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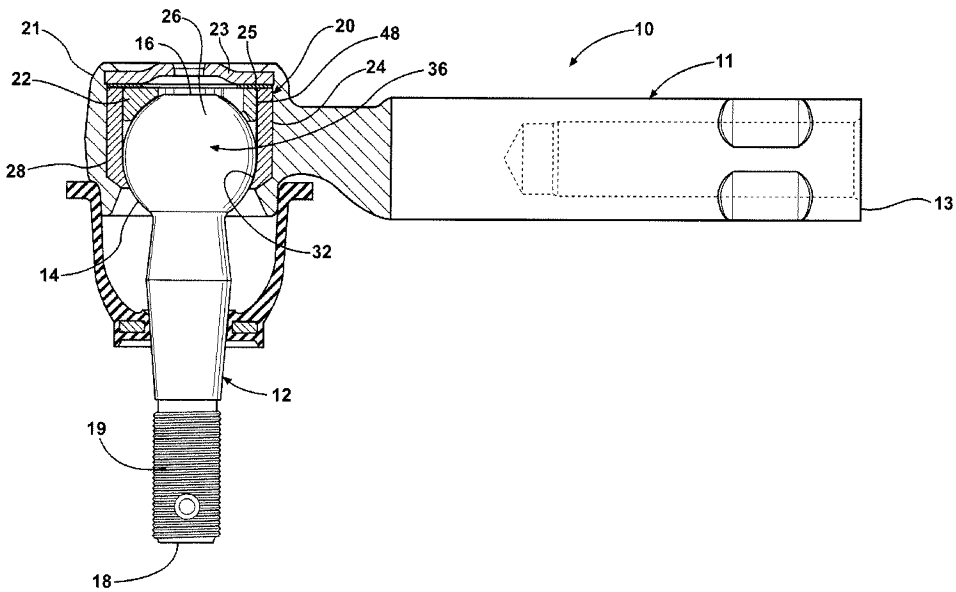
(54) **Titre : JOINT A ROTULE POURVU D'UN PALIER SUPERIEUR AMELIORE ET PROCEDE DE CONSTRUCTION DE CELUI-CI**
(54) **Title: BALL JOINT WITH IMPROVED UPPER BEARING AND METHOD OF CONSTRUCTION THEREOF**



(57) **Abrégé/Abstract:**
A ball joint (10) for interconnecting relatively movable components is provided. The ball joint includes a housing and a stud with a spherical bearing surface disposed in the housing. The bearing has a concave spherical bearing surface which is brought into sliding abutment with the spherical bearing surface of the stud. The bearing is of a monolithic piece of fiber- reinforced polyamide material and includes carbon fibers which extend circumferentially about the concave spherical bearing surface.

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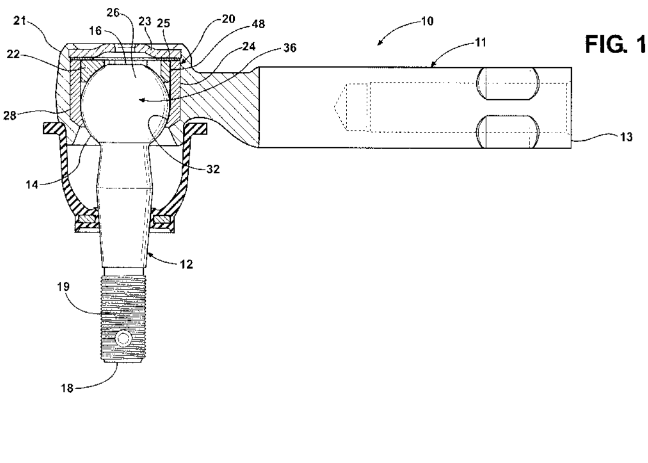

FIG. 1

(57) **Abstract**: A ball joint (10) for interconnecting relatively movable components is provided. The ball joint includes a housing and a stud with a spherical bearing surface disposed in the housing. The bearing has a concave spherical bearing surface which is brought into sliding abutment with the spherical bearing surface of the stud. The bearing is of a monolithic piece of fiber- reinforced polyamide material and includes carbon fibers which extend circumferentially about the concave spherical bearing surface.

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BALL JOINT WITH IMPROVED UPPER BEARING AND METHOD OF CONSTRUCTION THEREOF

[0001]

BACKGROUND OF THE INVENTION

1. Technical Field

[0002] This invention relates generally to joints for linking relatively movable vehicle steering components to one another, such as ball joints, tie rod ends, and sway bar links.

2. Related Art

[0003] Vehicle suspension systems and steering systems typically include joints, such as tie rod end ball-type joints for operable attachment of a tie rod end to a steering knuckle and a ball joint for coupling the steering knuckle to a control arm. In addition, other applications, such as carnival rides or any other mechanism with relatively movable joints, typically have ball joints to facilitate the relative movement between linked components. Upon assembly of ball joints, it is generally desirable to build in frictional resistance to joint movement that is within a predetermined torque tolerance. In addition, it is essential that the ball joints exhibit a long and useful life, and of additional importance, it is important that the ball joints be economical in manufacture. If the frictional resistance or torque is too high, it may impede the motion of the mechanism and/or make installation difficult. If the frictional resistance is too low, it may result in an undesirable "out-of-box feel".

[0004] It is known to construct ball joints from metal, including coated metal bearings against which a metal ball stud pivots. However, although the coated metal bearings can

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provide a desirable "out-of-box" feel and exhibit a long and useful life, they typically come at a high cost in manufacture.

[0005] In an effort to reduce costs associated with manufacture, it is known to construct tie rod end ball joints including acelal or glass-filled nylon bearings against which a metal ball stud pivots. Although the cost of manufacture is greatly reduced, the acetal or glass-filled nylon bearings provide a reduced useful life.

SUMMARY OF THE INVENTION

[0006] According to one aspect of the present invention, a ball joint socket is provided including a housing with a stud having a spherical bearing surface disposed in the housing and including a bearing having a concave spherical bearing surface brought into sliding abutment with the spherical bearing surface of the stud. The bearing is of a monolithic piece of fiber-reinforced polyamide material including carbon fibers which extend circumferentially about the concave spherical bearing surface.

[0007] In accordance with another aspect of the present invention, the fiber-reinforced polyamide material includes glass fibers and bronze flakes which both extend circumferentially about the concave spherical bearing surface.

[0008] In accordance with yet another aspect of the invention, the fiber-reinforced polyamide material has a composition including greater than about 57% nylon; greater than 0% and less than about 30% glass fiber; greater than 0% and less than about 10% carbon fiber, and greater than 0% and less than about 10% bronze flake.

[0009] In accordance with still another aspect of the invention, the fiber-reinforced polyamide material includes greater than 0% and less than about 3% white pigment.

[0010] In accordance with a further aspect of the invention, the ball joint socket is a provided in a tie rod end.

[0011] In accordance with another aspect of the invention, a method of constructing a ball joint socket is provided. The method includes inserting a bearing constructed as a monolithic piece of fiber-reinforced polyamide material including carbon fibers which extend circumferentially about a concave spherical bearing surface of the bearing into a metal housing and bringing the concave spherical bearing surface into sliding abutment with a metal spherical bearing surface of a stud.

[0012] In accordance with yet another aspect of the invention, the method includes the step of providing the fiber-reinforced polyamide material including glass and bronze flakes both of which extend circumferentially about a concave spherical bearing surface.

[0013] In accordance with still another aspect of the invention, the method includes the step of providing the fiber-reinforced polyamide material with a composition including greater than about 57% nylon; greater than 0% and less than about 30% glass fiber; greater than 0% and less than about 10% carbon fiber, and greater than 0% and less than about 10% bronze flake.

[0014] In accordance with another aspect of the invention, the method includes the step of providing the fiber-reinforced polyamide material with greater than 0% and less than about 3% white pigment.

[0015] In accordance with another aspect of the invention, the method includes the step of inserting the ball joint socket in a tie rod end.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] These and other aspects, features and advantages of the invention will become more readily appreciated when considered in connection with the following detailed description of presently preferred embodiments and best mode, appended claims and accompanying drawings, in which:

[0017] Figure 1 is a cross-sectional view of a tie rod end including a ball joint socket constructed in accordance with one presently preferred aspect of the invention;

[0018] Figure 2 is a plan view of an upper bearing of the ball joint socket of Figure 1 constructed in accordance with one aspect of the invention;

[0019] Figure 3 is a plan view of a lower bearing of the ball joint socket of Figure 1; and

[0020] Figure 4 is a perspective and elevation view of the upper bearing of the ball joint socket of Figure 1 and showing a direction of a flow of material during an injection molding process.

DETAILED DESCRIPTION OF PRESENTLY PREFERRED EMBODIMENTS

[0021] Referring in more detail to the drawings, Figure 1 illustrates a ball joint **10**, shown by way of example as an outer tie rod end ball-type joint assembly, referred to hereafter as tie rod end **10**, constructed in accordance with one exemplary embodiment of the present invention. The tie rod end **10** has a tie rod housing **11** with an end **13** configured for attachment to an inner steering component (not shown), such as an inner tie rod assembly via an adjuster, for example. The tie rod end **10** also includes a stud **12** which has a spherical bearing surface **14** at one end, represented substantially as a ball **14**, and has an opposite end **18** configured for attachment to a vehicle steering member (not shown), such as by threads **19**, for example. The vehicle steering member could be, for example, a steering knuckle (not shown) of a vehicle.

[0022] The tie rod end **10** further includes a ball socket assembly, referred to hereafter as socket assembly **20**, with an upper (or first) bearing **22** and a lower (or second) bearing **24**. The upper and lower bearings **22, 24** are configured for sliding engagement with the spherical bearing surface **14** of the stud **12**. In use, the loading between the spherical bearing surface **14** of the stud **12** and the socket assembly **20** is radial or substantially radial, such as between about 400 to 1500 lbs, while the axial loading imparted on the tie rod end **10** in use is negligible. In the exemplary embodiment, a desired preload on the spherical bearing surface **14** of the stud **12** is established during assembly by roll forming or folding an end of a socket **21** of the tie rod housing **11** about an end cap **23** with a spring washer **25** being captured between the upper bearing **22** and the end cap **23**. The upper and lower bearings **22, 24** have spherical bearing surfaces which are configured to slidingly engage opposite sides of the spherical bearing surface **14** of the stud **12**.

[0023] The heavily loaded lower bearing **24** can be provided, for example, as a standard metal bearing and can further be coated with a low-friction coating **26**. The lower bearing **24** can be constructed of any suitable hardened metal, such as a sintered powder metal, for example.

[0024] The lower bearing **24** of the exemplary embodiment has an outer cylindrical wall **28** which extends between opposite ends, and the wall **28** is sized suitably for receipt in the housing or socket **21** of the tie rod **11**. The lower bearing **24** has a substantially concave spherical bearing surface **32** with a generally similar spherical curvature as the spherical bearing surface **14** of the stud **12** for sliding abutment therewith. As best shown in Figure 3, the lower bearing **24** of the exemplary embodiment has a plurality of lubrication grooves **34** which extend radially into the bearing surface **32**. The grooves **34** extend between and through the opposite ends of the lower bearing **24** and function primarily to transfer lubricant, such as grease, for example, to prevent pressurization of the lubricant within the socket assembly **20** and to reduce friction between the bearings **22, 24** and the spherical bearing surface **14** of the stud **12**, thereby extending the useful life of the tie rod end **10**. It should be understood that the grooves **34** can be formed with a multitude of shapes and depths, as desired.

[0025] The stud **12** may be constructed from any suitable metal, such as AISI 4140 steel, for example. The spherical bearing surface **14** is represented here as being generally spherical in shape and is further represented, by way of example, as being free from any lubrication coating, although a lubricating coating could be formed on its outer surface, if desired.

[0026] The upper bearing **22** is constructed from a novel thermoplastic fiber-reinforced polyamide **27** (nylons), such as nylon 6/6 (polyhexamethylene adipamide). Due to the novel thermoplastic fiber-reinforced polyamide, the upper bearing **22** exhibits a long and useful life, substantially comparable to a metal bearing; provides the tie rod end **10** with a desirable "out-of-box" feel and is economical in manufacture, being much less costly to make than a standard metal bearing.

[0027] In manufacture, the fiber-reinforced polyamide material of the upper bearing **22** is injection molded to provide the upper bearing **22** with its enhanced performance characteristics. Referring now to Figure 4, during injection molding, the thermoplastic material flows through a sprue in a radial direction, represented generally at **38**, whereupon the material flows circumferentially within the mold cavity, as represented generally by arrows **40**, to form the geometric configuration of the upper bearing **22**. As shown in Figure 2, the fibers dispersed within the nylon **41** include carbon fibers **42**, glass fibers **44** and bronze flakes **46**. The fibers **42, 44**, and flakes **46** are uniformly dispersed in the nylon **41**, thereby providing the upper bearing **22** as a homogeneous or substantially homogeneous, solid monolithic piece of fiber-reinforced material **27**, "as injection molded". The fiber-reinforced material **27** of the upper bearing **22** includes the following composition of the nylon and fibers: greater than about 57% nylon **41**; greater than 0% and less than about 30% glass fiber **44**; greater than 0% and less than about 10% carbon fiber **42**, and greater than 0% and less than about 10% bronze flake **46**, and if desired for enhanced appearance, less than about 3% white pigment. The nylon **41** provides strength and lubricity; the glass fibers **44** provide strength; the carbon fibers **42** provide strength and lubricity; and the bronze flakes **46** provide durability and enhanced appearance. The finished upper bearing **22** has an 80 Shore D durometer hardness.

[0028] The upper bearing **22** has an outer cylindrical wall **48** which extends between opposite ends, and the wall **48** is sized suitably for receipt in the lower bearing **24**. The upper bearing **22** has a substantially concave spherical bearing surface **50** having a generally similar spherical curvature as the spherical bearing surface **14** of the stud **12** for sliding abutment of the circumferentially extending fibers **42, 44**, flakes **46** and nylon **41** therewith. The upper bearing **22** is also shown as having a plurality of lubrication grooves **52** which extend radially into the bearing surface **50**. The grooves **52** extend between and through the opposite ends of the upper bearing **22** and function primarily to transfer lubricant, such as grease, for example, to prevent pressurization of the lubricant within the bearing assembly **20** and to reduce friction between the bearing assembly **20** and the spherical bearing surface **14** of the stud **12**, thereby extending the useful life of the tie rod end **10**.

[0029] An exemplary method of constructing a ball joint **10** is provided. The exemplary method includes the step of injection molding a bearing **22** into a monolithic piece of fiber-reinforced polyamide material including carbon fibers **42** which extend circumferentially about a concave spherical bearing surface **50**. The method continues with the step of inserting the bearing **22** into sliding abutment with a metal spherical bearing surface **14** of a stud **12**. The bearing **22** may be injection molded to have a composition including greater than about 57% nylon **41**; greater than 0% and less than about 30% glass fiber **44**; greater than 0% and less than about 10% carbon fiber **42**; and greater than 0% and less than about 10% bronze flake **46** with the glass fibers **44** and bronze flakes **46** both extending circumferentially about the concave spherical bearing surface **50**.

[0030] Obviously, many modifications and variations of the present invention are possible in light of the above teachings. For example, as discussed above, it is contemplated that the spherical bearing surface **14** of the stud **12** could have grooves for channeling grease, with the upper and lower bearings **22, 24** being formed without grooves. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A ball joint, comprising:

a housing;

a stud having a spherical bearing surface disposed in said housing;

a bearing having a concave spherical bearing surface brought into sliding abutment with said spherical bearing surface of said stud; and

said bearing being a monolithic piece of fiber-reinforced polyamide material

including carbon fibers, substantially all of said individual carbon fibers being substantially oriented in a circumferentially direction.

2. The ball joint as set forth in claim 1 wherein said fiber-reinforced polyamide material includes glass fibers and bronze flakes both extending circumferentially about said concave spherical bearing surface.

3. The ball joint as set forth in claim 2 wherein said fiber-reinforced polyamide material has a composition including greater than about 57% nylon; greater than 0% and less than about 30% glass fiber; greater than 0% and less than about 10% carbon fiber, and greater than 0% and less than about 10% bronze flake.

4. The ball joint as set forth in claim 3 wherein said fiber-reinforced polyamide material includes greater than 0% and less than about 3% white pigment.

5. The ball joint as set forth in claim 1 wherein said bearing is an upper bearing and further including a lower bearing.

6. The ball joint as set forth in claim 5 wherein said upper bearing is received in said lower bearing.

7. The ball joint as set forth in claim 5 wherein at least one of said upper and lower bearings is provided with lubrication grooves.

8. The ball joint as set forth in claim 5 wherein said lower bearing is provided with a low-friction coating.

9. The ball joint as set forth in claim 5 further including an end cap and a washer spring captured between said upper bearing and said end cap.

10. The ball joint as set forth in claim 1 wherein said stud has an end with threads opposite of said spherical bearing surface.

11. A method of constructing a ball joint, comprising:

injection molding a polyamide material with carbon fibers into a bearing with a concave spherical bearing surface wherein during the injection molding process the polyamide material flows circumferentially to substantially orient the carbon fibers within the polyamide material in a circumferential direction throughout the bearing; and

inserting the fiber-reinforced polyamide bearing with the substantially circumferentially aligner or carbon fibers into a metal housing and bringing the concave spherical bearing surface into sliding abutment with a metal spherical bearing surface of a stud.

12. The method of claim 11 further including providing the fiber-reinforced polyamide material including glass and bronze flake both extending circumferentially about the concave spherical bearing surface.

13. The method of claim 12 further including providing the fiber-reinforced polyamide material having a composition including greater than about 57% nylon; greater than 0% and less than about 30% glass fiber; greater than 0% and less than about 10% carbon fiber, and greater than 0% and less than about 10% bronze flake.

14. The method of claim 13 further including providing the fiber-reinforced polyamide material includes greater than 0% and less than about 3% white pigment.

15. The method as set forth in claim 11 further including the step of injection molding a bearing before the step of inserting the bearing into sliding abutment with the metal spherical surface of the stud.

FIG. 1

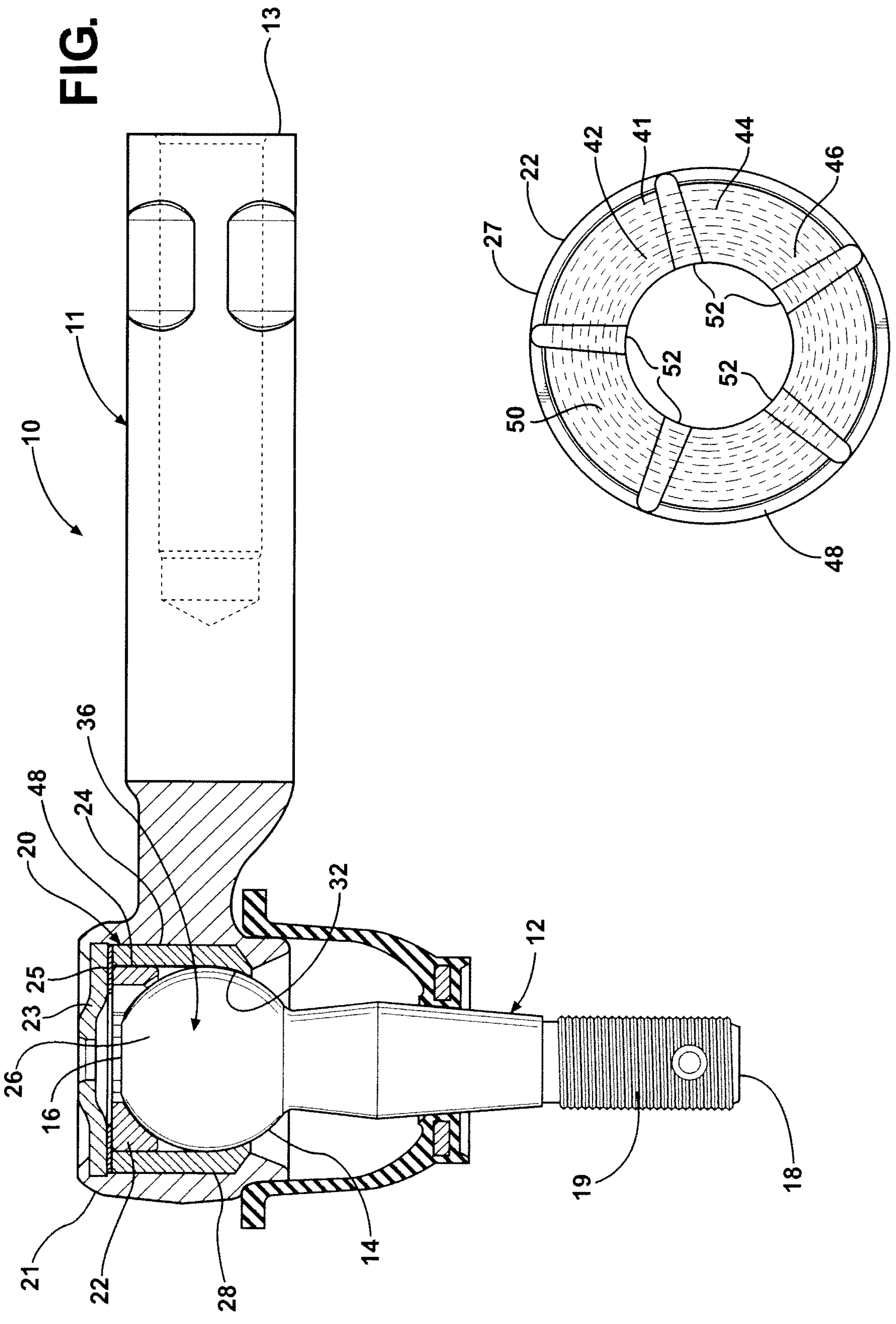
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FIG. 2

FIG. 3

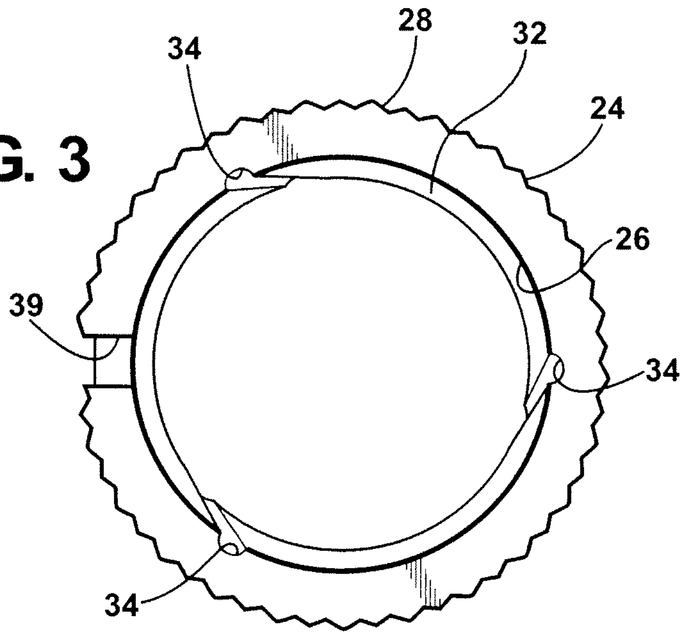
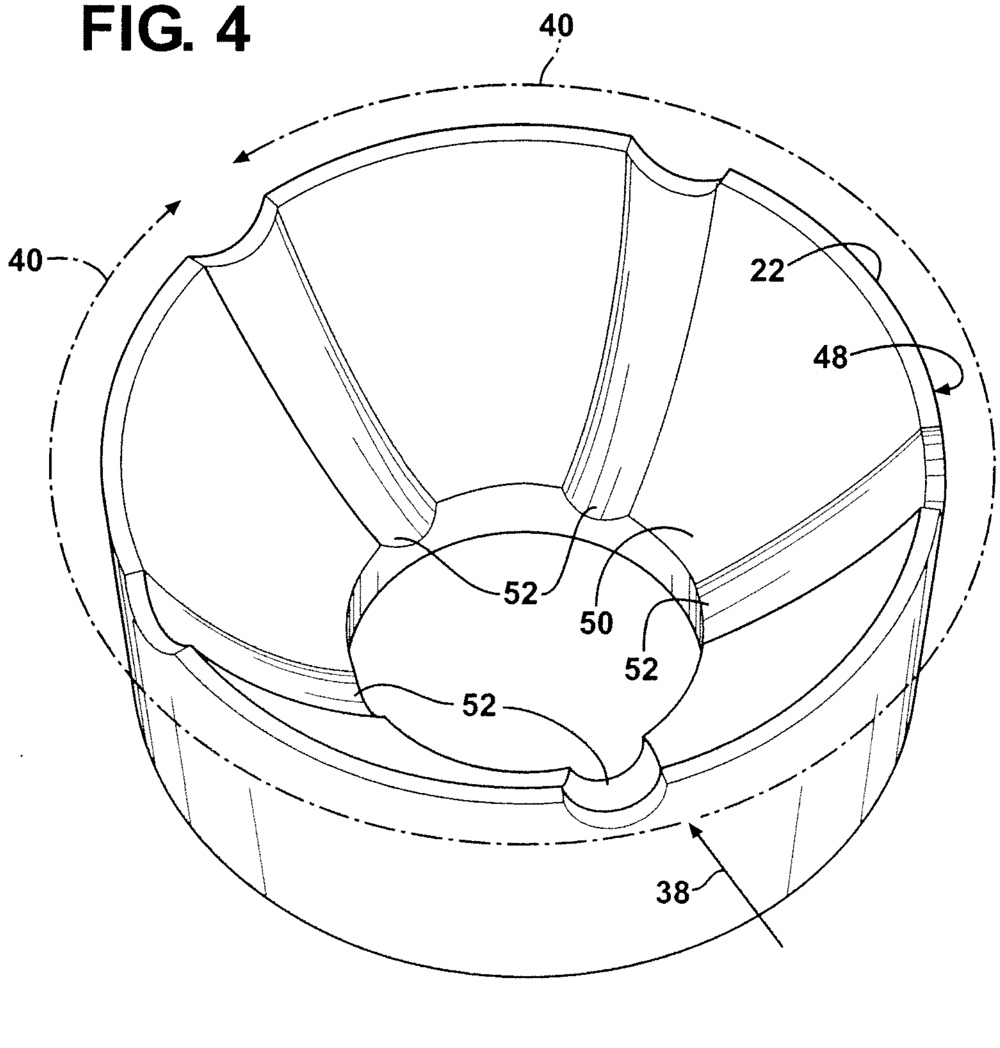
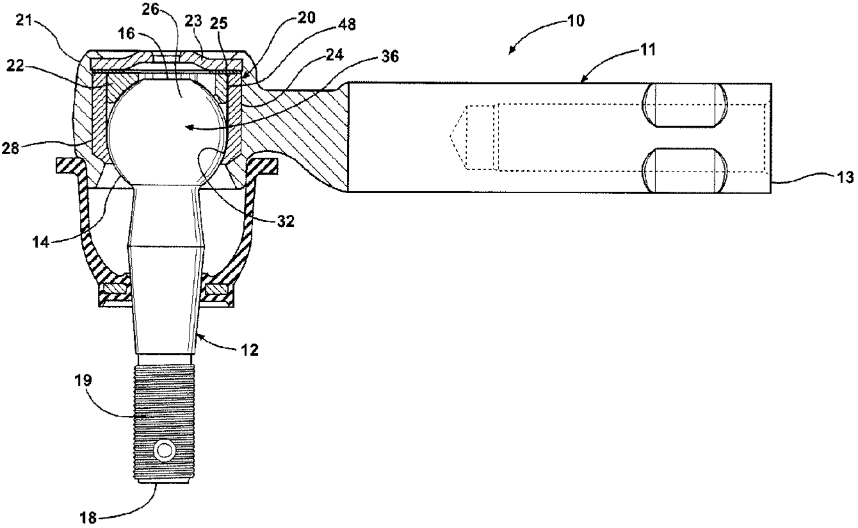


FIG. 4





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