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(54) Title: BEAD PLATE GAS FITTING OPENING AND FORMING METHOD

(57) Abstract: A gas bellows includes an air fitting having a fitting diameter; and a bead plate having a gas opening formed therethrough holding the air fitting. The gas opening is tapered to form a chamfer having a maximum diameter that is not greater than the fitting diameter. Methods of forming the gas opening are also disclosed.
BEAD PLATE GAS FITTING OPENING AND FORMING METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to gas fittings, and more particularly, to bead plate gas fittings.

2. Description of the Related Art

[0002] Bead plates, which can also be called end closures, are used in the construction of gas bellows. The bead plate acts as an end closure for the gas bellows, sealing the inner chamber of the gas bellows. A gas bellows can have two bead plates, one on the top and one on the bottom, with each bead plate connecting to a flexible material within the gas bellows to form the sealed inner chamber.

[0003] Bead plates are often included with gas openings, which can be referred to as air openings when the gas bellows is filled with air, so that the gas level within the gas bellows can be adjusted. The gas openings include a gas fitting, which can be also be called an air fitting, which connects to a gas source to provide gas into the bellows or remove excess gas. It has been found that larger gas fittings can have gas leaks through the gas opening, which is detrimental to performance.

[0004] What is needed in the art is a way to produce a gas bellows with gas openings that are less prone to leakage.

SUMMARY OF THE INVENTION

[0005] The present invention provides a method of forming a bead plate that reduces the susceptibility of one or more gas openings of the bead plate to gas leakage by adjusting the positioning of the gas opening on the bead plate and/or reducing the chamfer of the gas opening.
The invention in one form is directed to a gas bellows including an air fitting having a fitting diameter; and a bead plate having a gas opening formed therethrough holding the air fitting. The gas opening is tapered to form a chamfer having a maximum diameter that is not greater than the fitting diameter.

The invention in another form is directed to a method of installing a gas fitting in a bead plate including the steps of: providing the bead plate and the gas fitting having a fitting diameter that is to be held by the bead plate; determining the fitting diameter; forming a gas opening in the bead plate that is tapered to form a chamfer having a maximum diameter, the gas opening being formed so that the maximum diameter is approximately equal to the fitting diameter; and placing the gas fitting within the gas opening so that the gas opening holds the gas fitting.

The invention in yet another form is directed to method for finishing a bead plate including the steps of: providing the bead plate having an edge formed therein; determining a forming location at a distance from the edge; and forming a gas opening at the forming location such that a deformation of the gas opening does not occur.

An advantage of the present invention is the gas opening can be formed in the bead plate with a reduced risk of a deformation being produced in the forming process, reducing the risk of gas leakage from the bellows.

Another advantage of the present invention is the gas opening can be formed with cold forming techniques while being less prone to gas leakage than known gas openings formed with cold forming techniques.

Yet another advantage of the present invention is that reducing gas leakage from the gas opening is achieved by a relatively simple method which is easily implemented to produce bead plates according to the present invention.
**BRIEF DESCRIPTION OF THE DRAWINGS**

[0012] 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 an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

[0013] Fig. 1 is a perspective view of a bead plate formed according to the prior art;

[0014] Fig. 2 is a perspective view of a gas opening shown in Fig. 1;

[0015] Fig. 3 is a perspective view of a gas opening formed according to the present invention;

[0016] Fig. 4 is a cross-sectional view of the prior art gas opening shown in Fig. 2 taken along line 4-4;

[0017] Fig. 5 is a cross-sectional view of the gas opening shown in Fig. 3 taken along line 5-5;

[0018] Fig. 6 is a top view of an installed prior art bead plate;

[0019] Fig. 7 is a top view of a bead plate with a gas opening formed according to the present invention;

[0020] Fig. 8 is a perspective view of a prior art bead plate with gas openings formed according to known methods that has a deformed chamfer; and

[0021] Fig. 9 is a perspective view of a bead plate with gas openings formed according to the present invention that has a non-deformed chamfer.

[0022] Corresponding reference characters indicate corresponding parts throughout the several views. The exemplification set out herein illustrates one embodiment of the invention and such exemplifications is not to be construed as limiting the scope of the invention in any manner.

**DETAILED DESCRIPTION OF THE INVENTION**

[0023] Referring now to the drawings, and more particularly to Fig. 1, there is shown a gas bellows 10 that is formed according to the prior art. As can be seen, the gas bellows 10 includes
a bead plate 12 with a pair of gas openings 14 that are formed adjacent to an edge 16 formed in the bead plate 12. The gas openings 14 are sized to allow for gas fittings 18 to connect to an interior chamber (not shown) of the gas bellows 10, so that gas can be added to or removed from the interior chamber. The interior chamber can be, for example, a rubber bladder. As can be seen, the gas openings 14 are surrounded by ring shaped indents 20 that are flat and formed as a result of the process that creates the gas openings 14 in the bead plate 12. The gas openings 14 each have a threading 22, to connect the gas fittings 18, with a chamfer 26 between the indents 20 and the threadings 22. As can be seen, parts of the indents 20 overlap with the edge 16 in the bead plate 12. The significance of this overlap will be further described below.

[0024] Referring now to Fig. 2, one of the gas openings 14 of bead plate 12 is shown in better detail. As can be seen, there is a noticeable deformation 24 that is formed by the chamfer 26 of the gas opening 14. This deformation 24 provides a leak path for gas to uncontrollably escape out of the gas opening 14, which is undesirable. The deformation 24 is caused during formation of the bead plate 12 after the gas opening 14 and indents 20 have been formed. The bead plate 12 can be formed using a cold forming process including, for example, a punching process that creates the gas opening 14 in the bead plate 12.

[0025] Referring now to Fig. 3, a portion of a bead plate 30 is shown with a gas opening 32 that is formed according to an aspect of the present invention. As can be seen, a portion of the gas opening 32 overlaps with an edge 34 in the bead plate 30 and the gas opening 32 has a chamfer 36 between an indent 38 formed around the gas opening 32 and a threading 35 of the gas opening 32. This particular gas opening 32 was formed, using a cold forming process, adjacent to the edge 34 in the bead plate 30 with a set of modified tooling so that the chamfer 36 was reduced as much as possible, which can be seen when comparing chamfer 36 to chamfer 24 shown in Figs. 1 and 2. While a slight deformation 40 is still produced, the deformation 40 of
the gas opening 32 formed with a reduced chamfer 36 is noticeably smaller than the deformation 24 produced when forming the gas opening 14 shown in Figs. 1 and 2.

[0026] To further emphasize the reduction in the chamfer of the gas opening according to the present invention, reference is now made to Figs. 4 and 5. Fig. 4 shows a cross-section of the gas opening 14 shown in Fig. 2. Gas fittings 18 have a diameter D1 that is signified by an arrow. As can be seen, the diameter D1 of the gas fittings 18 is slightly less than a diameter D2 of a top 17 of the opening 14. In this regard, it is possible to decrease the diameter D2 of the top 17 of the opening 14 to reduce the chamfer 26 while still allowing for the gas fittings 18 to be held in the opening 14. As shown, the diameter D1 of the gas fittings 18 is approximately 16 mm while the diameter D2 of the top 17 of the opening 14 is approximately 18 mm, with a tolerance of about 0.5 mm. Thus, the diameter D2 of the top 17 is approximately 12.5% larger than the diameter D1 of the gas fittings 18. Fig. 5 shows a cross-section of the gas opening 32 shown in Fig. 3. As previously described and can be seen, the gas opening 32 has a reduced chamfer 36 compared to that of gas opening 14. The gas opening 32 has a diameter D3 at a top 33 of the gas opening 32 that is approximately equal to the diameter D1 of the gas fittings 18. In other words, the diameter D3 can correspond to a maximum diameter D3 of the chamfer 36, which can be around 16 mm with a tolerance of 0.4 mm. The value of the maximum diameter D3 is only given as an example for when the diameter D1 of the gas fittings 18 is 16 mm, and not meant to limit the scope of the present invention. This reduction in diameter reduces the chamfer 36 of gas opening 32 in comparison to chamfer 26 of gas opening 14. The chamfer 36 can be formed utilizing a cold forming process, similar to chamfer 26, but a different set of tooling can be used to reduce the diameter D3 at the top 33 of the gas opening 32. It is contemplated that chamfer 36 could be reduced further by modifying the tooling used to form the chamfer 36 such that the tooling reduces the diameter D3 of the top 33 of the gas opening 32.
The reason for the deformations 24, 40 being formed is believed to be due to the cold forming process used to form the gas openings 14, 32 in combination with the proximity of the gas openings 14, 32 to the edges 16, 34 in the bead plates 12, 30. Using current cold forming processes, it is impossible to completely remove the chamfers 26, 36 at the beginning of the threading. During the forming process, the material of the bead plates 12, 30 is bent inwards, which creates a bending radius. When the gas openings 14, 32 are formed very close to the edges 16, 34 in the bead plates 12, 30, the bending radius can result in the deformations 24, 40 that are observed. As such, reducing the chamfers 26, 36 helps reduce the possibility of deformations, but may not entirely eliminate them from occurring.

To further reduce the presence of deformations, it has been found that the gas openings can be distanced away from the edge in the bead plate to reduce the impact of the bending radius that occurs during cold forming of the gas opening. Referring now to Fig. 6, a gas bellows 50 formed according to the prior art is shown installed within a vehicle. As can be seen, the gas bellows 50 has a bead plate 52 on top that is connected to gas fittings 54 that extend away from the bead plate 52 with one of the gas fittings 54 connected to gas lines 56. The gas fittings 54 are covering gas openings (not shown), but the circumferences of the gas fittings 54 approximately show the edges of the gas openings. As can be seen, the edges of the gas openings significantly overlap an edge 58 formed in the bead plate 52, similar to the overlap shown in Figs. 1 and 2, which leads to the deformations previously shown. It is desirable to move the gas openings away from the edge 58, but the distance that the gas openings can be moved away from the edge 58 is limited by a chassis beam 60 held above the gas bellows 50. There must be some clearance between the gas fittings 54 and the chassis beam 60, when viewed from a top view, so that the gas fittings 54 can extend from the bead plate 52 without contacting the chassis beam 60.
Referring now to Fig. 7, a bead plate 70 is shown with gas openings 72 formed according to the present invention. It should be appreciated that the bead plate 70 shown is illustrative only, and that many different configurations of bead plates can be formed according to the present invention. The gas openings 72 have chamfers 71 and threadings 73, similar to previously described gas openings. As can be seen, the gas openings 72 have been spaced away from an edge 74 formed in the bead plate 70 to reduce the effect of the bending radius that occurs during cold forming of the gas openings 72. In this regard, the gas openings 72 have forming locations L1 and L2, corresponding to centers of the gas openings 72, that are farther from the edge 74 in the bead plate 70 than the gas openings of the bead plate 52 shown in Fig. 6. The forming locations L1 and L2 therefore have distances D4 and D5 away from the edge 74. For example, the forming locations L1 and L2 of gas openings 72 can be about 2 mm to 6 mm closer to the center of the bead plate 70 than the gas openings of bead plate 52. These values for distances D4 and D5 are exemplary only and not limiting. By distancing the gas openings 72 away from edge 74, deformations (and therefore gas leaks) in the flat indents of the gas openings 72 can be partially or completely eliminated compared to the prior art. The edge 74 can, for example, be tangential to a periphery of an indent 77 surrounding the gas opening 72, allowing the gas opening 72 to be placed as close to the edge 74 as possible without forming a significant deformation. While not shown, it is also contemplated that gas openings 72 can be produced with a reduced chamfer, as previously described. Gas openings 72 can therefore combine the benefits of being spaced away from edge 74 and a reduced chamfer to offer better protection against deformations being formed adjacent to the gas openings 72 during production of the bead plate 70.

The present invention also provides a method for installing a gas fitting, such as gas fitting 18 shown in Fig. 1, in a bead plate, such as bead plate 30 shown in Figs. 3 and 5. The gas
fitting 18 has a diameter D1, which is determined by measurement or otherwise, that will be held by the bead plate 30. A gas opening 32 is formed in the bead plate 30. The gas opening 32 is tapered to form a chamfer 36 that has a maximum diameter D3. The gas opening 32 is formed so that the maximum diameter D3 of the chamfer 36 is approximately equal to the diameter D1 of the gas fitting 18, with the maximum diameter D3 having a total tolerance of 6% (3% larger or 3% smaller) of diameter D1. For example, when a gas fitting 18 with a diameter D1 of 16.0 mm is used, the chamfer 36 is contemplated as being formed with a maximum diameter D3 of between 16.0 and 16.4 mm, which has slightly less than the acceptable 3% larger tolerance. It should be appreciated that the gas opening 32 can also be formed so that the maximum diameter D3 of the chamfer 36 is between 15.6 and 16.0 mm, which has slightly less than the acceptable 3% smaller tolerance. Once the gas opening 32 is formed, the gas fitting 18 is placed within the gas opening 32 so that the gas opening 32 holds the gas fitting 18.

[0031] The present invention also provides a method for finishing a bead plate. The method includes the steps of providing a bead plate, such as bead plate 70 shown in Fig. 5, that has an edge 74 formed at a periphery of the bead plate 70. A forming location L1, L2 can be determined that is a distance D4, D5 from the edge 74 in the bead plate 70. A gas opening 72 can be formed at the forming location L1, L2. The distance D4, D5 from the edge 74 of the bead plate 70 can be any value that will not interfere with installation of the bead plate 70 in a vehicle, with exemplary values being between about 2 mm and 6 mm. The forming step can be a cold forming process, such as punching. The method can further include the step of determining a minimum chamfer 71 that can be used during formation of the gas opening 72. The gas opening 72 can be formed to include the determined minimum chamfer 71.

[0032] Figs. 8 and 9 demonstrate the difference between a bead plate 80 formed according to known methods (shown in Fig. 8) and a bead plate 90 formed according to the present invention
(shown in Fig. 9). As can be seen in Fig. 8, a chamfer 82 of a gas opening 84 has a significant deformation 86 that disrupts the circular shape of the gas opening 84 and makes it difficult to seal a gas fitting (not shown) that will be held in the gas opening 84. In contrast, the bead plate 90 shown in Fig. 9 has a gas opening 92 that is formed 3 mm away from an edge 94 formed in the bead plate 90, has a substantially non-deformed chamfer 96 and has a substantially circular shape that is easy to seal when a gas fitting (not shown) is held in the gas opening 92. It can therefore be seen that by moving the gas opening 92 away from the edge 94, the gas opening 92 can be formed with a non-deformed chamfer 96.

[0033] 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. A gas bellows, comprising:
   an air fitting having a fitting diameter; and
   a bead plate having a gas opening formed therethrough holding said air fitting, said gas
   opening being tapered to form a chamfer, said chamfer having a maximum diameter that is not
   greater than said fitting diameter.

2. The gas bellows according to claim 1, wherein said bead plate has an edge formed
   therein and said gas opening is surrounded by an indent, wherein said indent is spaced from said
   edge so that said indent does not overlap said edge.

3. The gas bellows according to claim 2, wherein said edge is tangential to a periphery of
   said indent.

4. The gas bellows according to claim 1, wherein said maximum diameter is
   approximately 16.0 mm.

5. The gas bellows according to claim 1, wherein said gas opening is formed using a cold
   forming technique.

6. The gas bellows according to claim 1, wherein said chamfer is located between an
   indent surrounding said gas opening and a threading formed on a wall of said gas opening.
7. The gas bellows according to claim 1, wherein said maximum diameter is within 3% of said fitting diameter.

8. A method of installing a gas fitting in a bead plate, comprising the steps of:
   providing said bead plate and said gas fitting having a fitting diameter that is to be held by said bead plate;
   determining said fitting diameter;
   forming a gas opening in said bead plate that is tapered to form a chamfer having a maximum diameter, said gas opening being formed so that said maximum diameter is approximately equal to said fitting diameter; and
   placing said gas fitting within said gas opening so that said gas opening holds said gas fitting.

9. The method according to claim 8, wherein said gas opening is formed such that an indent surrounding said gas opening does not overlap with an edge formed in said bead plate.

10. The method according to claim 8, wherein said gas opening is formed using a cold forming technique.

11. The method according to claim 8, wherein said maximum diameter of said chamfer is within 3% of said fitting diameter.

12. The method according to claim 8, wherein said maximum diameter is approximately 16.0 mm.
13. A method for finishing a bead plate, comprising the steps of:
providing said bead plate, said bead plate having an edge formed therein;
determining a forming location at a distance from said edge; and
forming a gas opening at said forming location such that a significant deformation of said
gas opening does not occur.

14. The method according to claim 13, wherein said gas opening is formed with an
indent surrounding said gas opening, wherein said indent does not overlap said edge.

15. The method according to claim 14, wherein said edge is tangential to a periphery of
said indent.

16. The method according to claim 13, wherein said gas opening is formed using a cold
forming technique.

17. The method according to claim 16, wherein said cold forming technique is punching.

18. The method according to claim 13, further comprising the step of forming a
threading in a wall of said gas opening.
WHAT IS CLAIMED IS:

1. A gas bellows, comprising:
   - an air fitting having a fitting diameter; and
   - a bead plate having an edge formed therein and a gas opening formed therethrough

   holding said air fitting, said gas opening being surrounded by an indent and being tapered to
   form a chamfer, said chamfer having a maximum diameter that is not greater than said fitting
diameter, said edge being tangential to a periphery of said indent.

4. The gas bellows according to claim 1, wherein said maximum diameter is
   approximately 16.0 mm.

5. The gas bellows according to claim 1, wherein said gas opening is formed using a cold
   forming technique.

6. The gas bellows according to claim 1, wherein said chamfer is located between an
   indent surrounding said gas opening and a threading formed on a wall of said gas opening.

7. The gas bellows according to claim 1, wherein said maximum diameter is within 3% of
   said fitting diameter.

8. A method of installing a gas fitting in a bead plate, comprising the steps of:
   - providing said bead plate having an edge formed therein and said gas fitting having a
     fitting diameter that is to be held by said bead plate;
   - determining said fitting diameter;
forming a gas opening in said bead plate with an indent surrounding said gas opening and which is tapered to form a chamfer having a maximum diameter, said gas opening being formed so that said maximum diameter is approximately equal to said fitting diameter and said edge is tangential to a periphery of said indent; and

placing said gas fitting within said gas opening so that said gas opening holds said gas fitting.

10. The method according to claim 8, wherein said gas opening is formed using a cold forming technique.

11. The method according to claim 8, wherein said maximum diameter of said chamfer is within 3% of said fitting diameter.

12. The method according to claim 8, wherein said maximum diameter is approximately 16.0 mm.

13. A method for finishing a bead plate, comprising the steps of:
providing said bead plate, said bead plate having an edge formed therein;
determining a forming location at a distance from said edge; and
forming a gas opening with an indent surrounding said gas opening at said forming location such that a significant deformation of said gas opening does not occur, said edge being tangential to a periphery of said indent.

16. The method according to claim 13, wherein said gas opening is formed using a cold forming technique.
forming technique.

17. The method according to claim 16, wherein said cold forming technique is punching.

18. The method according to claim 13, further comprising the step of forming a threading in a wall of said gas opening.
A. CLASSIFICATION OF SUBJECT MATTER
F16L 51/02(2006.01)i, F16L 27/10(2006.01)i, F16L 55/00(2006.01)i

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)
F16L 51/02; F16L 23/00; F16L 39/00; B21D 039/04; B21D 039/06; F16L 3/04; F16L 5/02; F16L 27/10; F16L 55/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKompass(KIPO internal) & keywords: gas bellows, bead plate, fitting, chamfer, deformation, and gasket

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
  "E" earlier application or patent but published on or after the international filing date
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  "&" document member of the same patent family

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