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Ruby, III et al.

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(54) **PINCH SENSOR WITH DOOR SEAL**

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(51) **Int. Cl.**
G01L 1/00 (2006.01)

(52) **U.S. Cl.** **73/768**

(58) **Field of Classification Search** 73/768
See application file for complete search history.

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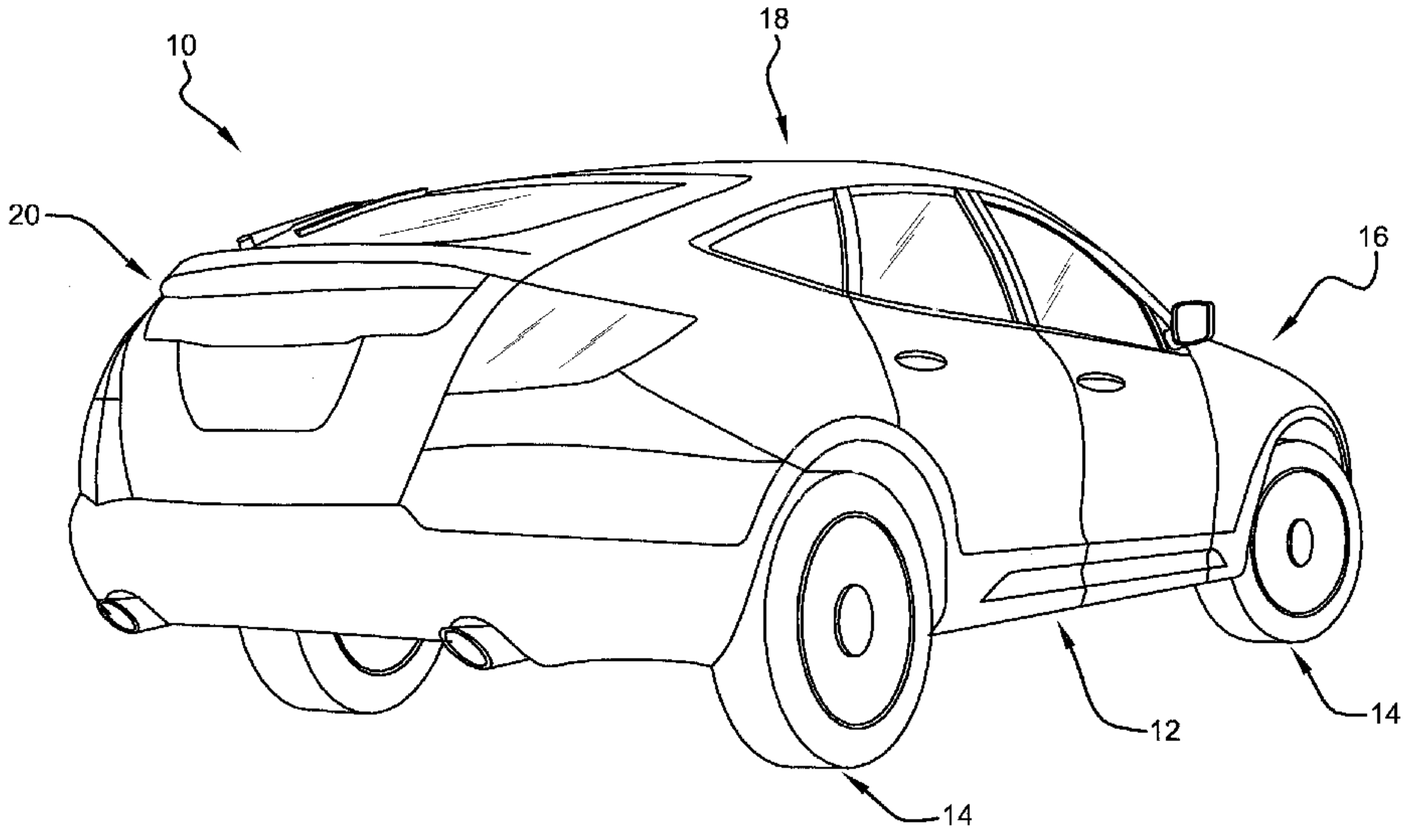
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(57) **ABSTRACT**

A sensor apparatus may include an attachment member operatively attached to a closure member of an associated vehicle, a sensor housing substantially enclosing an associated pinching sensor, a neck portion connecting the sensor housing to the attachment member, and a seal extending from the neck portion and contacting a body portion of the associated vehicle when the closure member is in a closed position.

20 Claims, 7 Drawing Sheets



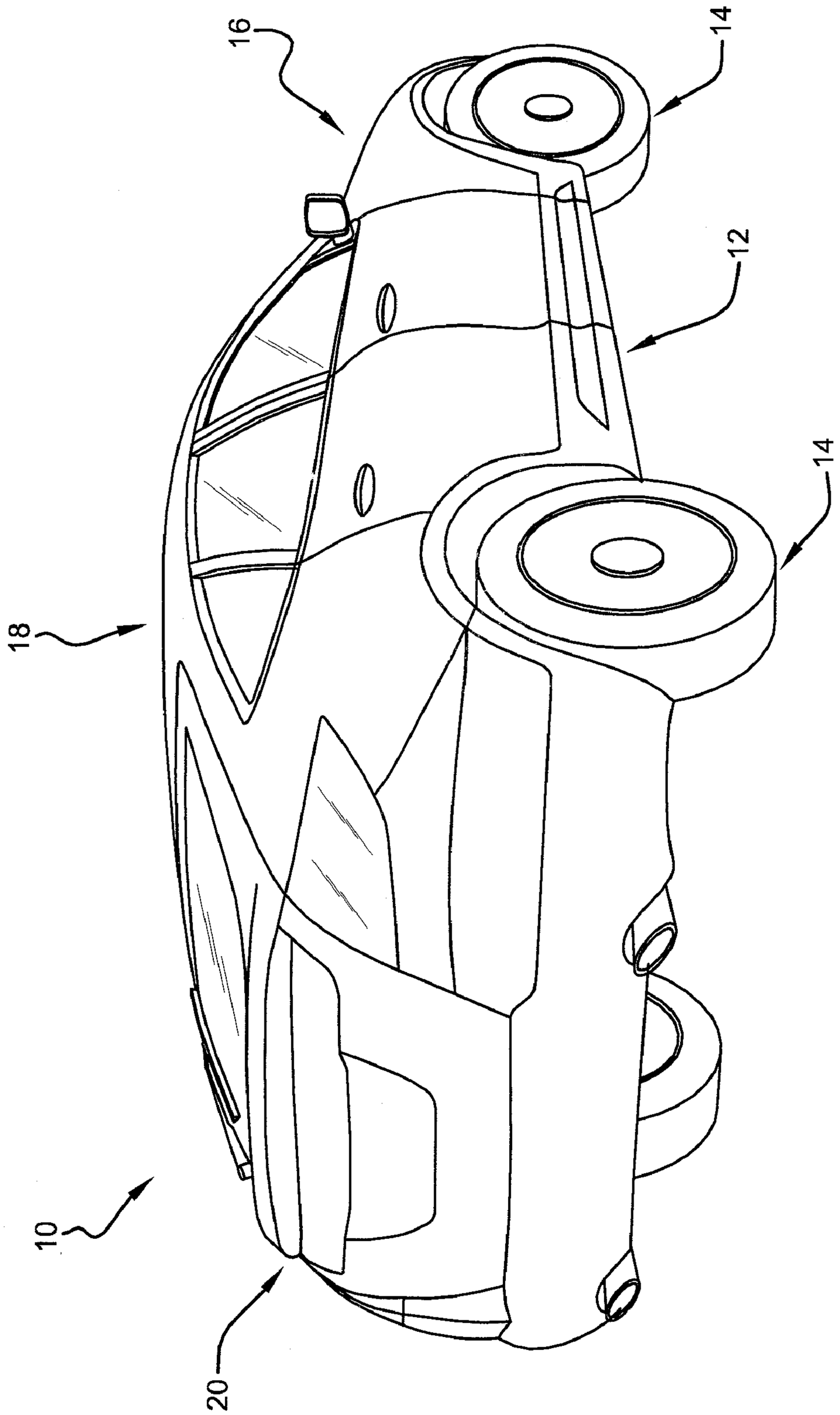


FIG. 1

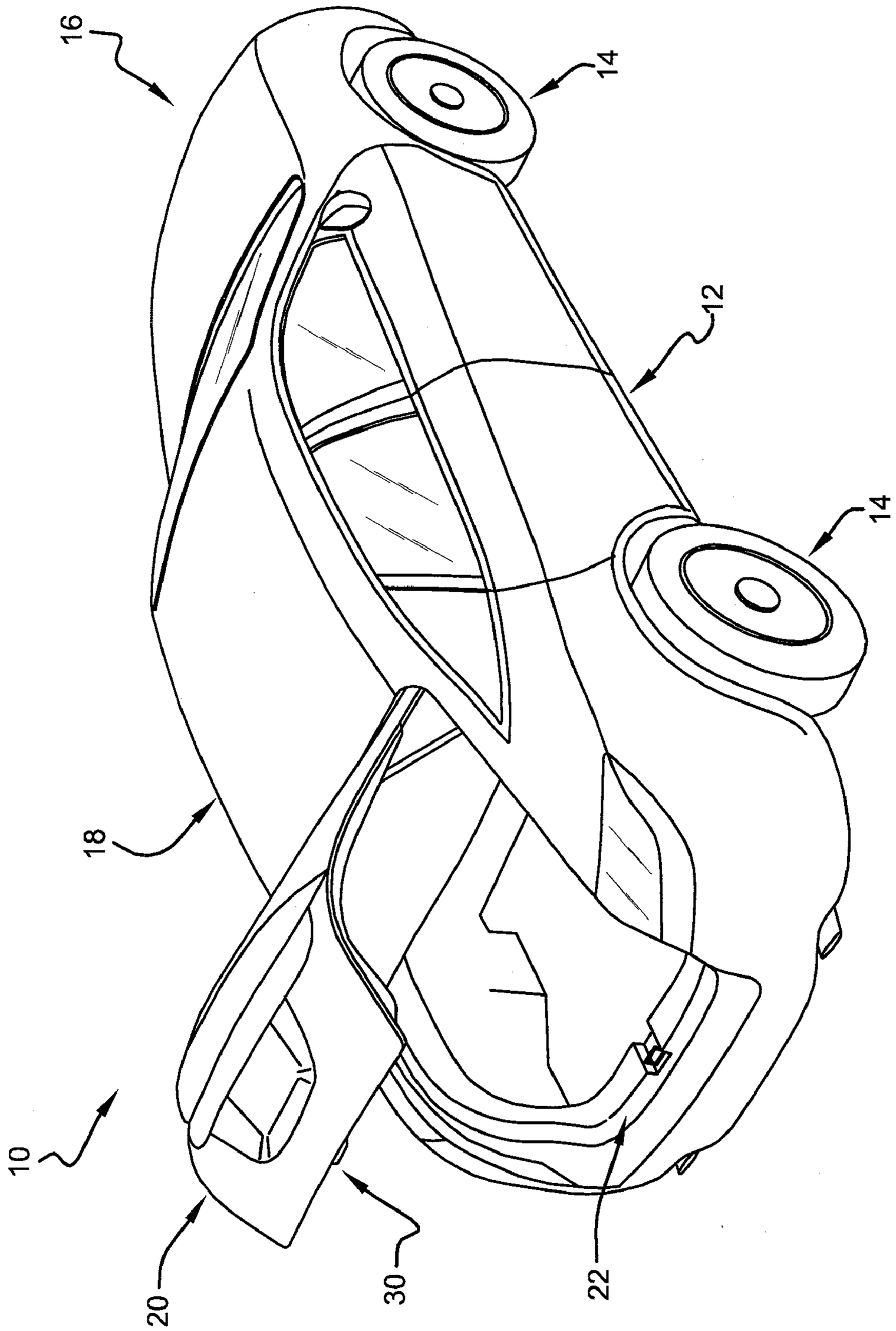


FIG. 2

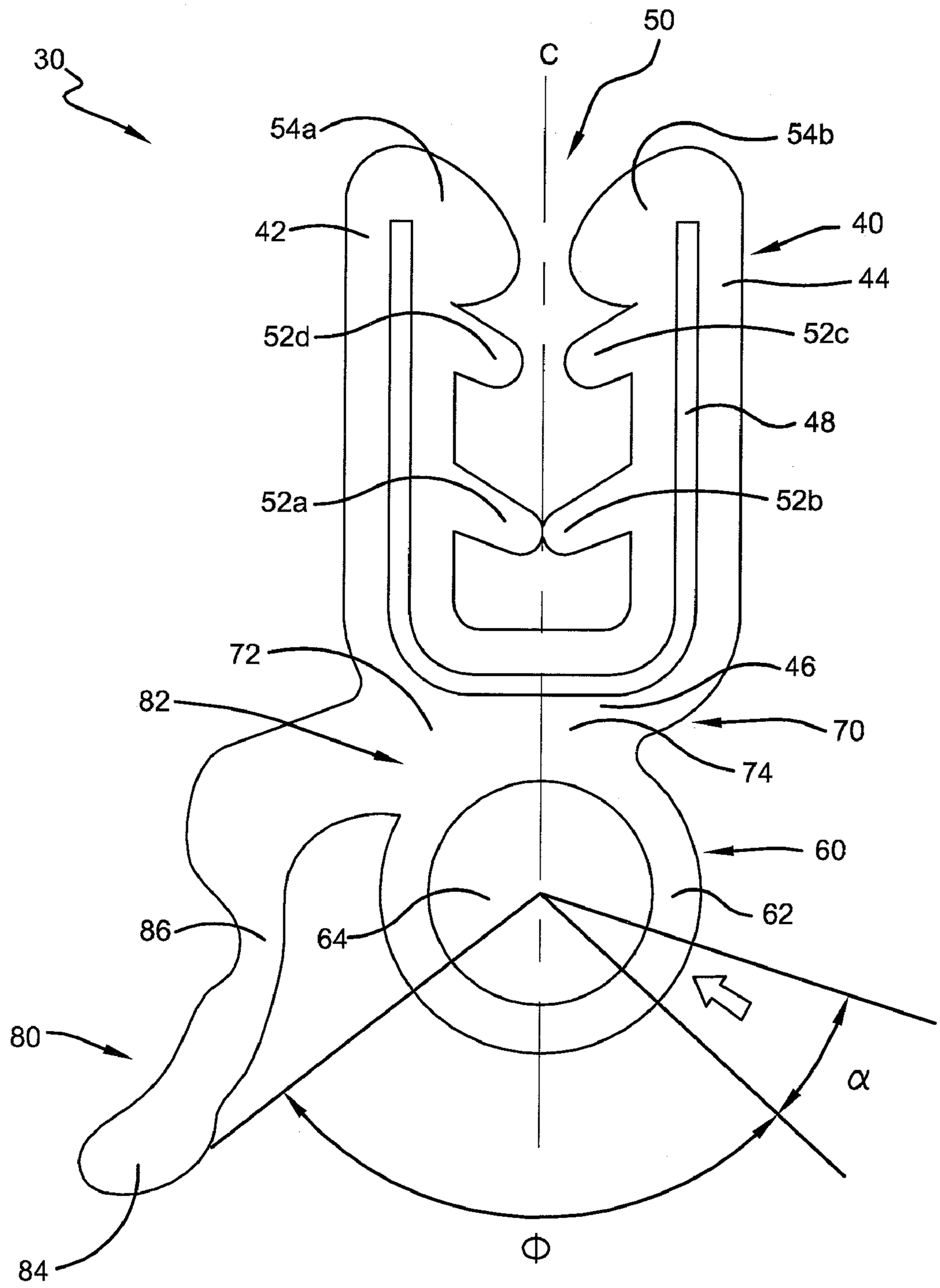

30
50
C
54a
54b
42
40
44
52d
52c
48
52a
52b
72
46
82
70
74
60
86
64
62
80
α
Φ
84

FIG. 3

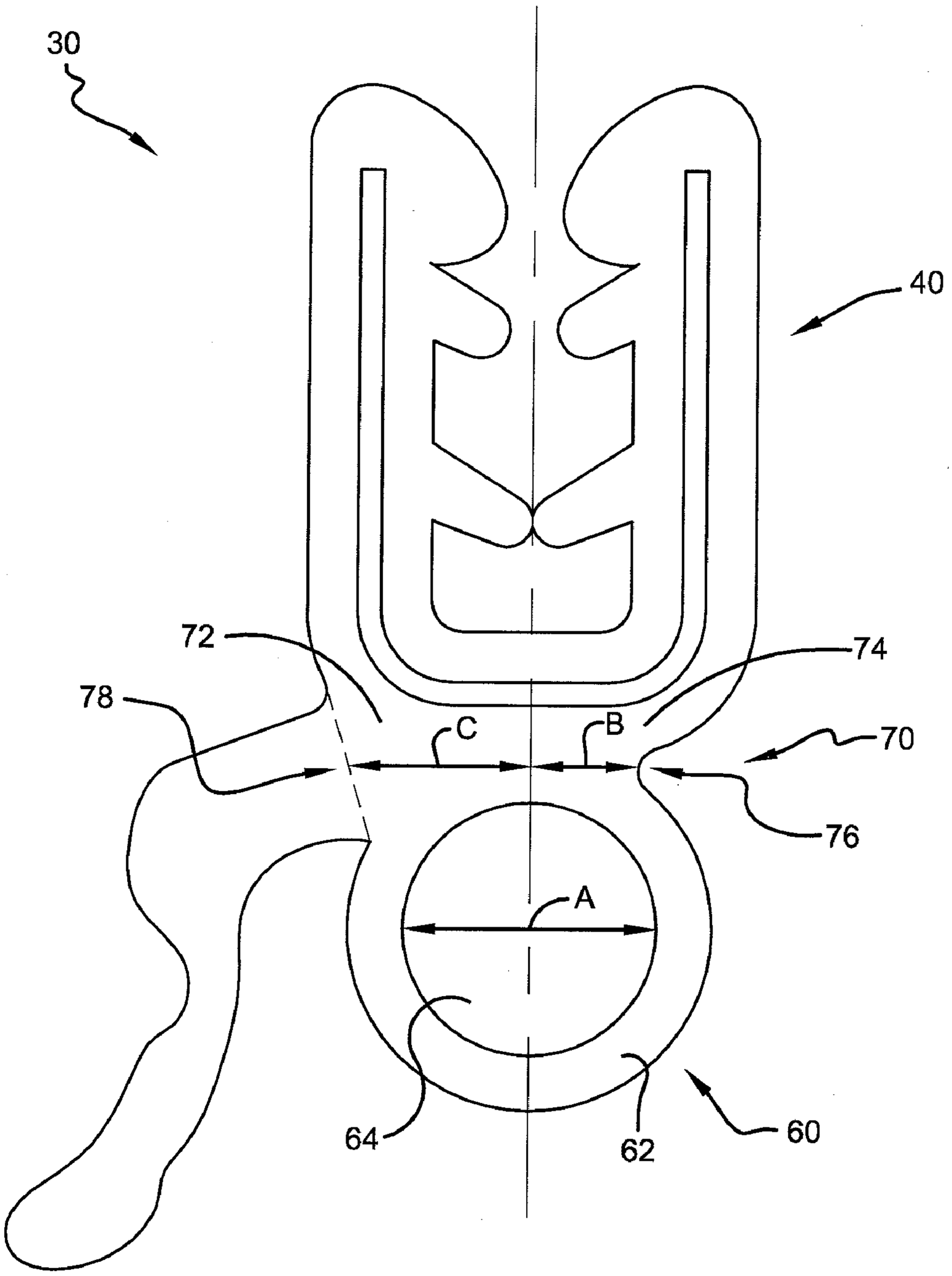


FIG. 4

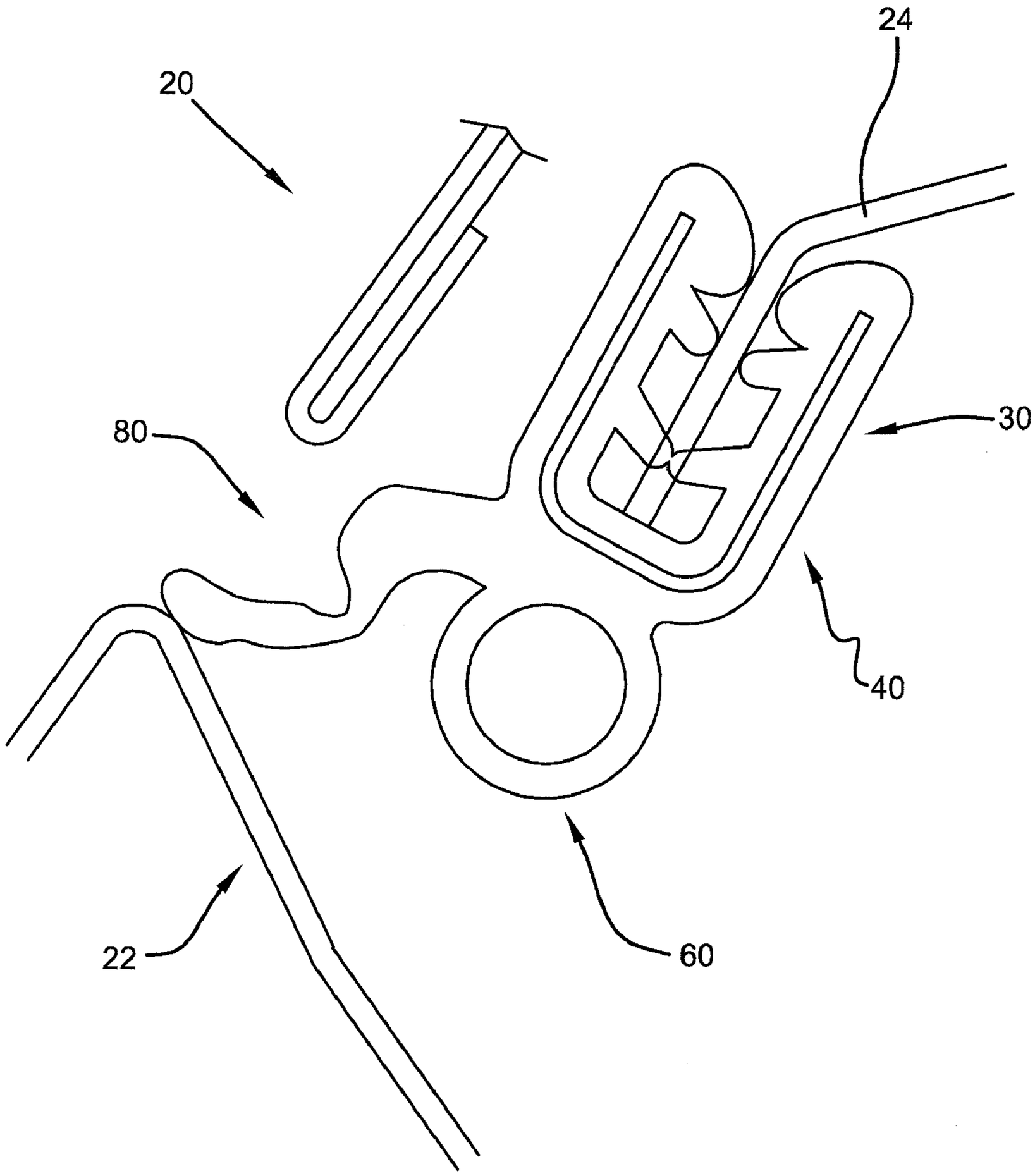


FIG. 5

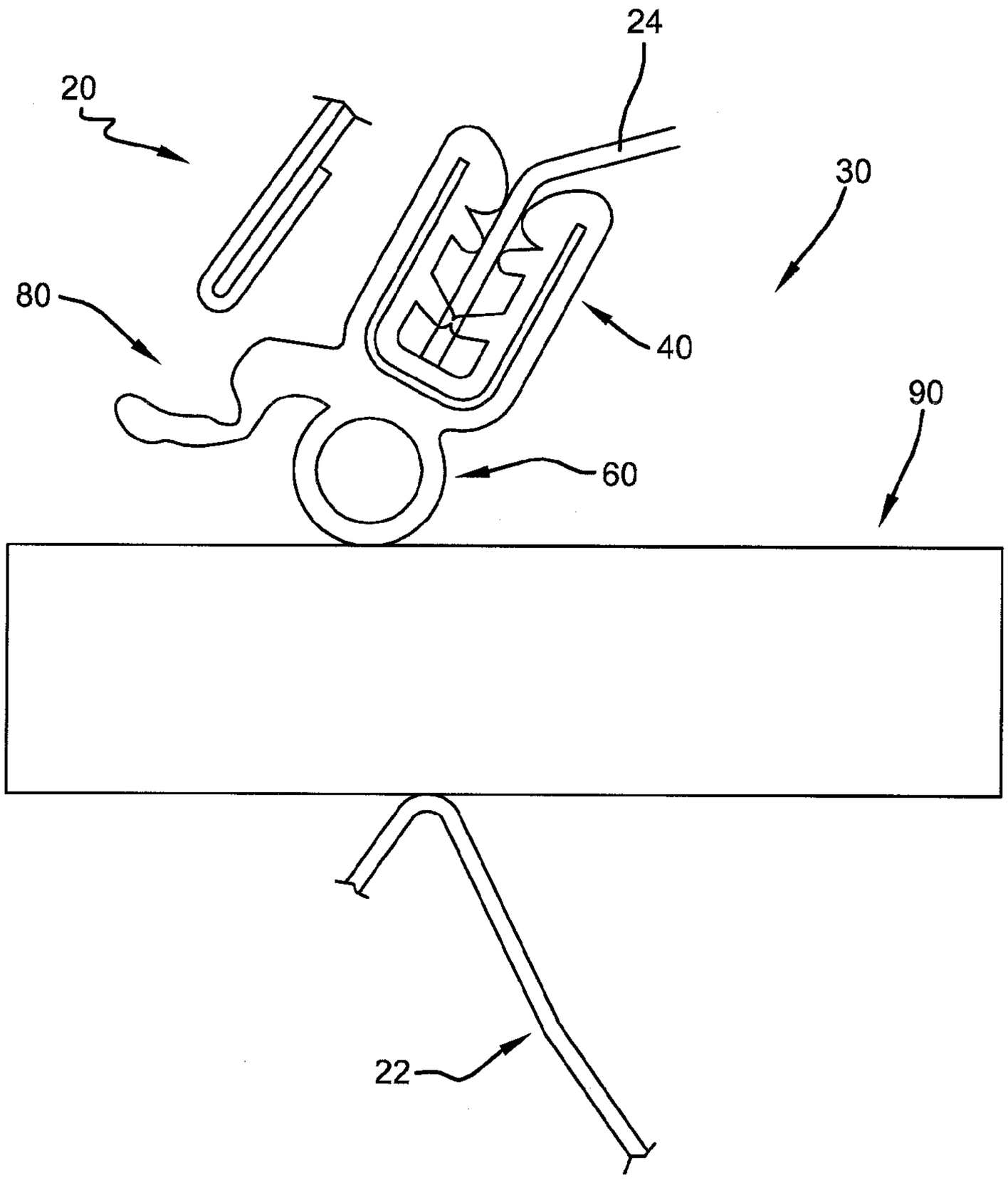


FIG. 6

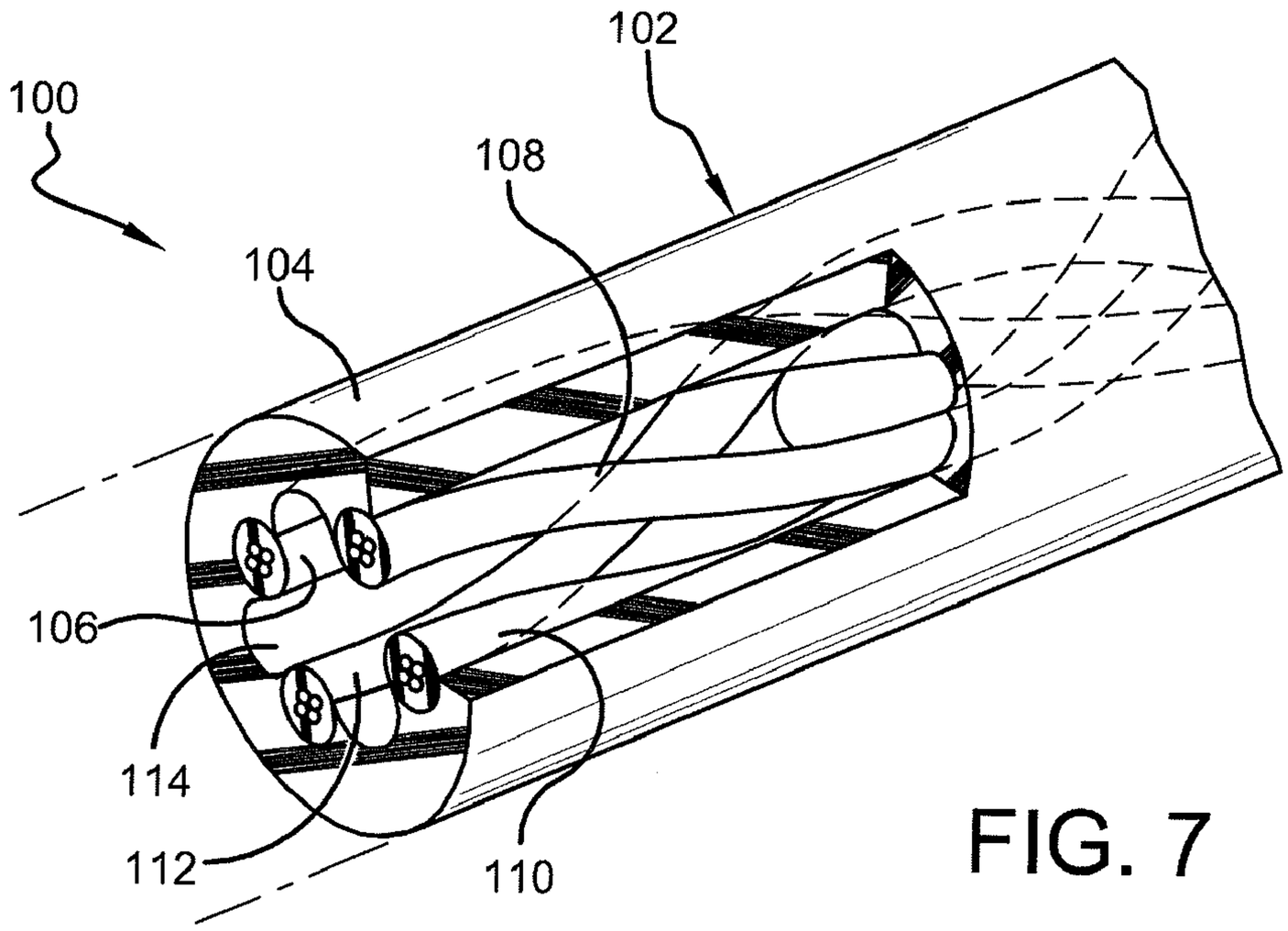


FIG. 7

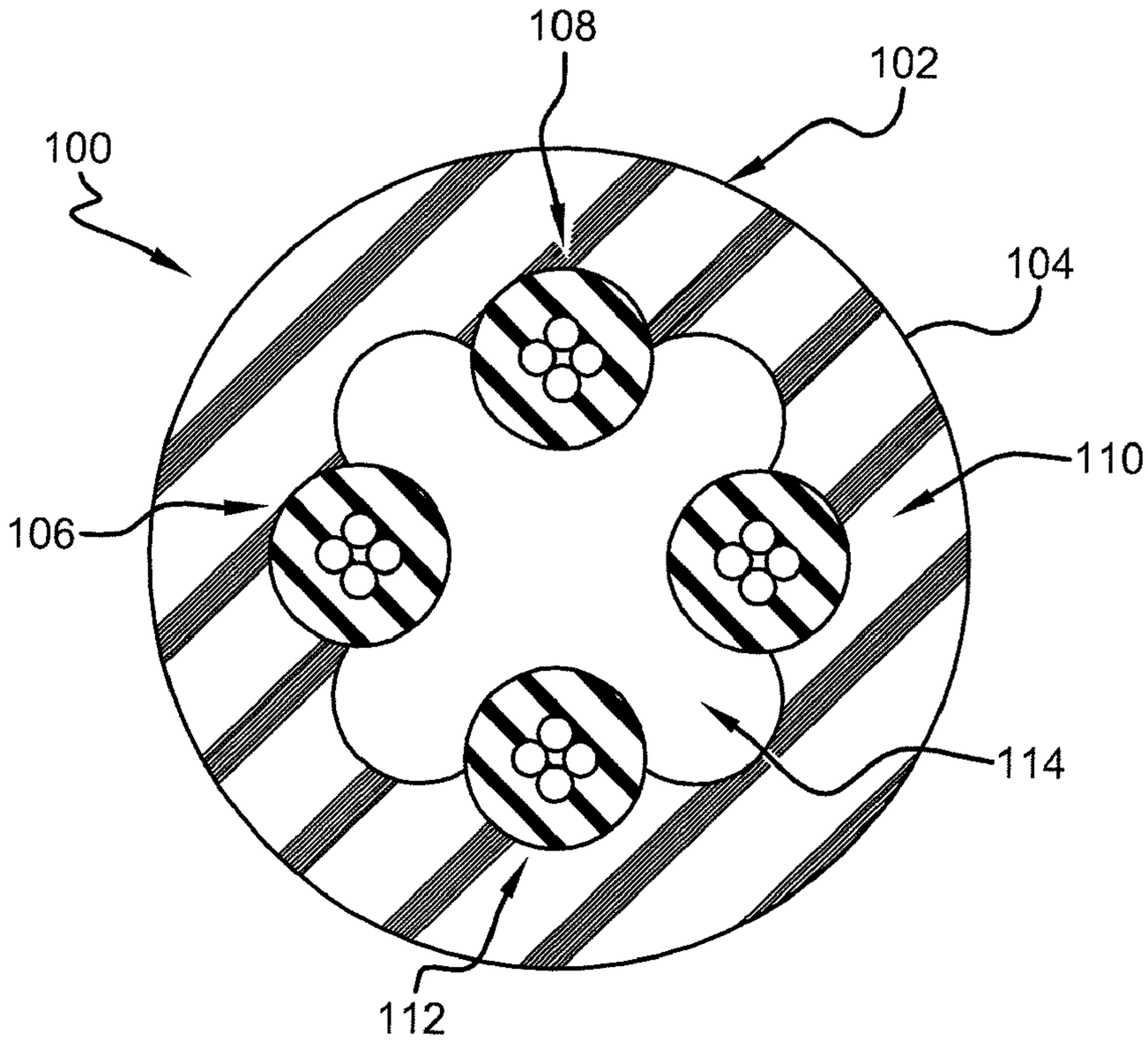


FIG. 8

PINCH SENSOR WITH DOOR SEAL

I. BACKGROUND

A. Field of Invention

The present invention relates generally to vehicle door and window pressure sensors, and more specifically to pressure sensors used with automatic doors or windows.

B. Description of the Related Art

It is well known in the automotive industry to include pressure sensors (pressure-activated sensors) for door and window openings, especially for automatic or motorized door and window systems. Pressure sensors are used in passenger vehicles and in other applications for use in preventing an automatic powered door or window from forcibly closing over an obstruction, such as the arms, legs, or fingers of a passenger. The pressure sensors are typically referred to as "pinch sensors." The pressure or pinch sensor detects when an object is pinched between the door and the door frame or the window and the window frame. The pressure or pinch sensor prevents the door or window from closing and causing damage to the pinched object.

Various mechanisms have been used to detect when a object is pinched between the door or window and the vehicle body. While these mechanism function well for their intended use, there are disadvantages. One disadvantage is the pressure or pinch sensor may not detect an object when the object is offset to one side of the sensor.

Therefore, what is needed is an apparatus for detecting when an object is pinched in a closing door or window, in which the apparatus includes a door or window seal.

II. SUMMARY

According to one embodiment of this invention, a sensor apparatus comprises: an attachment member defining an interior having a plurality of ribs, the attachment member including a first end rib located near a top portion of the attachment member, the attachment member including substantially parallel first and second side members and a base member substantially perpendicular to the first and second side members, wherein the first end rib is larger than any of the plurality of ribs, and wherein the attachment member is adapted to receive a portion of a closure member of an associated vehicle within the interior; a sensor housing defining an interior and substantially enclosing an associated pinching sensor within the interior, the sensor housing adjacent the base member of the attachment member; a neck portion connecting the sensor housing to the base member of the attachment member; and a seal extending from the neck portion, the seal including an intermediate pivot point located between the neck portion and a distal end of the seal, the seal including an outer portion extending from the intermediate pivot point to the distal end, wherein the outer portion of the seal pivots about the intermediate pivot point when the seal contacts a body portion of the associated vehicle when the closure member is in a closed position. In another embodiment, the first and second side members of the attachment member are substantially equal in length and the base member of the attachment member is substantially shorter than the first and second side members. In another embodiment, the first side member includes the first end rib and the second side member includes a second end rib, wherein the first and second end ribs are substantially the same size. In another embodiment, the neck portion includes substantially more material on a first side of the neck portion than on the second side of the neck portion. In another embodiment, the seal extends from the first side of the neck portion. In another embodiment, the neck portion includes substantially more material between the sensor housing and the first side member of the attachment member than between the sensor housing and the second side member of the attachment member. In another embodiment, the seal extends from between the sensor housing and the first side member of the attachment member. In another embodiment, a center of the interior of the sensor housing is located substantially equidistant from the first and second side members of the attachment member. In another embodiment, a center of the interior of the sensor housing is substantially aligned with both a center of the interior of the attachment member and a center of the base of the attachment member. In another embodiment, the sensor housing is located between a plane defined by an exterior surface of a length of the first side member and a plane defined by an exterior surface of a length of the second side member. In another embodiment, the sensor housing is substantially circular. In another embodiment, the intermediate pivot point has substantially less material than the adjacent portions of the seal.

According to another embodiment of this invention, a sensor apparatus comprises: an attachment member defining an interior having a plurality of ribs, the attachment member including substantially parallel first and second side members and a base member substantially perpendicular to the first and second side members, wherein the attachment member is adapted to receive a portion of a closure member of an associated vehicle within the interior; a sensor housing defining an interior and substantially enclosing an associated pinching sensor within the interior, the sensor housing adjacent the base member of the attachment member, the sensor housing located substantially equidistant from the two side members of the attachment member; a neck portion connecting the sensor housing to a bottom portion of the attachment member, the neck portion including substantially more material on a first side of the neck portion than on the second side of the neck portion, wherein the ratio of a width of the first side of the neck portion to a width of the second side of the neck portion is between 1.2 and 2.5, wherein the ratio of a width of the interior of the sensor housing to the width of the first side of the neck portion is between 0.8 and 1.8; and a seal extending from the first side of the neck portion, wherein a distal end of the seal contacts a body portion of the associated vehicle when the closure member is in a closed position. In another embodiment, the ratio of the width of the first side of the neck portion to the width of the second side of the neck portion is between 1.2 and 2.0. In another embodiment, the ratio of the width of the first side of the neck portion to the width of the second side of the neck portion is between 1.5 and 2.0. In another embodiment, the ratio of the width of the first side of the neck portion to the width of the second side of the neck portion is between 1.6 and 1.8. In another embodiment, the ratio of the width of the interior of the sensor housing to the width of the first side of the neck portion is between 1.0 and 1.6. In another embodiment, the ratio of the width of the interior of the sensor housing to the width of the first side of the neck portion is between 1.2 and 1.5. In another embodiment, the ratio of the width of the interior of the sensor housing to the width of the first side of the neck portion is between 1.3 and 1.5.

According to another embodiment of this invention, a sensor apparatus comprises: an attachment member defining an interior and including a plurality of ribs within the interior, wherein the attachment member is substantially U-shaped with first and second side members substantially parallel and substantially equal in length and a base member substantially shorter than the first and second side members and substan-

tially perpendicular to the first and second side members, wherein the attachment member is adapted to receive a portion of a closure member of an associated vehicle within the interior, wherein the attachment member includes at least one end rib located near a top portion of the first side member, wherein the at least one end rib is larger than any of the plurality of ribs; a sensor housing substantially enclosing and defining an interior for receiving an associated pinching sensor, the sensor housing located adjacent the base member of the attachment member, the sensor housing located substantially equidistant from the first and second side members of the attachment member, wherein a center of the interior of the sensor housing is substantially aligned with both a center of the interior of the attachment member and a center of the base of the attachment member, wherein the sensor housing is located between a plane defined by an exterior surface of a length of the first side member and a plane defined by an exterior surface of a length of the second side member; a neck portion connecting the sensor housing to the base member of the attachment member, the neck portion including substantially more material between the sensor housing and the first side member of the attachment member than between the sensor housing and the second side member of the attachment member; and a seal extending from the neck portion between the sensor housing and the first side member of the attachment member, the seal including an intermediate pivot point located between the neck portion and a distal end of the seal, the seal including an outer portion extending from the intermediate pivot point to the distal end, wherein the outer portion pivots about the intermediate pivot point when the seal contacts a body portion of the associated vehicle.

According to another embodiment of this invention, a sensor apparatus comprises: an attachment member for attachment to a closure member; a pinch sensor connected to the attachment member through a neck portion; and a seal extending from the neck portion, the seal having a hinge located between the neck portion and a distal end of the seal, the hinge defined by a portion of the seal that is thinner than adjacent portions of the seal.

One advantage of this invention is the integrated pinch sensor and door seal. Another advantage of this invention is a greater operating angle or range for detecting objects pinched between a door or window and the vehicle body.

Still other benefits and advantages of the invention will become apparent to those skilled in the art to which it pertains upon a reading and understanding of the following detailed specification.

III. BRIEF DESCRIPTION OF THE DRAWINGS

The invention may take physical form in certain parts and arrangement of parts, embodiments of which will be described in detail in this specification and illustrated in the accompanying drawings which form a part hereof and wherein:

FIG. **1** is a rear perspective view of a vehicle with a rear hatch in a closed position, according to one embodiment;

FIG. **2** is a rear perspective view of a vehicle with a rear hatch in an open position, according to one embodiment;

FIG. **3** is a cross-sectional view of the sensor showing the operational range, according to one embodiment;

FIG. **4** is the cross-sectional view of the sensor showing the relative dimensions, according to one embodiment;

FIG. **5** is a cross-sectional view of a sensor installed on the rear door of the vehicle, according to one embodiment;

FIG. **6** is a cross-sectional view of a sensor with an object pinched between the rear door and the vehicle body, according to one embodiment;

FIG. **7** is a partial cut-away view of a pinch sensor, according to one embodiment;

FIG. **8** is a cross-sectional view of a pinch sensor, according to one embodiment.

IV. DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings wherein the showings are for purposes of illustrating embodiments of the invention only and not for purposes of limiting the same, and wherein like reference numerals are understood to refer to like components, FIGS. **1** and **2** show a vehicle **10**, which may be equipped with sensor apparatus **30** according to one embodiment of this invention. It should be understood that this invention will work with any vehicle including, but not limited to, any automobile, truck, pickup truck, sport utility vehicle (SUV), and crossover vehicle. The vehicle **10** may include a frame **12**, one or more ground engaging wheels **14** mounted to the frame **12**, and a locomotion source **16**, mounted to the frame **12**, for use in providing locomotion for the vehicle **10**. The vehicle **10** may include have a passenger compartment **18** which can house one or more passengers as is well known in the art. The vehicle **10** may also include a closure member **20**. For some non-limiting examples, the closure member **20** can be a door, a tailgate, a hatch, a trunk lid, a window, a sunroof or moon roof, or a sliding door. The sensor apparatus **30** can be attached to either the closure member **20** or the vehicle body or closure member frame **22**.

With reference now to FIGS. **3-6**, the sensor apparatus **30** may include an attachment member **40**, a sensor housing **60**, and a seal **80**. The sensor apparatus **30** can be formed of any material chosen with ordinary skill in the art. In one embodiment, the sensor apparatus **30** is formed of EPDM rubber. The attachment member **40** may include two side members **42**, **44** and a base member **46**. The attachment member **40** may include a metal support structure **48**. The attachment member **40** may include a plurality of ribs **52***a*, **52***b*, **52***c*, **52***d* located within an interior **50**. The attachment member **40** may include end ribs **54***a*, **54***b* to improve the position control of the sensor apparatus **30**. The attachment member **40** can be substantially symmetrical about a center line C. The interior **50** can receive a portion of the closure member **20**. In one embodiment, the interior **50** receives a bracket **24** attached to the closure member **20**. One or more of the shape of the attachment member **40**, the plurality of ribs **52***a*, **52***b*, **52***c*, **52***d*, and the end ribs **54***a*, **54***b* can secure the attachment member **40** to the closure member **20**.

With continuing reference now to FIGS. **3-6**, the sensor housing **60** may include a sheath or casing member **62**, which substantially encloses and defines an interior **64** for receiving a pressure sensor or pinch sensor **100**, as is well known in the art. The sensor housing **60** can be connected to the attachment member **40** by a neck member **70**. In one embodiment, the neck member **70** is asymmetrical about a center line C. The neck member **70** may have substantially more material on a left side **72** of the center line C than a right side **74** of the center line C. This extra material stiffens the sensor housing **60** from external forces acting on the sensor housing **60** in the area indicated by angle alpha (α) in FIG. **3**. With this extra material, the sensor housing **60** compresses from external forces acting on the sensor housing **60** in the area indicated by angle phi (Φ) and angle alpha (α). Thus, the sensor housing **60** has a larger operational range for external forces acting on

the sensor housing **60** in the area indicated by both angle phi (Φ) and angle alpha (α). In contrast, without this extra material, external forces acting on the sensor housing **60** in the area indicated by angle alpha (α) do not compress the sensor housing **60**.

With continuing reference now to FIG. **4**, the sensor apparatus **30** has a dimension A, a dimension B, and a dimension C. Dimension A is the size of the interior **64** of the sensor housing **60**. In one embodiment, interior **64** is substantially circular and dimension A is the diameter of the substantially circular interior **64**. Dimension B is the distance between the center line C and an outer surface **76** of the right side **74** of the neck member **70**. Dimension C is the distance between the center line C and a transition area **78** between the neck member **70** and the seal **80** on the left side **72**. The ratio of dimension A to dimension B (A:B or A/B) is between 2.0 and 3.0. In one embodiment, the ratio of dimension A to dimension B is between 2.0 and 2.5. In another embodiment, the ratio of dimension A to dimension B is between 2.2 and 2.5. In a more specific embodiment, the ratio of dimension A to dimension B is between 2.3 and 2.4. The ratio of dimension A to dimension C is between 0.8 and 1.8. In one embodiment, the ratio of dimension A to dimension C is between 1.0 and 1.6. In another embodiment, the ratio of dimension A to dimension C is between 1.2 and 1.5. In a more specific embodiment, the ratio of dimension A to dimension C is between 1.3 and 1.5. The ratio of dimension C to dimension B is between 1.2 and 2.5. In one embodiment, the ratio of dimension C to dimension B is between 1.2 and 2.0. In another embodiment, the ratio of dimension C to dimension B is between 1.5 and 2.0. In a more specific embodiment, the ratio of dimension C to dimension B is between 1.6 and 1.8.

With continuing reference to FIGS. **3-6**, the seal **80** can extend from the neck member **70**. The seal **80** may include a proximal end **82** and a distal end **84**. The proximal end **82** can form a portion of the left side **72** of the neck member **70**. The seal may include an intermediate pivot point **86** between the proximal end **82** and the distal end **84**. The intermediate pivot point **86** may have substantially less material than the adjacent portions of the seal **80**. The intermediate pivot point **86** can be substantially thinner than the adjacent portions of the seal **80**. This thinner portion **86** of the seal **80** creates a hinge for the distal end **84** of the seal **80** to pivot about. The portion of the seal **80** from the intermediate pivot point **86** and the proximal end **82** may remain substantially stationary with respect to the neck member **70** when the distal end **84** pivots about the intermediate pivot point **86**. When the closure member **20** is in the closed position, shown in FIG. **5**, the seal **80** contacts the vehicle body or closure member frame **22**.

With reference now to FIGS. **7** and **8**, one embodiment of the pressure sensor **100** is shown and described. It will be appreciated that other types of pressure sensors may be used within the scope of the present disclosure. The pressure sensor **100** includes a main body **102** with a substantially circular cross section. The main body **102** includes an outer sheath portion **104** and four electrode wires **106**, **108**, **110**, **112**. The outer sheath portion **104** is made of a resilient dielectric material such as a rubber material or a soft synthetic resin material. The outer sheath portion **104** includes an aperture **114**, which has an X-shaped cross section. The aperture **114** progressively varies its circumferential position about a center axis of the outer sheath portion **104** along the longitudinal direction of the outer sheath portion **104**. Each one of four radial ends of the aperture **114** shifts its circumferential position along a corresponding spiral path in the longitudinal direction of the outer sheath portion **104**. Each of the four electrode wires **106**, **108**, **110**, **112** is a resilient stranded wire, which is formed by stranding a plurality of electrically conductive wires. Each of the four electrode wires **106**, **108**, **110**, **112** is covered with an electrically conductive rubber. The electrode wires **106**, **108**, **110**, **112** are radially spaced from each other across the aperture **114** and are spirally wound along a length of the outer sheath portion **104**. The electrode wires **106**, **108**, **110**, **112** are integrally secured to the inner peripheral surface portion of the outer sheath portion **104**. Thus, when the outer sheath portion **104** is resiliently deformed by the application of an external force, the electrode wires **106**, **108**, **110**, **112** are flexed. When the outer sheath portion **104** is resiliently deformed until the electrode wire **106** or **110** contacts with the electrode wire **108** or **112**, an electrical current is formed between the contacting wires. When the outer sheath portion **104** is restored to its original shape, the electrode wires **106**, **108**, **110**, **112** are also restored to their original shape.

With reference now to all the FIGURES, the closure member **20** may have a closed position, as shown in FIGS. **1** and **5**, and an open position, as shown in FIGS. **2** and **6**. The closure member **20** may include the sensor apparatus **30**, which senses when an obstruction or object **90** is squeezed or pinched between the closure member **20** and the closure member frame **22**, as shown in FIG. **6**. In an alternate embodiment, the closure member frame **22** includes the sensor apparatus **30**. The closure member **20** may have any automatic or motorized opening and closing system chosen with ordinary skill in the art. If the sensor apparatus **30** detects an object **90** being squeezed or pinched between the closure member **20** and the closure member frame **22** during an automatic closing operation, then the sensor apparatus **30** can stop the closure member **20** from closing. In addition, the sensor apparatus **30** could also cause the closure member **20** to open. This can prevent the object **90** from being damaged.

Numerous embodiments have been described, hereinabove. It will be apparent to those skilled in the art that the above methods and apparatuses may incorporate changes and modifications without departing from the general scope of this invention. It is intended to include all such modifications and alterations in so far as they come within the scope of the appended claims or the equivalents thereof.

Having thus described the invention, it is now claimed.

We claim:

1. A sensor apparatus comprising:

an attachment member defining an interior having a plurality of ribs, the attachment member including substantially parallel first and second side members and a base member substantially perpendicular to the first and second side members, wherein the attachment member is adapted to receive a portion of a closure member of an associated vehicle within the interior;

a sensor housing defining an interior and substantially enclosing an associated pinching sensor within the interior, the sensor housing adjacent the base member of the attachment member, the sensor housing located substantially equidistant from the two side members of the attachment member;

a neck portion connecting the sensor housing to a bottom portion of the attachment member, the neck portion including substantially more material on a first side of the neck portion than on a second side of the neck portion, wherein the ratio of a width of the first side of the neck portion to a width of the second side of the neck portion is between 1.2 and 2.5, wherein the ratio of a width of the interior of the sensor housing to the width of the first side of the neck portion is between 0.8 and 1.8; and

a seal extending from the first side of the neck portion, wherein a distal end of the seal contacts a body portion of the associated vehicle when the closure member is in a closed position.

2. The sensor apparatus of claim **1** wherein the seal includes an intermediate pivot point located between the neck portion and a distal end of the seal, the seal including an outer portion extending from the intermediate pivot point to the distal end, wherein the outer portion of the seal pivots about the intermediate pivot point when the seal contacts a body portion of the associated vehicle when the closure member is in a closed position.

3. The sensor apparatus of claim **2** wherein the intermediate pivot point has substantially less material than the adjacent portions of the seal.

4. The sensor apparatus of claim **1** wherein the seal extends from between the sensor housing and the first side member of the attachment member.

5. A sensor apparatus comprising:

an attachment member defining an interior having a plurality of ribs, the attachment member including substantially parallel first and second side members and a base member substantially perpendicular to the first and second side members, wherein the attachment member is adapted to receive a portion of a closure member of an associated vehicle within the interior;

a sensor housing defining an interior and substantially enclosing an associated pinching sensor within the interior, the sensor housing adjacent the base member of the attachment member, the sensor housing located substantially equidistant from the two side members of the attachment member;

a neck portion connecting the sensor housing to a bottom portion of the attachment member, the neck portion including substantially more material on a first side of the neck portion than on a second side of the neck portion; and,

a seal extending from the first side of the neck portion, wherein a distal end of the seal contacts a body portion of the associated vehicle when the closure member is in a closed position;

wherein the sensor comprises at least one of the following:

(a) the ratio of the width of the first side of the neck portion to the width of the second side of the neck portion is between 1.2 and 2.0;

(b) the ratio of the width of the first side of the neck portion to the width of the second side of the neck portion is between 1.5 and 2.0;

(c) the ratio of the width of the first side of the neck portion to the width of the second side of the neck portion is between 1.6 and 1.8;

(d) the ratio of the width of the interior of the sensor housing to the width of the firs side of the neck portion is between 1.0 and 1.6;

(e) the ratio of the width of the interior of the sensor housing to the width of the first side of the neck portion is between 1.2 and 1.5; and,

(f) the ratio of the width of the interior of the sensor housing to the width of the first side of the neck portion is between 1.3 and 1.5.

6. The sensor apparatus of claim **5** wherein the ratio of the width of the first side of the neck portion to the width of the second side of the neck portion is between 1.2 and 2.0.

7. The sensor apparatus of claim **5** wherein the ratio of the width of the first side of the neck portion to the width of the second side of the neck portion is between 1.5 and 2.0.

8. The sensor apparatus of claim **5** wherein the ratio of the width of the first side of the neck portion to the width of the second side of the neck portion is between 1.6 and 1.8.

9. The sensor apparatus of claim **5** wherein the ratio of the width of the interior of the sensor housing to the width of the first side of the neck portion is between 1.0 and 1.6.

10. The sensor apparatus of claim **5** wherein the ratio of the width of the interior of the sensor housing to the width of the first side of the neck portion is between 1.2 and 1.5.

11. The sensor apparatus of claim **5** wherein the ratio of the width of the interior of the sensor housing to the width of the first side of the neck portion is between 1.3 and 1.5.

12. A sensor apparatus comprising:

an attachment member defining an interior having a plurality of ribs, the attachment member including substantially parallel first and second side members and a base member substantially perpendicular to the first and second side members, wherein the attachment member is adapted to receive a portion of a closure member of an associated vehicle within the interior;

a sensor housing defining an interior and substantially enclosing an associated pinching sensor within the interior, the sensor housing adjacent the base member of the attachment member, the sensor housing located substantially equidistant from the two side members of the attachment member;

a neck portion connecting the sensor housing to a bottom portion of the attachment member, the neck portion including substantially more material on a first side of the neck portion than on a second side of the neck portion, wherein the ratio of a width of the first side of the neck portion to a width of the second side of the neck portion is at least 1.2, wherein the ratio of a width of the interior of the sensor housing to the width of the first side of the neck portion is at least 0.8; and,

a seal extending from the first side of the neck portion, wherein a distal end of the seal contacts a body portion of the associated vehicle when the closure member is in a closed position.

13. The sensor apparatus of claim **12** wherein the first and second side members of the attachment member are substantially equal in length and the base member of the attachment member is substantially shorter than the first and second side members.

14. The sensor apparatus of claim **12** wherein the first side member includes a first end rib and the second side member includes a second end rib, wherein the first and second end ribs are substantially the same size.

15. The sensor apparatus of claim **12** wherein the seal extends from between the sensor housing and the first side member of the attachment member.

16. The sensor apparatus of claim **12** wherein a center of the interior of the sensor housing is substantially aligned with both a center of the interior of the attachment member and a center of the base of the attachment member.

17. The sensor apparatus of claim **12** wherein the sensor housing is located between a plane defined by an exterior surface of a length of the first side member and a plane defined by an exterior surface of a length of the second side member.

18. The sensor apparatus of claim **12** wherein the sensor housing is substantially circular.

19. The sensor apparatus of claim **12** wherein the seal includes an intermediate pivot point located between the neck portion and a distal end of the seal, the seal including an outer

portion extending from the intermediate pivot point to the distal end. wherein the outer portion of the seal pivots about the intermediate pivot point when the seal contacts a body portion of the associated vehicle when the closure member is in a closed position.

20. The sensor apparatus of claim **19** wherein the intermediate pivot point has substantially less material than the adjacent portions of the seal.

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