Title: CONSTANT VELOCITY JOINT BOOT WITH INTEGRAL ROLLING DIAPHRAGM AREA

Abstract: A boot cover assembly for an articulating joint. The articulating joint includes a first rotational member and a second rotational member. The boot includes a first portion constructed of a first material and a second portion constructed of a second material. The first portion is coupled to the second portion of the boot cover assembly.
— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

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CONSTANT VELOCITY JOINT BOOT
WITH INTEGRAL ROLLING DIAPHRAGM AREA

Technical Field
The present invention relates to boot cover assemblies and in particular to a constant velocity joint (CVJ) boot cover assembly constructed of at least two different materials.

Background Art
Universal joints, and especially constant velocity joints, operate to transmit torque between two rotational members. The rotational members are typically interconnected by a cage, or yoke, that allows the rotational members to operate with their respective axes at a relative angle. Constant velocity joints and similar rotating couplings typically include a boot cover assembly to enclose and protect the coupling during operation. Since the boot cover assembly partially flexible, the boot cover assembly is able to seal around the joint while permitting articulation and relative axial movement of the joint. The boot cover assembly seals lubricant in the joint so as to reduce friction and extend the life of the joint. The boot cover assembly also seals out dirt, water and other contaminants to protect the functionality of the joint. However, leaks in the boot cover assembly may reduce the life of the joint, and contaminants in the grease may disturb the chemical composition of the grease, degrading its performance.

Universal joints are commonly classified by their operating characteristics. One important operating characteristic relates to the relative angular velocities of the two shafts connected thereby. In a constant velocity type of universal joint, the instantaneous angular velocities of the two shafts are always equal, regardless of the relative angular orientation between the two shafts. In a non-constant velocity type of universal joint, the instantaneous angular velocities of the two shafts vary with the angular orientation (although the average angular velocities for a complete rotation are equal). Another important operating characteristic is the ability of the joint to allow relative axial movement between the two shafts. A fixed joint does not allow this relative movement, while a plunge joint does.

FIG. 1 illustrates a prior art CVJ 20. CVJ 20 includes driven end 22 and a driving end 24. CVJ 20 further includes a joint assembly 26 coupled to a shaft 28 with a boot cover
assembly 30 connected therebetween. CVJ 20 further includes a grease cover 32 that seals the driven end 22. Boot cover assembly 30 includes a metal cover 34 and a flexible boot 40. A portion of metal cover 34 is crimped onto boot 40 for attachment thereto. Boot cover assembly 30 protects the moving parts of CVJ 20 during operation. Joint assembly 26 includes a first rotational member 42, a second rotational member 44, and a plurality of balls 46. Shaft 28 is splined to second rotational member 44 to allow axial movement therebetween. Metal cover 34 has an axial length L1 that is defined by the axial distance that metal cover 34 extends from the first rotational member 42 to the crimped attachment of metal cover 34.

Joint assembly 26 can be any type of articulated universal joint, including a plunging tripod, a fixed tripod, a plunging ball joint, and a fixed ball joint. Typical joint assemblies are disclosed in commonly-owned U.S. Patent Nos. 6,817,950, 6,776,720, 6,533,669 and 6,368,224, and U.S. Patent No. 5,899,814, the disclosures of which are hereby incorporated by reference in their entireties. As will be discussed in greater detail herein, boot 40 is especially adapted for a joint assembly 26. During operation of CVJ 20, boot 40 accommodates relative axial displacement of joint assembly 26 and shaft 28 while maintaining a seal therebetween.

With continual reference to FIG. 1 and specific reference to FIG. 2, the prior art boot 40 includes a body having a small end 54, a large end 56, a middle portion 58, and a curved portion 60. As illustrated in FIG. 1, small end 54 is coupled to shaft 28 and large end 56 is crimped to metal cover 34, which is, in turn, coupled to first rotational member 42. Small end 54 may be coupled to shaft 28 with a conventional type of 'hose clamp' connector or any other suitable means.

While boot cover assembly 30 may be adequate for current applications, greater relative angles of operation of CVJ 20 may result in shaft 28 contacting large end 56. To avoid this contact, greater clearance between metal cover 34 and shaft 28 may be required. However, the resulting larger diameter of the metal cover 34 would increase the weight of the CVJ 20. Also to avoid this contact, a shorter axial length L1 may be provided to permit greater articulation, or a greater operating angle, within CVJ 20. However, a shorter axial length L1 would result in greater stresses in the crimped connection between metal cover 34 and large end 56 as axial movement between shaft 28 and second rotational member 44 causes curved portion 60 to roll and operation at greater operating angles induces stresses in boot 40.
that, at least in part, transmit through the crimped connection. Additionally, the rotational speeds (over about 10,000 rpm) of the CVJ 20 imparts centrifugal forces on the boot 40 which may distort the shape of the boot 40 and impart additional stresses and forces into the crimped connection. Additionally, the rotational speeds (over about 10,000 rpm) of the CVJ 20 may result in greater decoupling stresses and forces within the crimped connection. These increased decoupling stresses and forces may result in premature failure of the crimped connection. That is, values of stresses, forces, and deflection that can be tolerated in curved portion 60 cannot be tolerated in the crimped connection of boot cover assembly 30. Furthermore, a desirable boot cover assembly would provide a more reliable interconnection between the cover and boot than the crimped connection of the prior art.

What is needed, therefore, is a boot cover assembly that can accommodate greater axial extension and relative angles within a joint assembly, reduce weight, simplify manufacture, and produce a more reliable boot cover assembly.

**Disclosure of the Invention**

An embodiment of the present invention includes a boot cover assembly for an articulating joint. The articulating joint includes a first rotational member and a second rotational member. The boot includes a first portion constructed of a first material and a second portion constructed of a second material. The first portion is coupled to the second portion of the boot cover assembly.

Another embodiment of the present invention includes an articulating joint that has a first rotational member, a second rotational member coupled with and positioned concentric to the first rotational member, and a boot cover assembly. The boot cover assembly is constructed from at least two distinct materials, and the boot cover assembly is selectively coupled to both the first rotational member and the second rotational member.
**Brief Description of Drawings**

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a sectional view of a prior art constant velocity joint.

FIG. 2 is a sectional view of a prior art boot.

FIG. 3 is a sectional view of a joint assembly in accordance with an embodiment of the present invention.

FIG. 4 is a sectional view of a boot cover assembly in accordance with an embodiment of the present invention.

FIG. 4A is an enlarged view of a portion of FIG. 4, indicated at 4A in FIG. 4.

FIG. 4B is an enlarged view of a portion of FIG. 4, indicated at 4B in FIG. 4.

FIG. 5 is an enlarged partial sectional view the boot cover assembly of FIG. 4.

FIG. 5A is an enlarged view of a portion of FIG. 5, indicated at 5A in FIG. 5.

FIG. 6 is an enlarged partial sectional view of an embodiment of a boot cover assembly in accordance with the present invention.

FIG. 7 is a sectional view of another embodiment of a boot cover assembly in accordance with the present invention.

FIG. 8 is a partial sectional view of a molding device used to form a boot cover assembly in accordance with the present invention.

FIG. 9 is a partial sectional view of the molding device of FIG. 8.

**Detailed Description**

FIG. 3 illustrates a joint 120 having a driven end 122 and a driving end 124. Joint 120 further includes a joint assembly 126 that is coupled to a shaft 128. A boot cover assembly 130 is connected between the joint assembly 126 and the shaft 128. A grease cover 132 seals the driven end 122 of joint 120. Joint assembly 126 includes a first rotational member 142, a second rotational member 144, and a plurality of balls 146. As illustrated, shaft 128 is splined to second rotational member 144.
FIGS. 4 and 5 illustrate boot cover assembly 130 in greater detail. Boot cover assembly 130 serves to protect moving parts of joint 120. However, unlike the prior art boot cover assembly 30, boot cover assembly 130 does not include a traditional metal cover. Boot cover assembly 130 includes a cover portion 154, a boot portion 156, and a coupling region 158.

Cover portion 154 is formed of a first material 162, and boot portion 156 is formed of a second material 164, as discussed below. Coupling region 158, while illustrated by a line in FIGS. 3-5, is preferably a region containing both the first material 162 and the second material 164 that exhibits both a chemical and/or physical bonding therebetween (as best seen in FIG. 5A). FIGS. 3-5 illustrate a sealing portion 160 formed on at least a portion of cover portion 154. Sealing portion 160 is preferably formed of a flexible material that ensures a seal between cover portion 154 and first rotational member 142.

Cover portion 154 has a radially extending annular face 170 that abuts the first rotational member 142, and an axially extending cylindrical body 172 that extends between the first rotational member 142 and the coupling region 158. Cylindrical body 172 has an axial length L2 (see FIG. 4) that is defined by the distance that cover portion 154 extends from the first rotational member 142 to the coupling region 158. As shown, axial length L2 of boot cover assembly 130 is shorter than axial length L1 (see FIG. 1) of boot cover assembly 30.

Cover portion 154 further includes an axially extending lip 174 (FIGS. 3 and 4) that may incorporate a retention bead 176 (as best seen in FIG. 4A). Cover portion 154 may incorporate an integrated seal 178 (as best seen in FIG. 4B) extending therefrom. Retention bead 176 may be positioned within a circular groove (not shown) of first rotational member 142 to provide a more effective seal between cover portion 154 and first rotational member 142. Cover portion 154 also includes apertures 180 to allow fasteners (not shown) to directly fasten cover portion 154 to first rotational member 142. Integrated seal 178 includes a raised annular portion.

Boot cover assembly 130 may be formed by injection molding. During the molding process for boot cover assembly 130, a mold (not shown) is prepared for a two-shot injection. Boot cover assembly 130 may be molded in a single process that includes introduction of at least the first material 162 and the second material 164. The mold includes a cover region and a boot region. Boot cover assembly 130 may be molded in the shape illustrated in FIGS. 3-5,
as the first material is injected into the cover region and the second material injected into the boot region. The molded boot cover assembly is then allowed to cure, thereby forming the boot cover assembly 130.

First material 162 is preferably a relatively rigid material, and may be selected from the family of thermoplastic polyester resins, specifically polybutylene terephthalate (PBT) and polyethylene terephthalate (PET) or may be a thermoplastic vulcinizates (TPV) or a nylon or nylon blend. First material 162 may also be a resin and a filler to increase rigidity and strength. Also preferably, first material 162 has hardness values in the range of about 70 to about 150 Rockwell R, about 40 to about 140 Rockwell M, or greater than about 70 Shore D. While fillers such as carbon fiber and glass fibers are preferred, other fillers compatible with the contemplated resins could also be used.

Second material 164 is preferably a flexible material, and may be plastic or any elastomer, such as rubber, silicone, or thermoplastic elastomer (TPE). Also preferably, second material 164 has hardness values in the range of about 55-75 Shore A or about 35-55 Shore D, and even more preferably, a hardness of about 40-44 Shore D. Materials that are specifically compatible with a typical boot cover assembly 130 environment are relatively rigid thermoplastic polyesters for first material 162, and thermoplastic polyester elastomers for second material 164 due to the desirable bonding formed in coupling region 158 during the two-shot molding process.

Sealing portion 160 provides for a more reliable seal between cover portion 154 and first rotational member 142. Sealing portion 160 and retention bead 176 are preferably formed of a sealing material such as flexible thermoplastic and may be formed of the same material as the second material 164. Sealing portion 160, retention bead 176, and integrated seal 178 are preferably formed during the molding process by injecting the sealing material into the mold, although other processes, including overmolding or welding, may be used. Preferably, sealing portion 160 is about 2-3 millimeters in thickness. When fasteners are inserted through apertures 180 to fasten cover portion 154 to first rotational member 142, integrated seal 178 is desirably in compression and exerting a force on first rotational member, thereby providing a positive seal therebetween.

The pressures induced by the molding process ensures that the coupling region 158 provides a reliable bond between cover portion 154 and boot portion 156. The pressures of the molding process and the flow of resins (first material 162, second material 164) in the
mold provide for a coupling region 158 that is both a chemical bond, as well as a physical bond (as best illustrated in FIG. 5A). The chemical bond may be cross-linked. The coupling region 158 forms a bond between cover portion 154 and boot portion 156 that is selectively in shear, compression and tension during operation of joint 120. These shear, compressive, and tensile forces are the result of at least deflection within boot cover assembly 130 due to torsional and rotational movement of joint 120.

The connection between cover portion 154 and boot portion 156 is more resistant to decoupling stresses and forces than the prior art crimped connection. That is, values of stresses, forces, and deflection that can be tolerated in coupling region 158 of boot cover assembly 130 may not be tolerated in the crimped connection of boot cover assembly 30. This more resistant connection can better accept greater articulation and axial movement within joint 120.

In addition, in accordance with one aspect of the invention, the first material 162 of cover portion 154 is lighter than the metals used to produce a typical prior art metal cover 34. Therefore, when assembled, boot cover assembly 130 provides a lighter joint 120. Additionally, since axial length L2 of boot cover assembly 130 is shorter than axial length L1 of boot 30, the shaft 128 may be shorter than the prior art shaft 28. A shorter shaft 128 may contribute to a reduced rotational weight of joint 120. Furthermore, a reduced axial length L2 will allow articulation within joint 120 of a greater angle before the shaft 128 contacts the boot cover assembly 130.

FIG. 6 illustrates an alternate embodiment of a boot cover assembly 230. Boot cover assembly 230 is intended for a similar application as boot cover assembly 130 and includes a first portion 254, a second portion 256, and a coupling portion 258. Coupling portion 258 provides a connection between first portion 254 and second portion 256. First portion 254 is formed of a first material 262, and second portion 256 is formed of a second material 264. Preferably, first portion 254 and second portion 256 are molded onto coupling portion 258. In one embodiment, first portion 254 and second portion 256 are simultaneously molded onto the coupling portion 258. While coupling portion 258 may be a stainless steel band with a phosphate coating, coupling portion 258 may be constructed of other metals and other coatings, or other suitable materials. Also, coupling portion 258 is not limited to the shape illustrated in the embodiment of FIG. 6, but may be any suitable shape.
FIG. 7 illustrates another alternate embodiment of a boot cover assembly 330. Boot cover assembly 330 is intended for a different application as boot cover assembly 130, such as a fixed joint where an internal rolling diaphragm is not desired. Boot cover assembly 330 includes a first portion 354, a second portion 356, and a coupling portion 358. First portion 354 is formed of a first material 362, and second portion 356 is formed of a second material 364. Coupling portion 358 provides a structural connection between first portion 354 and second portion 356. Preferably, first portion 354 and second portion 356 are molded onto coupling portion 358. In one embodiment, first portion 354 and second portion 356 are simultaneously molded onto the coupling portion 358, as discussed below. Coupling portion 358 is preferably constructed of the same material as coupling portion 258.

First material 262, 362 is preferably a relatively rigid material, and may be selected from the family of thermoplastic polyester resins, specifically polybutylene terephthalate (PBT) and polyethylene terephthalate (PET). First material 262, 362 forms a strong bond when molded to a metallic coupling portion 258, 358, especially when coupling portion 258, 358 is provided with a phosphate coating. Alternatively, first portion 254, 354 may be molded of a resin and a filler to increase rigidity and strength. While fillers such as carbon fiber and glass fibers are preferred, other fillers compatible with the contemplated resins could also be used.

Second material 264, 364 is preferably a flexible material, and may be plastic or any elastomer, such as rubber, silicone, or thermoplastic elastomer (TPE). Second material 264, 364 also forms a strong bond when molded to a metallic coupling portion 258, 358, especially when coupling portion 258, 358 is provided with a phosphate coating. Sealing portion 260 is preferably formed in a similar manner as sealing portion 160.

While the invention has been described with respect to specific examples including preferred modes of carrying out the invention, those skilled in the art will appreciate that there are numerous variations and permutations of the above described systems and techniques that fall within the spirit and scope of the invention as set forth in the appended claims.
Claims

What is claimed is:

1. A boot cover assembly for an articulating joint, the articulating joint including a first rotational member and a second rotational member, the boot cover assembly comprising:
   a first portion formed of a first material; and
   a second portion formed of a second material that is different from said first material, wherein said first portion of said boot cover assembly is secured to said second portion of said boot cover assembly during the forming of said first portion.

2. The boot cover assembly of claim 1, further comprising a coupling region interposed between said first portion and said second portion, wherein said coupling region includes both said first material and said second material.

3. The boot cover assembly of claim 2, wherein said coupling region includes chemical bonding.

4. The boot cover assembly of claim 2, wherein said coupling region includes physical bonding.

5. The boot cover assembly of claim 1, further comprising a coupling device interposed between said first portion and said second portion, wherein at least one of said first portion and said second portion is molded onto said coupling device.

6. The boot cover assembly of claim 5, wherein both of said first portion and said second portion are simultaneously molded onto said coupling device.

7. The boot cover assembly of claim 1, further comprising a bead positioned between said first portion of said boot cover assembly and the first rotational member.

8. The boot cover assembly of claim 1, wherein said second portion is selectively coupled to the second rotational member of the articulating joint.

9. The boot cover assembly of claim 1, wherein said first portion is selectively coupled to the first rotational member of the articulating joint.
10. The boot cover assembly of claim 1, wherein said second material is selected from the group consisting of a thermoplastic elastomer, rubber, and silicone.

11. The boot cover assembly of claim 1, wherein said first material is selected from the group consisting of PBT, PET, and filled polyester resins.

12. The boot cover assembly of claim 1, further comprising a sealing portion formed on at least a portion of said first portion.

13. An articulating joint comprising:

   a first rotational member;

   a second rotational member coupled with and positioned coaxial to said first rotational member; and

   a boot cover assembly constructed from at least two distinct materials, wherein said boot cover assembly is selectively coupled to both said first rotational member and said second rotational member.

14. The articulating joint of Claim 13, wherein said boot cover assembly further comprises a boot portion and a cover portion, wherein said cover portion is constructed of a first material and said boot portion is constructed of a second material.

15. The articulating joint of Claim 14, further comprising a coupling region interposed between said boot portion and said cover portion, wherein said coupling region includes both said first material and said second material.

16. The articulating joint of Claim 14, further comprising a coupling device interposed between said boot portion and said cover portion, wherein at least one of said boot portion and cover second portion is molded onto said coupling device.

17. The articulating joint of Claim 13, wherein at least a portion of said boot cover assembly is selected from the group consisting of a thermoplastic elastomer, a rubber and a silicone.

18. The articulating joint of Claim 13, wherein at least a portion of said boot cover assembly is made of a material selected from the group consisting of PBT, PET and filled polyester resins.
19. The articulating joint of Claim 13, further comprising a sealing portion at least partially interposed between said first rotational member and said boot cover assembly, wherein said sealing portion is formed on at least a portion of said cover portion.

20. The articulating joint of Claim 19, wherein said sealing portion comprises an integrated seal and a retention bead.

21. The articulating joint of Claim 19, wherein said sealing portion includes a bead that is at least partially interposed within a groove formed in the first rotational member.

22. The articulating joint of Claim 19, wherein said sealing portion is formed of a different material than said boot cover assembly.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. F16D3/84 F16J3/04

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)
F16D  F16J

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)
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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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

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*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

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Date of the actual completion of the international search

8 November 2006

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22/11/2006

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Foulger, Matthew
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