(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
17 January 2013 (17.01.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/009368 A1

(51) International Patent Classification:
F42B 33/00 (2006.01) *F16L 3/13* (2006.01)
F42B 15/00 (2006.01) *F16B 2/24* (2006.01)

(21) International Application Number:
PCT/US2012/029102

(22) International Filing Date:
14 March 2012 (14.03.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
13/183,062 14 July 2011 (14.07.2011) US

(71) Applicant *(for all designated States except US)*: **RAYTHEON COMPANY** [US/US]; 870 Winter Street, Waltham, Massachusetts 02451-1449 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **HERNANDEZ, Christopher L.** [US/US]; 201 East Forrest Feezor Street, Vail, Arizona 85641-2793 (US). **EGBERT, Ryan A.** [US/US]; 9173 East La Palma Drive, Tucson, Arizona 85747 (US).

(74) Agent: **JOHNSON, Christopher L.**; Thorpe North & Western LLP, 8180 S. 700 E., Suite 350, Sandy, Utah 84070 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: SPRING CLIP RETENTION SYSTEMS SUITABLE FOR USAGE WITHIN VEHICLES AND GUIDED MUNITIONS

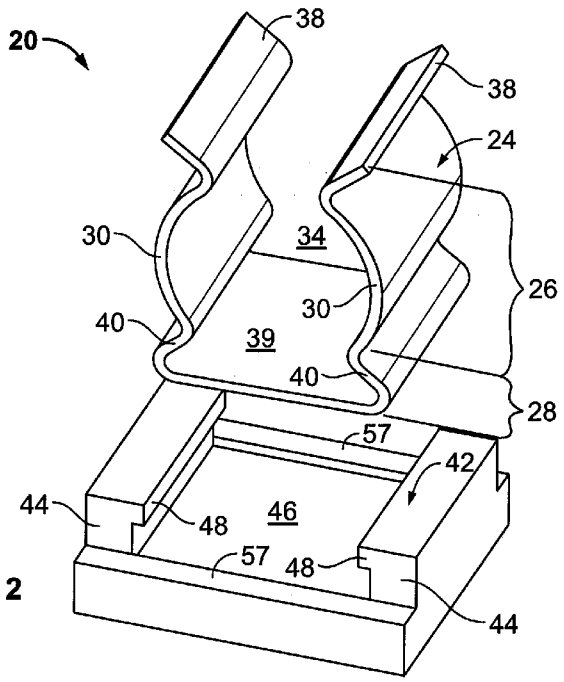

FIG. 2

(57) Abstract: Spring clip retention system including a captive feature (42) and a spring clip (24). The captive feature (42) includes opposing ledges (48) and a channel (46) formed beneath and partially enclosed by the opposing ledges (48). The spring clip (24) includes opposing retainer arms (30) and a base portion (28), which extends between the opposing retainer arms (30) and which is received within the channel (46). The spring clip (24) deflects outward when the component is inserted between the opposing retainer arms (30). The base portion (28) abuts the undersides of the opposing ledges (48) when the spring clip (24) is deflected outward by insertion of the component to prevent disengagement of the base portion (28) from the captive feature (42) in a direction substantially normal to the longitudinal axis of the channel (46).

WO 2013/009368 A1

Declarations under Rule 4.17:

— *as to the identity of the inventor (Rule 4.17(i))*

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

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

SPRING CLIP RETENTION SYSTEMS SUITABLE FOR USAGE WITHIN VEHICLES AND GUIDED MUNITIONS

TECHNICAL FIELD

[0001] The following disclosure relates generally to mounting systems and, more particularly, to spring clip retention systems that enable various objects to be removably secured within guided munitions, motor vehicles, and other platforms without the usage of adhesives or threaded fasteners.

BACKGROUND

[0002] Modern guided munitions commonly incorporate different types of components having generally cylindrical outer geometries, such as electromagnetic interference suppressor cores (e.g., ferrite beads) and hardline connections (e.g., cryogenic gas lines). During assembly of the guided munition, the cylindrical components are mounted within the munition's casing or shell adjacent other fabricated components. The mounting means utilized to retain a given cylindrical component in a desired position within the guided munition preferable does so in a highly secure manner to ensure that the component does not become dislodged or displaced when subjected to considerable loading conditions that occur during munition operation; e.g., high shock loads that occurring during munition launch and considerable centrifugal forces that may occur during munition flight of non-roll stabilized munition. Adhesives have traditionally been utilized to bond cylindrical components to the interior of the munition's shell, to a munition's bulkhead, or to another internal structure provided within the munition's shell. However, the usage of adhesives often requires surface cleaning and curing processes that add undesired complexity and delay to the overall munition assembly process. In addition, high strength, high temperature, industrial-grade adhesives may outgass and release caustic chemicals into the munition's interior over time, which can potentially interfere with proper operation of the munition.

[0003] To overcome the above-described limitations associated with adhesive mounting, mounting hardware can be utilized to secure cylindrical components in a desired position. Spring clips, for example, provide a relatively simple, low cost, and easy to use means of retaining a cylindrical component in a desired position.

Advantageously, a spring clip can secure a cylindrical component without the usage of adhesives or additional hardware by exerting a circumferential clamping force on the exterior of the cylindrical component. However, the spring clip itself must typically be mounted to an internal structure within the guided munition. The spring clips can be adhesively bonded to internal structure of the guided munition; however, this presents essentially the same drawbacks as does bonding the cylindrical component directly to the internal structure. Fasteners are commonly utilized to mechanically secure spring clips in place; however, the usage of fasteners adds undesired cost, complexity, and part count to the guided munition. Furthermore, in the case of threaded fasteners, the formation of mating threads within the munition's internal structure adds further complexity to the fabrication process and, in certain cases, may be prohibited by spatial restrictions. As a still further disadvantage, the mechanical fastening of spring clips to a munition's internal structure is generally not amenable to automation and consequently increases human touch requirements during the assembly process.

[0004] It would thus be desirable to provide embodiments of a spring clip retention system suitable for reliably securing a generally cylindrical component within a desired position (e.g., adjacent another fabricated component) within a guided munition without the usage of fasteners or adhesives. It would further be desirable if such a spring clip retention system could also be utilized to mount generally cylindrical components within other platforms including, for example, motor vehicles. Ideally, embodiments of such a spring clip retention system would be relatively compact, lightweight, and inexpensive to produce, and would readily permit removal and repositioning of the generally cylindrical component on an as-needed basis. It would also be desirable to provide embodiments of a guided munition including such a spring clip retention system. Other desirable features and characteristics of the present invention will become apparent from the subsequent Detailed Description and the appended Claims, taken in conjunction with the accompanying Drawings and this Background.

BRIEF SUMMARY

[0005] Embodiment of a spring clip retention system are provided for securing a generally cylindrical component in a desired position. In one embodiment, the spring clip retention system includes a captive feature and a spring clip. The captive feature

includes opposing ledges and a channel, which is formed beneath and which is partially enclosed by the opposing ledges. The spring clip includes opposing retainer arms, which is configured to receive and resiliently retain the generally cylindrical component therebetween, and a base portion, which extends between the opposing retainer arms and received within the channel. The spring clip deflects outward and increases in width when the generally cylindrical component is inserted between the opposing retainer arm. The base portion the base portion abutting the undersides of the opposing ledges when the spring clip is deflected outward by insertion of the generally cylindrical component to prevent disengagement of the base portion from the captive feature in a direction substantially normal to the longitudinal axis of the channel.

[0006] Embodiments of a guided munition are further provided. In one embodiment, the guided munition includes a munition mounting structure, a generally cylindrical component, and a spring clip retention system. The spring clip retention system includes, in turn, a captive feature and a spring clip. The captive feature is fixed coupled to the munition mounting structure and includes an outer surface, an inner channel, and a longitudinal opening extending from the outer surface to the inner channel. The width of the inner channel exceeds the width of the longitudinal opening. The spring clip includes opposing retainer arms, which resiliently retaining the generally cylindrical component therebetween; and a base portion, which extends from the opposing retainer arms, through the longitudinal opening, and into the inner channel in a first direction. The spring clip deflects outward when the generally cylindrical component is inserted between the opposing retainer arms. The maximum width of the base portion exceeds the width of the longitudinal opening when the spring clip is deflected outward by insertion of the generally cylindrical component to prevent disengagement of the base portion from the captive feature in a second direction substantially opposite the first direction to secure the generally cylindrical component to the munition mounting structure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] At least one example of the present invention will hereinafter be described in conjunction with the following figures, wherein like numerals denote like elements, and:

[0008] FIG. 1 is an exploded end view of a spring clip retention system and a generally cylindrical component illustrated in accordance with an exemplary embodiment of the present invention;

[0009] FIGs. 2 and 3 are isometric views of a spring clip retention system prior to and after insertion of a spring clip into a mating mounting structure, respectively, and illustrated in accordance with an exemplary embodiment of the present invention;

[0010] FIGs. 4-7 are cross-sectional views taken through the exemplary spring clip retention system shown in FIGs. 1-3 and illustrating the spring clip retention system at various stages of assembly;

[0011] FIG. 8 is an isometric view of a spring clip retention system integrated into the seeker bulkhead of a guided munition in accordance with a further exemplary embodiment of the present invention; and

[0012] FIG. 9 is a cross-sectional view of the spring clip retention system shown in FIG. 8 and illustrating the manner in which axial sliding of a spring clip can be prevented utilizing a protruding member, such as a dowel pin.

DETAILED DESCRIPTION

[0013] The following Detailed Description is merely exemplary in nature and is not intended to limit the invention or the application and uses of the invention. Furthermore, there is no intention to be bound by any theory presented in the preceding Background or the following Detailed Description.

[0014] FIGs. 1 and 2 are exploded end and isomeric views, respectively, of a spring clip retention system **20** and a generally cylindrical component **22** (shown in FIG. 1 only) illustrated in accordance with an exemplary embodiment of the present invention. Notably, spring clip retention system **20** is capable of retaining cylindrical component **22** (FIG. 1) in a desired position, such as against or adjacent another fabricated component, in a highly secure manner and without the usage of adhesives or threaded fasteners. Spring clip retention system **20** is also relatively lightweight,

compact, and inexpensive to produce. For at least these reasons, spring clip retention system **20** is well-suited for usage in conjunction with munitions; e.g., spring clip retention system **20** may be integrated into the seeker of a guided munition, as described more fully below in conjunction with FIGs. 8 and 9. In addition, spring clip retention system **20** is well-suited for usage within motor vehicles. These examples notwithstanding, it is emphasized that spring clip retention system **20** can be utilized across a wide variety of commercial and non-commercial industries to retain various different types of cylindrical objects without the usage of adhesives or threaded fasteners.

[0015] As appearing herein, the phrase "generally cylindrical component" is utilized to denote an object having a substantially elliptical outer geometry, as taken along at least a segment of the object's longitudinal axis or centerline. In many cases, the generally cylindrical component will have a substantially circular outer geometry, as taken along the component's entire length; however, this may not always be the case. The generally cylindrical component preferably has a substantially rigid or hard outer surface to enable the component to be firmly secured by a spring clip included within spring clip retention system **20** via a press-fit or snap-fit insertion, as described more fully below. In view of the versatility of spring clip retention system **20**, the generally cylindrical component can assume a wide variety of different forms depending upon the particular application in which retention system **20** is employed. A non-exhaustive list of generally cylindrical components that may be retained by spring clip retention system **20** includes connector bodies, suppressor cores, harness connectors, tubes, wire bundles, and various types of hardlines including, but not limited to, gas lines, fuel lines, pneumatic lines, and hydraulic lines.

[0016] With continued reference to the illustrated example shown in FIGs. 1 and 2, spring clip retention system **20** includes a spring clip **24** having a retainer portion **26** and a base portion **28**. Retainer portion **26** includes two opposing retainer arms **30**, which are spaced apart in a lateral direction (represented in FIG. 1 by double headed arrow **32**) and which open in a direction substantially opposite base portion **28**. Opposing retainer arms **30** each have a substantially arcuate or concave geometry suitable for receiving and retaining generally cylindrical component **22** therebetween.

Opposing retainer arms **30** define a generally annular central corridor or opening **34** into which cylindrical component **22** may be inserted, as described more fully below. Spring clip **24** is chosen or designed such that the maximum width of cylindrical component **22** (represented in FIG. 1 by double headed arrow **36**) is greater than the maximum width of central opening **34** (represented in FIG. 1 by double headed arrow **32**) when spring clip **24** is in a non-deflected state (shown in FIG. 1). As a result, retainer arms **30** spread apart or deflect outward to accommodate generally cylindrical component **22** when component **22** is inserted into central opening **34** of retainer portion **26**. If desired, retainer arms **30** may be fabricated to terminate in flanges **38**, which angle outward from the centerline of spring clip **24** to facilitate the insertion of generally cylindrical component **22** and the corresponding deflection of retainer arms **30**.

[0017] Base portion **28** extends from retainer portion **26** in a first radial direction (downward in the illustrated orientation) and in a lateral direction to join opposing retainer arms **30**. As shown in FIGs. 1 and 2, base portion **28** includes a bottom connecting wall **39** and opposing sidewalls **40**, which are joined to opposing sides of bottom connecting wall **39**. Opposing sidewalls **40** extend laterally inward from opposing ends of connecting wall **39** to connect with retainer arms **30** of retainer portion **26**. Bottom connecting wall **39** has a substantially flat or plate-like geometry. By comparison, sidewall **40** each have a substantially arcuate geometry and curve inward such that sidewalls **40** laterally converge when moving from bottom connecting wall **39** toward opposing retainer arms **30**. As a result of this structural configuration, spring clip **24** has a substantially hourglass-shaped profile when transitioning from retainer portion **26** to base portion **28**. Stated differently, convergent sidewalls **40** of base portion **28** cooperate or combine with opposing retainer arms **30** to impart spring clip **24** with an inwardly-tapered waist section, when viewed from an end of spring clip **24**. Spring clip **24** is preferably fabricated as a single, unitary, or monolithic piece such that base portion **28** is integrally formed with retainer potion **26**. Spring clip **24** can be fabricated utilizing any suitable technique including, for example, stamping or cold drawing. In certain embodiments, spring clip **24** may be a commercial off-the-shelf component.

[0018] Spring clip **24** is fabricated from a resilient material. Although spring clip **24** may be fabricated from other resilient materials, including certain plastics, spring clip **24** is preferably fabricated from a metal or alloy, such as aluminum, steel, or brass. Due to the inherent resiliency of spring clip **24**, retainer arms **30** exert a circumferential clamping force on generally cylindrical component **22** when inserted between arms **30** to decrease the likelihood of component **22** from becoming dislodged in the event of, for example, the application of shock forces or other disruptive forces to spring clip retention system **20**. The outwardly curved geometry of retainer arms **30** further helps to maintain cylindrical component **22** in a generally centered position after insertion into retainer portion **26**. Retainer arms **30**, and more generally spring clip **24**, secure generally cylindrical component **22** in a desired position utilizing a relatively simple and reliable press-fit or snap-fit type mechanism. The magnitude of the circumferential clamping force exerted on generally cylindrical component **22** by spring clip **24** can be adjusted, as appropriate, by varying the thickness of spring clip **24**, the material from which spring clip **24** is fabricated, and the dimensions of spring clip **24** (in particular, the diameter of central opening **34**) relative to the outer diameter of component **22**.

[0019] In addition to spring clip **24**, spring clip retention system **20** includes a channeled or slotted captive feature **42**. Captive feature **42** includes a main body **44** having an inner channel **46** formed therein (partially shown in phantom in FIG. 1 and laterally bound by opposing sidewalls **49** identified in FIG. 1). In the illustrated example, main body **44** and inner channel **46** have substantially U-shaped and rectangular cross-sectional geometries, respectively. Two opposing and laterally-converging rails or ledges **48** extend inwardly from opposing sidewalls **49** to partially enclose inner channel **46**. As identified in FIG. 1, opposing ledges **48** laterally bound, and thus partially define, a longitudinal slot or opening **50** in the outer face of body **44**, which extends from an outer surface **52** of body **44** to inner channel **46**. In view of this structural configuration, channel **46** is partially open or exposed, as taken along its length, through outer surface **52** of captive feature **42**. Taken in a lateral direction, the width of longitudinal opening **50** (represented in FIG. 1 by double headed arrow **54**) is less than the width of inner channel **46** (represented in FIG. 1 by double headed arrow **56**). In addition, the width of longitudinal opening **50** (again, represented in FIG. 1 by

double headed arrow **54**) is less the maximum width of base portion **28** of spring clip **24** in a non-deflected state (again, represented in FIG. 1 by double headed arrow **43**). Lastly, the width of inner channel **46** (again, represented in FIG. 1 by double headed arrow **56**) is preferably, although not necessarily, slightly greater than the width of the maximum width of base portion **28** of spring clip **24** in a non-deflected state (again, represented in FIG. 1 by double headed arrow **43**).

[0020] Although the possibility that captive feature **42** may be fabricated as an independent piece is by no means precluded, it is preferred that captive feature **42** is machined into, cast into, or otherwise integrally formed with a larger mounting structure included within the particular platform or system within which spring clip retention system **20** is utilized (not shown in FIGs. 1 and 2). For example, in embodiments wherein spring clip retention system **20** is deployed onboard a guided munition, captive feature **42** may be integrated into an airframe element or bulkhead, such as a seeker bulkhead of the type described below in conjunction with FIGs. 8 and 9. In embodiments wherein spring clip retention system **20** is utilized in conjunction with a motor vehicle, captive feature **42** may be integrated into a structural element included within the vehicular framework.

[0021] FIG. 3 is an isometric view of spring clip retention system **20** in an assembled state. Generally cylindrical component **22** is not shown in FIG. 3 to more clearly illustrate the manner in which base portion **28** of spring clip **24** engages inner channel **46** of captive feature **42**. As can be seen in FIG. 3, base portion **28** is matingly received within inner channel **46** when spring clip retention system **20** is assembled. In the illustrated assembled stated, bottom connecting wall **39** is placed flat against or seats flush on the floor of channel **46**. Base portion **28** extends from opposing retainer arms **30**, through opening **50** (identified in FIG. 1), and into inner channel **46**. Conversely, opposing retainer arms **30** extend from opposing sides of base portion **28** in a direction substantially opposite captive feature **42**. As further shown in FIG. 3, when spring clip retention system **20** is assembled, the outer edges of base portion **28** may also abut axial hardstop features **57** (e.g., longitudinally-spaced end walls) to prevent axial sliding of spring clip **24** within inner channel **46**, as described more fully below.

[0022] FIGs. 4-7 are cross-sectional views taken through the exemplary spring clip retention system **20** shown in FIGs. 1-3 and illustrating system **20** at various stages of assembly. Referring initially to FIG. 4, spring clip **24** is illustrated in a non-deflected state positioned immediately above longitudinal opening **50** provided in captive feature **42**. Spring clip **24** is now inserted into inner channel **46** of captive feature **42** through opening **50**. With reference to FIG. 5, opposing retainer arms **30** are squeezed inward (indicated in FIG. 5 by arrows **58**) to cause the inward deflection of the lower corners of base portion **28** (indicated in FIG. 5 by arrows **60**). In this manner, base portion **28** is laterally compressed such that the maximum width of base portion **28** is decreased to be slightly less than the width of longitudinal opening **50** thereby permitting the passage of base portion **28** through opening **50** (indicated in FIG. 5 by arrow **62**). Opposing retainer arms **30** are then released to allow spring clip **24** to expand and return to its non-deflected state (indicated in FIG. 6 by arrows **64**). In preferred embodiments wherein the maximum width of base portion **28** exceeds the width of opening **50** when spring clip **24** is in a non-deflected state, the maximum width of base portion **28** again surpasses the width of opening **50** to prevent the inadvertent disengagement of base portion **28** from inner channel **46**. At this juncture, sufficient clearance may still be provided between spring clip **24** and the interior surfaces of captive feature **42** to permit limited movement (more informally, "rattling") of base portion **28** within inner channel **46**.

[0023] Continuing to FIG. 7, generally cylindrical component **22** is next inserted between retainer arms **30** through the upper opening in retainer portion **26** (indicated in FIG. 7 by arrow **66**). As noted above, the outer diameter of generally cylindrical component **22** is greater than the maximum inner width of retainer arms **30**. Thus, as indicated in FIG. 7 by arrows **68**, insertion of generally cylindrical component **22** between retainer arms **30** results in the outward spread of arms **30** and, more generally, the outward deflection of spring clip **24**. This, in turn, results in an expansion in the maximum width of base portion **28**. In this laterally-expanded state, base portion **28** abuts the undersides of opposing ledges **48** to prevent disengagement of base portion **28** from inner channel **46** of captive feature **42** in a direction substantially normal to the longitudinal axis of inner channel **46**; i.e., a direction substantially opposite to

arrow **66** shown in FIG. 7. Stated differently, opposing ledges **48** extend inwardly into the laterally-tapered waist section of spring clip **24** to prevent withdrawal of spring clip **24** from channel **46** in a radial direction. In the expanded state, base portion **28** fully occupies and contacts the various surfaces defining inner channel **46** to firmly secure spring clip **24**, and therefore generally cylindrical component **22**, with respect to captive feature **42**. In this manner, spring clip retention system **20** takes advantage of the inherent outward deflection of spring clip **24** caused by insertion of generally cylindrical component **22** to provide a structurally secure and fixed coupling with captive feature **42**. Notably, this coupling is created without the usage of adhesives or threaded fasteners. In addition, as spring clip **24** is sufficiently resilient to accommodate additional outward deflection or lateral expansion beyond that required to bring base portion **28** into contact with opposing ledges **48**, spring clip **24** and captive feature **42** may be manufactured within relatively broad tolerances. As a still further advantage, by performing the above-described steps in a reverse order (in particular, by removing generally cylindrical component **22** from between opposing retainer arms **30**), spring clip retention system **20** can be readily dissembled if, for example, repositioning or reinstallation of spring clip **24** should be desired.

[0024] Axial sliding of spring clip **24**, and specifically base portion **28**, within inner channel **46** may be deterred by frictional forces created by contact between base portion **28** and the various surfaces defining channel **46** including the undersides of convergent ledges **48**. This notwithstanding, in preferred embodiments, spring clip retention system **20** is manufactured to include at least one axial location feature that engages spring clip **24** to prevent axial sliding of base portion **28** within channel **46**. In certain embodiments, the axial location feature may assume the relatively simple form of end walls partially or fully enclosing channel **46**, as taken in a longitudinal direction. For example, as briefly described above, captive feature **42** may be manufactured to include first and second end walls **57** (shown in FIGs. 1-4), which are spaced apart by a longitudinal distance substantially equivalent to the length of base portion **28** such that walls **57** contact or abut opposing edges of bottom connecting wall **28** when base portion **28** is inserted into channel **46** to constrain movement of spring clip **24** in either axial direction. In further embodiments, other types of axial hardstop features may be utilized in place of end walls **57**, such as one or more bumps,

tabs, or other protrusions. In still further embodiments, a protruding member may be inserted into captive feature **42** and extend outwardly therefrom to contact an interior portion of base portion **28**. An example of a spring clip retention system wherein axial sliding of a spring clip is prevented by a protruding member is described below in conjunction with FIGs. 8 and 9.

[0025] FIGs. 8 and 9 are isometric and cross-sectional views, respectively, of a spring clip retention system **80** illustrated in accordance with a further exemplary embodiment of present invention. In many respects, spring clip retention system **80** is identical to spring clip retention system **20** described above in conjunction with FIGs. 1-7; this may be most easily appreciated by comparing FIGs. 3 and 7 to FIGs. 8 and 9, respectively, wherein like reference numerals have been utilized to denote like structural elements. However, in contrast to the previously-described embodiment, a first opening **82** has been formed through bottom connecting wall **39**; and a second opening **84** has been formed in the floor of inner channel **46**. Openings **80** and **82** when base portion **28** of spring clip **24** is properly positioned within channel **46**. A protruding member **86**, such as a dowel pin, in inserted into openings **82** and **84**; and projects upward from the floor of channel **46** and through bottom wall **39** to physically obstruct movement of base portion **28** in either axial direction. Protruding member **86** may be maintained in place by frictional forces resulting from a press-fit. The length of protruding member **86** and the depth of opening **84** are preferably chosen such that protruding member **86** is prevented from disengaging or backing-out of opening **84** in a high vibratory environment by abutment with generally cylindrical component **22**, as shown most clearly in FIG. 9.

[0026] In embodiments wherein a protruding member **86** assumes the form of a freely-removable feature, either or both ends of channel **46** may be left open to permit base portion **28** to be slid into channel **46** in an axial direction. More specifically, base portion **28** may first be slid axially into channel **46** through an open channel end (e.g., the open channel end shown in FIG. 8) and moved into the desired position. Protruding member **82** may then be inserted through opening **82** provided in bottom wall **39** and into the aligning opening **84** provided in the floor of channel **46** to fixate spring clip **24** in its proper axial position. Generally cylindrical component **22** may

then be inserted between opposing retainer arms **30** to further secure spring clip **24** to captive feature **42** and complete the assembly process. In such embodiments, the maximum width of base portion **28** need not be less than the width of opening **50** (identified in FIGs. 1, 4, and 5) when spring clip **24** is inwardly deflected by squeezing opposing retainer arms **30** toward one another as base portion **28** is not inserted through opening **50** during assembly.

[0027] As noted above, captive feature **42** is preferably integrally formed with a larger mounting structure included within the platform, device, or vehicle within which spring clip retention system **20** is deployed. In certain preferred embodiments, spring clip retention system **20** is utilized within a guided munition, such as guided munition **90** shown in FIG. 8. In this case, captive feature **42** may be machined into or other integrally formed with a primary structural element of guided munition **90**, such as an airframe structure or a seeker bulkhead **92** (generically referred to herein as a "vehicular mounting structure"). In such embodiments, generally cylindrical component **22** will often assume the form of a hardline connect (e.g., a cryogenic gas line) or a suppressor core (e.g., a ferrite bead), as generically illustrated in FIG. 9. In further preferred embodiments wherein spring clip retention system **20** is utilized within a motor vehicle, captive feature **42** may be machined into or otherwise integrally formed with the vehicular framework (also generically referred to herein as a "vehicular mounting structure"); and generally cylindrical component **22** may assume the form of, for example, a hard wire bundle or a fuel line.

[0028] The foregoing has thus provided embodiments of a spring clip retention system suitable for reliably securing a generally cylindrical component within a desired position (e.g., adjacent another fabricated component) without the usage of fasteners or adhesives thereby reducing touch labor and hardware cost. Advantageously, the above-described embodiments of the spring clip retention system are relatively compact, lightweight, and inexpensive to produce, and readily permit removal and repositioning of the generally cylindrical component as needed. The foregoing has also provided embodiments of a guided munition including such a spring clip retention system. While useful in a wide variety applications and contexts, embodiments of the spring clip retention system are especially well-suited for usage

within guided munitions and motor vehicles. As appearing herein, the term "vehicle" is utilized to encompass both motor vehicles and guided munitions, which deliver a payload to a designated delivery point. The term "vehicle" also encompasses Unmanned Aerial Vehicles, exoatmospheric vehicles, spacecraft, and other airborne and space-borne platforms of type which carry at least one deployable device or structure, as well as water- and land-based robotic vehicles.

[0029] While at least one exemplary embodiment has been presented in the foregoing Detailed Description, it should be appreciated that a vast number of variations exist. It should also be appreciated that the exemplary embodiment or exemplary embodiments are only examples, and are not intended to limit the scope, applicability, or configuration of the invention in any way. Rather, the foregoing Detailed Description will provide those skilled in the art with a convenient road map for implementing an exemplary embodiment of the invention. It being understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiment without departing from the scope of the invention as set-forth in the appended Claims.

CLAIMS

What is claimed is:

1. A spring clip retention system for securing a generally cylindrical component in a desired position, the spring clip retention system comprising:

a captive feature, comprising:

opposing ledges; and

a channel formed beneath and partially enclosed by the opposing ledges;

a spring clip, comprising:

opposing retainer arms configured to receive and resiliently retain the generally cylindrical component therebetween, the spring clip deflecting outward and increasing in width when the generally cylindrical component is inserted between the opposing retainer arms; and

a base portion extending between the opposing retainer arms and received within the channel, the base portion abutting the undersides of the opposing ledges when the spring clip is deflected outward by insertion of the generally cylindrical component to prevent disengagement of the base portion from the captive feature in a direction substantially normal to the longitudinal axis of the channel.

2. A spring clip retention system according to Claim 1 wherein the captive feature further comprises an longitudinal opening laterally bound by the opposing ledges and extending from an outer surface of the captive feature to the channel, the width of the longitudinal opening being less than the width of the channel and less than the maximum width of the base portion when the spring clip is deflected outward by insertion of the generally cylindrical component.

3. A spring clip retention system according to Claim 2 wherein the maximum with of the base portion is greater than the width of the longitudinal opening when the spring clip is in a non-deflected state.

4. A spring clip retention system according to Claim 2 wherein the spring clip is movable into a compressed deflected position prior to insertion of the generally cylindrical component by squeezing together the opposing retainer arms, the maximum width of the base portion being less than the width of the longitudinal opening in the compressed deflected position to permit insertion of the base portion into the channel through the longitudinal opening during assembly of the spring clip retention system.

5. A spring clip retention system according to Claim 1 wherein at least one end of the inner channel is open in an axial direction, and wherein the base portion of the spring clip is slidably inserted into the inner channel through the open end.

6. A spring clip retention system according to Claim 1 wherein spring clip has a substantially hourglass-shaped end profile when moving from the clip portion to the base portion.

7. A spring clip retention system according to Claim 1 wherein the spring clip consists of a unitary resilient piece.

8. A spring clip retention system according to Claim 1 wherein the mounting structure comprises:

a U-shaped main body in which the inner channel is formed; and

opposing ledges extending inwardly from the U-shaped main body to partially enclose the inner channel and define, at least in part, the longitudinal opening.

9. A spring clip retention system according to Claim 8 wherein the base portion contacts the inner surfaces of the opposing ledges when the base portion is received by the inner channel and spring clip is deflected outward by insertion of the component.

10. A spring clip retention system according to Claim 1 further comprising at least one axial location feature fixedly coupled to the mounting structure and contacting the spring clip to prevent axial sliding of the base portion within the inner channel.

11. A spring clip retention system according to Claim 10 wherein the at least one axial location feature comprises a protruding member extending from the channel in the first direction to engage the base portion.

12. A spring clip retention system according to Claim 11 wherein the base portion has an aperture therein, and wherein the protruding member extends into the aperture.

13. A spring clip retention system according to Claim 12 wherein the protruding member comprises a dowel pin.

14. A spring clip retention system according to Claim 1 further comprising a vehicular frame member to which the mounting structure is fixedly coupled.

15. A spring clip retention system according to Claim 14 wherein the mounting structure is integrally formed with the vehicular frame member.

16. A spring clip retention system according to Claim 14 wherein the vehicular frame member comprises the seeker bulkhead of a guided munition.

17. A spring clip retention system for securing a generally cylindrical component within a vehicle, the spring clip retention system comprising:

a vehicular mounting structure;

a captive feature integrally formed with the vehicular mounting structure, captive feature comprising:

an outer surface;

an inner channel; and

an longitudinal opening extending from the outer surface to the inner channel, the width of the inner channel exceeding the width of the longitudinal opening; and

a spring clip, comprising:

opposing retainer arms configured to receive and retain the generally cylindrical component therebetween, the spring clip deflecting outward when the generally cylindrical component is inserted between the opposing retainer arms; and

a base portion extending from the opposing retainer arms, through the longitudinal opening, and into the inner channel in a first direction, the maximum width of the base portion exceeding the width of the longitudinal opening when the spring clip is deflected outward by insertion of the generally cylindrical component to prevent disengagement of the base portion from the captive feature in a second direction substantially opposite the first direction.

18. A guided munition, comprising:

a munition mounting structure;

a generally cylindrical component; and

a spring clip retention system, comprising:

a captive feature fixedly coupled to the munition mounting structure, the captive feature having an outer surface, an inner channel, and a longitudinal opening extending from the outer surface to the inner channel, the width of the inner channel exceeding the width of the longitudinal opening; and

a spring clip, comprising:

opposing retainer arms resiliently retaining the generally cylindrical component therebetween, the spring clip deflecting outward when the generally cylindrical component is inserted between the opposing retainer arms; and

a base portion extending from the opposing retainer arms, through the longitudinal opening, and into the inner channel in a first direction, the maximum width of the base

portion exceeding the width of the longitudinal opening when the spring clip is deflected outward by insertion of the generally cylindrical component to prevent disengagement of the base portion from the captive feature in a second direction substantially opposite the first direction to secure the generally cylindrical component to the munition mounting structure.

19. A guided munition according to Claim 18 wherein the generally cylindrical component comprises an electromagnetic interference suppressor core.

20. A guided munition according to Claim 18 wherein the munition mounting structure comprises a seeker bulkhead.

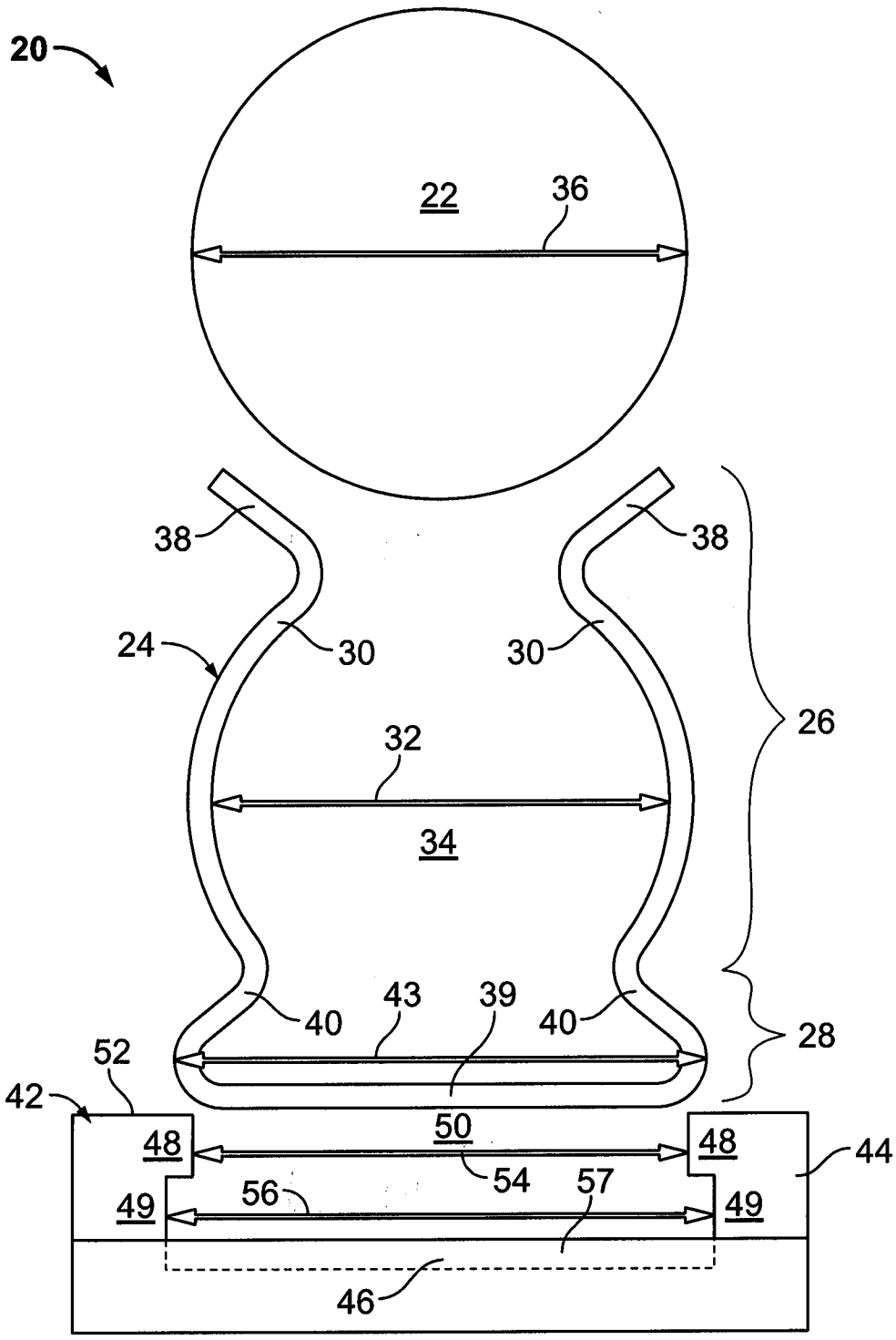
20
22
36
38
38
24
30
30
26
32
34
40
43
39
40
28
52
42
50
48
48
44
54
57
49
56
49
46

FIG. 1

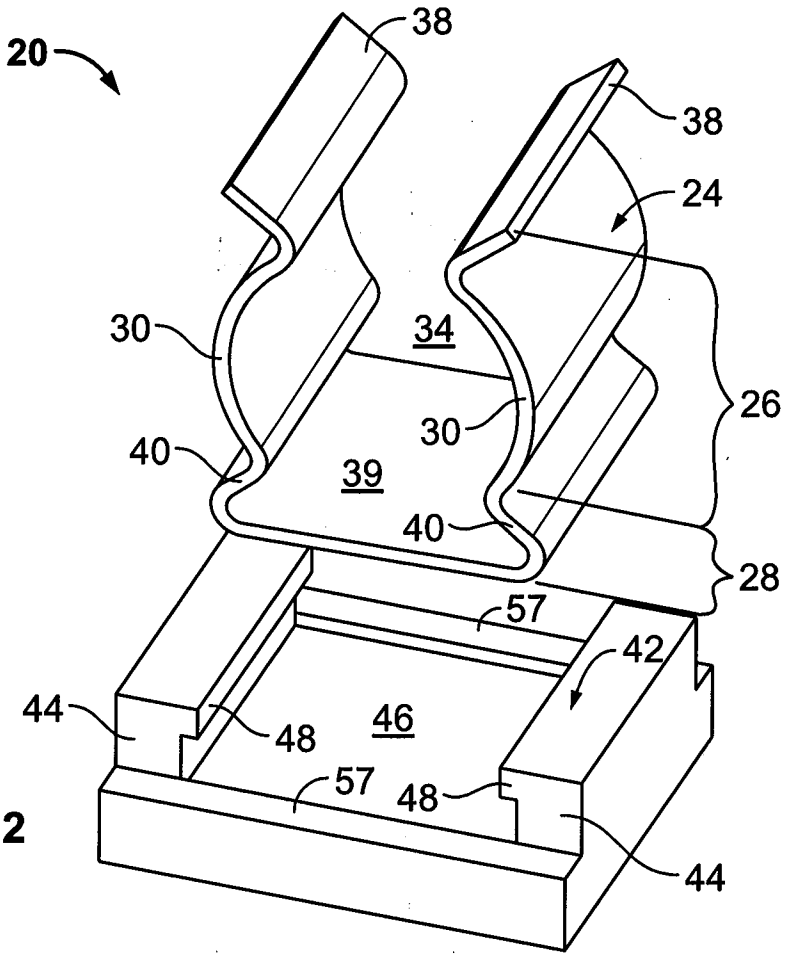
20
38
38
24
30
34
26
30
40
39
40
28
57
42
44
48
46
57
48
44

FIG. 2

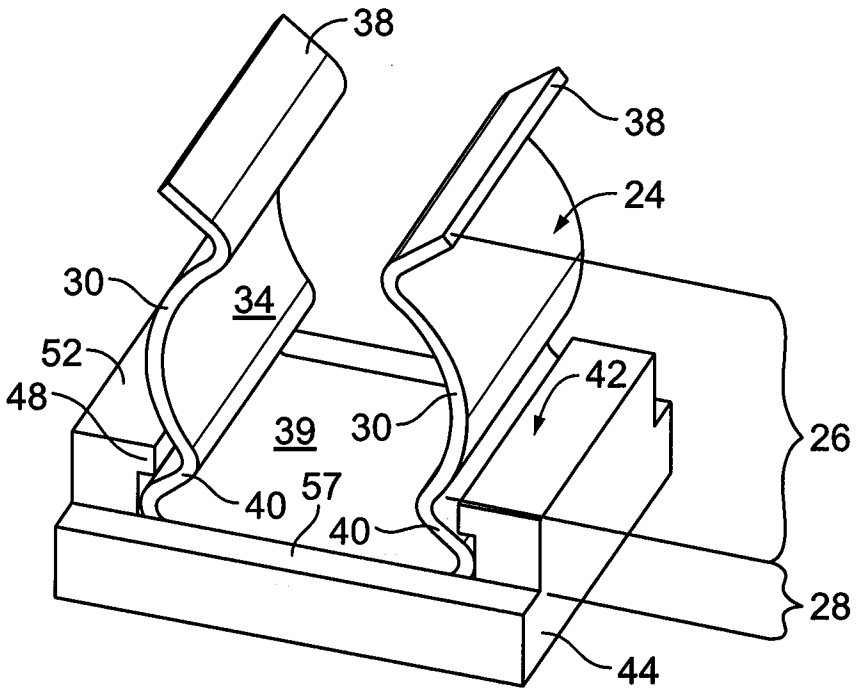
38
38
24
30
34
52
48
42
39
30
26
40
57
40
28
44

FIG. 3

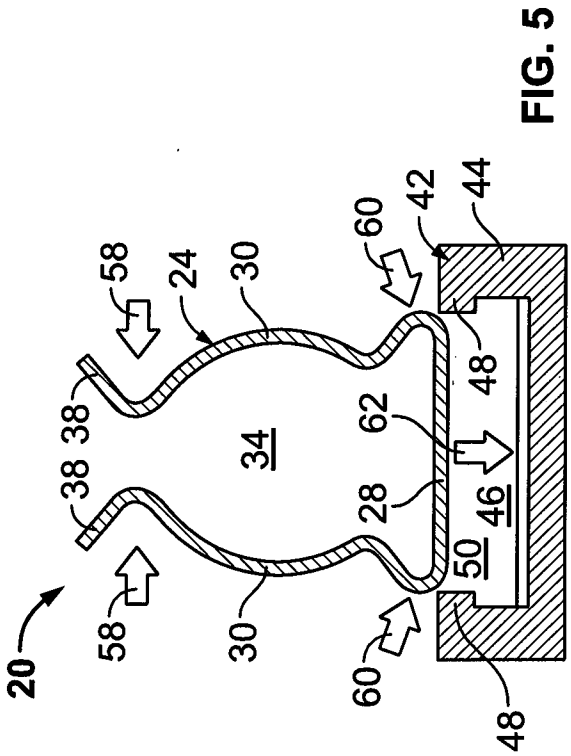

FIG. 5

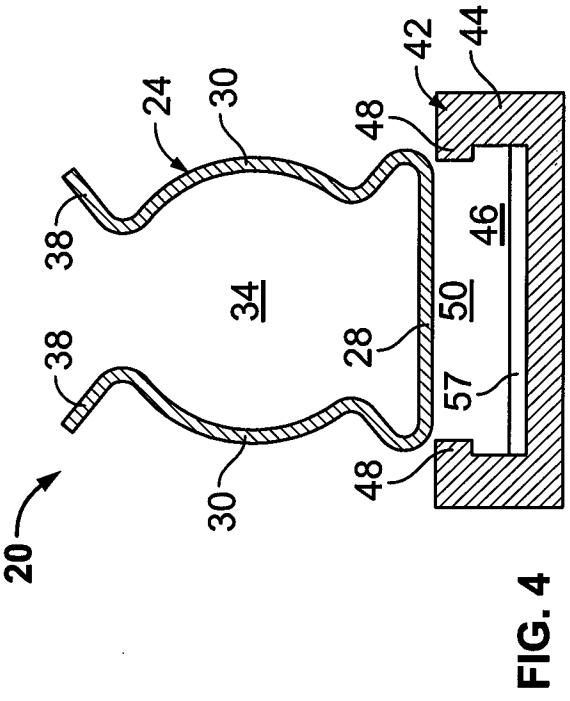

FIG. 4

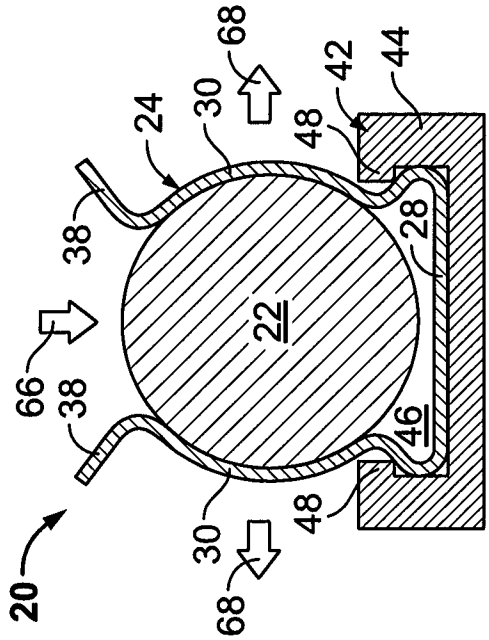

FIG. 7

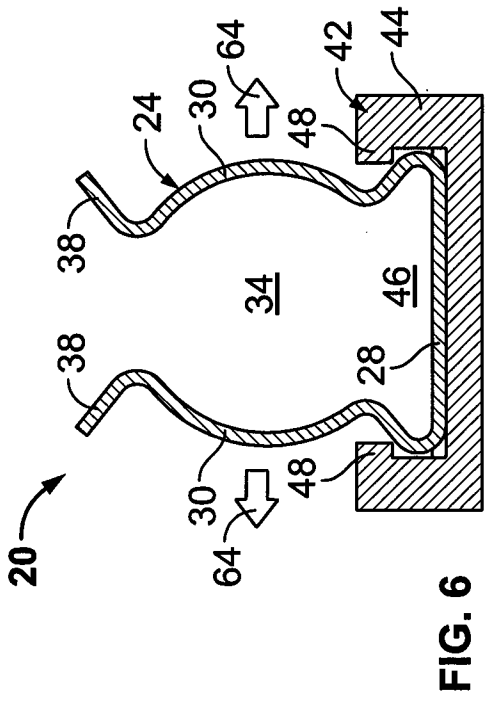

FIG. 6

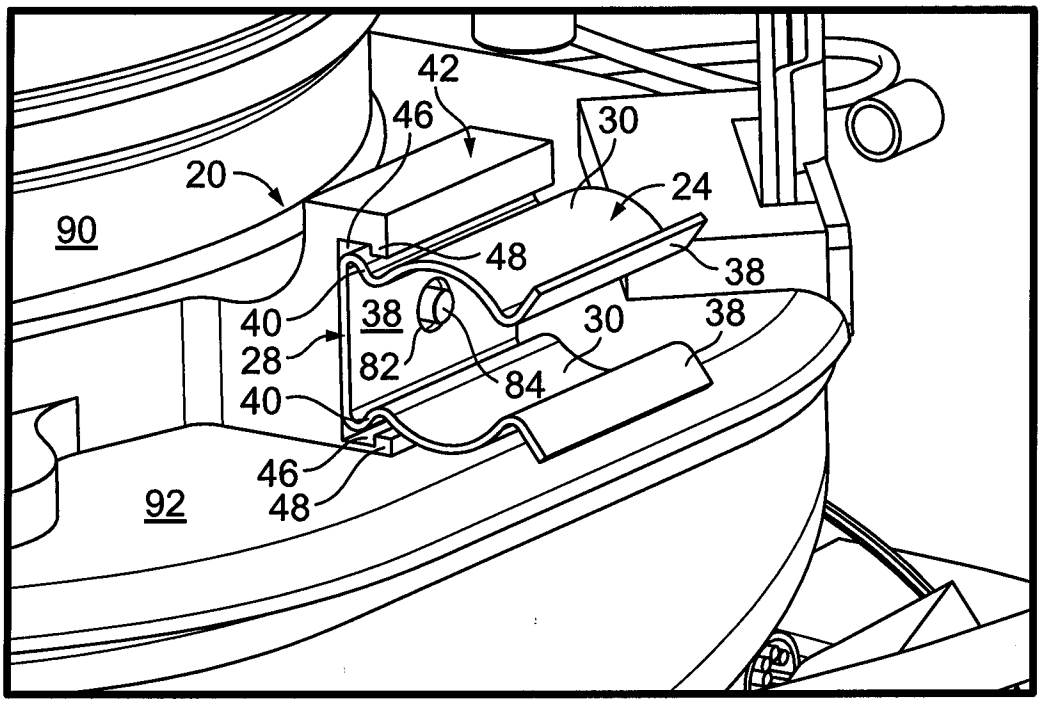
42
46
30
20
24
90
48
38
40
38
30
38
28
82
84
40
46
48
92

FIG. 8

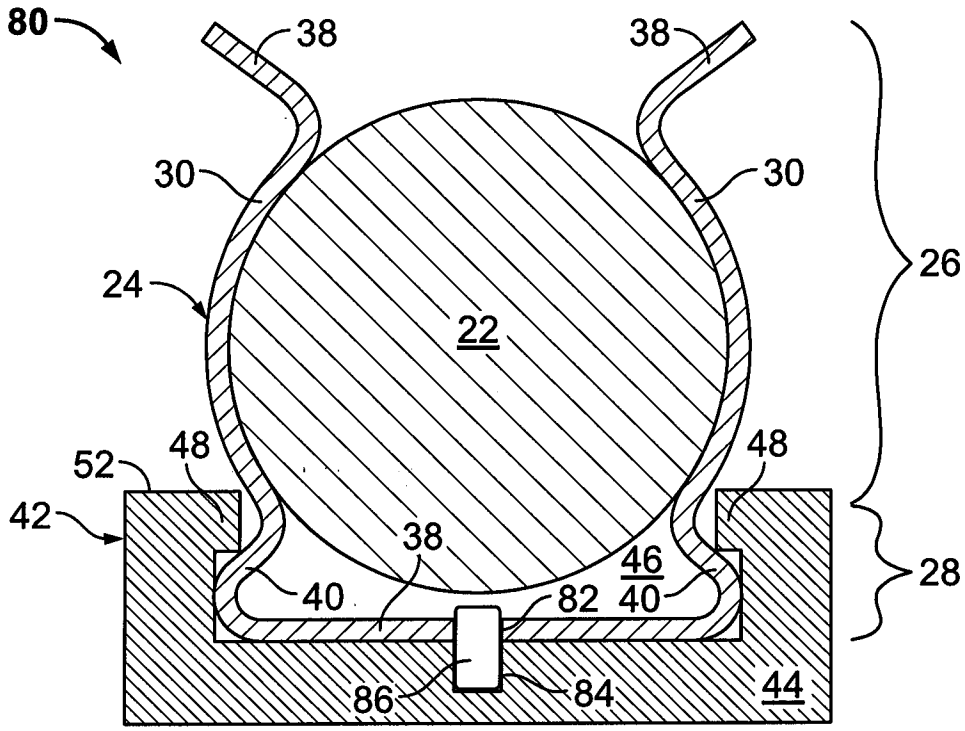
80
38
38
30
30
24
26
22
48
48
52
42
38
46
40
40
82
86
84
44
28

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/029102

A. CLASSIFICATION OF SUBJECT MATTER
INV. F42B33/00 F42B15/00 F16L3/13 F16B2/24
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F42B F16L F16B B25H A47F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	EP 1 849 923 A2 (MEA POLYMER BETON B V [NL]) 31 October 2007 (2007-10-31) paragraphs [0020], [0039] figures 18-21 -----	1-4,6-13 14-20
X	CA 1 057 723 A1 (HILTI AG) 3 July 1979 (1979-07-03) page 8, line 20 - page 10, line 29 figures 5-7 -----	1,5
Y	US 5 816 539 A (CHAN ALLAN L [US] ET AL) 6 October 1998 (1998-10-06) column 8, lines 9-13 figures abstract -----	14-17
	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] 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

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 June 2012	26/06/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Gex-Collet, A

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/029102

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2011/026237 A1 (PORTER JAMES L [US] ET AL) 3 February 2011 (2011-02-03) paragraphs [0014] - [0023] figures 1-4	18-20
A	US 2 068 932 A (QUARNSTROM BERT L) 26 January 1937 (1937-01-26) the whole document	1-13
A	FR 2 469 895 A3 (LEGOANVEC MARCEL [FR]) 29 May 1981 (1981-05-29) figures	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2012/029102

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1849923 A2	31-10-2007	NONE	
CA 1057723 A1	03-07-1979	AT 356467 B	25-04-1980
		AU 510221 B2	12-06-1980
		AU 2482577 A	09-11-1978
		BE 854176 A1	01-09-1977
		CA 1057723 A1	03-07-1979
		CH 620750 A5	15-12-1980
		DE 2619702 A1	24-11-1977
		FI 771262 A	05-11-1977
		FR 2350492 A1	02-12-1977
		GB 1570349 A	02-07-1980
		IT 1085762 B	28-05-1985
		JP 52135094 A	11-11-1977
		NO 771546 A	07-11-1977
		SE 417634 B	30-03-1981
		SE 7705066 A	05-11-1977
		US 4119285 A	10-10-1978
US 5816539 A	06-10-1998	US 5529264 A	25-06-1996
		US 5743492 A	28-04-1998
		US 5816539 A	06-10-1998
		US 5850989 A	22-12-1998
US 2011026237 A1	03-02-2011	CA 2748556 A1	07-10-2010
		EP 2373950 A2	12-10-2011
		US 2011026237 A1	03-02-2011
		WO 2010114584 A2	07-10-2010
US 2068932 A	26-01-1937	NONE	
FR 2469895 A3	29-05-1981	NONE	