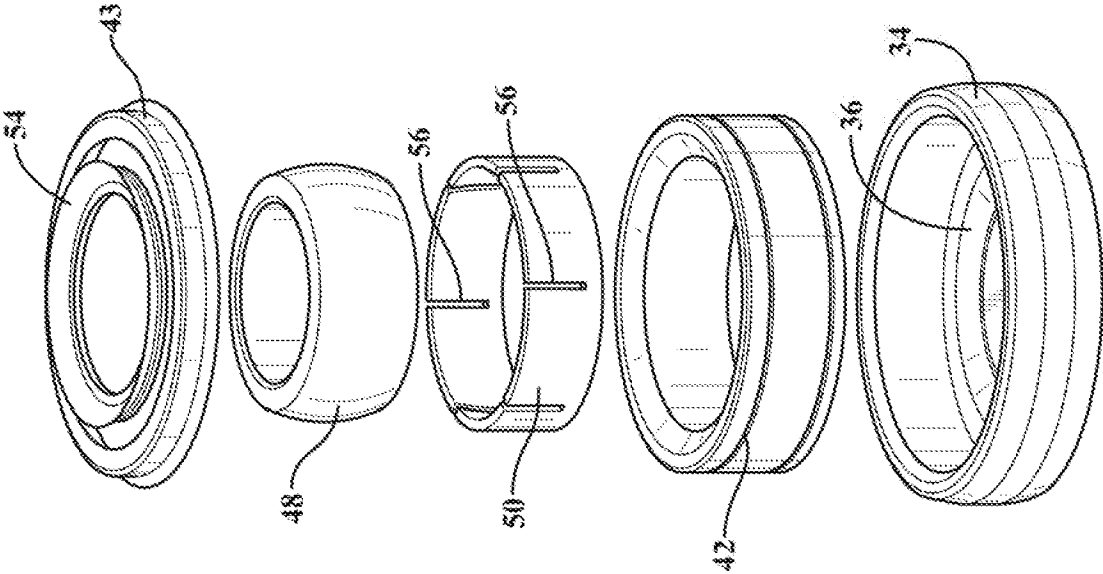


FIG. 4

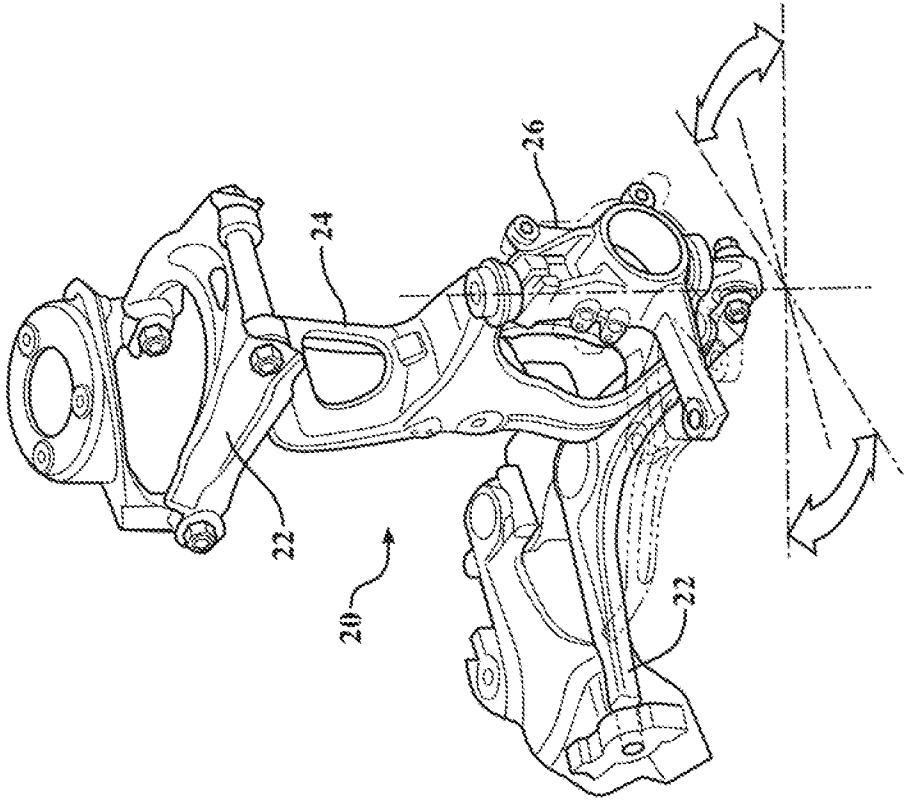


FIG. 3

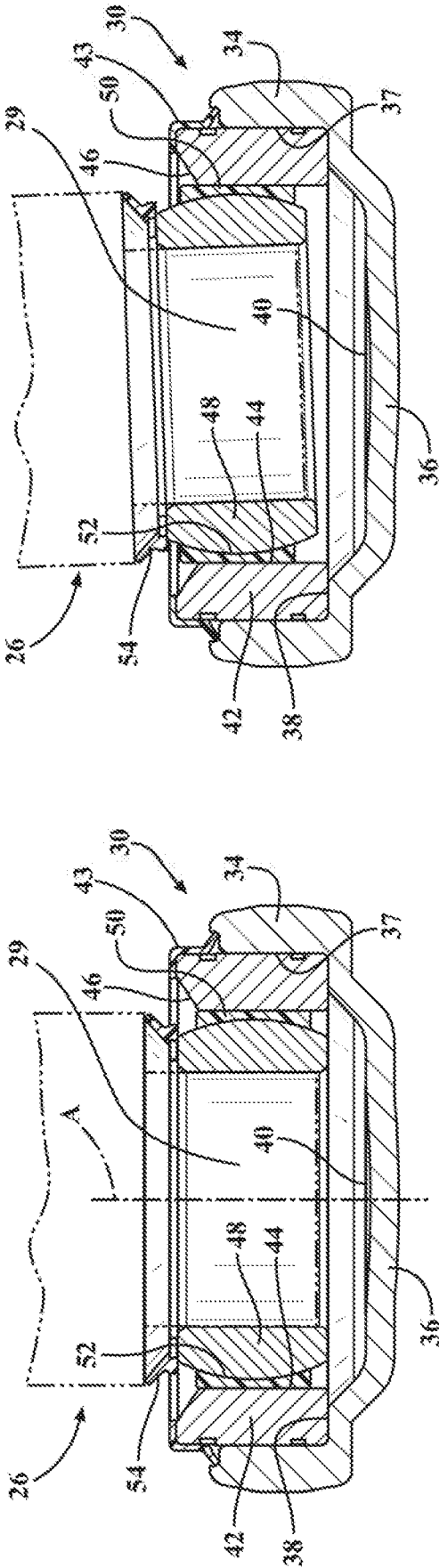


FIG. 7

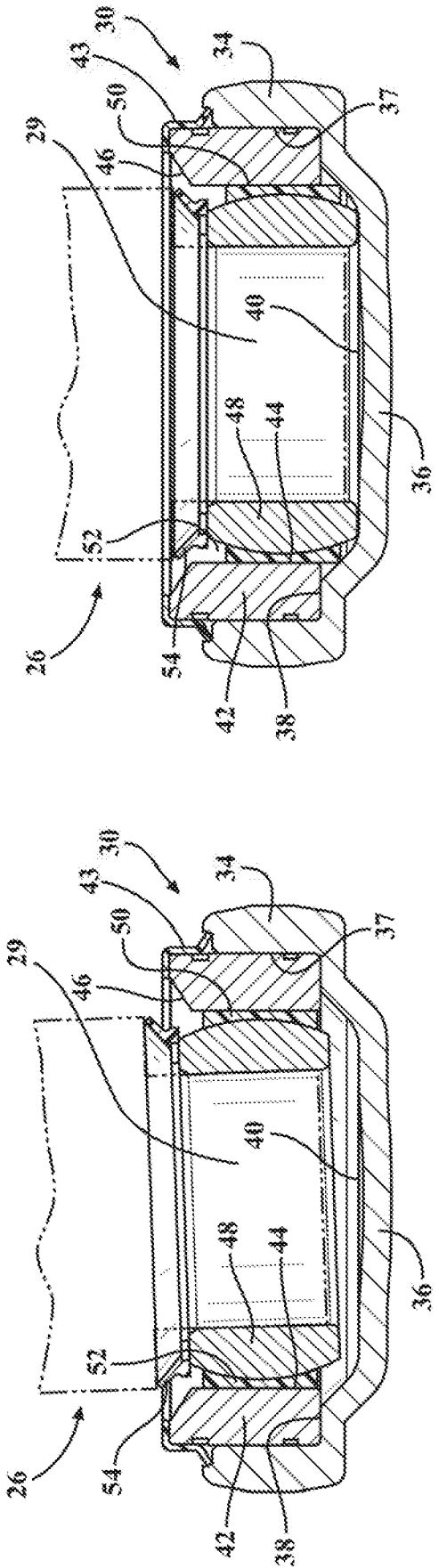


FIG. 8

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2019/022438

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16C17/26 F16C11/06 B60G7/02
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)
F16C 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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 042 294 A (URBACH BRIAN A [US]) 28 March 2000 (2000-03-28) column 2, line 57 - column 3, line 23; figures	1-7, 10-15
X,P	WO 2018/165082 A1 (FED MOGUL MOTORPARTS LLC [US]) 13 September 2018 (2018-09-13) paragraphs [0033] - [0042]; figures 5-7	1,2,4,7, 10,11,13
X	US 2010/109274 A1 (DIENER ANDRE [DE] ET AL) 6 May 2010 (2010-05-06) paragraphs [0021] - [0025]; figures	1,3,4,7, 10,12,13



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

5 June 2019

Date of mailing of the international search report

14/06/2019

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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