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(54) Fire and smoke protection system

(57) A smoke or fire protection device to seal an opening (12) comprising a flexible protection member (106) that can be put in a protection arrangement in which the protection element (106) counteracts the spread of

smoke and/or fire through the opening (12), and can be put in a storage arrangement in which the opening (102) is unsealed, wherein the protection element (106) only comprises metal foil or metal foil and a wire mesh.

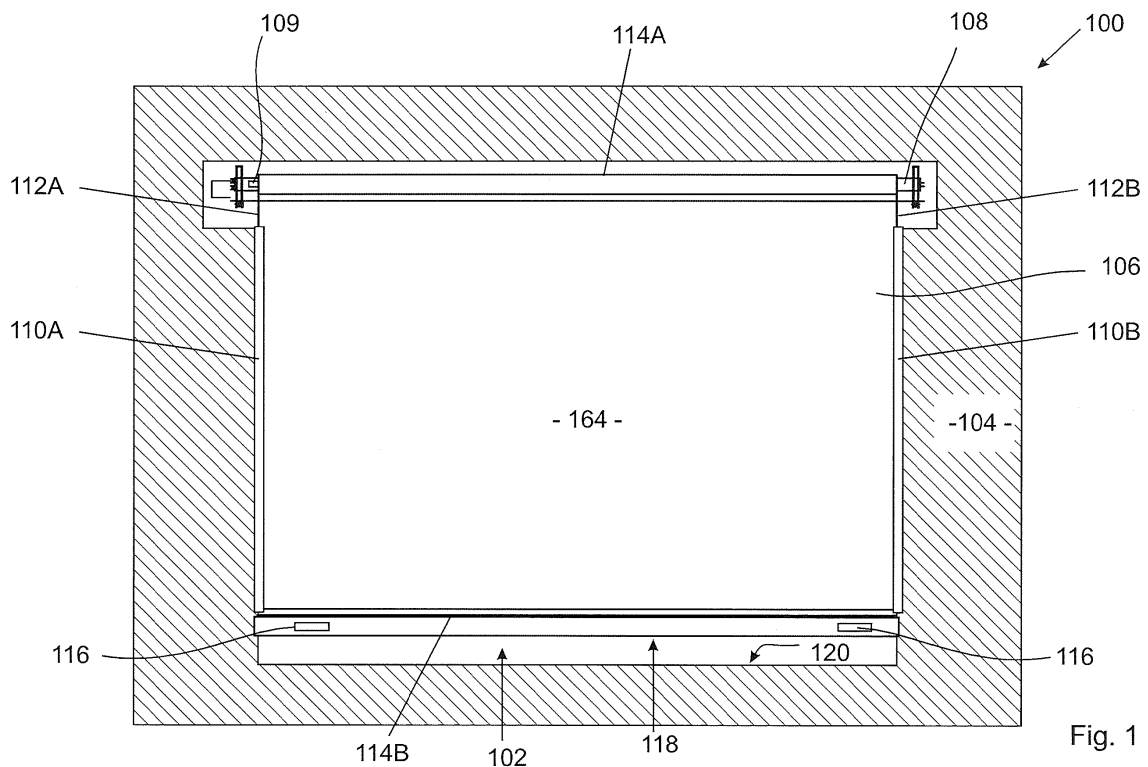


Fig. 1

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Description

[0001] The invention relates to a smoke or fire protection device to seal an opening comprising (a) a flexible protection member that can be put in a protection arrangement in which the protection element counteracts the spread of smoke and of fire through the opening and can be put in a storage arrangement in which the opening is unsealed.

[0002] This kind of smoke or fire protection devices usually fall into two categories.

[0003] Typically, the devices that have been developed to limit the spread of fire and smoke fall into two categories. A first type of devices has attempted to limit the spread of fire and smoke by sealing openings with flexible protection members including a plurality of slats. Examples of such devices include fire protection roller shutters, fire doors, and curtains made of metal components that slide over and relative to one another. Advantageously, these devices limit the spread of fire and smoke while being capable of withstanding mechanical loads particularly well, including after exposure to fire. Unfortunately, these devices are typically heavy and require a large amount of space.

[0004] A second type of devices has attempted to limit the spread of fire and smoke by sealing openings with a flexible protection member manufactured from a fire resistant material that can be wound around a reel or winding shaft. The fire resistant materials used in such devices typically include woven textile fabrics having warp and weft threads. Beneficially, these devices reduce the spread of fire and smoke, are relatively light in weight, and save space. However, these devices are generally less resistant to mechanical influences and loads than devices of the first type described above.

[0005] Both types have the specific disadvantage that they are difficult to clean. This is generally of only little concern, but can be important for specific areas of application, e.g. in the food industry.

[0006] It is another disadvantage of both of the above described devices that they require a significant amount of space.

[0007] It is the underlying problem of the present invention to provide a smoke or fire protection device that is easier to clean.

[0008] The invention solves this problem by means of a smoke or fire protection device according to the preamble of claim 1, wherein the protection element only comprises metal foil. It is an advantage of this smoke or fire protection device that it is very easy to clean. As the protection element only comprises metal foil, the protection element usually is smooth and does not contain grooves or undercuts. For this reason, the protection element can also be disinfected easily. This is a major advantage in for example the food industry.

[0009] It is another advantage that the protection element carries almost no dust.

[0010] It is another advantage of the present invention that the smoke or fire protection device take up only very little space.

[0011] According to a preferred embodiment, the metal foil has a thickness of more than 100 μm . These kind of metal foils are thick enough to be sufficiently stable.

[0012] According to a preferred embodiment, the smoke or fire protection device comprises a winding shaft about and onto which the flexible protection member is fully wound when the system is in the storage arrangement so as not to occlude the opening. The flexible protection member can be unwound from the winding shaft in order to bring it in its protection arrangement in which it occludes the opening. It is therefore an advantage to choose the thickness of the metal foil sufficiently small so that the protection element can be wound and unwound easily.

[0013] According to a preferred embodiment, the flexible protection member comprises a plurality of elongate segments wherein each elongate segment is formed from a single layer of metal foil. This makes it possible to manufacture even large protection elements from smaller bit of metal foil.

[0014] Preferably, the flexible protection member comprises a plurality of elongate clamping members with each elongate clamping member extending between and coupling adjacent elongate segments. Clamping is an easy and at the same time reliable way to join two pieces of metal foil. At the same time, the structure of the metal foil suffers only a little damage or no damage at all, so that it retains its strength.

[0015] According to a preferred embodiment, the flexible protection member is imprinted or embossed with a pattern. This leads to a higher resistance against a localised force that act in a normal direction onto the protection element. Preferably, the metal foil element is manufactured from a steel whose strength increases with heat. In this case, the metal foil element can be wound or unwound many times in order to test this local protection device easily. In the event of a fire, the protection element can be brought into the protection arrangement. The heat of the fire then leads to an increase in yield strength. In other words, the protection element has its highest strength when it is needed most.

[0016] It is in particular preferred that the metal foil element is manufactured from dual-face steel. Dual-face steel is a high-strength steel that has a ferrite and martensitic microstructure. This leads to a high strength and an increased formability at the same time.

[0017] In still another example embodiment, a flexible protection member may be manufactured with a metal foil element imprinted or embossed with a pattern. Subsequently, when exposed to a force at particular location, the imprinted or embossed material in the vicinity of the force location deforms in order to resist the force and oppose tearing of the flexible protection member.

[0018] In yet another example embodiment, a flexible protection member is formed from a plurality of segments such that adjacent segments are coupled together by a clamping member. Each segment is, generally, made from one or more materials and/or one or more layers of materials that are configured in a desired arrangement similar to the manner in which a flexible protection member having a single segment might be configured and constructed. Generally, each segment is identical to the other segments of the flexible protection device, but may include one or more different materials, layers or structures such that segments near the mid-section of the flexible protection member, for example, may have different mechanical and fire resistant properties than segments nearer the other sections of the flexible protection member. Each clamping member is selected from a plurality of different types of clamping members, some of which are described herein. Typically, the clamping members are of the same type and extend beyond the appropriate extent of the flexible protection member into the system's guides to improve deployment and retraction of the flexible protection member, but may comprise individually different types of clamps and may not all similarly extend into the system's guides. Advantageously, the clamping members add mechanical strength and stability to the flexible protection member, reduce sagging of the flexible protection member during exposure to fire or high temperatures, improve deployment and retraction of the flexible protection member by virtue of one or more of the clamping members extending into the system's guides.

[0019] As may be gleaned from the foregoing description and from the remaining description below, the fire and smoke protection system is configurable and operable to substantially limit the spread of fire and smoke through an opening. The system has many advantages and benefits over other systems that may become apparent upon reading and understanding the present specification when taken in conjunction with the appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Fig. 1 displays a schematic, front elevational view of a fire and smoke protection system, in accordance with a general example embodiment, for substantially sealing an opening in a building structure and limiting the spread of fire and smoke through the opening during a fire.

Fig. 2 displays a schematic, partial, front elevational view of a flexible protection member of a fire and smoke protection system having elongate clamping members in accordance with a first example embodiment.

Fig. 3 displays a schematic, cross-sectional view of an elongate clamping member of the flexible protection member of Fig. 2 taken along lines 18-18 and showing portions of the adjacent elongate segments.

Fig. 4 displays a schematic, partial, front elevational view of a flexible protection member of a fire and smoke protection system having elongate clamping members in accordance with a second example embodiment.

Fig. 5 displays a schematic, cross-sectional view of an elongate clamping member of the flexible protection member of Fig. 4 taken along lines 22-22 and showing portions of the adjacent elongate segments.

Fig. 6 displays a schematic, partial, front elevational view of a flexible protection member of a fire and smoke protection system having elongate clamping members in accordance with a third example embodiment.

Fig. 7 displays a schematic, cross-sectional view of an elongate clamping member of the flexible protection member of Fig. 6 taken along lines 24-24 and showing portions of the adjacent elongate segments.

Fig. 8 displays a schematic, partial, front elevational view of a flexible protection member of a fire and smoke protection system having elongate clamping members 232 in accordance with a fourth example embodiment.

Fig. 9 displays a schematic, cross-sectional view of an elongate clamping member of the flexible protection member of Fig. 8 taken along lines 26-26 and showing portions of the adjacent elongate segments.

Fig. 10 displays a schematic, partial, front elevational view of a flexible protection member of a fire and smoke protection system having elongate clamping members in accordance with a fifth example embodiment.

Fig. 11 displays a schematic, cross-sectional view of an elongate clamping member of the flexible protection member of Fig. 10 taken along lines 28-28 and showing the elongate clamping member in a closed configuration.

Fig. 12 displays a schematic, cross-sectional view of the elongate clamping member of Fig. 11 in an open configuration.

Fig. 13 displays a schematic, front elevational view of a flexible protection member of a fire and smoke protection system in accordance with a sixth example embodiment, having a front surface imprinted or embossed with a pattern.

Fig. 14 displays a schematic, partial, front elevational view of a fire and smoke protection system, in accordance with a seventh example embodiment, in which the flexible protection member is formed from a multi-layer structure including a metal foil element and multiple wire mesh elements.

Fig. 15 displays a schematic, partial, front elevational view of a fire and smoke protection system, in accordance with an eighth example embodiment, in which the flexible protection member is formed from a multi-layer structure including multiple metal foil elements and multiple wire mesh elements.

[0021] Referring now to the drawings in which like elements and steps have similar numbers throughout the several views, Fig. 1 displays a schematic, front elevational view of a fire and smoke protection system 100, in accordance with a general example embodiment, for substantially sealing an opening 102 in a building structure and limiting the spread of fire and smoke through the opening 102 during a fire. The fire and smoke protection system 100 (also sometimes referred to herein as the "system 100") is adapted for secure connection to a wall 104 relative to the opening 102 and is configurable in a first configuration (also sometimes referred to herein as a "storage configuration") that permits ingress and egress through the opening 102 when no fire or smoke exists. The system 100 is also configurable in a second configuration (also sometimes referred to herein as a "fully-deployed configuration" or a "protection configuration") in which the system 100 significantly limits or prevents the spread of fire and smoke through the opening 102 during a fire.

[0022] The fire and smoke protection system 100 comprises a flexible protection member 106 and a winding shaft 108 (or reel 108) about and onto which the flexible protection member 106 is fully-wound (and, hence, fully-retracted) when the system 100 is configured in the storage configuration so as not to occlude the opening 102. Conversely, the flexible element 106 is fully-unwound from the winding shaft 108 when the system 100 is configured in the fully-deployed configuration so that the flexible protection member 106 fully occludes the opening 102. Thus, the flexible protection member 106 is selectively configurable to occlude or not occlude the opening 102.

[0023] The flexible protection member 106 generally includes a sheet-like member that is relatively thin in thickness as compared the lateral and longitudinal dimensions thereof. For reference, the term "longitudinal" is used herein to refer to the direction in which the flexible protection member 106 is deployed or retracted, and frequently has its longest dimension. The term "lateral" is used herein to refer to the direction perpendicular to the longitudinal direction and in which the flexible protection member 106 often has its shortest dimension other than thickness.

[0024] The fire and smoke protection system 100 may be additionally configured in a plurality of intermediate configurations as illustrated in Fig. 1. As seen in the intermediate configuration of Fig. 1, the flexible protection member 106 is substantially unwound from the winding shaft 108 and extended to significantly, although not entirely, occlude the opening 102. In other intermediate configurations, the flexible protection member 106 is partially unwound from the winding shaft 108 and occludes the opening 102 to a lesser or greater extent. It should be understood and appreciated that although the flexible protection member 106 of the fire and smoke protection system 100 is oriented to deploy and retract in the vertical direction according to the first example embodiment and other example embodiments described herein, the flexible protection member 106 may be oriented to deploy and retract in the horizontal direction (or, for that matter, in other directions) in other example embodiments. For this reason, the terms "horizontal" and "vertical" are sparingly used herein.

[0025] The system 100 also comprises a winding shaft motor 109 mounted within the winding shaft 108 that is operable to rotate the winding shaft 108 in order to retract and wind the flexible protection member 106 onto the winding shaft 108 or to extend and unwind the flexible protection member 106 from the winding shaft 108. A first guide 110A and an opposed second guide 110B of the system 100 are secured to the wall 104 at respectively opposed locations relative to the opening 102 and define recesses therein for at least partially and respectively receiving opposed first and second lateral edges 112A, 112B of the flexible protection member 106. During winding or unwinding of the flexible protection member 106 onto/from the winding shaft 108 as the system 100 is reconfigured between the storage configuration and fully-deployed configuration, the first and second lateral edges 112A, 112B of the flexible protection member 106 ride and move respectively within and relative to the recesses of the first and second guides 110A, 110B. The guides 110, according to the first example embodiment, may comprise channel, angle, plate, and/or other similar members appropriately sized and mounted relative to the wall 104 and opening 102 for receiving the lateral edges 112 of the flexible protection member 106. The guides 110 are generally manufactured from an appropriately selected material capable of withstanding the high temperatures produced by fires absent yielding, deflection, or deformation.

[0026] Additionally, the flexible protection member 106 has a first longitudinal edge 114A and an opposed second

longitudinal edge 114B that extend between the element's first and second lateral edges 112A, 112B. The first longitudinal edge 114A is generally secured to the winding shaft 108 to facilitate winding and unwinding of the flexible protection member 106 to or from the winding shaft 108. The fire and smoke protection system 100 further comprises a rail 116 that is mounted to a foot 118 of the flexible protection member 106. The foot 118 is connected to and extends along the second longitudinal edge 114B of the flexible protection member 106 and at least between the lateral edges 112 thereof. When the system 100 is configured in the storage configuration, the rail 116 resides in a position flush with a first longitudinal edge of the opening 102 to permit ingress and egress through the opening 102. When the system 100 is configured in the protection configuration, the rail 116 resides in position in contact with and substantially parallel to an opposed, second longitudinal edge 120 of the opening 102.

[0027] The flexible protection member 106 further comprises a metal foil element 164 that extends between the first and second lateral edges 112A, 112B of the flexible protection member 106. As used herein, the term "metal foil" refers generally to a foil made from steel, titanium, or copper (since copper does not rust), but may include other metal materials or alloys in various example embodiments. However, according to this and other example embodiments described herein, the metal foil element 164 is manufactured from high grade, stainless steel such as, for example and not limitation, V4A steel (also known as 1.4404 steel) or a stainless steel having eighteen percent (18%) chrome and ten percent (10%) nickel that demonstrates low strain hardening, as the flexible protection member 106 may be rolled and unrolled many times to test Operation of the fire and smoke protection system 100. Alternatively, the metal foil element 164 may be manufactured from a steel whose yield strength increases with heating (such as, for example, a dual phase steel) in order to provide the flexible protection member 106 with increased strength during and after a fire. Generally, the metal foil has a thickness between twenty micrometers (20 μm) and two hundred micrometers (200 μm) when the metal foil is not used alone in a flexible protection member 106. When the metal foil is used alone, the metal foil typically has a thickness of more than one hundred micrometers (100 μm).

[0028] It should be understood and appreciated that the metal foil element 164 of this example embodiment (and, for that matter, the other example embodiments described herein) is self-supporting, meaning that it is sufficiently strong and stable enough to carry its own weight absent support from other elements or components. By virtue of the metal foil elements 164 being self-supporting, the flexible protection members 106 described herein having metal foil elements 164 as a single element of a multi-layer structure are possible, but would not be possible if the metal foil elements 164 comprised metal foil merely mounted on a fire resistant material.

[0029] In the paragraphs that follow, a number of different elongate clamping members 232 are described in further detail.

[0030] Fig. 2 displays a schematic, partial, front elevational view of a flexible protection member 106 having elongate clamping members 232 in accordance with a first example embodiment. As seen in Fig. 2, the flexible protection member 106 has a first lateral edge 112A, an opposed second lateral edge 112B, a first longitudinal edge 114A, and an opposed second longitudinal edge 114B. The flexible protection member 106 comprises a plurality of elongate segments 230 with each elongate segment 230 extending between lateral edges 112A, 112B. Each elongate segment 230 is formed from a single layer of metal foil. The flexible protection member 106 further comprises a plurality of elongate clamping members 232 with each elongate clamping member 232 extending between and coupling adjacent elongate segments 230 and extending between lateral edges 112A, 112B.

[0031] Fig. 3 displays a schematic, cross-sectional view of an elongate clamping member 232 of the flexible protection member 106 of Fig. 2 taken along lines 18-18 and showing portions of the adjacent elongate segments 230A, 230B. As illustrated in Fig. 3, elongate segment 230A is folded along fold line 234A to define first and second portions 236A, 236B of elongate segment 230A in a substantially "U-shape" configuration. Similarly, elongate segment 230B is folded along fold line 234B to define first and second portions 238A, 238B in a substantially "U-shape" configuration. Elongate segment 230A and elongate segment 230B are arranged such that the first portion 236A of elongate segment 230A resides between the first portion 238A of elongate segment 230B and the second portion 238B of elongate segment 230B. Similarly, the first portion of 238A of elongate segment 230B resides between the first portion 236A of elongate segment 230A and the second portion 236B of elongate segment 230A.

[0032] Frictional forces between portions 236A, 236B of elongate segment 230A and portions 238A, 238B of elongate segment 230B aid in holding the elongate segments 230A, 230B together and resisting forces that tend to cause separation. To enhance the frictional forces, a strip made of non-flammable material and having rough surfaces may be positioned between portions 236A, 236B of elongate segment 230A and portions 238A, 238B of elongate segment 230B.

[0033] The elongate clamping member 232 comprises a first elongate clamping rod 240A and an opposed second elongate clamping rod 240B. The first elongate clamping rod 240A resides adjacent the second portion 236B of elongate segment 230A and defines a plurality of bores 242A that are laterally offset relative to one another at a respective plurality of discrete locations between the lateral edges 112A, 112B of the flexible protection member 106. Similarly, the second elongate clamping rod 240B resides adjacent the second portion 238B of elongate segment 230B and defines a plurality of bores 242B that are laterally offset relative to one another at a respective plurality of discrete locations between lateral edges 112A, 112B axially-aligned with bores 242A of the first elongate clamping rod 240A. Elongate segments 230A,

230B similarly define a plurality of bores 244 extending through portions 236A, 238A and parts of portions 236B, 238B at a respective plurality of discrete locations between lateral edges 112A, 112B and that are, respectively, cooperative and coaxially-aligned with respective bores 242A, 242B. The elongate clamping member 232 further comprises a plurality of pre-tensioning members 246 such that a respective pre-tensioning member 246 is present within coaxially aligned bores 242A, 242B, 244. The pre-tensioning members 246 apply a pre-tensioning force, "F", to the first and second elongate clamping rods 240 pre-tensioning the elongate clamping rods 240 relative to one another and causing the elongate clamping rods 240A, 240B to securely hold portions 236A, 238A and parts of portions 236B, 238B of adjacent elongate segments 230A, 230B together. Pre-tensioning members 246 acceptable in accordance with this example embodiment include, for example and not limitation, fasteners, rivets, tie rods, screws, and tension springs. Generally, the pre-tensioning force, F, is selected to hold adjacent elongate segments 230A, 230B together when a load force, "G", corresponding to twice the weight of the components of the flexible protection member 106 present below the elongate clamping member 232 is applied.

[0034] It should be understood and appreciated that clamping of adjacent elongate members 230A, 230B together constitutes an improvement over coupling of the elongate members 230A, 230B with seams. Thus, although adjacent elongate segments 230A, 230B are punctured in connection with use of the elongate clamping members 232 and, hence, the elongate segments 230A, 230B are weakened, the mechanical weakening of the flexible protection member 106 due to seaming is substantially greater.

[0035] Fig. 4 displays a schematic, partial, front elevational view of a flexible protection member 106 having elongate clamping members 232 in accordance with a second example embodiment. As seen in Fig. 4, the flexible protection member 106 has a first lateral edge 112A, an opposed second lateral edge 112B, a first longitudinal edge 114A, and an opposed second longitudinal edge 114B. The flexible protection member 106 comprises a plurality of elongate segments 230 with each elongate segment 230 extending between lateral edges 112A, 112B. Each elongate segment 230 is formed from a single layer of metal foil. The flexible protection member 106 further comprises a plurality of elongate clamping members 232 with each elongate clamping member 232 extending between and coupling adjacent elongate segments 230 and extending between lateral edges 112A, 112B.

[0036] Fig. 5 displays a schematic, cross-sectional view of an elongate clamping member 232 of the flexible protection member 106 of Fig. 4 taken along lines 22-22 and showing portions of the adjacent elongate segments 230A, 230B. As illustrated in Fig. 5, elongate clamping member 232 comprises a first elongate piping/welt member 250A and an opposed second elongate piping/welt member 250B that each extend between the lateral edges 112A, 112B of the flexible protection member 106. A portion of elongate segment 230A wraps around the first elongate piping/welt member 250A to form a first elongate piping/welt 252A and first elongate loop 253A extending between the lateral edges 112A, 112B of the flexible protection member 106. Similarly, a portion of elongate segment 230B wraps around the second elongate piping/welt member 250B to form a second elongate piping/welt 252B and second elongate loop 253B extending between the lateral edges 112A, 112B of the flexible protection member 106.

[0037] The elongate clamping member 232 further comprises a first elongate clamping rod 240A and an opposed second elongate clamping rod 240B. The first and second elongate clamping rods 240A, 240B define respective elongate recesses 254A, 254B for receiving respective portions 256A, 256B of an elongate retaining member 258 therein. The elongate retaining member 258 locks the first elongate clamping rod 240A to the second elongate clamping rod 240B. When locked together, the first and second elongate clamping rods 240A, 240B define elongate piping/welt cavities 259A, 259B extending between the lateral edges 112A, 112B of the flexible protection member 106 in which the first and second elongate piping/welts 252A, 252B respectively reside, thereby coupling elongate segments 230A, 230B.

[0038] It should be understood and appreciated that while each elongate segment 230 has been described with reference to Figs. 21 and 22 as being formed by a single layer of fire resistant material, each elongate segment 230 may also be formed using any of the materials and according to any of the structures (including, without limitation, the multi-layer structures) for flexible protection members 106 described herein. It should also be understood and appreciated that the elongate clamping member of Figs. 21 and 22 may be employed with elongate segments 230 employing single layers of fire resistant materials or employing multi-layer structures having one or more fire resistant materials. Additionally, it should be understood and appreciated that as the elongate segments 230 are formed of metal foil elements 164, the elongate segments 230A, 230B may be wrapped respectively around the first and second elongate piping/welt members 250A, 250B and welded respectively to themselves to form very stable elongate piping/welts 252A, 252B. Further, if such elongate piping/welts 252A, 252B are formed, a clasp may be employed in lieu of elongate clamping member 232 resulting in a particularly secure connection between the elongate segments 230A, 230B.

[0039] Fig. 6 displays a schematic, partial, front elevational view of a flexible protection member 106 having elongate clamping members 232 in accordance with a third example embodiment. As seen in Fig. 6, the flexible protection member 106 has a first lateral edge 112A, an opposed second lateral edge 112B, a first longitudinal edge 114A, and an opposed second longitudinal edge 114B. The flexible protection member 106 comprises a plurality of elongate segments 230 with each elongate segment 230 extending between lateral edges 112A, 112B. Each elongate segment 230 is formed from a single layer of metal foil. The flexible protection member 106 further comprises a plurality of elongate clamping

members 232 with each elongate clamping member 232 extending between and coupling adjacent elongate segments 230 and extending between lateral edges 112A, 112B.

[0040] Fig. 7 displays a schematic, cross-sectional view of an elongate clamping member 232 of the flexible protection member 106 of Fig. 6 taken along lines 24-24 and showing portions of the adjacent elongate segments 230A, 230B. As illustrated in Fig. 7, elongate clamping member 232 comprises a first elongate piping/welt member 250A and an opposed second elongate piping/welt member 250B that each extend between the lateral edges 112A, 112B of the flexible protection member 106. A portion of elongate segment 230A wraps around the first elongate piping/welt member 250A to form a first elongate piping/welt 252A and first elongate loop 253A extending between the lateral edges 112A, 112B of the flexible protection member 106. Similarly, a portion of elongate segment 230B wraps around the second elongate piping/welt member 250B to form a second elongate piping/welt 252B and second elongate loop 253B extending between the lateral edges 112A, 112B of the flexible protection member 106.

[0041] The elongate clamping member 232 further comprises a first elongate clamping rod 240A and an opposed second elongate clamping rod 240B. The first and second elongate clamping rods 240A, 240B define respective coaxially-aligned bores 260A, 260B for receiving fasteners 262A, 262B therein. The fasteners 262A, 262B lock the first elongate clamping rod 240A to the second elongate clamping rod 240B. When locked together, the first and second elongate clamping rods 240A, 240B define elongate piping/welt cavities 259A, 259B extending between the lateral edges 112A, 112B of the flexible protection member 106 in which the first and second elongate piping/welts 252A, 252B respectively reside, thereby coupling elongate segments 230A, 230B.

[0042] Additionally, it should be understood and appreciated that as the elongate segments 230 are formed of metal foil elements 164, the elongate segments 230A, 230B may be wrapped respectively around the first and second elongate piping/welt members 250A, 250B and welded respectively to themselves to form very stable elongate piping/welts 252A, 252B.

[0043] Fig. 8 displays a schematic, partial, front elevational view of a flexible protection member 106 having elongate clamping members 232 in accordance with a fourth example embodiment. As seen in Fig. 8, the flexible protection member 106 has a first lateral edge 112A, an opposed second lateral edge 112B, a first longitudinal edge 114A, and an opposed second longitudinal edge 114B. The flexible protection member 106 comprises a plurality of elongate segments 230 with each elongate segment 230 extending between lateral edges 112A, 112B. Each elongate segment 230 is formed from a single layer of metal foil. The flexible protection member 106 further comprises a plurality of elongate clamping members 232 with each elongate clamping member 232 extending between and coupling adjacent elongate segments 230 and extending between lateral edges 112A, 112B.

[0044] Fig. 9 displays a schematic, cross-sectional view of an elongate clamping member 232 of the flexible protection member 106 of Fig. 8 taken along lines 26-26 and showing portions of the adjacent elongate segments 230A, 230B. As illustrated in Fig. 9, elongate clamping member 232 comprises a first elongate piping/welt member 250A and an opposed second elongate piping/welt member 250B that each extend between the lateral edges 112A, 112B of the flexible protection member 106. A portion of elongate segment 230A wraps around the first elongate piping/welt member 250A to form a first elongate piping/welt 252A extending between the lateral edges 112A, 112B of the flexible protection member 106. Similarly, a portion of elongate segment 230B wraps around the second elongate piping/welt member 250B to form a second elongate piping/welt 252B extending between the lateral edges 112A, 112B of the flexible protection member 106.

[0045] The elongate clamping member 232 further comprises an elongate clamping clip 264 extending slightly beyond the lateral edges 112A, 112B of the flexible protection member 106. The elongate clamping clip 264 has an elongate central portion 266 and an elongate first leg 268A that extends away from the elongate central portion 266 and then loops back toward the elongate central portion 266 to define a first elongate channel 270A. The elongate clamping clip 264 also has an elongate second leg 268B that, similar to the elongate first leg 268A but in the opposite direction, extends away from the elongate central portion 266 and then loops back toward the elongate central portion 266 to define a second elongate channel 270B. Collectively, the elongate central portion 266, elongate first leg 268A, and elongate second leg 268B form a cross-sectional shape corresponding to a tilted letter "S". The first and second elongate channels 270A, 270B respectively receive the first and second elongate piping/welts 252A, 252B.

[0046] The elongate clamping clip 264 is manufactured, according to the example embodiment, from a fire resistant, spring steel material that permits the ends of the elongate first and second legs 268A, 268B to be respectively spread apart from the elongate central portion 266 for the insertion of the first and second elongate piping/welts 252A, 252B into the first and second elongate channels 270A, 270B. Once the elongated piping/welts 252 are inserted, the elongate first and second legs 268A, 268B spring back toward the elongate central portion 266 securing the elongated piping/welts 252 and trapping respective portions of the elongate segments 230A, 230B therebetween. Also, the elongate piping/welts 252A, 252B are positioned at respective locations offset forward and aft from the plane of the elongate segments 230A, 230B.

[0047] It should be understood and appreciated that the elongate clamping member of Figs. 25 and 26 may be employed with elongate segments 230 employing single layers of fire resistant materials or employing multi-layer structures having

one fire resistant material. Additionally, it should be understood and appreciated that as the elongate segments 230 are formed of metal foil elements 164, the elongate segments 230A, 230B may be wrapped respectively around the first and second elongate piping/welt members 250A, 250B and welded respectively to themselves to form very stable elongate piping/welts 252A, 252B.

[0048] Fig. 10 displays a schematic, partial, front elevational view of a flexible protection member 106 having elongate clamping members 232 in accordance with a fifth example embodiment. As seen in Fig. 10, the flexible protection member 106 has a first lateral edge 112A, an opposed second lateral edge 112B, a first longitudinal edge 114A, and an opposed second longitudinal edge 114B. The flexible protection member 106 comprises a plurality of elongate segments 230 with each elongate segment 230 extending between lateral edges 112A, 112B. Each elongate segment 230 is formed from a single layer of metal foil. The flexible protection member 106 further comprises a plurality of elongate clamping members 232 with each elongate clamping member 232 extending between and coupling adjacent elongate segments 230 and extending between lateral edges 112A, 112B.

[0049] Fig. 11 displays a schematic, cross-sectional view of an elongate clamping member 232 of the flexible protection member 106 of Fig. 10 taken along lines 28-28 and showing portions of the adjacent elongate segments 230A, 230B. The elongate clamping member 232 is configurable in first, closed configuration (see Fig. 11) in which adjacent elongate segments 230A, 230B are clamped and coupled together, and a second, open configuration (see Fig. 12) in which adjacent elongate segments 230A, 230B are not clamped or coupled together. As illustrated in Fig. 11, elongate clamping member 232 comprises a first elongate piping/welt member 250A and an opposed second elongate piping/welt member 250B that each extend between the lateral edges 112A, 112B of the flexible protection member 106. A portion of elongate segment 230A wraps around the first elongate piping/welt member 250A to form a first elongate piping/welt 252A and elongate loop 253A extending between the lateral edges 112A, 112B of the flexible protection member 106. Similarly, a portion of elongate segment 230B wraps around the second elongate piping/welt member 250B to form a second elongate piping/welt 252B and elongate loop 253B extending between the lateral edges 112A, 112B of the flexible protection member 106.

[0050] The elongate clamping member 232 also comprises a first elongate clamping rod 240A and a second elongate clamping rod 240B pivotally, or hinged, attached to the first elongate clamping rod 240A in a scissor or criss-cross arrangement via an elongate pivot pin 272. The first elongate clamping rod 240A has an elongate first part 274A and an elongate second part 274B. Similarly, the second elongate clamping rod 240B has an elongate first part 276A and an elongate second part 276B.

[0051] Additionally, the elongate clamping member 232 defines first and second elongate piping/welt cavities 259A, 259B extending between the lateral edges 112A, 112B of the flexible protection member 106 for respectively receiving first and second elongate piping/welts 252A, 252B. More specifically, the elongate first part 274A of first elongate clamping rod 240A and the elongate first part 276A of second elongate clamping rod 240B form the first elongate piping/welt cavity 259A. Similarly, the elongate second part 274B of first elongate clamping rod 240A and the elongate second part 276B of second elongate clamping rod 240B form the second elongate piping/welt cavity 259B.

[0052] In use, the first elongate clamping rod 240A and second elongate clamping rod 240B are pivoted relative to one another about pivot pin 272 to configure the elongate clamping member 232 in the open configuration. The first and second elongate piping/welts 252A, 252B are then respectively inserted into and received by the first and second elongate piping/welt cavities 258A, 258B. Subsequently, the first elongate clamping rod 240A and second elongate clamping rod 240B are again pivoted relative to one another about pivot pin 272, but to configure the elongate clamping member 232 in the closed configuration. Once configured and secured in the closed configuration, for example and not limitation, by a biasing member or locking mechanism, the first and second elongate clamping rods 240A, 240B contact, or engage, elongate segments 230A, 230B and hold the first and second elongate piping/welts 252A, 252B within the first and second elongate piping/welt cavities 258A, 258B to securely couple elongate segments 230A, 230B.

[0053] The elongated clamping member 232 of this example embodiment is particularly well-suited for use with elongate segments 230 including one or more metal foil element(s) 164 that comprise at least one layer of metal foil material. If the elongate segments 230 are formed of metal foil elements 164, the elongate segments 230A, 230B may be wrapped respectively around the first and second elongate piping/welt members 250A, 250B and welded respectively to themselves to form very stable elongate piping/welts 252A, 252B.

[0054] It should be understood and appreciated that while each elongate segment 230 has been described with reference to Figs. 10, 11 and 12 as being formed by a single layer of fire resistant material, each elongate segment 230 may also be formed using any of the materials and according to any of the structures (including, without limitation, the multi-layer structures) for flexible protection members 106 described herein. It should also be understood and appreciated that the elongate clamping member of Figs. 10, 11 and 12 may be employed with elongate segments 230 employing single layers of fire resistant materials or employing multi-layer structures having one or more fire resistant materials.

[0055] In the previously described example embodiments of a fire and smoke protection system 100 and/or various components thereof, the flexible protection members 106 have been manufactured with substantially smooth front and back surfaces. However, if the flexible protection members 106 are made with front and/or back surfaces having a pattern

imprinted or embossed therein, the flexible protection members 106 deform and bulge in a malleable way locally in the areas of the imprinted or embossed pattern elements so that the imprint or embossed pattern elements yield, thereby increasing the resistance to forces applied normal to the surfaces.

[0056] Fig. 13 displays a schematic, front elevational view of a flexible protection member 106 of a fire and smoke protection system 100 in accordance with a sixth example embodiment. The flexible protection member 106, as seen in Fig. 13, has a first lateral edge 112A and an opposed second lateral edge 112B that each extend in a substantially longitudinal direction. The flexible protection member 106 also has a first longitudinal edge 114A and an opposed second longitudinal edge 114B that each extend in a substantially lateral direction between lateral edges 112A, 112B. Generally, the flexible protection member 106 comprises a sheet-like member that is minimal in thickness (as measured between front and back surfaces thereof) relative to the element's lateral and longitudinal dimensions.

[0057] The flexible protection member 106 includes a metal foil element 164 and has a front surface 290 (or face 290) that is imprinted or embossed with a pattern 292. As illustrated in Fig. 13, the pattern 292 comprises a honeycomb structure having a plurality of cells 294 (or pattern elements 294). Each cell 294 has a depth that corresponds to the thickness of the metal foil element 164 and, hence, the flexible protection member 106. Thus, according to this example embodiment, an acceptable depth for each cell 294 is 0.2 millimeters for a metal foil element 164 having a thickness of 0.2 millimeters. Also, the pattern 292 and cells 294 are sized and arranged to repeat the pattern 292 within a distance referred to as a mesh width. In accordance with this example embodiment, the mesh width comprises 10 millimeters, meaning that the pattern 292 and cells 294 repeat themselves every 10 millimeters.

[0058] While this example embodiment has been described with reference to a flexible protection member 106 having a honeycomb pattern 292, it should be understood and appreciated that the flexible protection member 106 may, in other example embodiments, have other types of patterns 292 that are formed with linear, non-linear, specifically-shaped, and arbitrarily-shaped elements, alone or in combination, and be formed with different mesh widths. For example and not limitation, the flexible protection member 106 of another example embodiment may have patterns 292 including lines, arcs, ellipses, polygons, or other geometric and non-geometric elements. It should also be understood and appreciated that the flexible protection member 106 of other example embodiments may have patterns 292 made by methods other than imprinting or embossing such as, for example but not limitation, molding, stamping, surface printing, or surface etching.

[0059] Additionally, it should be understood and appreciated that the flexible protection member 106 of other example embodiments may have patterns 292 formed by texturing of the element's front and/or back surfaces including, absent limitation, by the addition and/or removal of a material(s) to the front and/or back surfaces of the flexible protection member 106, or by the addition and/or removal, partially or entirely, of a coating, film, or other material(s) applied to the front and/or back surfaces of the flexible protection member 106. In addition, it should be understood and appreciated that while the flexible protection member 106 has been described with reference to Fig. 13 as being formed by a single layer of fire resistant material, the flexible protection member 106 may also be formed in other example embodiments using any of the materials and according to any of the structures (including, without limitation, the multi-layer structures) for flexible protection members 106 described herein.

[0060] Fig. 14 displays a schematic, partial, front elevational view of a fire and smoke protection system 100 in accordance with a seventh example embodiment. The fire and smoke protection system 100 is substantially similar to the fire and smoke protection system 100 of the first example embodiment, but includes a flexible protection member 106 having a multilayer structure in which a metal foil element 164 is interposed, or sandwiched, between a first layer 296 formed of a first wire mesh element 298A and a second layer 300 formed of a second wire mesh element 298B. In Fig. 14, the first layer 296 and metal foil element 164 near the corner of the flexible protection member 106 formed between longitudinal edge 114A and lateral edge 112B are peeled away to expose the multi-layer structure and for clarity. While not required, one or more of the metal foil element 164, first wire mesh element 298A, or second wire mesh element 298B may be connected together such as by contact welding. According to this and other example embodiments herein, the wire mesh elements 298 are manufactured from the same, or a similar, material as that of the metal foil element 164 including, but not limited to, an austenitic steel like, or similar to, the steels described above.

[0061] The flexible protection member 106 comprises a plurality of elongate strips 302 that extend in a lateral direction beyond lateral edges 112A, 112B and into respective first and second guides 110A, 110B to aid in guiding the flexible protection member 106 during reconfiguring of the system 100 between a storage configuration and protection configuration. The elongate strips 302 are secured to the flexible protection member 106 by clamping using elongate clamping members 232 (not shown) and methods similar to those described above with reference to Figs. 18 and 20. Each elongate strip 302 is positioned at a distance, "D", relative to the immediately preceding and succeeding elongate strips 302 in the longitudinal direction. A distance, D, acceptable in accordance with this example embodiment, includes fifty (50) centimeters. Alternatively, since the multi-layer structure of the flexible protection member 106 comprises a metal foil element 164 and wire mesh elements 298A, 298B, the elongate strips 302 may be welded, in other example embodiments, to the flexible protection member 106 in lieu of being clamped to the flexible protection member 106 using elongate clamping members 232. In still other example embodiments, the flexible protection member 106 comprises elongate

strips 302 that are present in addition to elongate clamping members 232.

[0062] Advantageously, the first and second wire mesh elements 298A, 298B generally have a higher tear resistance than the metal foil element 164. Typically, if the metal foil element 164 is hit by a water jet at a particular location, the metal foil element 164 will yield, bulge and possibly tear at the location. However, when reinforced and supported with an adjacent wire mesh element 298 as in this and other example embodiments, the notch stress at the base of the tear is small and the tear in the metal foil element 298 does not spread.

[0063] It should be understood and appreciated that while the flexible protection member 106 has been described with reference to Fig. 14 as being formed with wire mesh elements 298A, 298B, the flexible protection member 106 may alternatively be formed by substituting elements made from fire resistant materials, described or not described herein, for one or both of the wire mesh elements 298A, 298B. Also, it should be understood and appreciated that while the flexible protection member 106 has been described as comprising a particular multi-layer structure, the flexible protection member 106 may alternatively be formed using any of the materials and according to any of the structures (including, without limitation, the single and multi-layer structures) for flexible protection members 106 described herein.

Reference numerals

[0064]

100	smoke protection system	246	pre-tensioning member
102	opening	250	pipng/welt member
104	wall	252	pipng/welt
106	protection member	253	loop
108	winding shaft	254	recess
109	winding shaft motor	258	retaining member
110	guide	264	clamping clip
112	lateral edge	268	central position
114	longitudinal edge	270	channel
116	rail	272	pivot pin
118	foot	274	part
164	metal foil element	276	part
230	elongate segment	290	front surface
232	clamping member	292	pattern
234	fold line	294	cell
236	portion	296	first layer
238	portion	298	mesh element
240	clamping rod	300	second layer
242	bore	302	strip

Claims

1. A smoke or fire protection device to seal an opening (12) comprising

- (a) a flexible protection member (106) that can be put in a protection arrangement in which the protection element (106) counteracts the spread of smoke and/or fire through the opening (12), and can be put in a storage arrangement in which the opening (102) is unsealed, **characterized by** the fact that
- (b) the protection element (106) only comprises

- metal foil or
- metal foil and a wire mesh.

2. The smoke or fire protection device according to claim 1, **characterized in that** the metal foil has a thickness of more than 100 μm .

3. The smoke or fire protection device according to any of the preceding claims, **characterized by** a winding shaft (108) about and onto which the flexible protection member (106) is fully-wound when the system (100) is in the storage arrangement so as not to occlude the opening (102).
- 5 4. The smoke or fire protection device according to any of the preceding claims, **characterized in that** the flexible protection member (106) comprises a plurality of elongate segments (230) and that each elongate segment (230) is formed from a single layer of metal foil.
- 10 5. The smoke or fire protection device according to claim 4, **characterized in that** the flexible protection member (106) comprises a plurality of elongate clamping members (232) (with each elongate clamping member 232 extending between and coupling adjacent elongate segments 230). [0119]
- 15 6. The smoke or fire protection device according to any of the preceding claims, **characterized in that** the flexible protection member (106) is imprinted or embossed with a pattern (292).
7. The smoke or fire protection device according to any of the preceding claims, **characterized in that** the metal foil element (164) is manufactured from a steel whose yield strength increases with heating.
- 20 8. The smoke or fire protection device according to any of the preceding claims, **characterized in that** the metal foil element (164) is manufactured from dual phase steel.
- 25 9. The smoke or fire protection device according to any of the preceding claims, **characterized in that** the flexible protection member (106) has a pattern (292) formed by texturing of the element's front and/or back surfaces by the addition and/or removal, partially or entirely, of a coating, film, or other material(s) applied to the front and/or back surfaces of the flexible protection member (106).

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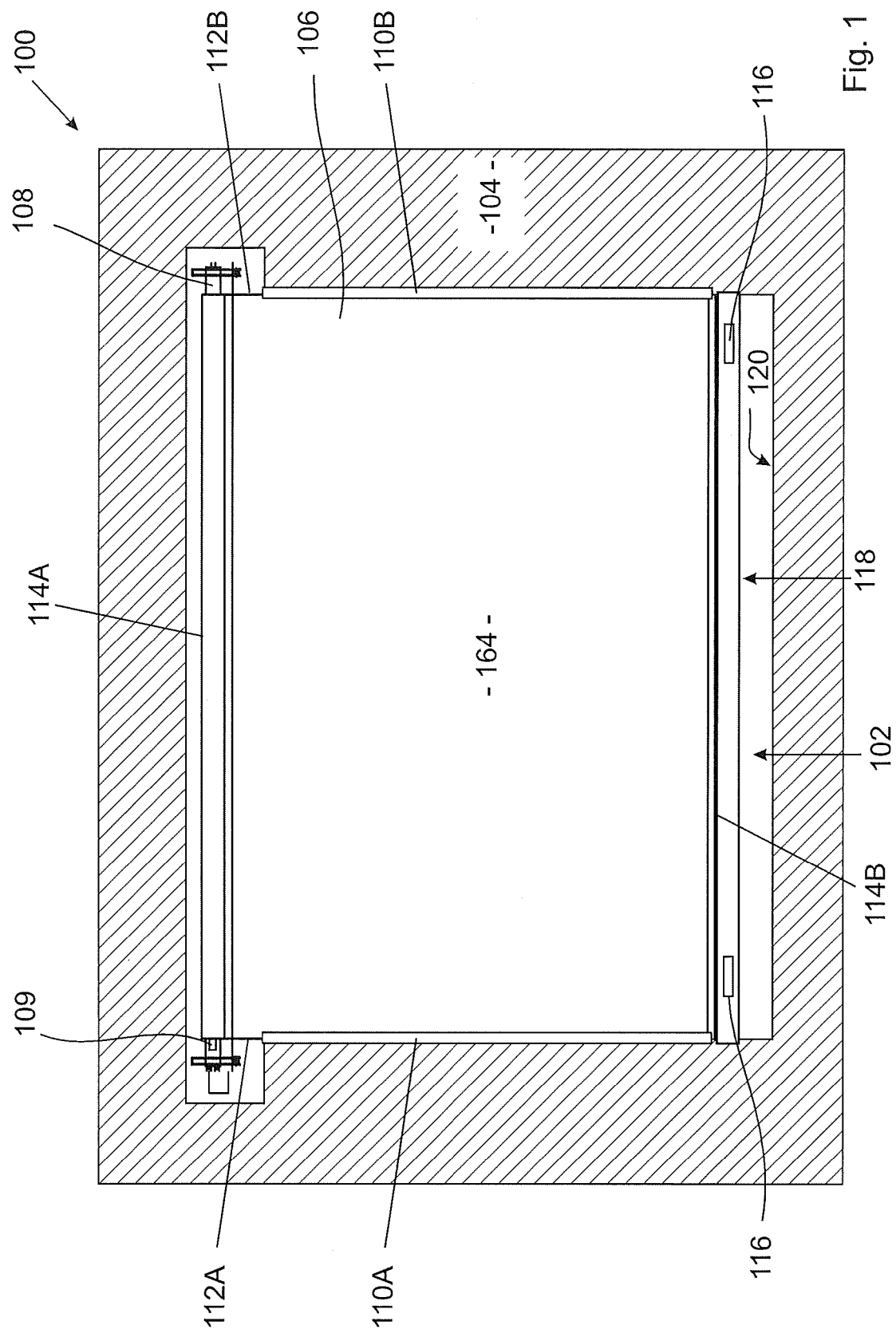
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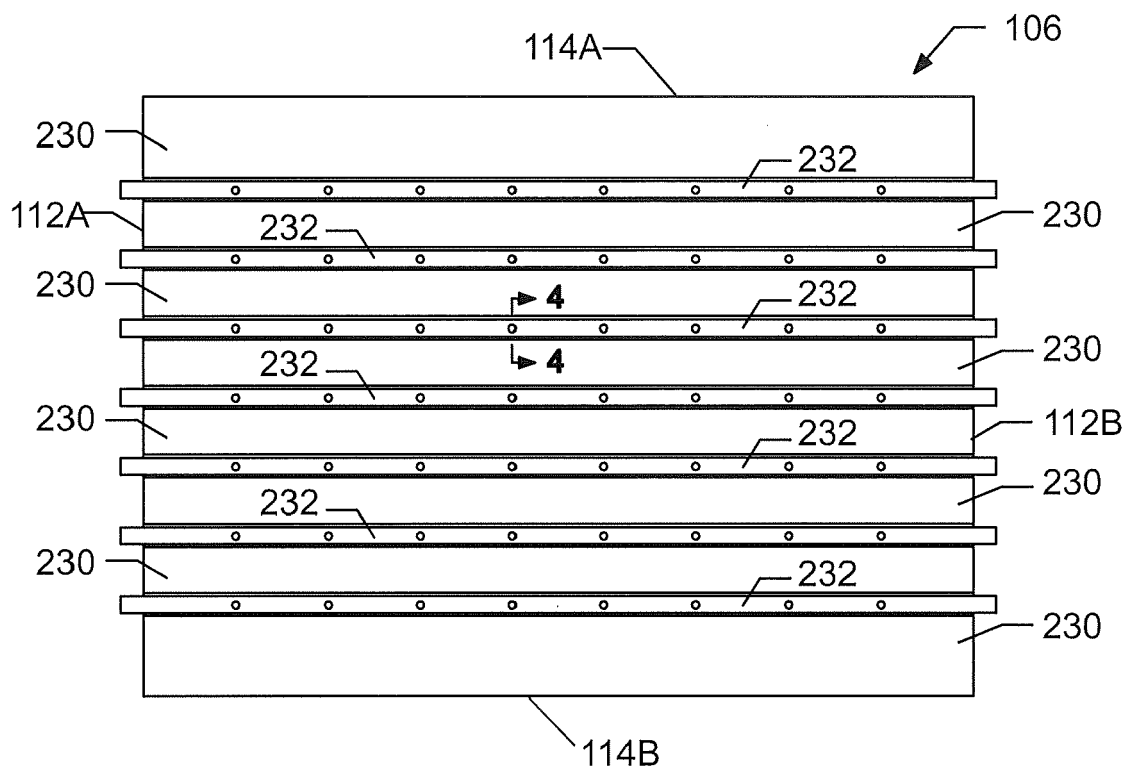


Fig. 2

FIG. 3

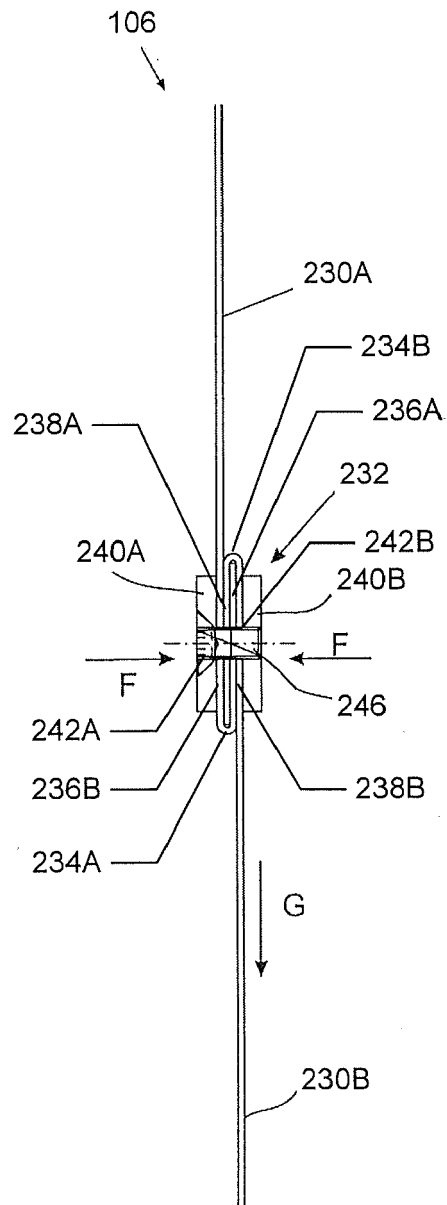


FIG. 4

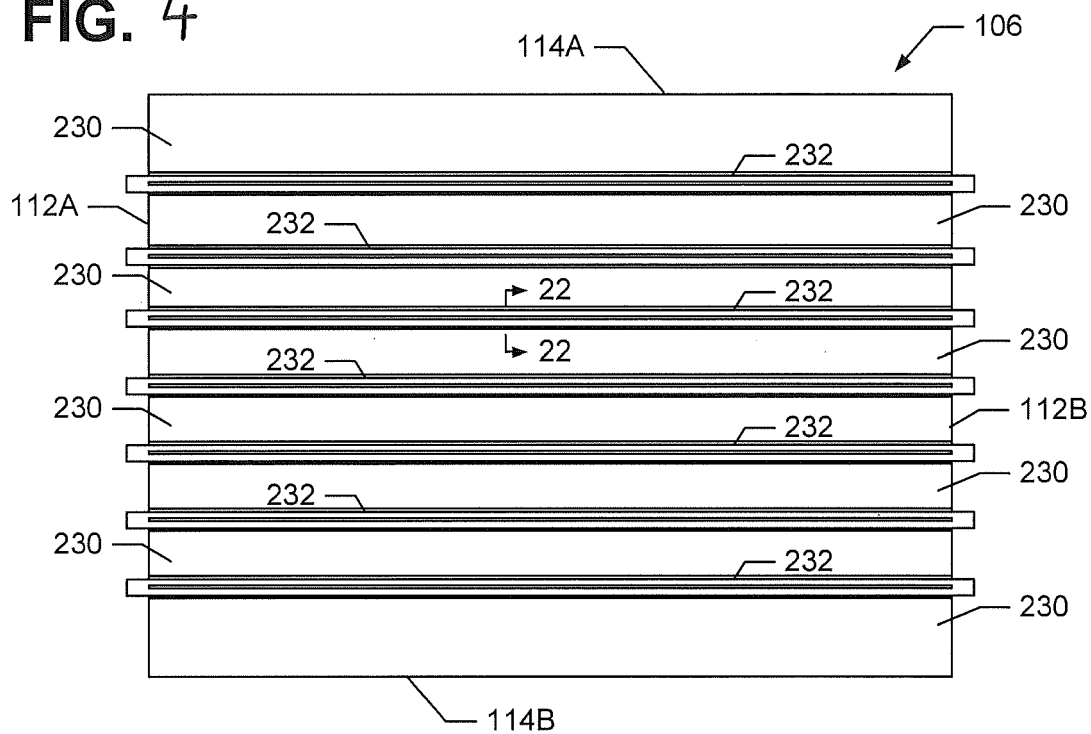


FIG. 6

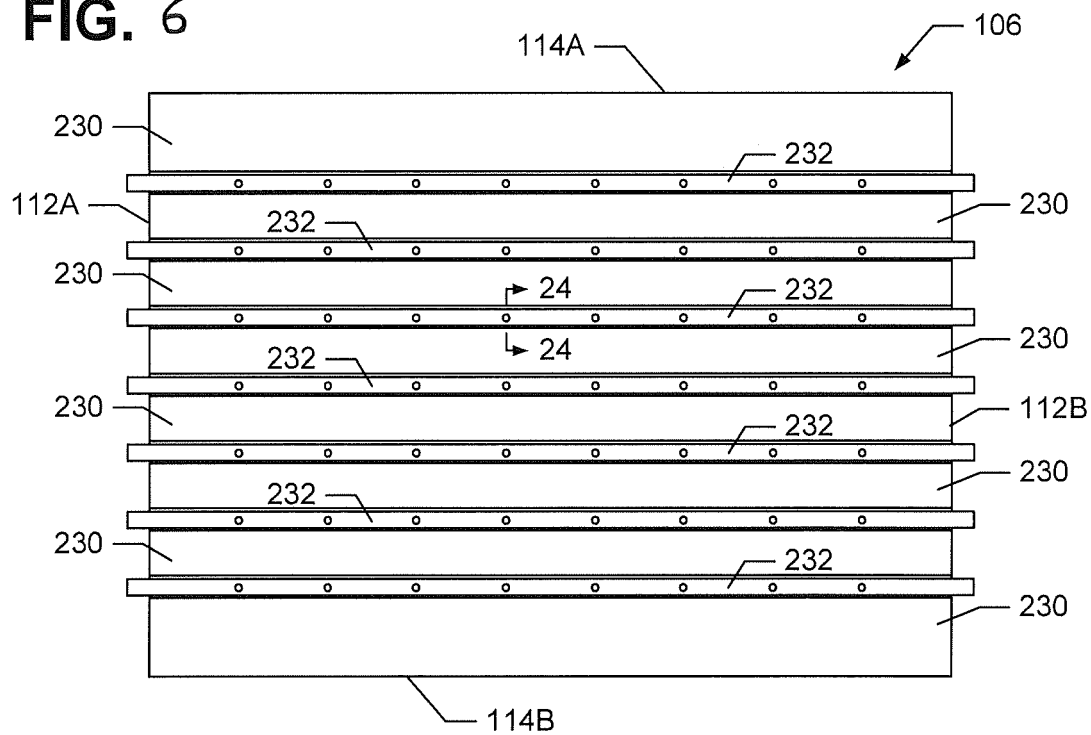


FIG. 5

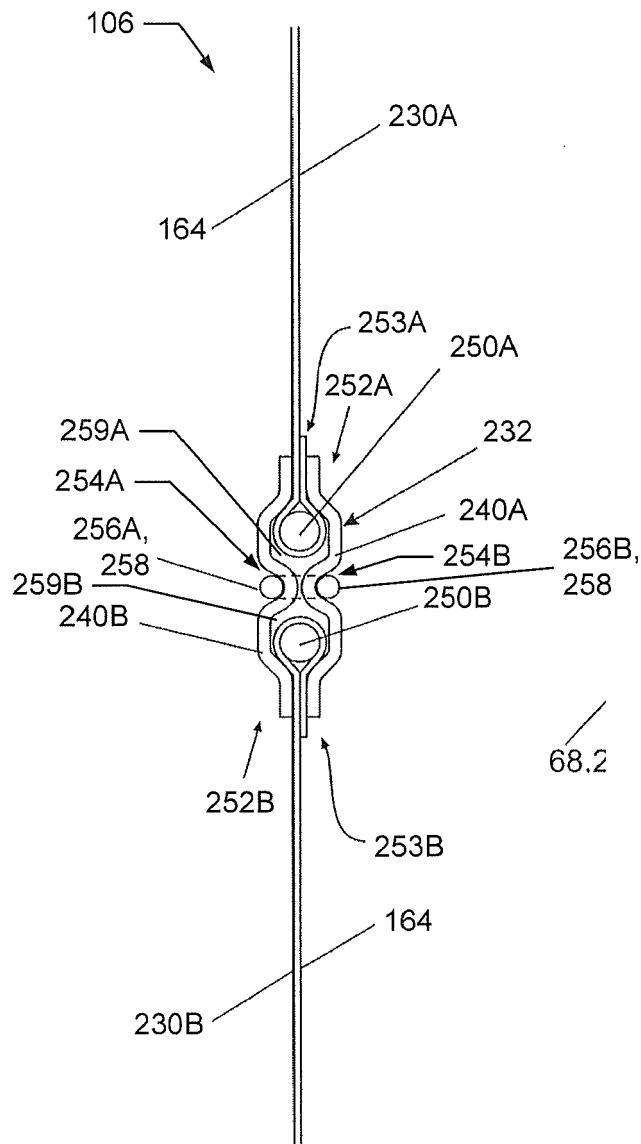


FIG. 7

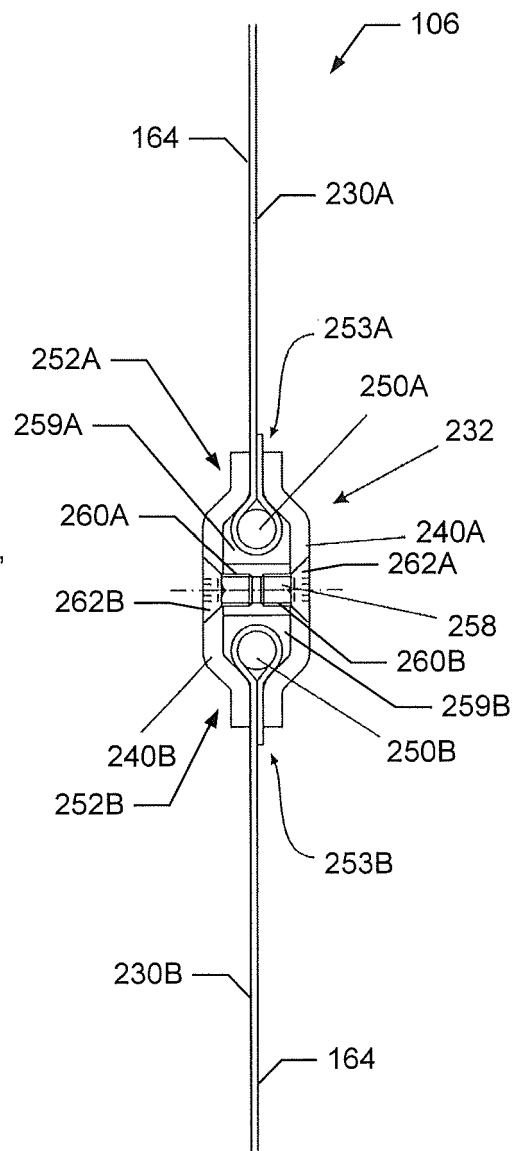


FIG. 8

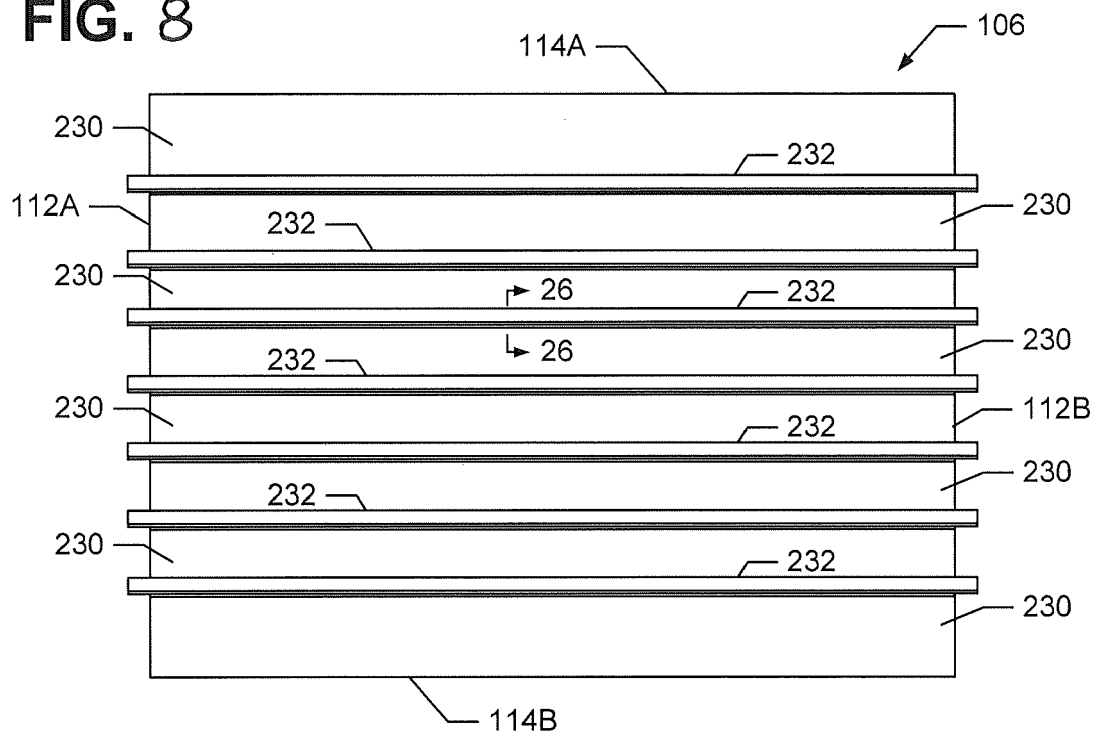


FIG. 10

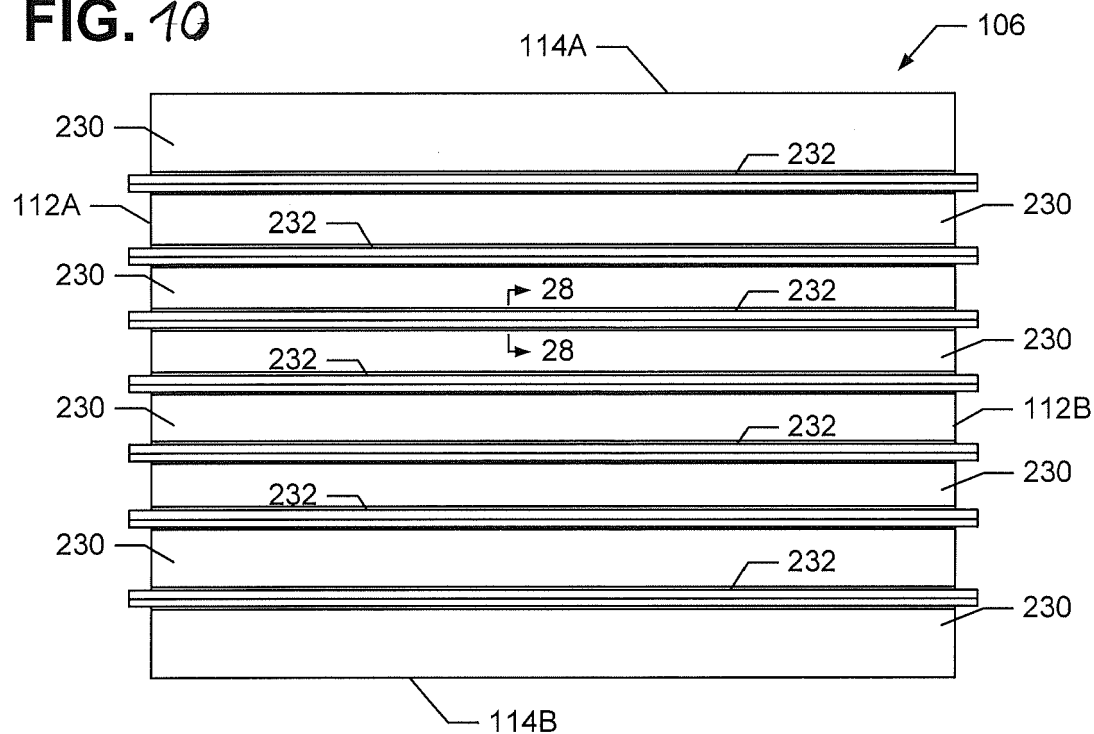


FIG. 9

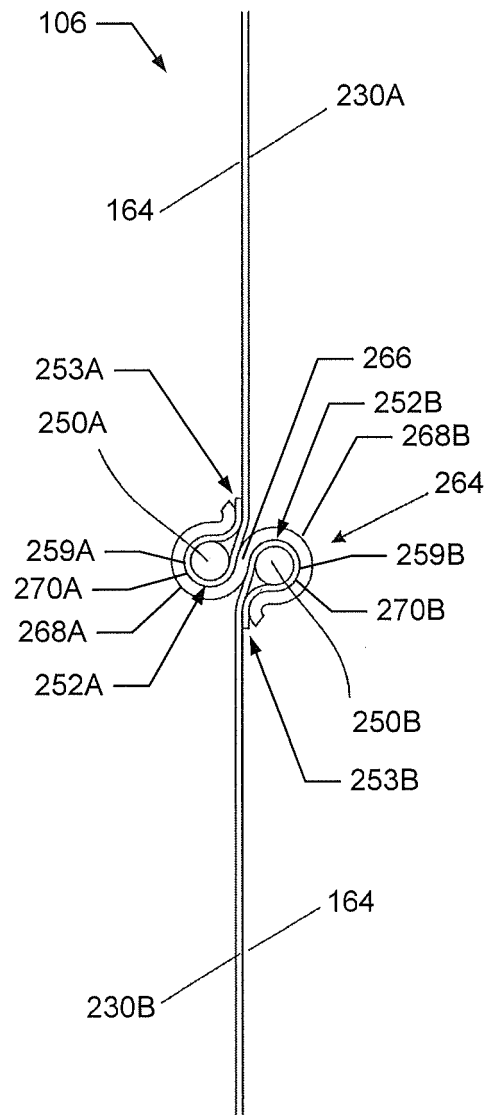


FIG. 11

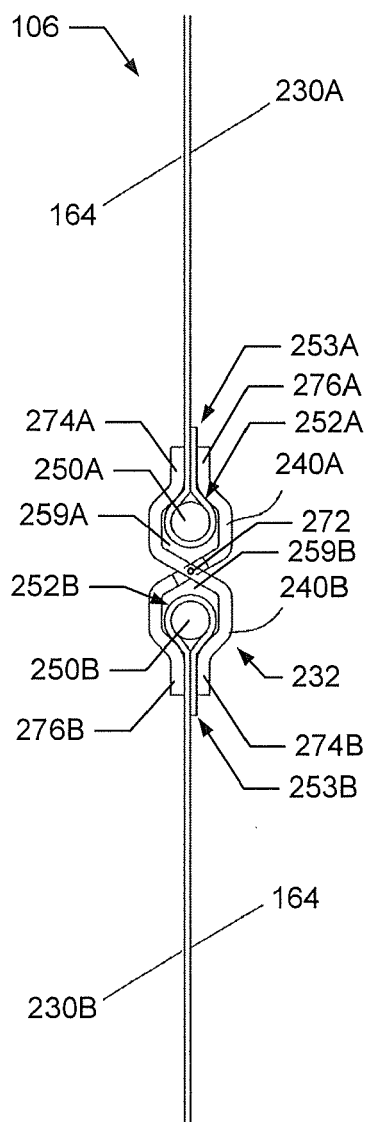


FIG. 12

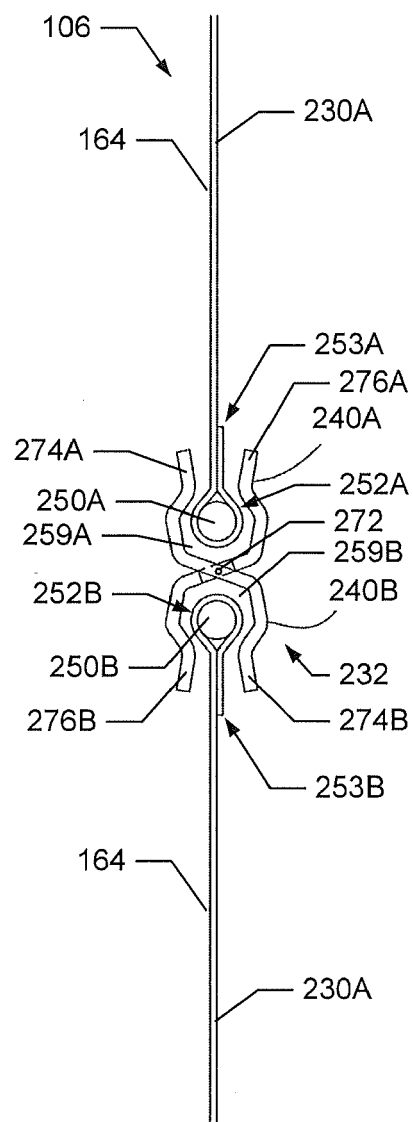


FIG.13

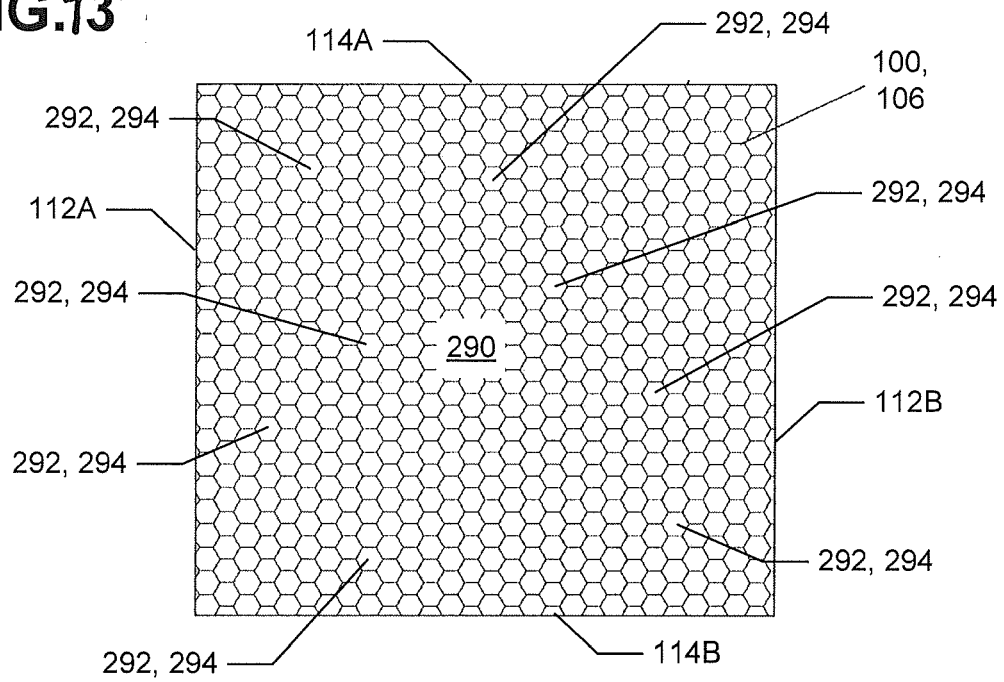


FIG. 14

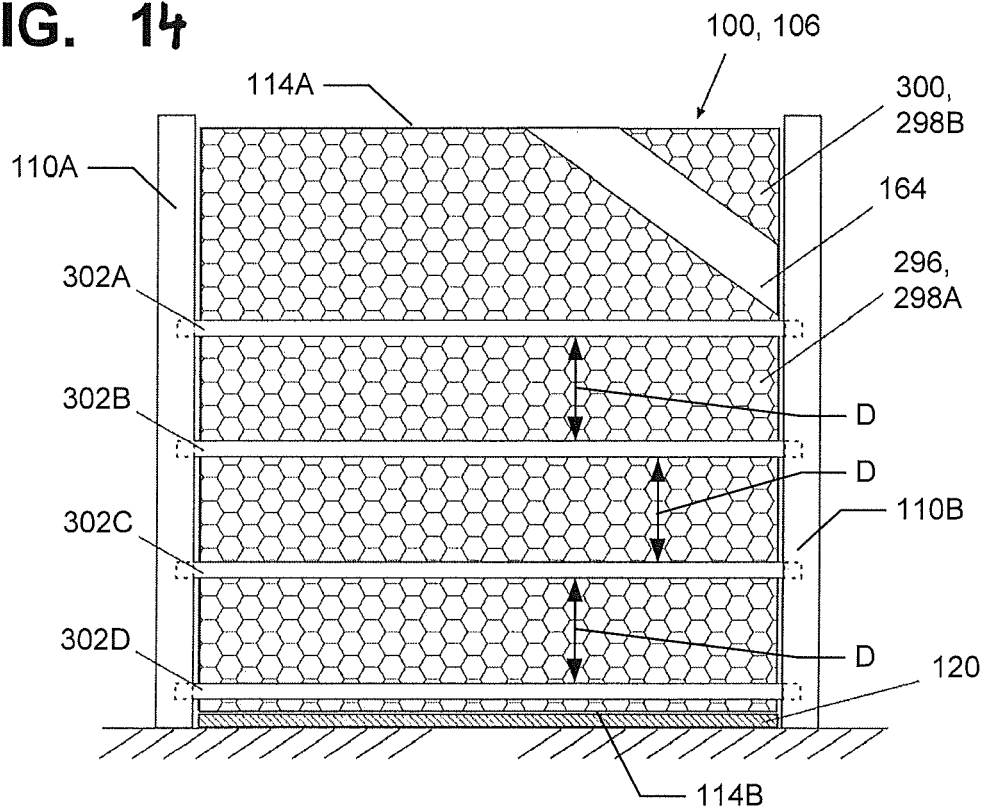


FIG. 15

