Title: AIR SPRING ASSEMBLY WITH BEAD PLATE TO FACILITATE CRIMPING

Abstract: An air spring assembly comprising a first end member; including a bead plate having an annular configuration and including a top surface, a bottom surface, a sidewall, and at least one slot in said sidewall; a second end member; and a flexible bladder extending between and sealingly connected to said first end member and said second end member to form a pressurized air chamber.
Published:

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

— before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))
AIR SPRING ASSEMBLY WITH BEAD PLATE TO FACILITATE CRIMPING

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a bead plate in an air spring assembly, and, more particularly, to a bead plate having relief slots.

2. Description of the Related Art

[0002] Pneumatic springs, commonly referred to as air springs, are used in numerous applications including absorbing shock loads in motor vehicles and maintaining spacing in seat suspension systems. Although air springs can assume various configurations, depending on the application, air springs typically consist of an internal pressurized fluid chamber formed by a flexible material, for example a rubber bellows, which is capped at each end by a pair of end members. The end members are attached to an opposing pair of spaced components in the vehicle or equipment. Generally, one end member is a piston that is movable relative to the bellows, and the other end member is an end cap, often in the form of a bead plate, which is disposed to receive the pressurized fluid. Such air springs typically have a large load carrying capacity while retaining excellent isolation of the vehicle or its suspended components from roadway undulations.

[0003] The piston causes compression and expansion of the fluid within the chamber, thereby moving the bellows to expand and compress. During compression (jounce travel), the pressure of the fluid within the air spring increases; and during extension (rebound travel), the pressure of the fluid within the air spring decreases. This compression and extension, expressed as a function of work (w=jF.dx), sufficiently damps the equipment or vehicle as it experiences road shock. Air springs are often engineered to have a specific spring rate or spring constant, which
yields predictable jounce and rebound characteristics for a desired application.

[0004] The efficiency, durability, and the life of an air spring can be greatly impacted by the structural integrity of the bead plate. The bead plate is attached to the vehicle or equipment structure via various fasteners (e.g., studs, blind nuts, brackets and pins). The pressurized fluid can be provided as a separate fitting or incorporated with an attachment stud. Typically, in order to create the pressurized chamber within the bellows, the bead plate is crimped around the integrally formed mounting bead ring at the top end of the bellows. However, the crimping process can create internal stresses in the bead plate that compromise its structural integrity, which can lead to fluid leakage and ultimately air spring failure.

[0005] What is needed in the art is an improved bead plate to reduce the likelihood of fluid leakage and air spring failure.

**SUMMARY OF THE INVENTION**

[0006] The present invention provides a bead plate structure with relief slots to relieve stresses in the crimping process.

[0007] The present invention in one form is directed to an air spring assembly comprising a first end member; including a bead plate having an annular configuration and including a top surface, a bottom surface, a sidewall, and at least one slot in said sidewall; a second end member; and a flexible bladder extending between and sealingly connected to said first end member and said second end member to form a pressurized air chamber.

[0008] The present invention in another form is directed to an end member for an air spring assembly, said end member comprising a bead plate having an annular configuration and including a top surface, a bottom surface, a sidewall, and at least one slot in said sidewall.

[0009] The present invention in yet another form is directed to a method of sealingly attaching
a flexible bladder to an end member of an air spring assembly; comprising providing a first end member, including a bead plate having an annular configuration and including a top surface, a bottom surface, a sidewall, and at least one slot in said sidewall; providing a flexible bladder; providing a crimping tool; and crimping the bead plate around at least part of the flexible bladder with said crimping tool, thereby sealingly attaching the flexible bladder to the first end member.

[0010] An advantage of the present invention is that internal stresses in a bead plate, created by the crimping process, are reduced.

**BRIEF DESCRIPTION OF THE DRAWINGS**

[0011] The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

[0012] Fig. 1 is an isometric view of the inventive end member for an air spring assembly;

[0013] Fig. 2 is a side view of the end member after it has been pre-deformed;

[0014] Figs. 3-4 are front views illustrating the crimping process of the end member during assembly;

[0015] Fig. 5 is an isometric cutaway illustrating the end member after it has been crimped; and

[0016] Fig. 6 is an isometric cutaway illustrating an alternate embodiment of the end member of Fig. 5 after it has been crimped.

[0017] Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate embodiments of the invention, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.
DETAILED DESCRIPTION OF THE INVENTION

[0018] Referring now to the drawings, and more particularly, to Fig. 1, there is shown an end member 10 including a bead plate 12 with a top surface 14, a bottom surface 16 and a sidewall 18. The end member 10 further includes at least one relief slot 20 in the form of a slot, cut and/or groove. The relief slots 20 in the sidewall 18 of the bead plate 12 extend substantially perpendicularly across the entire height of the sidewall 18 from the bottom surface 16 to the top surface 14. The relief slots 20, which are structurally designed to help relieve stresses in the crimping process, may also be configured to extend only partially across the height of the sidewall 18. The relief slots 20 may also be oriented at an angle less than 90 degrees from the top surface (not shown). Further, as shown in Fig. 2, the relief slots 20 may be cut into the sidewall 18 at variable depths.

[0019] Referring now to Figs. 2-4, there is shown the bead plate 12 of the present invention as it undergoes the crimping process to attach to a flexible member 22 in an air spring assembly 24. Once the bead plate is pre-deformed, as shown in Fig. 2, it is connected to the flexible member 22 by using a crimping device 26. Fig. 4 shows the bead plate 12 after it has been crimped to the flexible member 22.

[0020] Referring now to Fig. 5, there is shown a cutaway view of the bead plate 12 after it has been crimped. The relief slots 20 allow the bead plate 12 to more easily deform inwardly during the crimping process, which helps to reduce internal stresses. According to the present invention, the bead plate 12 is composed of metal, yet any material, including polymers may be used.

[0021] Referring now to Fig. 6, an alternative embodiment of the inventive bead plate 12 is shown after it has been crimped. Unlike relief slots 20, relief slots 28 do not pass completely through sidewall 18 yet still provide stress relief in bead plate 12 during the crimping process.
While this invention has been described with respect to at least one embodiment, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.
WHAT IS CLAIMED IS:

1. An air spring assembly, comprising:

   a first end member, including:

      a bead plate having an annular configuration and including:

         a top surface;

         a bottom surface;

         a sidewall; and

      at least one slot in said sidewall;

   a second end member; and

   a flexible bladder extending between and sealingly connected to said first end member

and said second end member to form a pressurized air chamber.

2. The air spring assembly of claim 1, wherein said at least one slot includes at least one

   of a slot, groove and cut.

3. The air spring assembly of claim 1, wherein said at least one slot extends substantially

   perpendicularly from said bottom surface.

4. The air spring assembly of claim 1, wherein said at least one slot extends substantially

   fully across a height of said sidewall from said bottom surface to said top surface.

5. The air spring assembly of claim 1, wherein said at least one slot extends at least

   partially across a height of said sidewall from said bottom surface to said top surface.
6. The air spring assembly of claim 1, wherein said at least one slot extrudes inwardly into said sidewall at a respective depth.

7. The air spring assembly of claim 1, wherein said at least one slot includes a plurality of slots evenly spaced around the periphery of the sidewall.

8. An end member for an air spring assembly, said end member comprising:
   a bead plate having an annular configuration and including:
     a top surface;
     a bottom surface;
     a sidewall; and
     at least one slot in said sidewall.

9. The end member of claim 8, wherein said at least one slot includes at least one of a slot, groove and cut.

10. The end member of claim 8, wherein said at least one slot extends substantially perpendicularly from said bottom surface.

11. The end member of claim 8, wherein said at least one slot extends substantially fully across a height of said sidewall from said bottom surface to said top surface.

12. The end member of claim 8, wherein said at least one slot extends at least partially across a height of said sidewall from said bottom surface to said top surface.
13. The end member of claim 8, wherein said at least one slot extrudes inwardly into said sidewall at a respective depth.

14. The end member of claim 8, wherein said at least one slot includes a plurality of slots evenly spaced around the periphery of the sidewall.

15. A method of sealingly attaching a flexible bladder to an end member of an air spring assembly, comprising:

   providing a first end member, including:

   a bead plate having an annular configuration and including:

   a top surface;

   a bottom surface;

   a sidewall; and

   at least one slot in said sidewall;

   providing a flexible bladder;

   providing a crimping tool; and

   crimping the bead plate around at least part of the flexible bladder with said crimping tool, thereby sealingly attaching the flexible bladder to the first end member.

16. The method of claim 15, wherein said at least one slot includes at least one of a slot, groove and cut.

17. The method of claim 15, wherein said at least one slot extends substantially perpendicularly from said bottom surface.
18. The method of claim 15, wherein said at least one slot extends substantially fully across a height of said sidewall from said bottom surface to said top surface.

19. The method of claim 15, wherein said at least one slot extends at least partially across a height of said sidewall from said bottom surface to said top surface.

20. The method of claim 15, wherein said at least one slot extrudes inwardly into said sidewall at a respective depth.
A. CLASSIFICATION OF SUBJECT MATTER

INV. F16F9/04
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)
F16F

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

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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Further documents are listed in the continuation of Box C.

See patent family annex.

Date of the actual completion of the international search
9 January 2017

Date of mailing of the international search report
24/02/2017

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<table>
<thead>
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<th>Publication date</th>
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<td>DE 4423885 A1</td>
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