US 20150175091A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2015/0175091 A1

(43) Pub. Date: Jun. 25, 2015

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(54) ELASTIC AVERAGING ALIGNMENT MEMBER

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(21) Appl. No.: **14/134,622**

(22) Filed: **Dec. 19, 2013**

Publication Classification

(51) **Int. Cl.**

B60R 13/02 (2006.01)

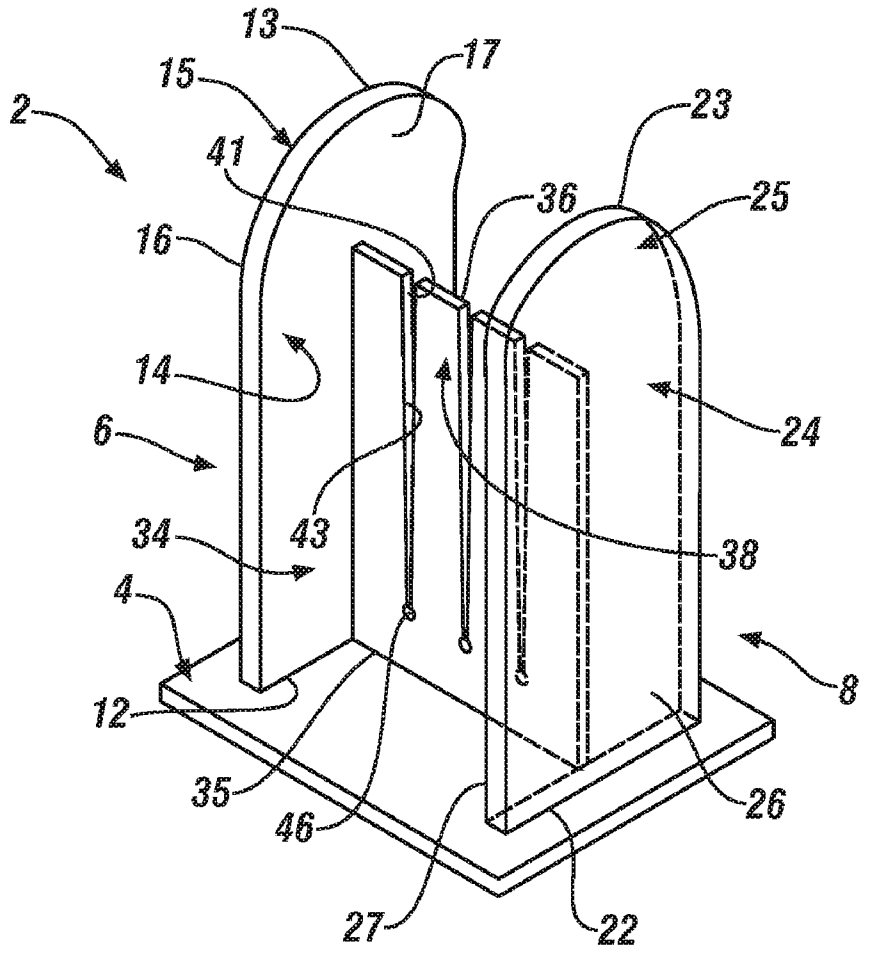
F16B 19/02 (2006.01)

(52) **U.S. Cl.**

CPC ***B60R 13/0206*** (2013.01); ***F16B 19/02*** (2013.01)

(57) **ABSTRACT**

An elastic averaging alignment member includes a base portion, a first elastic averaging member including a first end portion extending substantially perpendicularly from the base portion to a second end portion and a second elastic averaging member spaced from the first elastic averaging member. The second elastic averaging member includes a first end section extending substantially perpendicularly from the base portion to a second end section. At least one elastic averaging element arranged between the first and second elastic averaging members. At least one of the first and second elastic averaging members and the at least one elastic averaging element is configured and disposed to deform when the elastic averaging alignment member is passed into an alignment member receiver to establish an elastically average position of one component to another component.



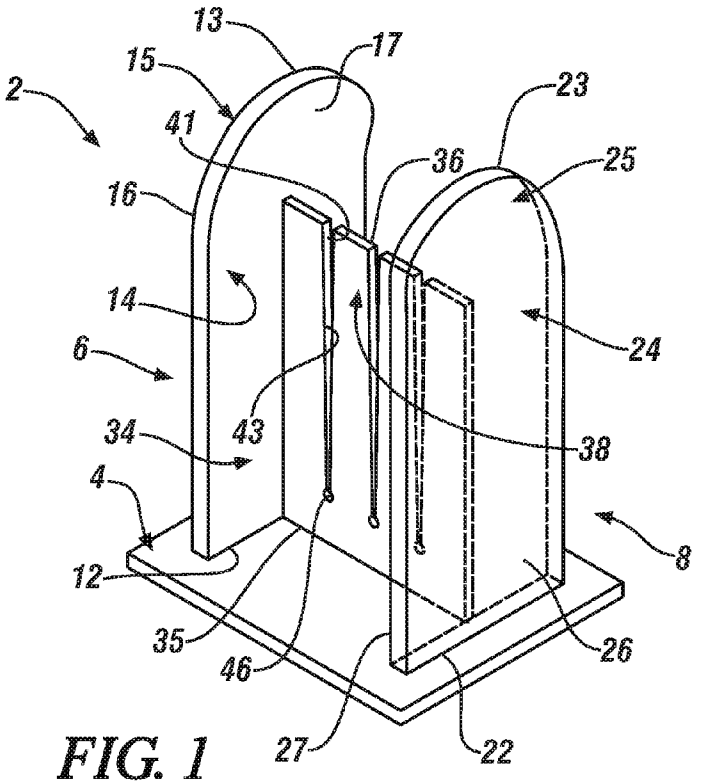

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FIG. 1

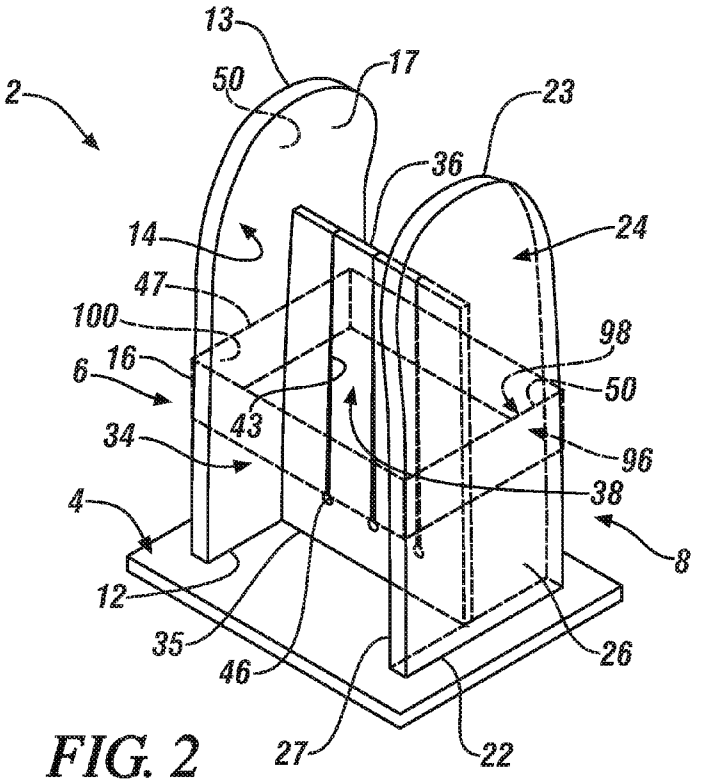
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FIG. 2

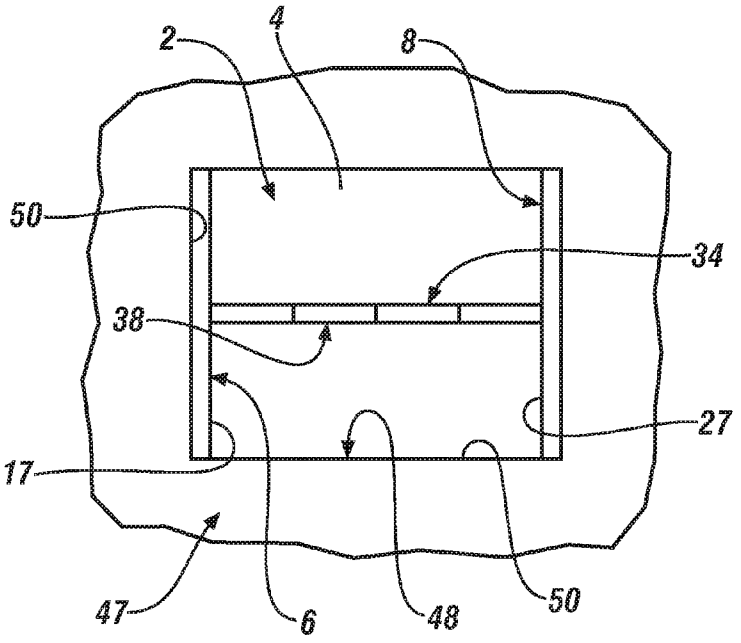
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FIG. 3

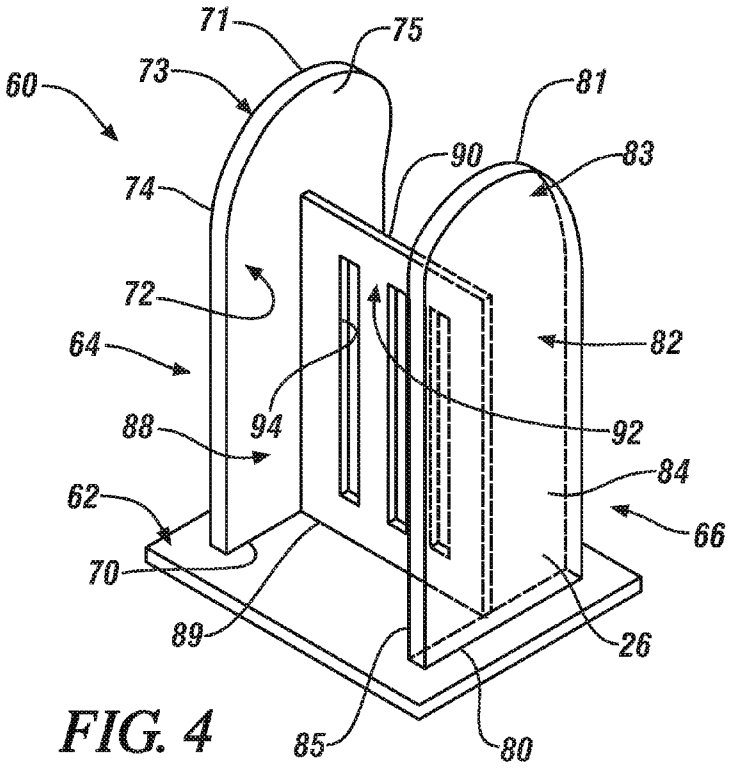
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FIG. 4

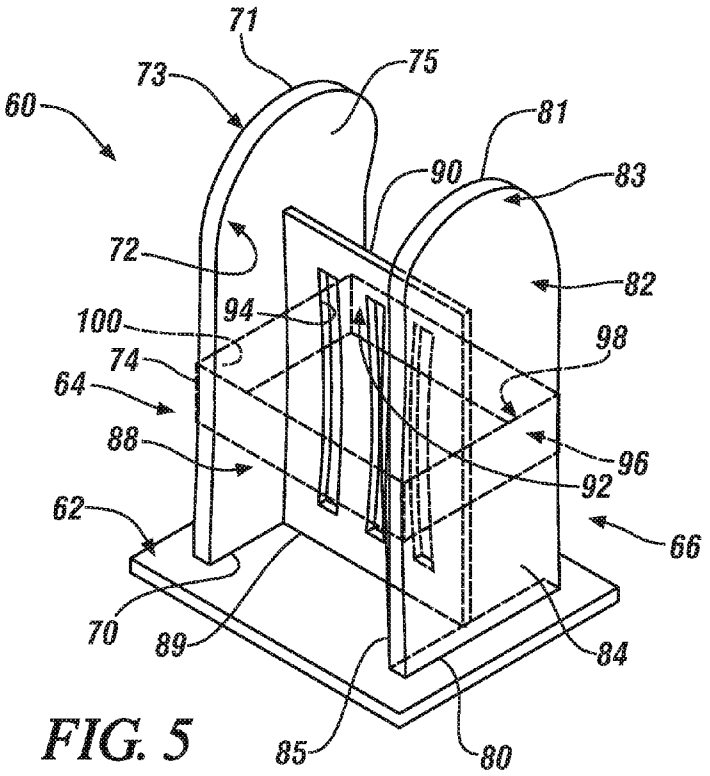
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FIG. 5

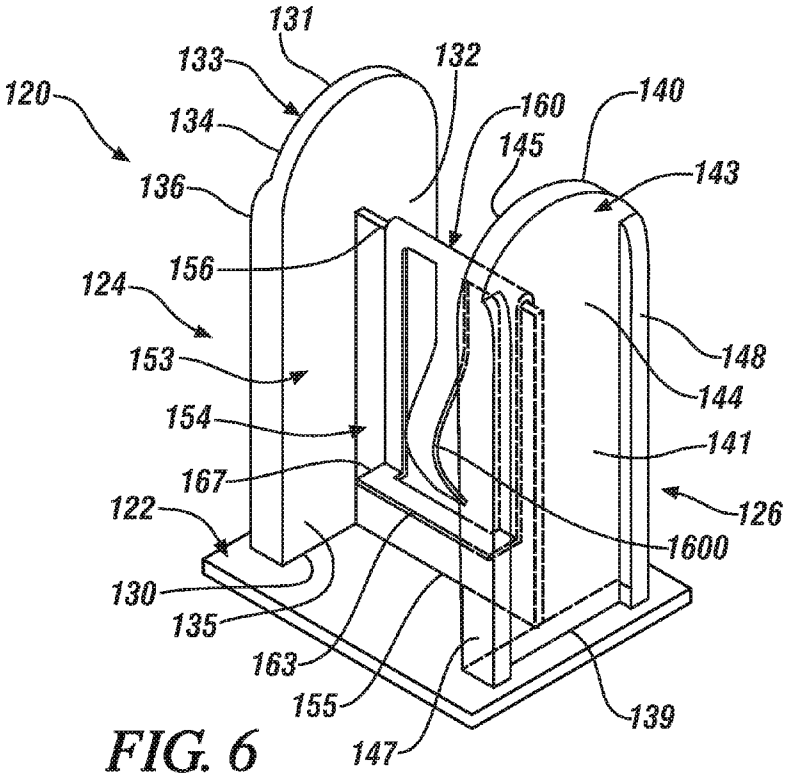
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FIG. 6

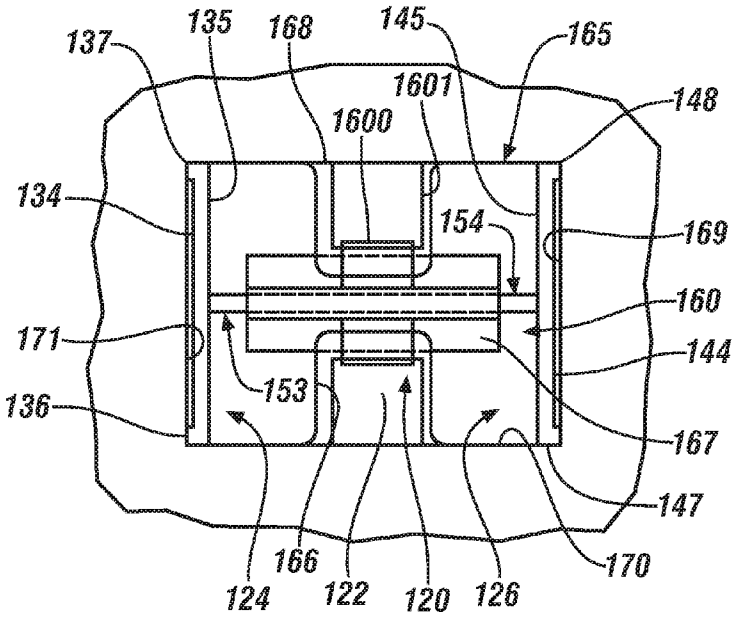
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FIG. 7

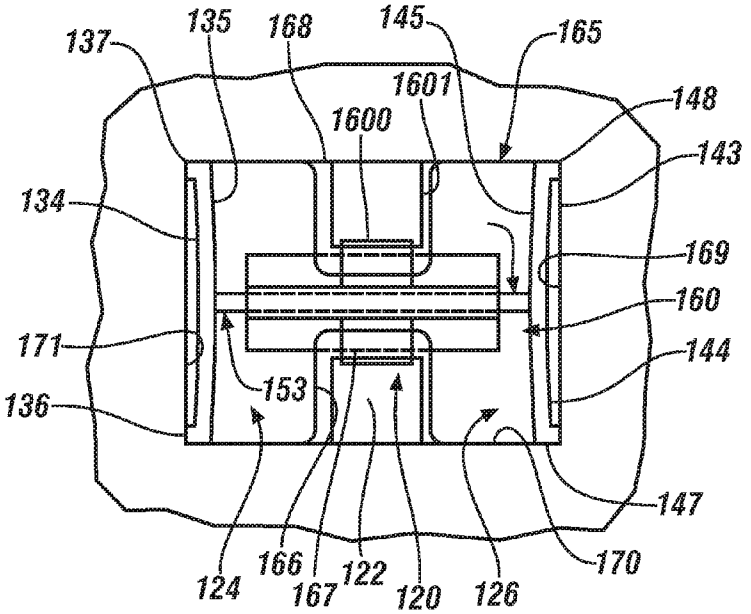
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FIG. 8

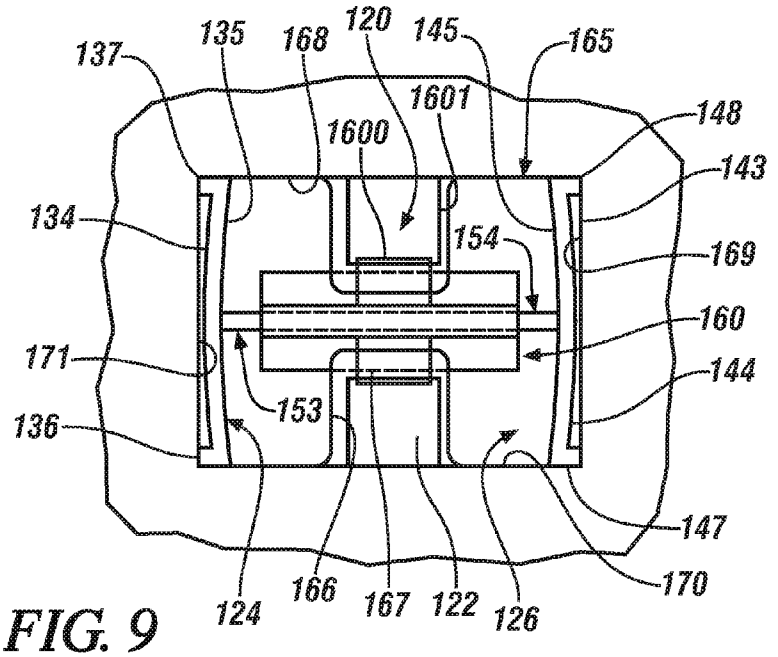

FIG. 9

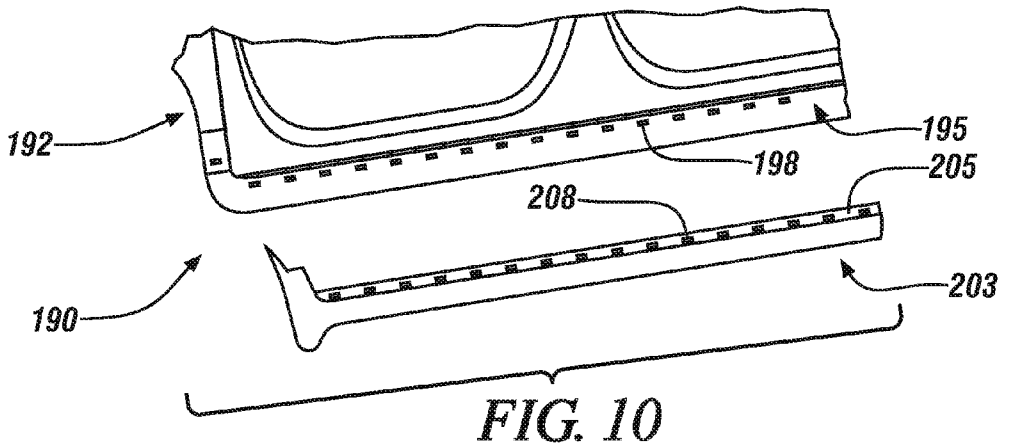

FIG. 10

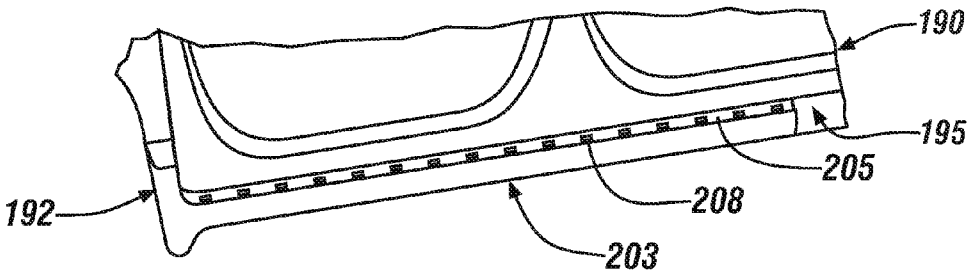

FIG. 11

ELASTIC AVERAGING ALIGNMENT MEMBER

FIELD OF THE INVENTION

[0001] The subject invention relates to fastening devices and, more particularly, to an elastic averaging alignment member.

BACKGROUND

[0002] Currently, components which are to be mated together in a manufacturing process are mutually located with respect to each other by 2-way and/or 4-way male alignment features, typically upstanding bosses, which are received into corresponding female alignment features, typically apertures in the form of holes or slots. There is a clearance between the male alignment features and their respective female alignment features which is predetermined to match anticipated size and positional variation tolerances of the male and female alignment features as a result of manufacturing (or fabrication) variances. As a result, there can occur significant positional variation as between the mated first and second components which may contribute to the presence of undesirably large and varying gaps and otherwise poor fit. Additional undesirable effects including squeaking, rattling and overall poor quality perception based on relative motion of the mated components.

SUMMARY OF THE INVENTION

[0003] In accordance with an exemplary embodiment, an elastic averaging alignment member includes a base portion, a first elastic averaging member including a first end portion extending substantially perpendicularly from the base portion to a second end portion and a second elastic averaging member spaced from the first elastic averaging member. The second elastic averaging member includes a first end section extending substantially perpendicularly from the base portion to a second end section. At least one elastic averaging element is arranged between the first and second elastic averaging members. At least one of the first and second elastic averaging members and the at least one elastic averaging element is configured and disposed to deform when the elastic averaging alignment member is passed into an alignment member receiver to establish an elastically average position of one component to another component.

[0004] In accordance with another exemplary embodiment, a method of aligning a first substrate to a second substrate with an elastic averaging alignment member includes positioning a first substrate including a plurality of elastic averaging alignment members each having at least two elastic averaging members joined by at least one elastic averaging element relative to a second substrate including a plurality of alignment member receivers, establishing an initial alignment of the plurality of elastic averaging alignment members with respective ones of the alignment member receivers, inserting the at least two elastic averaging members into respective one of the alignment member receivers, and deforming at least one of the at least two elastic averaging members and the at least one elastic averaging element of each of the elastic averaging alignment members to establish a desired final alignment of the first substrate relative to the second substrate.

[0005] In yet another exemplary embodiment of the invention, a motor vehicle includes a body having a trim component receiving zone provided with a plurality of alignment member receivers, and a trim component having a base portion provided with a plurality of elastic averaging alignment members. Each of the elastic averaging alignment members include a first elastic averaging member including a first end portion extending substantially perpendicularly from the trim component to a second end portion and a second elastic averaging member spaced from the first elastic averaging member. The second elastic averaging member includes a first end section extending substantially perpendicularly from the trim component to a second end section. At least one elastic averaging element is arranged between the first and second elastic averaging members. At least one of the first and second elastic averaging members and the at least one elastic averaging element is configured and disposed to deform when each of the plurality of elastic averaging alignment members is passed into a corresponding one of the plurality of alignment member receivers to establish an elastically averaged position of the trim component relative to the body.

[0006] The above features and advantages and other features and advantages of the invention are readily apparent from the following detailed description of the invention when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Other features, advantages and details appear, by way of example only, in the following detailed description of embodiments, the detailed description referring to the drawings in which:

[0008] FIG. **1** is a perspective view of an elastic averaging alignment member having a plurality of elastic averaging elements in accordance with an exemplary embodiment;

[0009] FIG. **2** is a perspective view of the elastic averaging alignment member of FIG. **1** illustrating the plurality of elastic averaging elements in a compressed configuration;

[0010] FIG. **3** is a plan view of the elastic averaging alignment member of FIG. **1** engaged with an alignment member receiver;

[0011] FIG. **4** is a perspective view of an elastic averaging alignment member in accordance with another aspect of the exemplary embodiment;

[0012] FIG. **5** is a perspective view of the elastic averaging alignment member of FIG. **4** engaged with an alignment member receiver;

[0013] FIG. **6** is a perspective view of an elastic averaging alignment member in accordance with another aspect of the exemplary embodiment;

[0014] FIG. **7** is a plan view of the elastic averaging alignment member of FIG. **6** entering into an alignment member receiver;

[0015] FIG. **8** is a plan view of the elastic averaging alignment member of FIG. **7** passing into the alignment member receiver;

[0016] FIG. **9** is a plan view of the elastic averaging alignment member of FIG. **8** seated within the alignment member receiver;

[0017] FIG. **10** is a partial perspective disassembled view of a motor vehicle and trim component including an elastic averaging alignment member in accordance with the exemplary embodiment; and

[0018] FIG. **11** is a partial perspective view of the motor vehicle of FIG. **8** illustrating the trim component joined to a

trim component receiving portion through the elastic averaging alignment member in accordance with the exemplary embodiment.

[0019] The following description is merely exemplary in nature and is not intended to limit the present disclosure, its application or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features.

DESCRIPTION OF THE EMBODIMENTS

[0020] The following description is merely exemplary in nature and is not intended to limit the present disclosure, its application or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features.

[0021] An elastic averaging alignment member in accordance with an exemplary embodiment is indicated generally at **2** in FIG. **1**. As used herein, elastic averaging provides elastic deformation of the interface(s) between mated components, wherein the average deformation provides a precise alignment, the manufacturing positional variance being minimized to X_{min}, defined by $X_{min}=X/\sqrt{N}$, wherein X is the manufacturing positional variance of the locating features of the mated components and N is the number of features inserted. To obtain elastic averaging, an elastically deformable component is configured to have at least one feature and its contact surface(s) that is over-constrained and provides an interference fit with a mating feature of another component and its contact surface(s). The over-constrained condition and interference fit resiliently reversibly (elastically) deforms at least one of the at least one feature or the mating feature, or both features. The resiliently reversible nature of these features of the components allows repeatable insertion and withdrawal of the components that facilitates their assembly and disassembly. Positional variance of the components may result in varying forces being applied over regions of the contact surfaces that are over-constrained and engaged during insertion of the component in an interference condition. It is to be appreciated that a single inserted component may be elastically averaged with respect to a length of the perimeter of the component. The principles of elastic averaging are described in detail in commonly owned, co-pending U.S. Patent Application No. 2013/0019455, the disclosure of which is incorporated by reference herein in its entirety. The embodiments disclosed herein provide the ability to convert an existing component that is not compatible with the described elastic averaging principles to an assembly that does facilitate elastic averaging and the benefits associated therewith.

[0022] Any suitable elastically deformable material may be used. The term "elastically deformable" refers to components, or portions of components, including component features, comprising materials having a generally elastic deformation characteristic, wherein the material is configured to undergo a resiliently reversible change in its shape, size, or both, in response to application of a force. The force causing the resiliently reversible or elastic deformation of the material may include a tensile, compressive, shear, bending or torsional force, or various combinations of these forces. The elastically deformable materials may exhibit linear elastic deformation, for example that described according to Hooke's law, or non-linear elastic deformation.

[0023] Numerous examples of materials that may at least partially form the components include various metals, polymers, ceramics, inorganic materials or glasses, or composites of any of the aforementioned materials, or any other combinations thereof Many composite materials are envisioned, including various filled polymers, including glass, ceramic, metal and inorganic material filled polymers, particularly glass, metal, ceramic, inorganic or carbon fiber filled polymers. Any suitable filler morphology may be employed, including all shapes and sizes of particulates or fibers. More particularly any suitable type of fiber may be used, including continuous and discontinuous fibers, woven and unwoven cloths, felts or tows, or a combination thereof Any suitable metal may be used, including various grades and alloys of steel, cast iron, aluminum, magnesium or titanium, or composites thereof, or any other combinations thereof. Polymers may include both thermoplastic polymers or thermoset polymers, or composites thereof, or any other combinations thereof, including a wide variety of co-polymers and polymer blends. In one embodiment, a preferred plastic material is one having elastic properties so as to deform elastically without fracture, as for example, a material comprising an acrylonitrile butadiene styrene (ABS) polymer, and more particularly a polycarbonate ABS polymer blend (PC/ABS), such as an ABS acrylic. The material may be in any form and formed or manufactured by any suitable process, including stamped or formed metal, composite or other sheets, forgings, extruded parts, pressed parts, castings, or molded parts and the like, to include the deformable features described herein. The material, or materials, may be selected to provide a predetermined elastic response characteristic. The predetermined elastic response characteristic may include, for example, a predetermined elastic modulus.

[0024] Elastic averaging alignment member **2** includes a base portion **4** that supports a first elastic averaging member **6** and a second elastic averaging member **8**. First elastic averaging member **6** extends from a first end portion **12** to a second end portion **13** through an intermediate portion **14**. Second end portion **13** includes a lead-in angle section **15**. First elastic averaging member **6** extends substantially perpendicularly from base portion **4** and includes a first or exterior surface **16** and an opposing second or interior surface **17**. Similarly, second elastic averaging member **8** extends from a first end portion **22** to a second end portion **23** through an intermediate portion **24**. Second end portion **23** includes a lead-in angle section **25**. Lead-in angle sections **15** and **25** facilitate insertion of elastic averaging alignment member **2** into an alignment member receiver as will be detailed more fully below. Second elastic averaging member **8** extends substantially perpendicularly from base portion **4** and is spaced from, and generally parallel to, first elastic averaging member **6**. Second elastic averaging member **8** includes a first or exterior surface **26** and a second or interior surface **27**.

[0025] In accordance with an exemplary embodiment, a web **34** extends between interior surface **17** of first elastic averaging member **6** and interior surface **27** of second elastic averaging member **8**. Web **34** includes a first end **35** and a second end **36**. In the exemplary embodiment shown, first end **35** is joined with base portion **4**. However, it should be understood that first end **35** may also be spaced from base portion **4**. Web **34** includes a plurality of elastic averaging elements, one of which is indicated at **38**. Elastic averaging elements **38** are defined by a plurality of openings or gaps **41** that extend from second end **36** toward first end **35**. In accordance with the exemplary aspect shown, openings **41** take the form of V-shaped notches **43** that terminate in a strain relief section

46. However it is understood that the notches could be shapes other than V-shaped and could, for example, be U-shaped. Strain relief section **46** substantially prevents openings **41** from extending completely through web **34** to first end **35**.

[0026] As shown in FIGS. **2** and **3**, when elastic averaging alignment member **2** is placed within an alignment member receiver **47**, elastic averaging elements **38** are compressed. More specifically, alignment member receiver **47** takes the form of an opening **48** defined by a plurality of edge or side portions **50**, which are indicated in FIG. **3**. Two opposing side portions **50** interact with first and second elastic averaging members **6** and **8** causing elastic averaging elements **38** to come together. At this point, elastic averaging elements **38** exert an outward force on first and second elastic averaging members **6** and **8** causing an inter-engagement of elastic averaging alignment member **2** and alignment member receiver **47**. In addition to an elastic deformation in elastic averaging element **38**, first and second elastic averaging members **6** and **8** may also elastically deform to contribute to establishing an elastically averaged position of one component to another component. More specifically, the compression of elastic averaging element **38** and/or first and second elastic averaging members **6** and **8**, when combined with compression of elastic averaging elements and/or members associated with additional elastic averaging alignment members, allows for components to be aligned or positioned. More specifically, each elastic averaging element and/or elastic averaging member may compress differently and also allow for further manipulation so that components that may be misaligned without elastic averaging, may now be aligned to one another to establish a desired fit and finish.

[0027] Reference will now follow to FIGS. **4** and **5** in describing an elastic averaging alignment member **60** in accordance with another aspect of the exemplary embodiment. Elastic averaging alignment member **60** includes a base portion **62** that supports a first elastic averaging member **64** and a second elastic averaging member **66**. First elastic averaging member **64** extends from a first end portion **70** to a second end portion **71** through an intermediate portion **72**. Second end portion **71** includes a lead-in angle section **73**. First elastic averaging member **64** extends substantially perpendicularly from base portion **62** and includes a first or exterior surface **74** and an opposing second or interior surface **75**. Similarly, second elastic averaging member **66** extends from a first end portion **80** to a second end portion **81** through an intermediate portion **82**. Second end portion **81** includes a lead-in angle section **83**. Lead-in angle sections **73** and **83** facilitate insertion of elastic averaging alignment member **60** into a mating component. Second elastic averaging member **66** extends substantially perpendicularly from base portion **62** and is spaced from, and generally parallel to, first elastic averaging member **64**. Second elastic averaging member **66** includes a first or exterior surface **84** and a second or interior surface **85**.

[0028] In accordance with the exemplary aspect shown, a web **88** extends between interior surface **75** of first elastic averaging member **64** and interior surface **85** of second elastic averaging member **66**. Web **88** includes a first end **89** and a second end **90**. In the exemplary embodiment shown, first end **89** is joined with base portion **62**. However, it should be understood that first end **89** may also be spaced from base portion **62**. Web **88** includes a plurality of elastic averaging elements, one of which is indicated at **92**. Elastic averaging elements **92** are defined by a plurality of openings **94** that extend along web **88** between first end **89** and second end **90**. In accordance with the exemplary aspect shown, openings **94** include a generally rectangular shape.

[0029] When elastic averaging alignment member **60** is placed within an alignment member receiver **96**, openings **94** facilitate a bending moment of elastic averaging elements **92**. More specifically, alignment member receiver **96** takes the form of an opening **98** defined by a plurality of edge or side portions, one of which is indicated at **100**. Two opposing side portions **100** interact with first and second elastic averaging members **64** and **66** causing web **88** to compress inward. At this point, web **88** exerts an outward force on first and second elastic averaging members **64** and **66** causing an inter-engagement of elastic averaging alignment member **60** and alignment member receiver **96**. First and second elastic averaging members **64** and **66** may also elastically deform. The compression of web **88** and/or elastic averaging members **64** and **66**, when combined with compression/bending/deflection of webs and/or elastic averaging members associated with additional elastic averaging alignment members, allows for components to be aligned with much better precision. More specifically, each elastic averaging element may compress/bend/deflect differently and also allow for further manipulation so that components that may have poor alignment and fit prior to elastic averaging may now be aligned to establish a desired fit and finish.

[0030] Reference will now follow to FIGS. **6** and **7** in describing an elastic averaging alignment member **120** in accordance with another aspect of the exemplary embodiment. Elastic averaging alignment member **120** includes a base portion **122** that supports a first elastic averaging member **124** and a second elastic averaging member **126**. First elastic averaging member **124** extends from a first end portion **130** to a second end portion **131** through an intermediate portion **132**. Second end portion **131** includes a distal section **133**. First elastic averaging member **124** extends substantially perpendicularly from base portion **122** and includes a first or exterior surface **134** and an opposing second or interior surface **135**. Exterior surface **134** includes a first rib **136** and a second rib **137**. First and second ribs **136** and **137** taper inwardly from first end portion **130** toward second end portion **131** to act as a lead-in. Similarly, second elastic averaging member **126** extends from a first end portion **139** to a second end portion **140** through an intermediate portion **141**. Second end portion **131** includes a distal section **143**. Second elastic averaging member **126** extends substantially perpendicularly from base portion **122** and is spaced from, and generally parallel to, first elastic averaging member **124**. Second elastic averaging member **126** includes a first or exterior surface **144** and a second or interior surface **145**. Exterior surface **144** includes a first rib **147** and a second rib **148**. Ribs **147** and **148** taper inwardly from first end portion **139** toward second end portion **140** to act as a lead-in. The lead-ins provided by the first and second ribs **136**, **147** and **137**, **148** facilitate insertion of elastic averaging alignment member **120** into an alignment member receiver **165**.

[0031] In accordance with the exemplary aspect shown, an elastic averaging element **153**, shown in the form of a web **154**, extends between interior surface **135** of first elastic averaging member **124** and interior surface **145** of second elastic averaging member **126**. Web **154** includes a first end **155** and a second end **156**. As discussed above, first end **155** is illustrated as being joined with base portion **122**. However, it

should be understood that first end **155** may also be spaced from base portion **122**. A retaining clip **160** is positioned upon web **154**.

[0032] The retaining clip **160** includes a clip member **163** and a spring member **1600** configured and disposed to engage with a portion **1601** of the alignment member receiver **165**. The portion **1601** of the alignment member receiver **165** includes a tab **166** and a flange **167**, which interferes with the tab **166** to thereby establish retention capability for elastic averaging alignment member **120**.

[0033] As shown in FIG. **7**, lead-ins provided by the first and second ribs **136**, **147** and **137**, **148** (see FIG. **6**) facilitate insertion of elastic averaging alignment member **120** into the alignment member receiver **165**, which is defined by a plurality of walls **168-171**. As elastic averaging alignment member **120** is passed into alignment member receiver **165**, ribs **136** and **137** engage with wall **171** and ribs **147** and **148** engage with wall **169** as shown in FIG. **8**. As elastic averaging alignment member **120** continues to pass into alignment member receiver **165**, ribs **135**, **136** and **147**, **148** cause first and second elastic averaging members **124** and **126** to deflect or bend around element **153** as shown in FIG. **9**. The bending of first and second elastic averaging members **124** and **126** facilitates an elastically averaged alignment of components. The interference between the tab **166** and the flange **167** establish a mechanical stop for any attempt at continued insertion beyond the point of contact between the tab **166** and the flange **167**. In addition, the spring member **1600** engages with the portion **1601** of the alignment member receiver **165** to establish retention capability.

[0034] Elastic averaging alignment members, as described above, may be employed in a wide range of configurations to facilitate a desired alignment of components to achieve a desired fit and finish. For example, as shown in FIGS. **10** and **11**, a motor vehicle **190** includes a body **192** having a trim component receiving portion **195**. Trim component receiving portion **195** is provided as a second component with a plurality of alignment member receivers, one of which is illustrated at **198**. A trim component, such as shown at **203**, is provided as a first component and includes a base portion **205** from which extend elastic averaging alignment members **208**. Elastic averaging alignment members **208** are initially and roughly aligned with and then inter-engaged with alignment member receivers **198** to position and align trim component **203** to body **192** at trim component receiving portion **195**. The use of elastic averaging alignment members allows for a much more desirable alignment then prior methods with manufactured clearances that established misalignments that would have previously resulted in a less than desirable fit and finish.

[0035] While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed, but that the invention will include all embodiments falling within the scope of the application.

What is claimed is:

1. An elastic averaging alignment member comprising:

a base portion;

a first elastic averaging member including a first end portion extending substantially perpendicularly from the base portion to a second end portion;

a second elastic averaging member spaced from the first elastic averaging member, the second elastic averaging member including a first end section extending substantially perpendicularly from the base portion to a second end section; and

at least one elastic averaging element arranged between the first and second elastic averaging members, at least one of the first and second elastic averaging members and the at least one elastic averaging element being configured and disposed to deform when the elastic averaging alignment member is passed into an alignment member receiver to establish an elastically averaged position of one component to another component.

2. The elastic averaging alignment member according to claim **1**, wherein the at least one elastic averaging element defines a web extending between the first and second elastic averaging members, the web including a first end arranged at the base portion that extends to a second end.

3. The elastic averaging alignment member according to claim **2**, further comprising a retaining clip operably disposed on the web.

4. The elastic averaging alignment member according to claim **2**, wherein web is formed to define a plurality of openings.

5. The elastic averaging alignment member according to claim **4**, wherein the plurality of openings extend between the first end and the second end of the web.

6. The elastic averaging alignment member according to claim **4**, wherein each of the plurality of openings is substantially rectangular.

7. The elastic averaging alignment member according to claim **4**, wherein each of the plurality of openings extends along the web through the second end to define at least one V-shaped notch.

8. The elastic averaging alignment member according to claim **1**, wherein the first elastic averaging member includes a first surface and an opposing second surface, the first surface including at least two ribs defining lead-ins facilitating insertion of the first and second elastic averaging alignment members into the alignment member receiver.

9. The elastic averaging alignment member according to claim **8**, wherein each of the at least two ribs extends substantially perpendicularly from the first surface.

10. The elastic averaging alignment member according to claim **9**, wherein each of the at least two ribs includes a first rib extending substantially perpendicularly from the first surface and a second rib extending substantially perpendicularly from the first surface and being spaced from the first rib.

11. A method of aligning a first substrate to a second substrate with elastic averaging alignment members, the method comprising:

positioning the first substrate including a plurality of elastic averaging alignment members having at least two elastic averaging members joined by at least one elastic averaging element relative to the second substrate including a plurality of alignment member receivers;

initially aligning the plurality of elastic averaging alignment members with respective ones of the plurality of alignment member receivers;

inserting the at least two elastic averaging members into one of the alignment member receivers; and

deforming at least one of the at least two elastic averaging members and the at least one elastic averaging element

to establish a desired final alignment of the first substrate relative to the second substrate.

12. The method of claim **11**, wherein deforming at least one of the at least two elastic averaging members and the at least one elastic averaging element comprises compressing a at least one of elastic averaging elements to close at least one of notches formed in a web extending between first and second elastic averaging members.

13. The method of claim **11**, wherein deforming at least one of the at least two elastic averaging members and the at least one elastic averaging element comprises compressing a plurality of elastic averaging elements to close a plurality of openings having a generally rectangular cross-section formed in a web extending between first and second elastic averaging members.

14. The method of claim **11**, wherein inserting the plurality of elastic averaging alignment members into one of the plurality of alignment member receivers includes bending the at least two elastic averaging members about the at least one elastic averaging element.

15. A motor vehicle comprising:

a body having a trim component receiving portion provided with a plurality of alignment member receivers; and

a trim component having a base portion provided with a plurality of elastically averaging alignment members; each of the plurality of elastic averaging alignment members comprising:

a first elastic averaging member including a first end portion extending substantially perpendicularly from the base portion to a second end portion;

a second elastic averaging member spaced from the first elastic averaging member, the second elastic averaging member including a first end portion extending substantially perpendicularly from the base portion to a second end portion; and

at least one elastic averaging element arranged between the first and second elastic averaging members, at least one of the first and second elastic averaging members and the at least one elastic averaging element being configured and disposed to deform when each of the plurality of alignment members are passed into corresponding ones of the plurality of alignment member receivers to establish an elastically average position of the trim component relative to the body.

16. The motor vehicle according to claim **15**, wherein the at least one elastic averaging element defines a web extending between the first and second elastic averaging members, the web including a first end coupled to the base portion that extends to a second end.

17. The motor vehicle according to claim **16**, wherein the at least one elastic averaging element comprises a plurality of elastic averaging elements defined by a plurality of openings formed in the web, the plurality of openings extending between the first end and the second end of the web.

18. The motor vehicle according to claim **17**, wherein the plurality of openings are substantially rectangular.

19. The motor vehicle according to claim **17**, wherein the plurality of openings extend along the web through the second end to define a plurality of V-shaped notches.

20. The motor vehicle according to claim **15**, wherein the first elastic averaging member includes a first surface and an opposing second surface coupled to the at least one elastic averaging element, the first surface including a lead-in defining first rib extending substantially perpendicularly from a first end of the first surface and a lead-in defining second rib extending substantially perpendicularly from a second, opposing end of the first surface.

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