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(54) STRUCTURAL REINFORCED COMPOSITE BEAM

STRUKTURELLER BEWEHRTER VERBUNDTRÄGER

POUTRE STRUCTURALE COMPOSITE RENFORCÉE

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Description

BACKGROUND OF THE INVENTION

1. Technical Field

[0001] This invention relates generally to beam assemblies for use in structural support applications.

2. Related Art

[0002] Structural beams are typically made of steel or wood. Each has its advantages and disadvantages. Composite plastics material has been used for railroad beam applications but likewise has its limitations.

[0003] While wood is readily available and relatively inexpensive, it has attributes which make it less than an ideal material for use in exterior beam applications. Woods beams are known to have inconsistent performance over their life span even when used under the best conditions. The wood in a new beam will continue to season and shrink over time. The environment also has a tremendous impact on the performance and integrity of the wood. When exposed to wet conditions, the wood absorbs water and becomes water-logged and heavy. Soaked wood can lose as much as 2/3 of its beam strength which has a direct impact on the load-carrying capacity of the beam. Wood is further prone to fungus and insect attack, rotting and deterioration, especially in extremely harsh, wet applications, greatly limiting the useful service life and safe utilization of wooden beams. Even extreme dry conditions present a problem of embrittlement and dry rot for wood. Wood can be quickly eroded under the load and abuse of heavy equipment, especially tracked vehicles, the caterpillar tracks of which are prone to digging into wood beams and gouging and shredding the wood fiber if exposed. Such wear and tear on exposed wood beams is greatly magnified in wet operating conditions and serves to thin the beams and create crack-initiation risers at the surface which further compromise the integrity load-carrying capacity of wood beams under heavy load.

[0004] Wood used in beam applications is sometimes treated with chemicals to help preserve the wood in wet conditions. Wood will also soak up any oil and other chemicals that it may come into contact with at a construction site. Some of these chemicals are toxic to the environment and can be leached back into the soil.

[0005] US2004/062915A1 discloses reinforced composite structural members formed by bonding reinforcing sections to external areas of a hollow profile formed of a thermoplastic resin cellulosic fiber composite material. JP2000-064505A discloses carbon fiber reinforced plastic composite steel aggregates for columns and beams. US2012/011804A1 discloses poles for supporting electric transmission lines. CN201671224U discloses a purline structure for use as a roof support in the field of house construction. EP1084816A2 discloses a component having a plastic body with ribs connected to a metal or reinforced plastic reinforcing member.

SUMMARY OF THE INVENTION

[0006] A composite beam assembly constructed according to one preferred embodiment of the invention comprises at least one beam member fabricated of plastics-based composite material and at least one flitch plate which may be fabricated of steel or other similarly performing material such as glass fiber reinforced resin. The at least one beam member and flitch plate are secured tightly together and the combination enhances the overall structural rigidity and beam strength of the beam assembly beyond what the at least one composite beam and flitch plate alone or in combination would provide in a disassembled state. The flitch plate has a longitudinal length and has top and bottom surfaces defining a height therebetween and first and second side surfaces defining a width therebetween. The composite beam assembly further comprises a rod extending laterally through holes formed in the flitch plate and beam. The rod compresses the flitch plate and beam against each other in a lateral direction. The width of the beam is greater than the width of the flitch plate. The flitch plate is secured to the beam to provide additional stiffness to the beam. The hole in the flitch plate is in the form of a slot extending in the longitudinal direction to allow relative longitudinal movement between the flitch plate and the beam in response to longitudinal expansion and contraction of the beam.

[0007] The structural reinforced composite beam assembly constructed according to a preferred embodiment of the invention has the advantage of being lighter, stronger, longer lasting and consistent in performance during its extended lifecycle than timber beams for outdoor applications in particular and its plastics-based beam members do not shrink overtime. The beam assembly does not lose strength in prolonged wet conditions, nor does it absorb water, rot or otherwise deteriorate during use or exposure. The beam assembly can be pre-engineered to the strength and load requirements of a particular job and will maintain its properties throughout its service life, unlike a wood beam.

BRIEF DESCRIPTION OF THE FIGURES

[0008] These and other features and advantages of the invention will be better understood when considered in connection with embodiments of the invention illustrated in the following figures and described in greater detail below:

Figure 1 is a perspective view of an embodiment of a structural reinforced composite beam assembly including two beam members and a flitch plate;
Figure 2 is a cross-sectional view of the beam assembly;
Figure 3 is a fragmented exploded view of one of the

beam members and the flitch plate, illustrating holes extending therethrough for receiving a rod;
Figure 4 is a cross-sectional view of another beam assembly held together with a clamp which is not part of the invention;
Figure 5 is a cross-sectional view of another beam assembly held together with a band which is not part of the invention;
Figure 6 is a fragmentary view of the flitch plate having a textured surface;
Figure 7 is a cross-sectional view of another beam assembly having a flitch plate with projections that pierce the material of the beam members;
Figure 8 is a cross-sectional view of another beam assembly having a flitch plate with ribs and/or posts that are received in the beam members;
Figures 9A-9D are cross-sectional views of another beam assembly and alternative flitch plates, where the flitch plates have a convex and/or concave outer surface;
Figure 10 is a cross-sectional view of another beam assembly with an alternative flitch plate;
Figure 11 is a cross-sectional view of another beam assembly with an alternative flitch plate;
Figure 12 is a cross-sectional view of another beam assembly with an alternative flitch plate;
Figure 13 is a cross-sectional view of another beam assembly with an alternative flitch plate;
Figure 14 is a cross-sectional view of another beam assembly with two flitch plates;
Figure 15 is a cross-sectional view of another beam assembly with two flitch plates;
Figure 16 is a cross-sectional view of another beam assembly with two flitch plates;
Figure 17 is a cross-sectional view of another beam assembly with an alternative flitch plate;
Figure 18 is a cross-sectional view of another beam assembly with two flitch plates;
Figure 19 is a cross-sectional view of another beam assembly with two flitch plates on opposite lateral sides of the beam member;
Figure 20 is a cross-sectional view of another beam assembly with two beam members and three flitch plates, with two of the flitch plates on opposite lateral sides of the beam assembly and one of the flitch plates between the two beam members;
Figure 21 is a cross-sectional view of another beam assembly with two beam members and two flitch plates, with one lateral side of the beam assembly free from a flitch plate; and
Figure 22 is a cross-sectional view of another beam assembly with one beam members and one flitch plate, with the flitch plate being on one side of the beam member.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0009] A structural reinforced composite beam assembly constructed according to an embodiment of the invention is generally shown in perspective view in Figure 1 and indicated by reference numeral 10.

[0010] The assembly 10 has a top surface 12, a bottom surface 14, longitudinally opposite ends 16 and laterally opposite sides 18. The beam assembly 10 has an overall length dimension Lbeam extending between the two ends 16, an overall width dimension Wbeam extending between the two sides 18, and an overall thickness Tbeam dimension extending between the top 12 and bottom 14 surfaces.

[0011] The assembly 10 illustrated in Figure 1 includes at least one and, as illustrated, a pair of individual beam members 20 and at least one flitch plate 22.

[0012] The beam members 20 each have a thickness dimension Tb, a width dimension Wb, and a length dimension Lb.

[0013] The beam members are of a plastics (polymer) material, preferably a structural thermoplastic composite polymer. One such material suitable for the beams 20 is an HDPE-based proprietary structural composite plastic beam material available from Axion Structural Innovations, of Zanesville, Ohio. Such plastics material comprises a blend of polypropylene and polyethylene (PP:PE) , but predominately polyethylene with 5-50% glass fiber reinforcement, and more preferably 5-25% glass fiber reinforcement. Other HDPE-based plastics materials may also be suitable depending upon the structural load requirements of a particular application, as well as plastics materials in general provided they are able to meet the load and strength and environmental requirements that a particular application may call for. It is thus to be understood that the invention contemplates the usage of a variety of plastics materials and plastic based composite material systems as the beam 20 material, particularly when coupled with the structural, load-enhancing flitch plate 22 to be explained in more detail below. The idea is that the composite plastics beams 20 and metallic flitch plate(s) 22 work in synergy to collectively provide a lightweight, strong and water/chemical resistant beam assembly suitably reinforced by the flitch plate(s) 22 to yield the strength and rigidity required of a particular job application for which the assembly 10 is to be used. The flitch plate(s) 22 thus open up the possibilities for the types of candidate plastics materials beyond what may be otherwise suitable for beam application on their own without the flitch plates. For example, plastics materials that on their own may not possess the strength or rigidity required for use on their own as beams 20 may well become suitable when paired with one or more flitch plates 22, such that the overall structure is able to meet the requirements of an application.

[0014] The dimensions of the individual beams 20 may vary depending upon the requirements of a particular ap-

plication and the material used for the beams. For example, the beam 20 may have a thickness Tb x width Wb x length Lb of, respectively, 22.86 cm x 17.78 cm x 7.34 m (9 inches x 7 inches x 24 feet). As will be explained below, the beam 20 may be turned on edge such that the TxWxL dimensions are now 17.78 cm x 22.86 cm x 6.10 m (7" x 9" x 20') as in the embodiment of Figure 4.

[0015] The flitch plate(s) 22 is preferably fabricated of metal and preferably steel. The grade of steel may be ASTM A36. The flitch plate(s) 22 each have a thickness dimension Tflitch, a width dimension Wflitch, and a length dimension Lflitch. For the 7.34 m (24 foot) beam 20 above with a 22.86 cm (9") thickness, the T, W and L dimensions of the flitch plates 22 are, for example, 21.59 cm x 1.27 cm x 7.32 m (8.5 inches x 0.5 inches x 288 inches). For the 17.78cm (7") beam thickness embodiment of Figure 4, the thickness of the flitch plates 22 is reduced to 16.51 cm (6.5"), the width reduced to 0.64 cm (0.25 inches), and the length reduced to 6.05 m (238 inches). Other materials could be used in the construction of the flitch plates, such as glass fiber reinforced resin. The selected material for the flitch plates will be different than the material of the beams. The thickness of the flitch plate(s) may vary depending upon the application.

[0016] As illustrated in Figures 1-2, the beams 20 and flitch plate(s) 22 extend in the lengthwise direction of the assembly 10. The beams 20 are arranged adjacent to one another. In between the beams 20 is provided at least one flitch plate 22. There may be additional flitch plates 22 between the beams 20 or to the outside of the beams 20.

[0017] It will be seen by a comparison of the dimensions that the flitch plates 22 are considerably narrower in width than that of the beams 20, and are slightly smaller in thickness (vertical height) and length than that of the beams 20. Preferably, at least the top edge of the flitch plates 22 is recessed below the top surface 12 of the beams 20. The invention does contemplate having one or more portions of the flitch plate projecting outwardly beyond a surface of the beams and such projecting feature (such as an ear) may function as an anchor point, a tie or strapping point for lifting or moving the mat, for example or securing the mat to something or something to the mat. The ear could also serve as a interconnection feature that may cooperate with a similar feature on an adjacent mat for linking the mats together with, for example, a rod extended through aligned openings on the ears. Recessing the flitch plates 22 below the surface of the beams 20 serves to keep the flitch plates 22 out of direct contact with equipment that may be moved against 10, or out of direct contact with additional structure to which the assembly 10 is mounted. For example, if the beam assembly 10 is used in a construction environment, for instance as support structure for building, adjacent structure may be kept out of contact with the flitch plate 22, protecting each from unnecessary wear or damage. The recessing of the flitch plate(s) 22 may also serve as a wear indicator of the beams 20, such that when the flitch plates 22 become exposed the users know it is time to replace the worn beams 20. And even if the flitch plates 22 do become exposed to the surface, the structural integrity of the assembly 10 remains intact. It may be desirable to recess the flitch plate(s) 22 from both the top 12 and bottom 14, especially if the assembly 10 is to be reversible in nature such that both surfaces may be at times facing upward and directly engaged by other structure, vehicles, or the like.

[0018] Another reason to recess the flitch plate(s) 22 from the bottom 14 as well is to keep the plates 22 from engaging the surface of adjacent structure on which the beam assemblies 10 are supported, especially if there is concern of damage that may be caused by direct exposure to metal edges of the flitch plate(s) 22. The length and width of the flitch plates 22 is at least 90% that of the length and width of beams 10 and with the edge surfaces of the flitch plates 22 preferably being recessed below the exposed top, bottom and end surfaces of the beams 20. Beams 20 may also display surprising surface durability and toughness, exhibiting a lack of chipping when exposed to other metal structure. These properties of the beams 20 may extend the useful life of protecting the flitch plates 22 in the assembly 10.

[0019] As illustrated in farther detail in Figure 2, the beams 20 and flitch plate(s) 22 are ganged together and secured by rods or bolts 24 that extend cross-wise to the beam assembly 10 between its opposite sides 18. There are a plurality of such rods 24 shown in the example. The rods 24 serve to tightly clamp the facing side surfaces of the beams 20 and flitch plate(s) 22 into firm frictional engagement with one another, thereby actively binding them against lateral and longitudinal movement that serves, together with the shear load of the rods 24, to transfer loading applied to the upper surface of the beams 20 to the flitch plates 22 consistently and predictably over the life of the assembly 10. The beams 20 and flitch plate(s) 22 are provided with cross holes 26, 28 that are positioned and dimensioned to receive the rods 24. The rods 24 may be 2.54 cm (1 inch) rods and preferably #7 Matlock® bolts and the holes in the beams 20 may measure about 2.69 cm (1.06"). The holes 28 in the flitch plates 22 are aligned with the holes 26 of the beams 20.

[0020] With reference to Figure 3, the holes 28 of the flitch plates 22 are preferably slotted in the lengthwise direction with rounded ends and a flat middle of the slot. The dimensions of the slotted holes 28 may be, for example, 2.69 cm (1.06") in height (i.e., the same as the height dimension of the holes 26 of the beams 20), and a length of 3.81 cm (1.5"). The extension of the holes 28 in the lengthwise direction of the flitch plates 22 is designed to accommodate the different coefficients of expansion of the plastic beams 20 and the metal flitch plates 22, which may cause the beams 20 to expand disproportionately to that of the flitch plates 22, particularly in the lengthwise direction where the extension of the materials may be the greatest. The slots thus allow the beams 20 to shift, as necessary, in the lengthwise direction due to

slight lengthening/retracting of the beams 20 relative to the flitch plates 22 with temperature changes so as not to cause binding and potential warpage of the beams 20 and flitch plates 22. Because of the relatively small cross section in the thickness (height) dimensions between top and bottom surfaces, the degree of lengthening/retraction is insignificant and so the height dimension of the slots 28 in the flitch plates can be the same as that of the holes 26 in the beams 20, such that their relative positions in the vertical direction never change with temperature.

[0021] While in accordance with the invention the flitch plate 22 and the beam 20 are described above as being fixed to each other via the use of the rods 24 to create a frictional engagement therebetween, the flitch plate 22 and beam 20 may be secured to each other in other ways which are not part of the invention. For example, the flitch plate 22 may be secured to the beam via the use of adhesives, bonding, welding, or brazing. In another approach, a screw may be threaded into one or more beams 20 to secure the beams 20 and the flitch plate 22. In yet another approach, a nut/bolt mechanism may be used, in which at least one nut is threaded over the end of a bolt extending through the beams 20 and flitch plate 22.

[0022] In yet another approach which is not part of the invention, shown in Figure 4, a mechanical clamp 32 may be placed over the assembly 10 to press the beams 20 and flitch plate 22 against each other. Similarly, as shown in Figure 5 which is not part of the invention, bands 34 may be applied around the assembly 10 to secure the beams 20 and flitch plates 22.

[0023] The flitch plate(s) 22 may be fabricated from steel plate stock or other similarly performing material, such as fiberglass, of suitable dimensions, examples which are provided above.

[0024] The flitch plate(s) 22 may have smooth sides or may, alternatively, have grip-enhancing features, such as knurling or other textured features 30, along some or all of the side surfaces, as shown in Figure 6. The texturing may be on one or several or all of the flitch plates 22. The texturing acts as an enhanced passive load transfer mechanism, wherein loading on the surface of the beams 20 is transferred in part to the flitch plates 22 through the gripping, friction action of the texturing. The bolts or rods 24 serve as active load transferring features wherein the load applied to the beams 20 is born in shear by the bolts 24 which are also supported by and transfer load to the flitch plates 22.

[0025] Additionally, or alternatively, the flitch plates 22 may include other grip enhancing features. For example, the flitch plates may include projections 40 that extend outward from the surfaces of the flitch plates 22, as shown in Figure 7. The projections 40 may be in the form of small spikes, points, hooks, or the like that act to pierce the adjacent surface of the beam 20 when compressed together. The projections 40 may be distributed substantially across the entire length of the flitch plate 22, or they may be distributed over portions of the flitch plate 22, with the remainder of the flitch plate being smooth or otherwise textured but free of the projections 40. The projections 40 may act as a passive load transferring mechanism, similar to the textured surface described above.

[0026] As shown in Figure 8, the flitch plate 22 may also include posts 42 or ribs 44 extending outwardly from the surfaces of the flitch plate 22, in a manner similar to the projections 40. The posts 42 or ribs 44 may be larger than the projections 40, and may be configured to be received in corresponding holes or grooves formed in the beam 20. The posts 42 or ribs 44 may therefore act in a manner similar to the rod 24 as an active load transfer mechanism. The posts 42 and/or ribs 44 may be distributed along substantially the entire length of the flitch plate 22, or they may be limited to particular locations. As shown on the left side of Figure 8, the rib 44 extends vertically. However, it will be appreciated that the rib 44 could also extend longitudinally along the beam 20, as illustrated by the right side of Figure 8, with the cross-section of the rib 44 appearing the same as the cross-section of the posts 42 in Figure 8.

[0027] As shown in Figures 9A-D, the flitch plate 22 may have concave outer surfaces that mate with corresponding convex outer surfaces of the beam 20. Alternatively, the flitch plate 22 may have convex outer surfaces that mate with a concave surface of the beam 20. The flitch plate 22 may include both a concave and a convex outer surface on opposite sides of the flitch plate 22, with corresponding mating surfaces of the beam. In yet another approach, the flitch plate 22 may include outer surfaces that are both concave and convex to define a complex curvature, with corresponding mating surfaces of the beam 20.

[0028] Figures 10 and 11 illustrate further alternative embodiments of the flitch plates 22, wherein the Figure 10 embodiment provides an L-shaped cross section for the flitch plate 22 and Figure 11 provides a T-shaped cross section. The short legs of the L and T are designed to engage a corresponding load-bearing surface of the beam(s) 20 and further provide load-transferring support to the beams 20. The short legs can all be arranged on one side (bottom of assembly 10) or be staggered to the top and bottom sides of the beam 10, and are preferably recessed below the outer surface(s) of the beams 20. Figures 10 and 11 illustrates the short legs of the L or T as being on the bottom of the beam assembly 10.

[0029] Figures 12-13 illustrates further alternative embodiments of the flitch plates 22, similar to the alternatives of Figures 10 and 11.

[0030] The Figure 12 embodiment provides a C-shaped cross section for the flitch plate 22. The short legs of the C are designed to engage a corresponding load-bearing surface of the beam(s) and further provide load-transferring support to the beams 20. The short legs can be arranged on both the top and bottom of the mat, and are preferably recessed below the outer surface(s) of the beams 20.

[0031] The Figure 13 embodiment provides an I-

shaped cross section (similar to a traditional I-beam) for the flitch plate 22. The short legs of the I-shape are designed to engage a corresponding load-bearing surface of the beam(s) and further provide load-transferring support to the beams 20. The short legs can be arranged on both the top and bottom of the mat, and are preferably recessed below the outer surface(s) of the beams 20.

[0032] As shown in Figures 14 and 15, multiple flitch plates 22 may be disposed between two of the beams 20, to create shapes similar to the T or I-shaped cross-sections. The Figure 14 embodiment utilizes two L-shaped flitch plates 22 to create a T-shape. The short legs of the Ls and the resulting T are designed to engage a corresponding load-bearing surface of the beam(s) and further provide load-transferring support to the beams 20. The short legs can all be arranged on one side (bottom of mat) or be staggered to the top and bottom sides of the beam assembly 10, and are preferably recessed below the outer surface(s) of the beams 20.

[0033] The Figure 15 embodiment utilizes two C shaped flitch plates 2 to create an I-shape. The short legs of the Cs that create the I-shape are designed to engage a corresponding load-bearing surface of the beam(s) and further provide load-transferring support to the beams 20. The short legs can be arranged on both the top and bottom of the mat, and are preferably recessed below the outer surface(s) of the beams 20.

[0034] Figure 16 illustrates another embodiment of combined flitch plates, in which two L-shapes are combined to create a Z-shape. The short legs of the Ls that create the Z-shape are designed to engage a corresponding load-bearing surface of the beam(s) and further provide load-transferring support to the beams 20. The short legs can be arranged on both the top and bottom of the mat, and are preferably recessed below the outer surface(s) of the beams 20.

[0035] Figure 17 illustrates another embodiment of the flitch plate, and provides a Z-shaped cross section (similar to the two Ls) for the flitch plate 22. The short legs of the Z-shape are designed to engage a corresponding load-bearing surface of the beam(s) and further provide load-transferring support to the beams 20. The short legs can be arranged on both the top and bottom of the mat, and are preferably recessed below the outer surface(s) of the beams 20.

[0036] Figure 18 illustrates two flat flitch plates 20 that may be combined to create an increased thickness flitch plate.

[0037] In each of the above described alternatives, the previously described features of the flitch plates 22 will also apply to the alternatives, such as the slots 28 and the surface feature 30.

[0038] The compressive strength of the composite beams greatly exceeds that of it wood counterparts. A surprising synergistic effect is realized when the high compression composite beams are paired with the flitch plates in the form of a beam assembly, wherein the bending load of the assembled assembly exceeds that of the collective load capacity of the beams and flitch plates alone. The high compression beams act to laterally support the flitch plates under bending load against beyond what would normally cause the flitch plate material to become wavy and buckle. Surprising levels of loading without failure are realized by the composite beam assembly described above Rather than buckling under extreme loads, the metallic flitch plate(s) will undergo a slight plastic deformation (stretching/thickening) of the opposing compressed and tensed edges of the flitch plates.

[0039] As shown in Figure 1, two beams 20 and one flitch plate 22 are assembled to define the overall assembly 10, along with the plurality of rods 24 extending laterally through the beams 20 and flitch plate 22. However, it will be appreciated that other quantities and arrangements of the beam(s) 20 and the flitch plate(s) 22 may also be used to create different support and stiffness properties of the assembly.

[0040] As shown in Figure 19, the assembly 10 includes a single beam 20 and two flitch plates 22. The flitch plates 22 are arranged on the lateral sides of the beam 20. As shown in the Figure 19, the flitch plates 22 are recessed inwardly relative to the outermost lateral surfaces of the beam 20. However, in another approach, depending on the target use of the assembly, the flitch plates 22 may be disposed over the outermost lateral surfaces of the beam, such that the lateral surfaces of the beam 20 are recessed inwardly from the edges of the flitch plate 22.

[0041] As shown in Figure 20, the assembly includes two beams 20 and three flitch plates, with one flitch plate 22 disposed between the beams 20, similar to the arrangement of the Figure 1, and two flitch plates disposed on the outermost lateral sides of the beam assembly 10, similar to the arrangement of Figure 19.

[0042] As shown in Figure 21, two flitch plates 22 and two beams 20 may be used, in which one lateral side of the assembly 10 is free from an attached flitch plate, and the other lateral side of the assembly 10 includes a flitch plate 22.

[0043] As shown in Figure 22, a single beam 20 and a single flitch plate 22 is assembled together, with the flitch plate 22 being disposed on one lateral side of the beam 10. The flitch plate 22 may be inwardly recessed relative to the outermost lateral surface of the beam 20, or the flitch plate may be placed over the outermost lateral surface of the beam 20.

[0044] It will be appreciated that further arrangements and quantities of beams 20 and flitch plates 22 may be used, including instances in which the lateral stackup of parts alternates between flitch plate and beam, or arrangements in which the lateral stackup has multiple flitch plates and/or beams adjacent each other and without the disposition of the other type of part therebetween.

[0045] Sometimes preservatives such as creosote, chromated copper arsenate (CCA), ammoniacal copper zinc arsenate (ACZA) and ammoniacal copper arsenate

(ACA) are used to treat wood timbers to protect against rot, and these materials may leach out of the lumber and into the environment. This does not happen with the assembly 10 made in accordance with the invention since its composite beams are not prone to moisture attack, do not require any chemical treatment, and do not absorb water or chemicals. The assembly 10 according to the invention remains inert and unchanged by the environment they occupy.

[0046] The beam assembly 10 may have further plating applied to the surface and/or ends and may further have coating applied to its surface(s) such as polymer coatings.

[0047] It is to be understood that the above drawings and description is exemplary of the construction and practice of embodiments of the invention and is not limiting of the invention. Rather, the invention is defined in the appended claims which follow.

Claims

1. A composite beam assembly (10) comprising:

a first plastic composite beam (20) having a longitudinal length and top and bottom surface (12, 14) defining a height therebetween and first and second side surfaces (18) defining a width therebetween; and

a flitch plate (22) having a longitudinal length and having top and bottom surfaces defining a height therebetween and first and second side surfaces defining a width therebetween;

wherein the width of the beam (20) is greater than the width of the flitch plate (22); and

wherein the flitch plate (22) is secured to the beam (20) to provide additional stiffness to the beam (20);

characterised in that the composite beam assembly (10) further comprises a rod (24) extending laterally through holes (28, 26) formed in the flitch plate (22) and beam (20), wherein the rod (24) compresses the flitch plate (22) and beam (20) against each other in a lateral direction;

wherein the hole (28) in the flitch plate (22) is in the form of a slot extending in the longitudinal direction to allow relative longitudinal movement between the flitch plate (22) and the beam (20) in response to longitudinal expansion and contraction of the beam (20).

2. The assembly of claim 1, wherein the flitch plate (22) is metal or fiber-reinforced resin.

3. The assembly of claim 1, further comprising a second composite plastic beam (20) secured to the flitch plate (22).

4. The assembly of claim 3, wherein the flitch plate (22) is disposed laterally between the first and second composite beams (20).

5. The assembly of claim 1, wherein the height of the flitch plate (22) is less than the height of the beam (20).

6. The assembly of claim 1, wherein the top of the flitch plate (22) is recessed relative to the top surface (12) of the beam (20), and the bottom of the flitch plate (22) is recessed relative to the bottom (14) of the beam (20).

7. The assembly of claim 1, wherein the flitch plate (22) includes a grip-enhancing feature (40) to increase friction between the flitch plate (22) and the beam (20).

8. The assembly of claim 1, wherein the flitch plate (22) includes a plurality of projections (40) that pierce the composite beam (20) or the flitch plate includes a plurality of posts (42) or ribs (44) extending from a surface thereof, wherein the posts (42) or ribs (44) are received in corresponding structure of the composite beam (20) when assembled.

9. The assembly of claim 1, wherein the flitch plate (22) has an L-shaped cross-section or a T-shaped cross-section having a long leg and at least one short leg, and the long leg and the at least one short leg each contact the composite beam (20).

10. The assembly of claim 1, wherein the assembly the first flitch plate (22) and the first composite beam (20) are the only flitch plate (22) and beam (20) of the assembly.

11. The assembly of claim 1, further comprising a second flitch plate (22), where the composite beam (20) is disposed laterally between the first and second flitch plates (22).

12. The assembly of claim 11, wherein the first and second flitch plates (22) are recessed inwardly from a laterally outermost surface of the beam (20).

13. The assembly of claim 1, wherein the flitch plate (22) has a C-shaped cross-section having a long leg and two short legs, and the short legs are recessed from an outermost surface of the beam (20) or the flitch plate (22) has an I-shaped cross-section with a long leg and four short legs, and the short legs are recessed from an outermost surface of the beam (20).

14. The assembly of claim 1, wherein the beam (20) comprises a blend of polypropylene and polyethylene (PP:PE) , but predominately polyethylene, with

5-50% glass fiber reinforcement; and wherein the flitch plate (20) is fabricated of steel or glass fiber reinforced resin material having a higher modulus of elasticity than that of said composite plastics beam material, said beam (20) and said flitch plate (22) being secured tightly together in side-by-side contacting relation and the resultant assembly having a higher load-bearing strength and stiffness than either the beam (20) or flitch plate (22) alone or in combination but not tightly secured to one another.

Patentansprüche

1. Verbundträgeranordnung (10), umfassend:

einen ersten Kunststoff-Verbundträger (20) mit einer Längslänge und oberen und unteren Fläche (12, 14), die eine Höhe dazwischen definieren, und ersten und zweiten Seitenflächen (18), die eine Breite dazwischen definieren; und
eine Sandwichplatte (22) mit einer Längslänge und mit oberen und unteren Flächen, die eine Höhe dazwischen definieren, und ersten und zweiten Seitenflächen, die eine Breite dazwischen definieren;
wobei die Breite des Trägers (20) größer als die Breite der Sandwichplatte (22) ist; und
wobei die Sandwichplatte (22) an dem Träger (20) befestigt ist, um dem Träger (20) zusätzliche Steifigkeit zu verleihen;
dadurch gekennzeichnet, dass die Verbundträgeranordnung (10) ferner eine Stange (24) umfasst, die sich seitlich durch Löcher (28, 26) erstreckt, die in der Sandwichplatte (22) und dem Träger (20) gebildet sind, wobei die Stange (24) die Sandwichplatte (22) und den Träger (20) in seitlicher Richtung gegeneinander zusammendrückt;
wobei das Loch (28) in der Sandwichplatte (22) in Form eines Schlitzes vorliegt, der sich in der Längsrichtung erstreckt, um relative Längsbewegung zwischen der Sandwichplatte (22) und dem Träger (20) als Reaktion auf Längsausdehnung und -kontraktion des Trägers (20) zu erlauben.

2. Anordnung nach Anspruch 1, wobei die Sandwichplatte (22) Metall oder faserverstärktes Harz ist.

3. Anordnung nach Anspruch 1, ferner umfassend einen zweiten Verbund-Kunststoffträger (20), der an der Sandwichplatte (22) befestigt ist.

4. Anordnung nach Anspruch 3, wobei die Sandwichplatte (22) seitlich zwischen den ersten und zweiten Verbundträgern (20) angeordnet ist.

5. Anordnung nach Anspruch 1, wobei die Höhe der Sandwichplatte (22) weniger als die Höhe des Trägers (20) ist.

6. Anordnung nach Anspruch 1, wobei die Oberseite der Sandwichplatte (22) relativ zu der oberen Fläche (12) des Trägers (20) zurückgesetzt ist und die Unterseite der Sandwichplatte (22) relativ zu der Unterseite (14) des Trägers (20) zurückgesetzt ist.

7. Anordnung nach Anspruch 1, wobei die Sandwichplatte (22) ein griffverbesserndes Merkmal (40) beinhaltet, um Reibung zwischen der Sandwichplatte (22) und dem Träger (20) zu erhöhen.

8. Anordnung nach Anspruch 1, wobei die Sandwichplatte (22) eine Vielzahl von Vorsprüngen (40) beinhaltet, die den Verbundträger (20) durchstoßen, oder die Sandwichplatte eine Vielzahl von Pfosten (42) oder Rippen (44) beinhaltet, die sich von einer Oberfläche davon erstrecken, wobei die Pfosten (42) oder Rippen (44) im zusammengebauten Zustand in einer entsprechenden Struktur des Verbundträgers (20) aufgenommen werden.

9. Anordnung nach Anspruch 1, wobei die Sandwichplatte (22) einen L-förmigen Querschnitt oder einen T-förmigen Querschnitt mit einem langen Schenkel und mindestens einem kurzen Schenkel aufweist und der lange Schenkel und der mindestens eine kurze Schenkel jeweils den Verbundträger (20) berühren.

10. Anordnung nach Anspruch 1, wobei die Anordnung die erste Sandwichplatte (22) und der erste Verbundträger (20) die einzige Sandwichplatte (22) und der einzige Träger (20) der Anordnung sind.

11. Anordnung nach Anspruch 1, ferner umfassend eine zweite Sandwichplatte (22), wobei der Verbundträger (20) seitlich zwischen den ersten und zweiten Sandwichplatten (22) angeordnet ist.

12. Anordnung nach Anspruch 11, wobei die ersten und zweiten Sandwichplatten (22) von einer seitlich äußersten Fläche des Trägers (20) nach innen zurückgesetzt sind.

13. Anordnung nach Anspruch 1, wobei die Sandwichplatte (22) einen C-förmigen Querschnitt mit einem langen Schenkel und zwei kurzen Schenkeln aufweist und die kurzen Schenkel von einer äußersten Fläche des Trägers (20) zurückgesetzt sind oder die Sandwichplatte (22) einen I-förmigen Querschnitt mit einem langen Schenkel und vier kurzen Schenkel aufweist und die kurzen Schenkel von einer äußersten Fläche des Trägers (20) zurückgesetzt sind.

14. Anordnung nach Anspruch 1, wobei der Träger (20) eine Mischung aus Polypropylen und Polyethylen (PP:PE), aber vorwiegend Polyethylen, mit 5-50 % Glasfaserverstärkung umfasst; und wobei die Sandwichplatte (20) aus Stahl oder glasfaserverstärktem Harzmaterial mit einem höheren Elastizitätsmodul als demjenigen des Verbund-Kunststoffträger-Materials hergestellt ist, wobei der Träger (20) und die Sandwichplatte (22) in einer Seite-an-Seite-Kontaktbeziehung fest zusammengehalten werden und die resultierende Anordnung eine höhere Tragfestigkeit und Steifigkeit als entweder der Träger (20) oder die Sandwichplatte (22) allein oder in Kombination, aber nicht fest miteinander verbunden, aufweist.

Revendications

1. Ensemble de poutre composite (10) comprenant :

une première poutre composite en plastique (20) ayant une longueur longitudinale et des surfaces supérieure et inférieure (12, 14) définissant une hauteur entre elles et des première et seconde surfaces latérales (18) définissant une largeur entre elles ; et
une plaque flitch (22) ayant une longueur longitudinale et ayant des surfaces supérieure et inférieure définissant une hauteur entre elles et des première et seconde surfaces latérales définissant une largeur entre elles ;
dans lequel la largeur de la poutre (20) est supérieure à la largeur de la plaque flitch (22) ; et dans lequel la plaque flitch (22) est fixée à la poutre (20) pour conférer une rigidité supplémentaire à la poutre (20) ;
caractérisé en ce que l'ensemble de poutre composite (10) comprend en outre une tige (24) s'étendant latéralement à travers des trous (28, 26) formés dans la plaque flitch (22) et la poutre (20), dans lequel la tige (24) comprime la plaque flitch (22) et la poutre (20) l'une contre l'autre dans une direction latérale ;
dans lequel le trou (28) dans la plaque flitch (22) se présente sous la forme d'une fente s'étendant dans la direction longitudinale pour permettre un mouvement longitudinal relatif entre la plaque flitch (22) et la poutre (20) en réponse à l'expansion et la contraction longitudinales de la poutre (20).

2. Ensemble selon la revendication 1, dans lequel la plaque flitch (22) est en métal ou en résine renforcée de fibres.

3. Ensemble selon la revendication 1, comprenant en outre une seconde poutre composite en plastique (20) fixée à la plaque flitch (22).

4. Ensemble selon la revendication 3, dans lequel la plaque flitch (22) est disposée latéralement entre les première et seconde poutres composite (20).

5. Ensemble selon la revendication 1, dans lequel la hauteur de la plaque flitch (22) est inférieure à la hauteur de la poutre (20).

6. Ensemble selon la revendication 1, dans lequel la partie supérieure de la plaque flitch (22) est en retrait par rapport à la surface supérieure (12) de la poutre (20), et la partie inférieure de la plaque flitch (22) est en retrait par rapport à la partie inférieure (14) de la poutre (20).

7. Ensemble selon la revendication 1, dans lequel la plaque flitch (22) comprend une caractéristique d'amélioration de la préhension (40) pour augmenter le frottement entre la plaque flitch (22) et la poutre (20).

8. Ensemble selon la revendication 1, dans lequel la plaque flitch (22) comprend une pluralité de saillies (40) qui transpercent la poutre composite (20) ou la plaque flitch comprend une pluralité de montants (42) ou de nervures (44) s'étendant à partir d'une surface de celle-ci, dans laquelle les montants (42) ou nervures (44) sont reçus dans la structure correspondante de la poutre composite (20) lorsqu'elle est assemblée.

9. Ensemble selon la revendication 1, dans lequel la plaque flitch (22) a une section transversale en forme de L ou une section transversale en forme de T ayant une branche longue et au moins une branche courte, et la branche longue et l'au moins une branche courte sont chacune en contact avec la poutre composite (20).

10. Ensemble selon la revendication 1, dans lequel l'ensemble de la première plaque flitch (22) et la première poutre composite (20) sont les seules plaque flitch (22) et poutre (20) de l'ensemble.

11. Ensemble selon la revendication 1, comprenant en outre une seconde plaque flitch (22), où la poutre composite (20) est disposée latéralement entre les première et seconde plaques flitch (22).

12. Ensemble selon la revendication 11, dans lequel les première et seconde plaques flitch (22) sont en retrait vers l'intérieur à partir d'une surface latéralement la plus à l'extérieur de la poutre (20).

13. Ensemble selon la revendication 1, dans lequel la plaque flitch (22) a une section transversale en forme de C ayant une jambe longue et deux jambes courtes, et les jambes courtes sont en retrait depuis une

surface la plus à l'extérieur de la poutre (20) ou la plaque flitch (22) a une section transversale en forme de I avec une branche longue et quatre branches courtes, et les branches courtes sont en retrait depuis une surface la plus à l'extérieur de la poutre (20).

14. Ensemble selon la revendication 1, dans lequel la poutre (20) comprend un mélange de polypropylène et de polyéthylène (PP:PE), mais principalement de polyéthylène, avec 5 à 50 % de renfort en fibre de verre ; et dans lequel la plaque flitch (20)est fabriquée en acier ou en un matériau en résine renforcée de fibres de verre ayant un module d'élasticité supérieur à celui du matériau de ladite poutre compositeen plastique, ladite poutre (20) et ladite plaque flitch (22) étant solidement fixées ensemble en relation de contact côte à côte et l'ensemble résultant ayant une résistance à la charge et une rigidité supérieures à celles de la poutre (20) ou de la plaque flitch (22) seules ou en combinaison mais non solidement fixées l'une à l'autre.

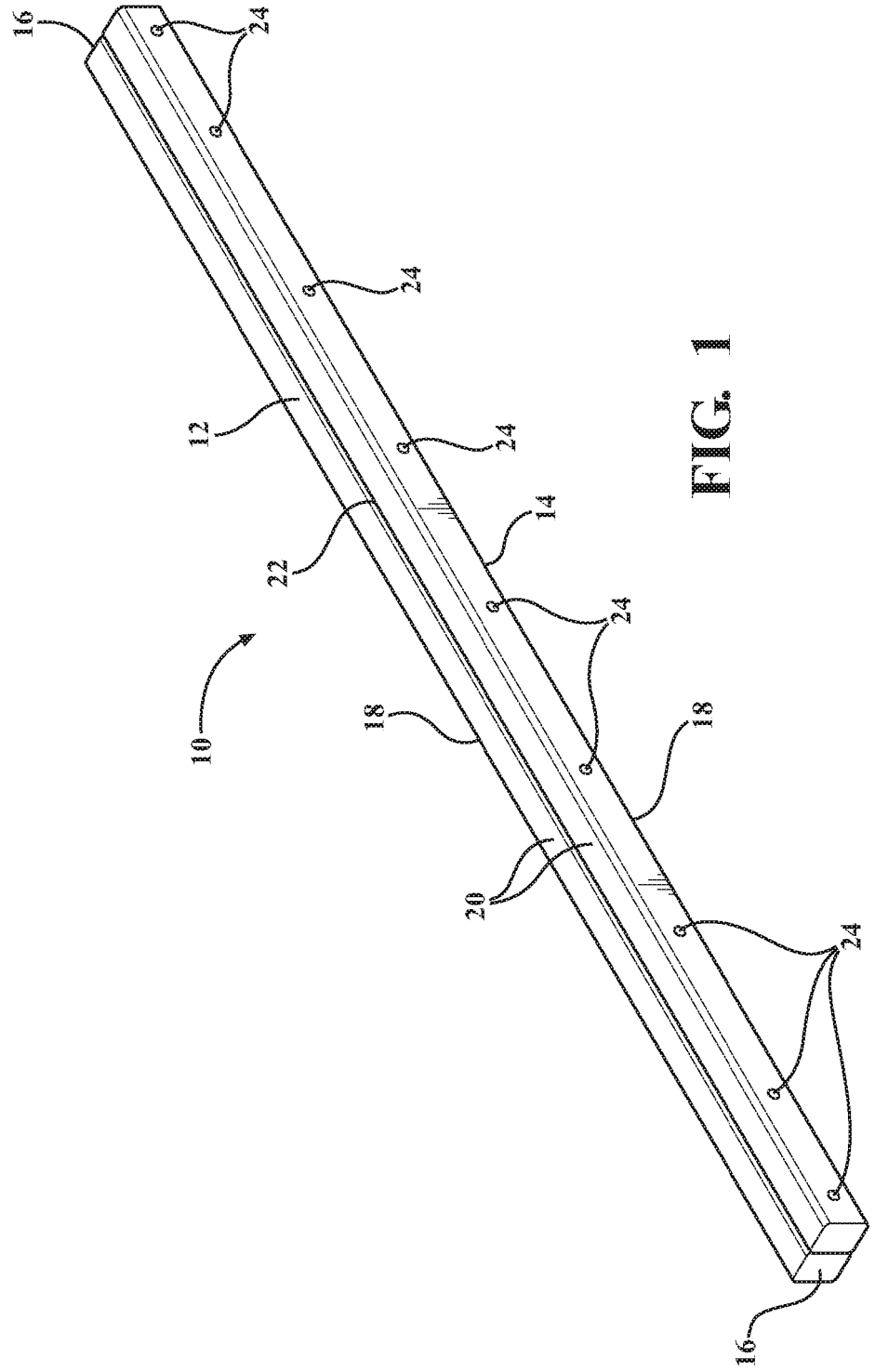


FIG. 1

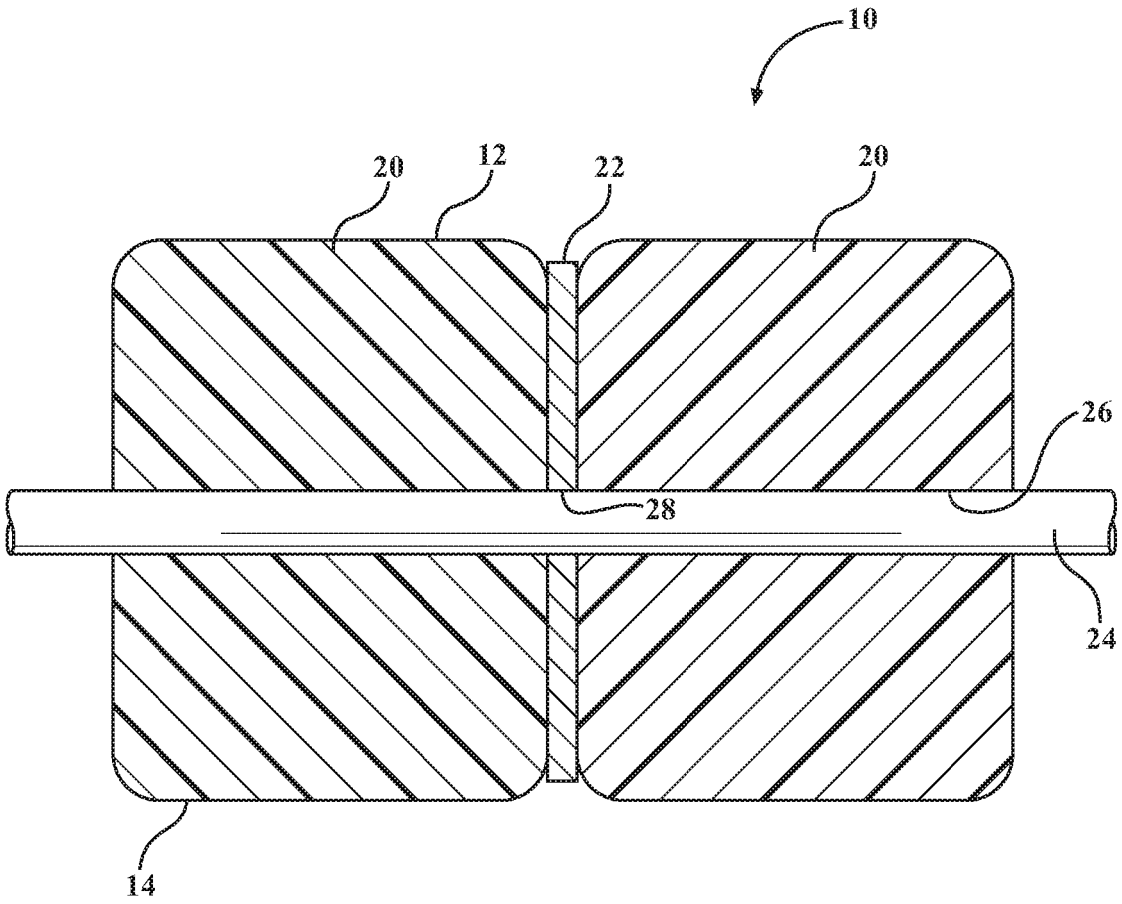


FIG. 2

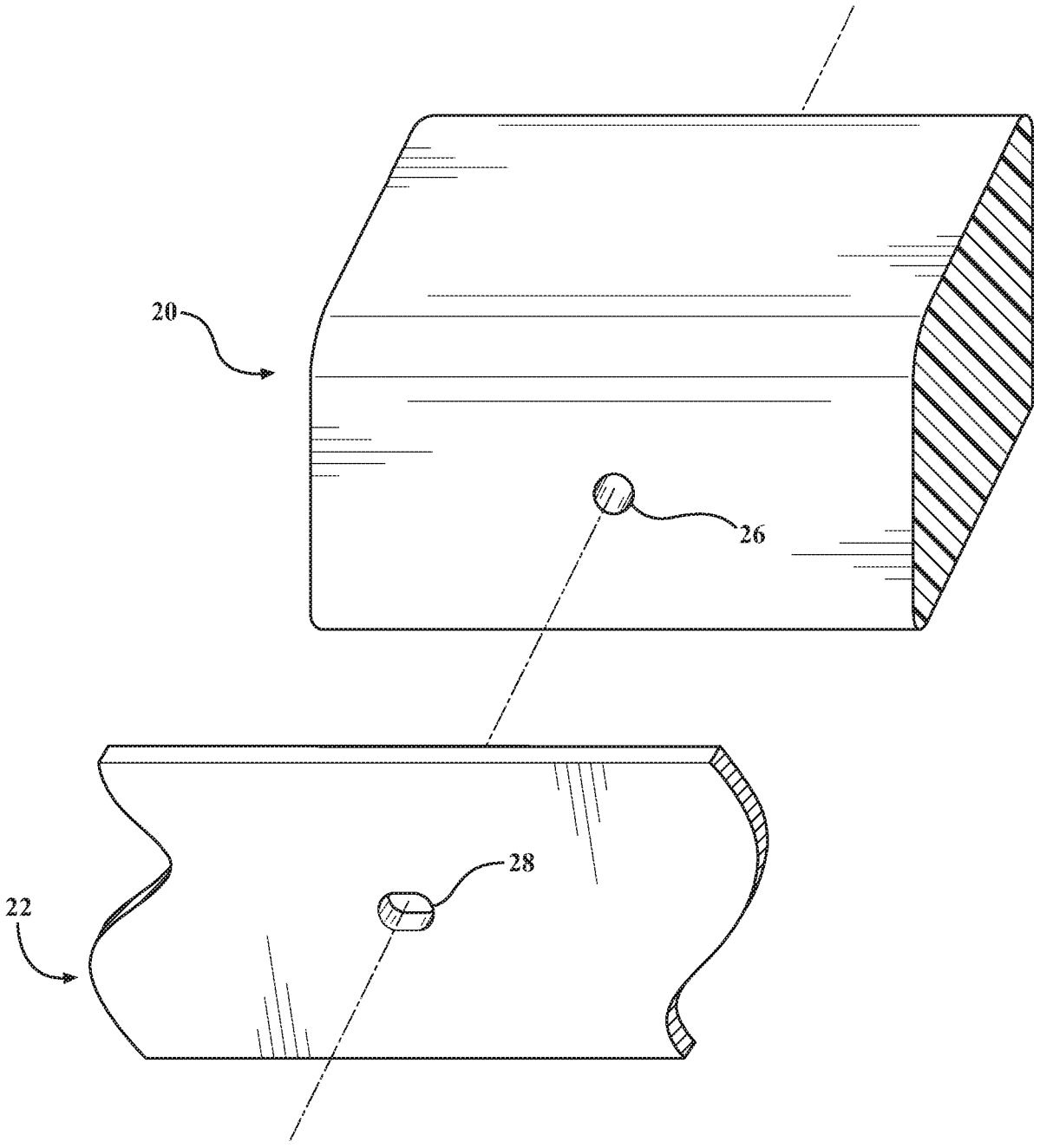


FIG. 3

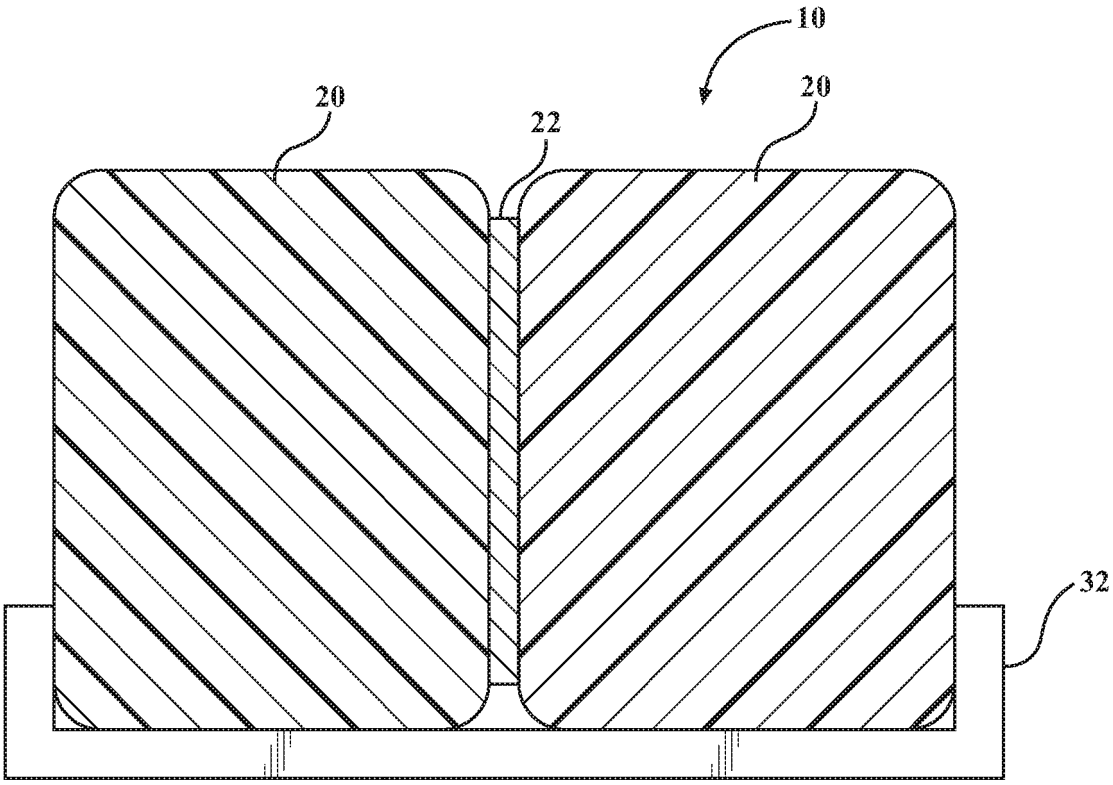


FIG. 4

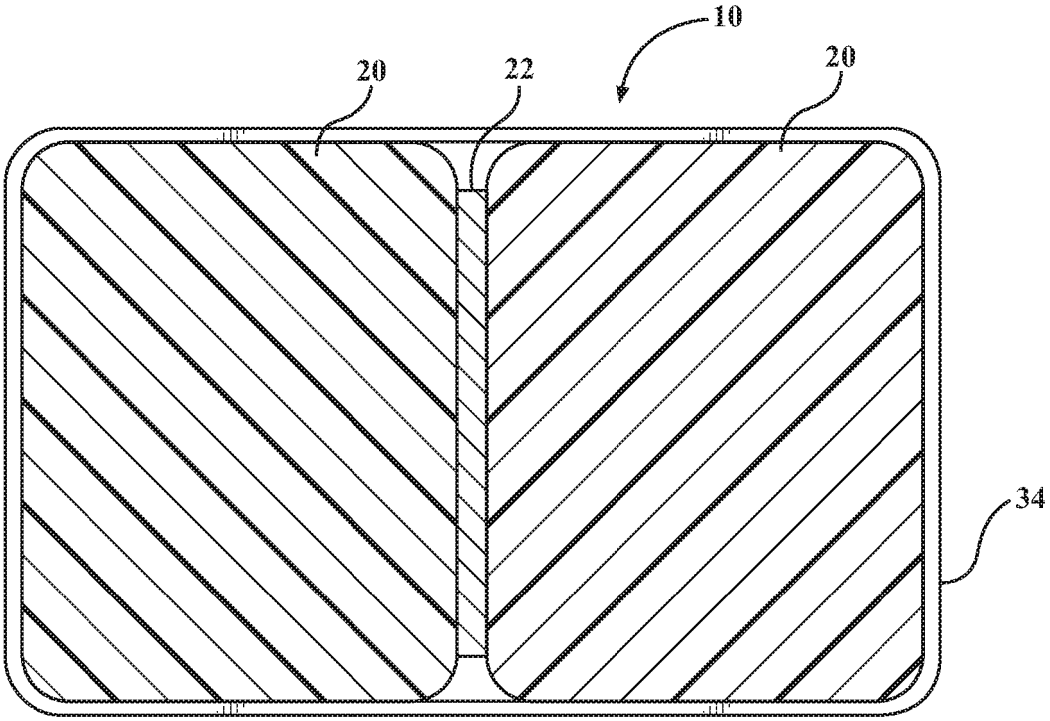


FIG. 5

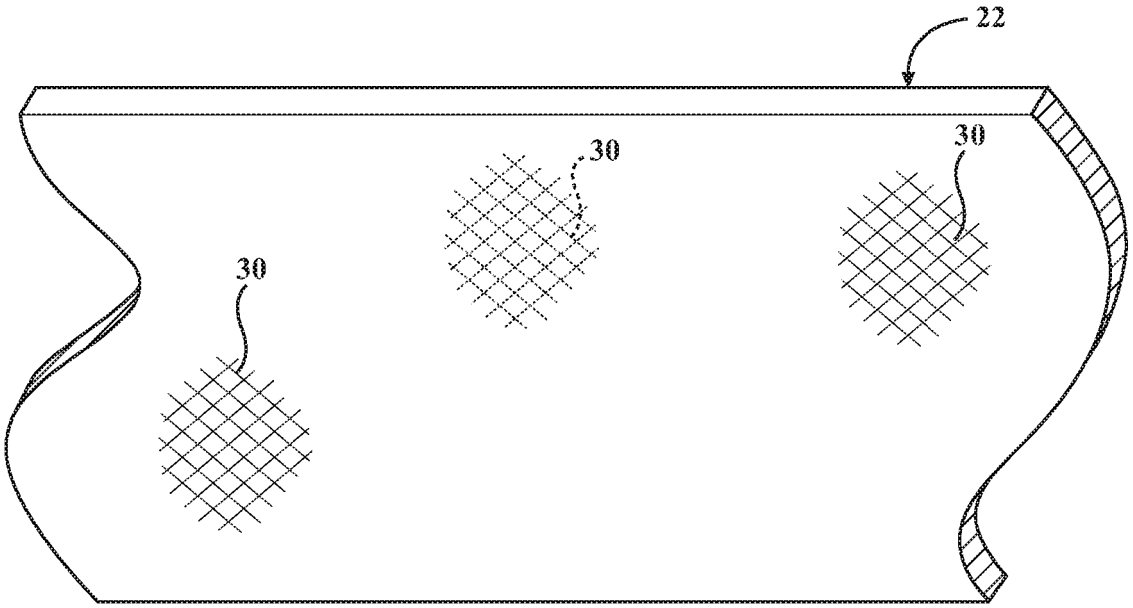


FIG. 6

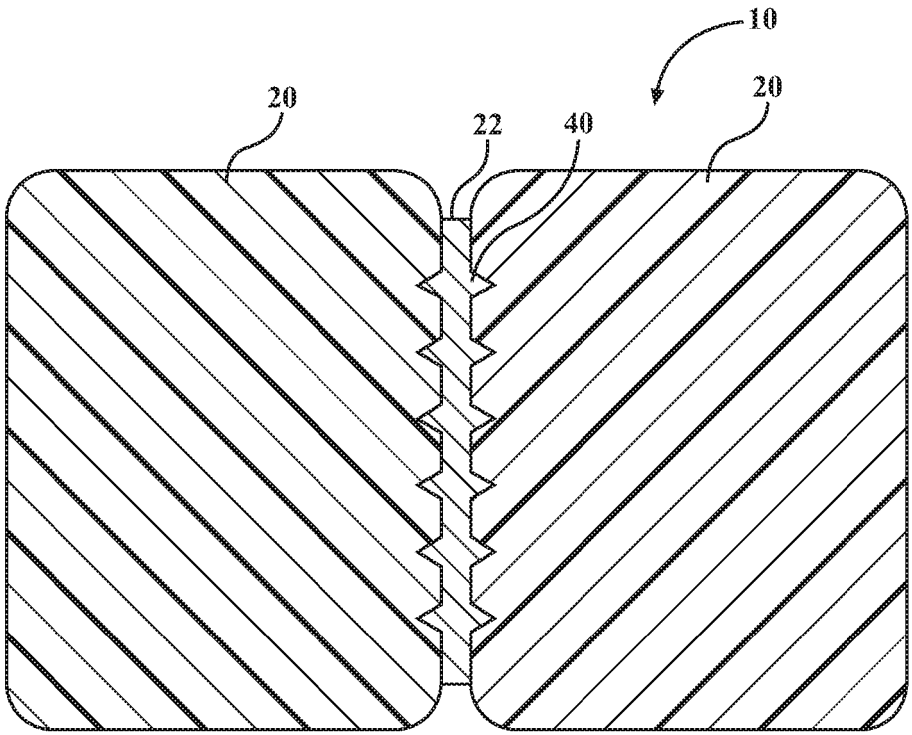


FIG. 7

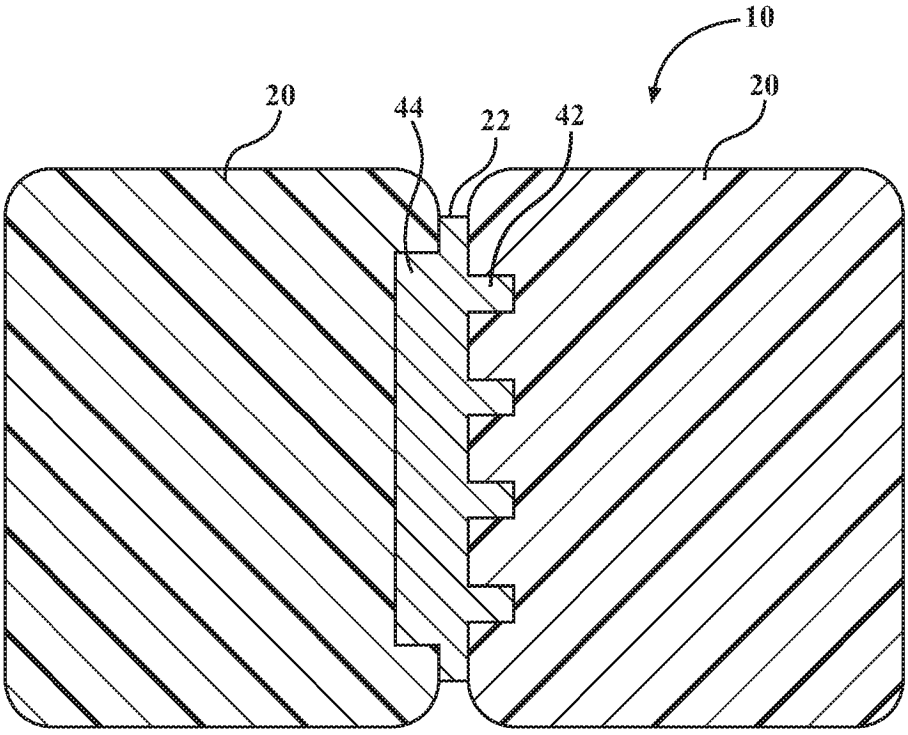


FIG. 8

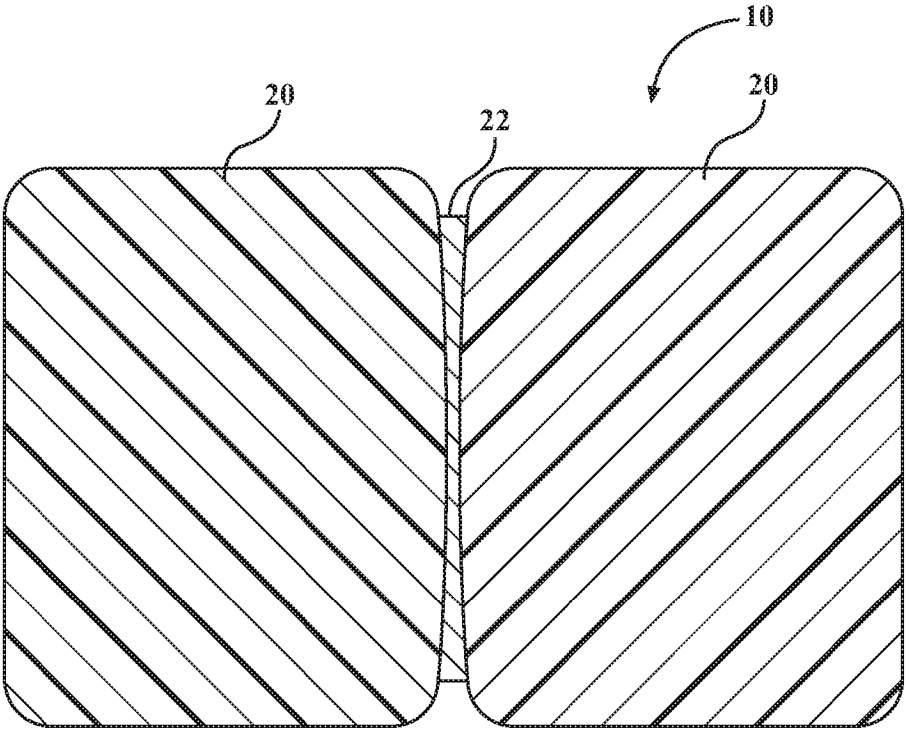


FIG. 9A

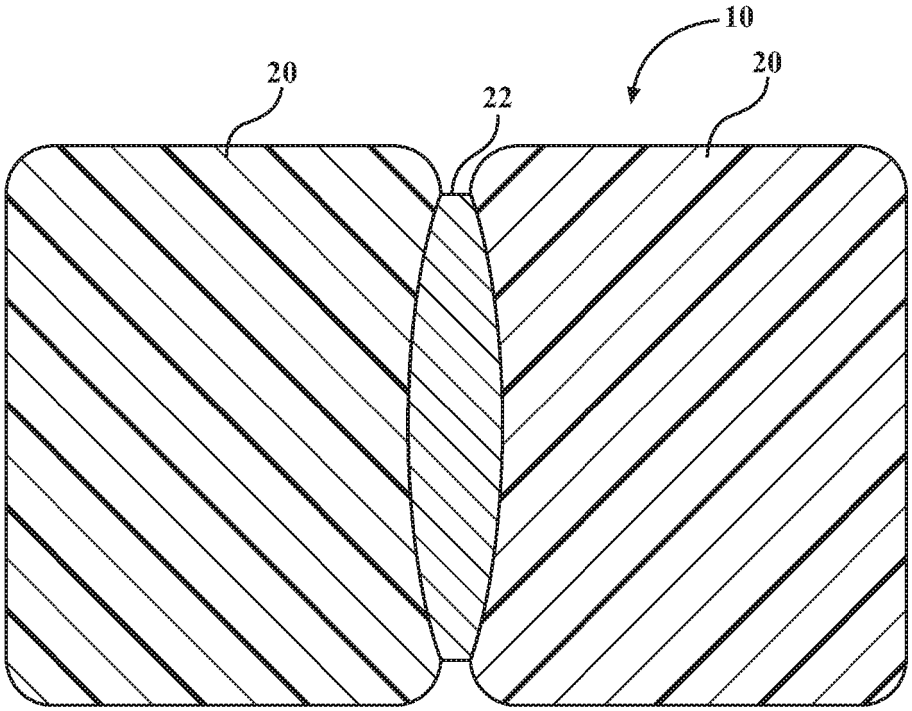


FIG. 9B

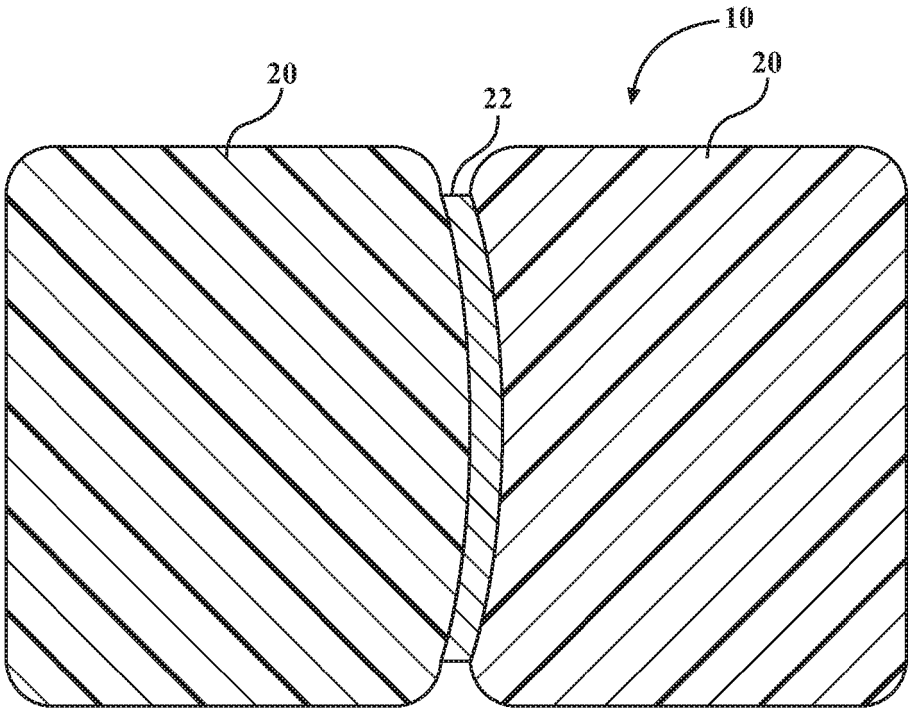


FIG. 9C

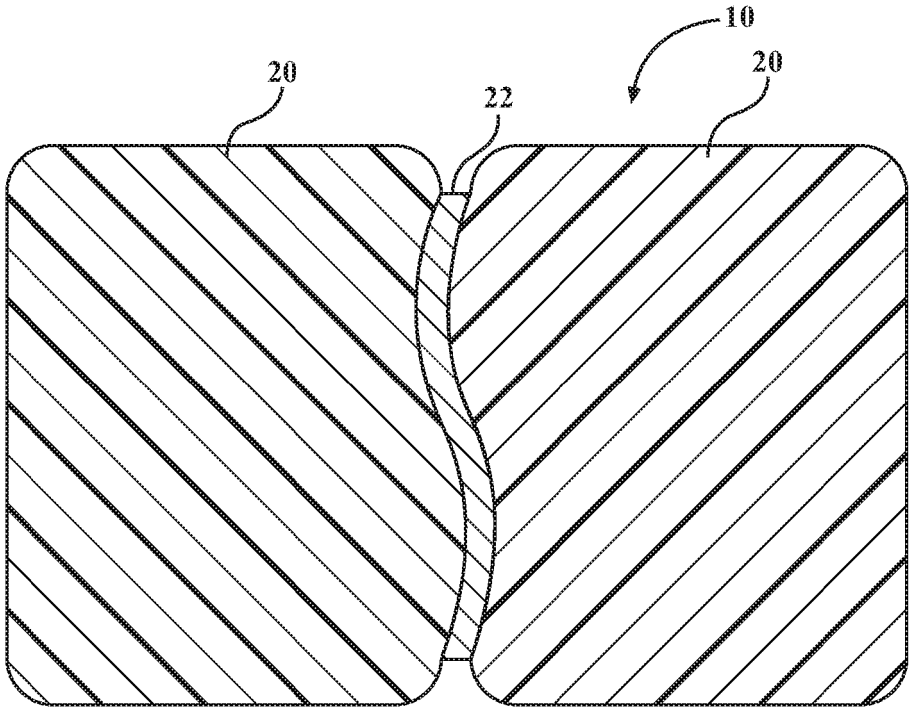


FIG. 9D

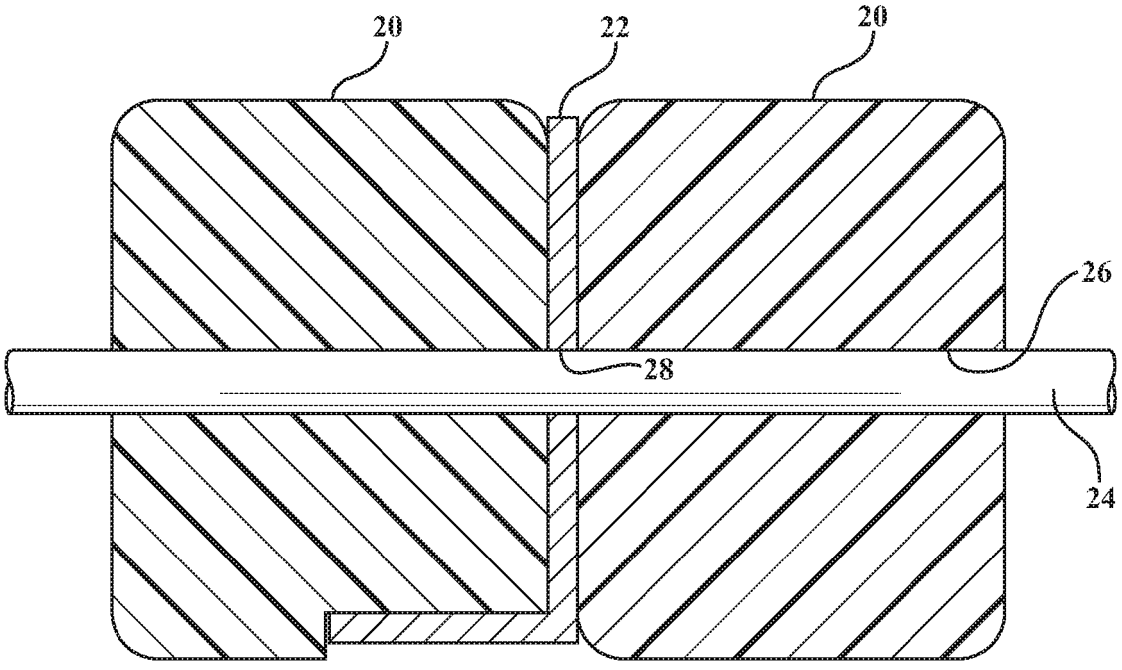


FIG. 10

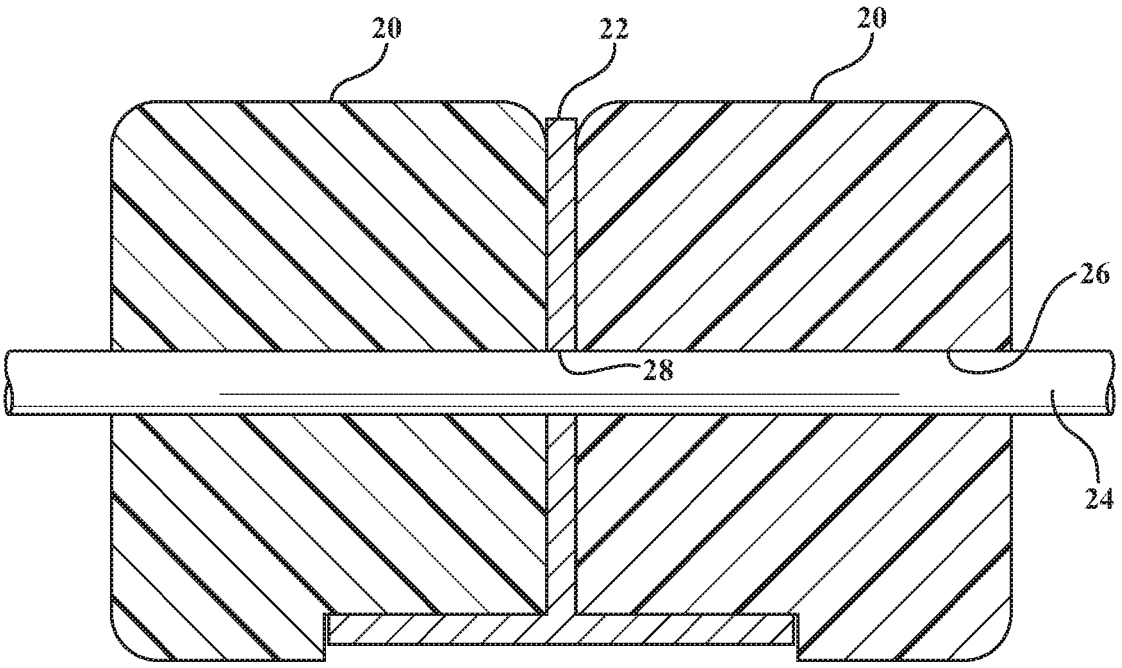


FIG. 11

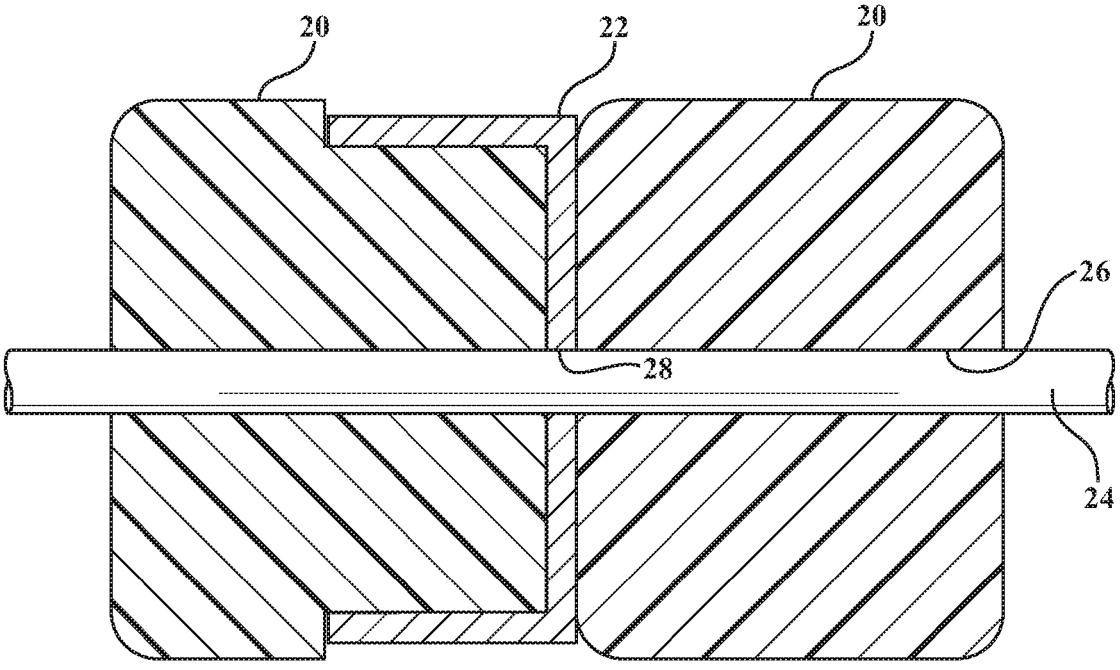


FIG. 12

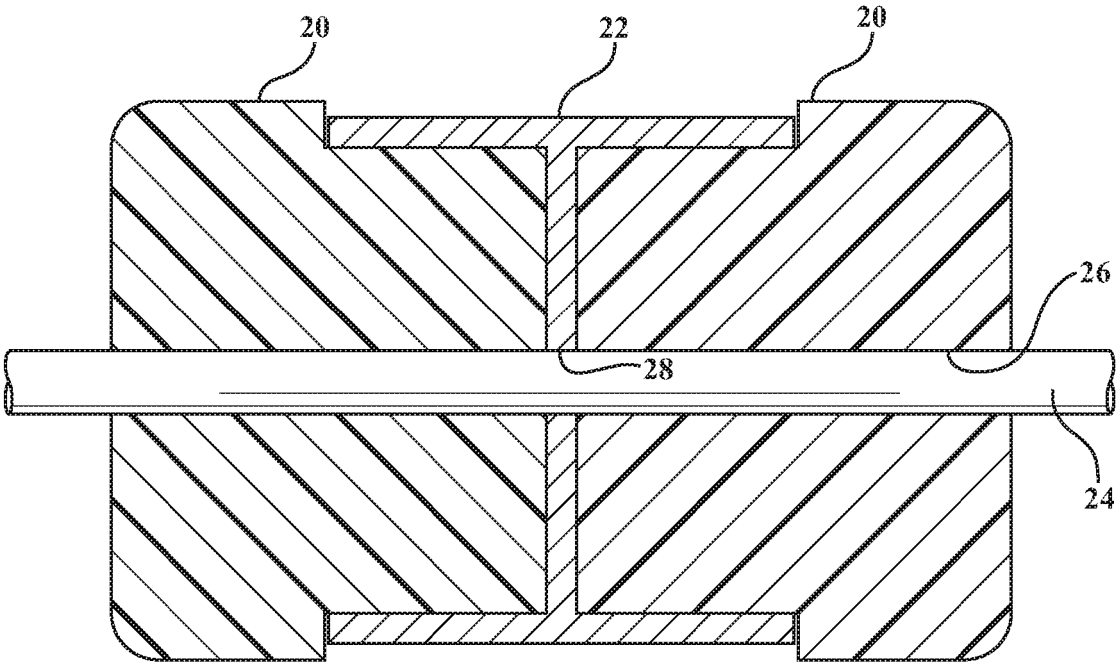


FIG. 13

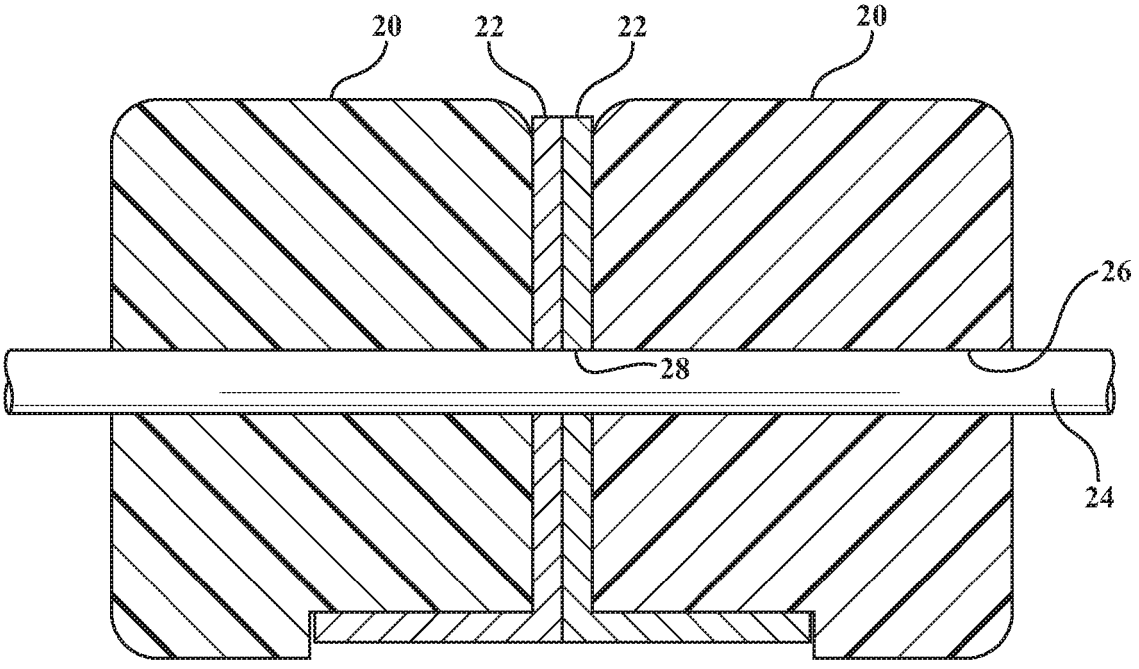


FIG. 14

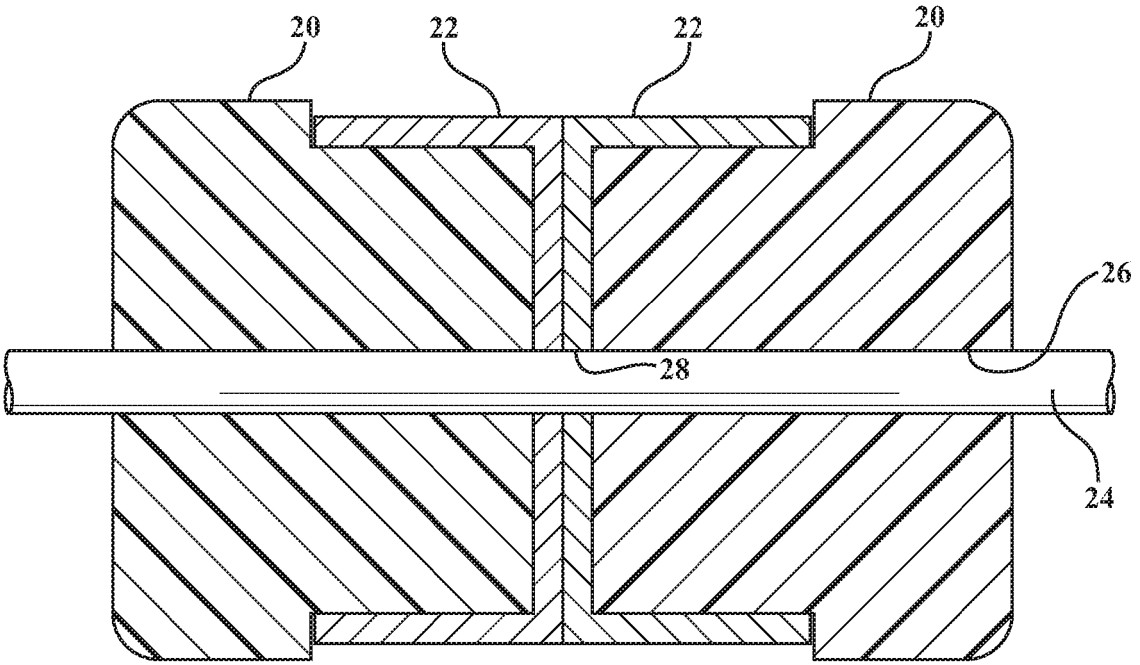


FIG. 15

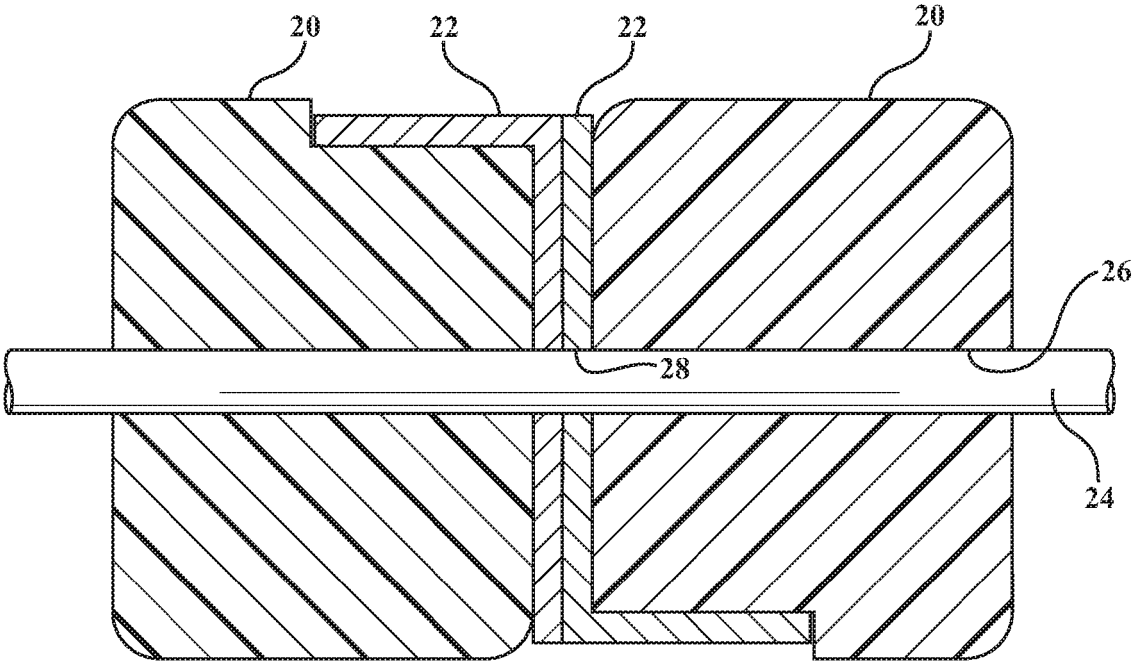


FIG. 16

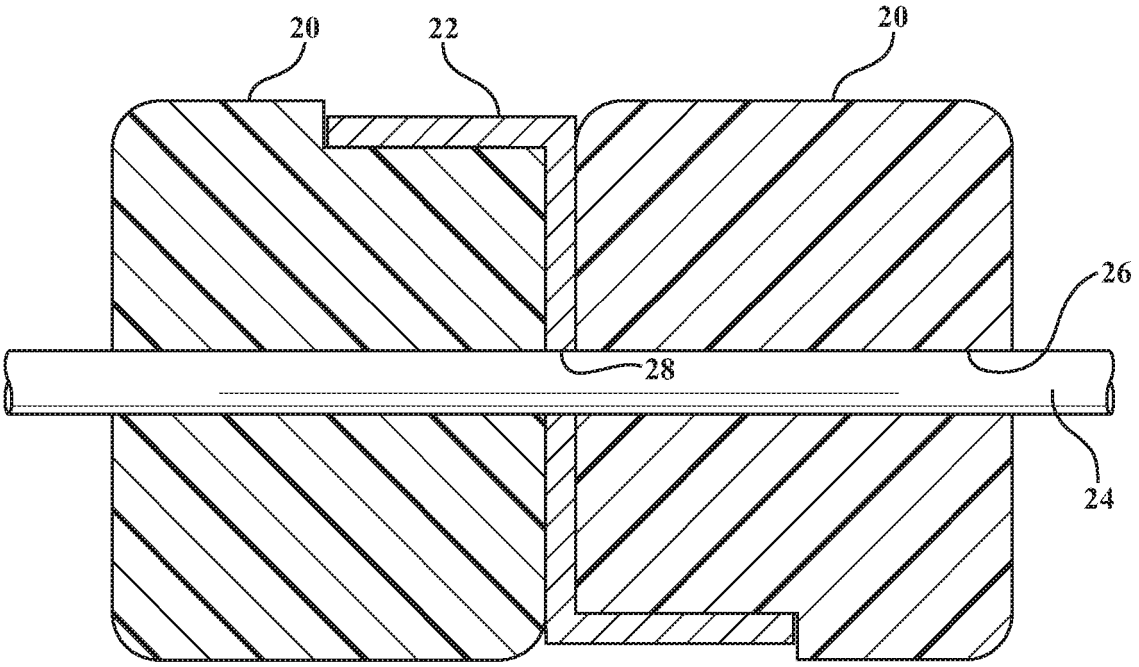


FIG. 17

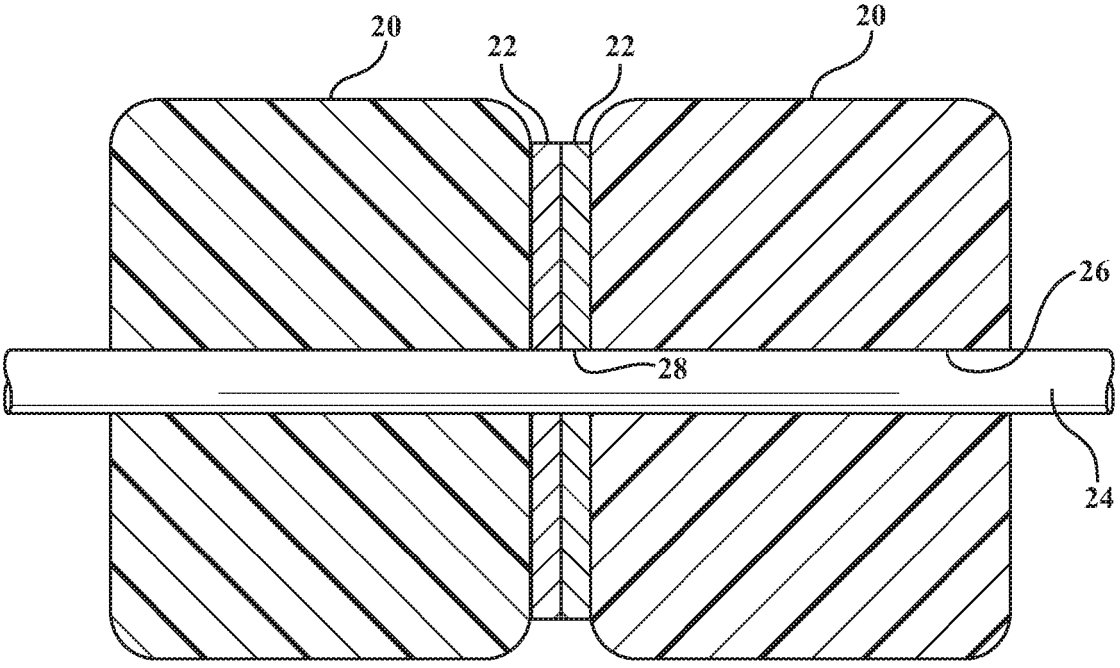


FIG. 18

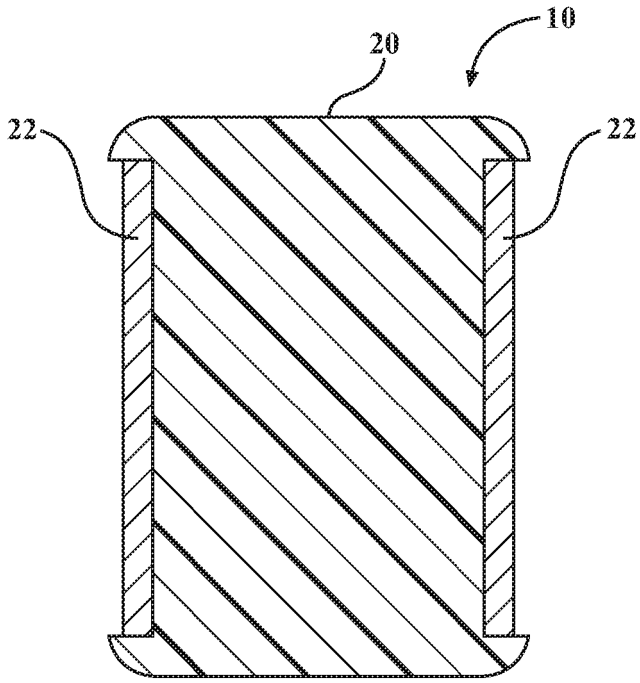


FIG. 19

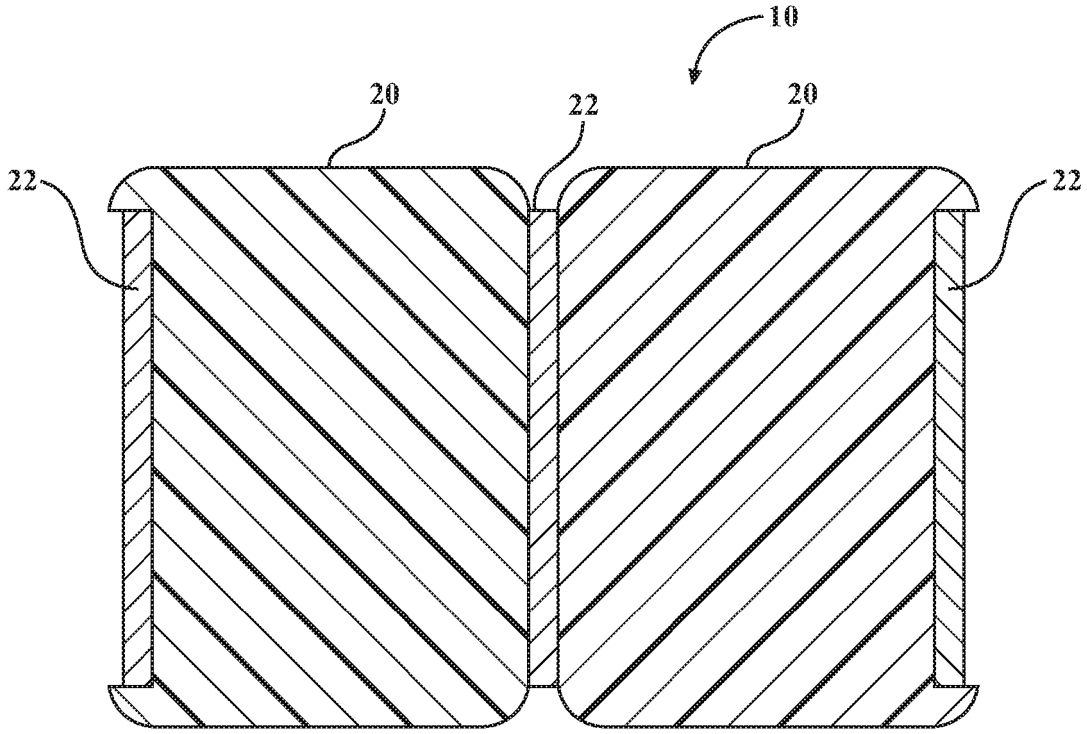


FIG. 20

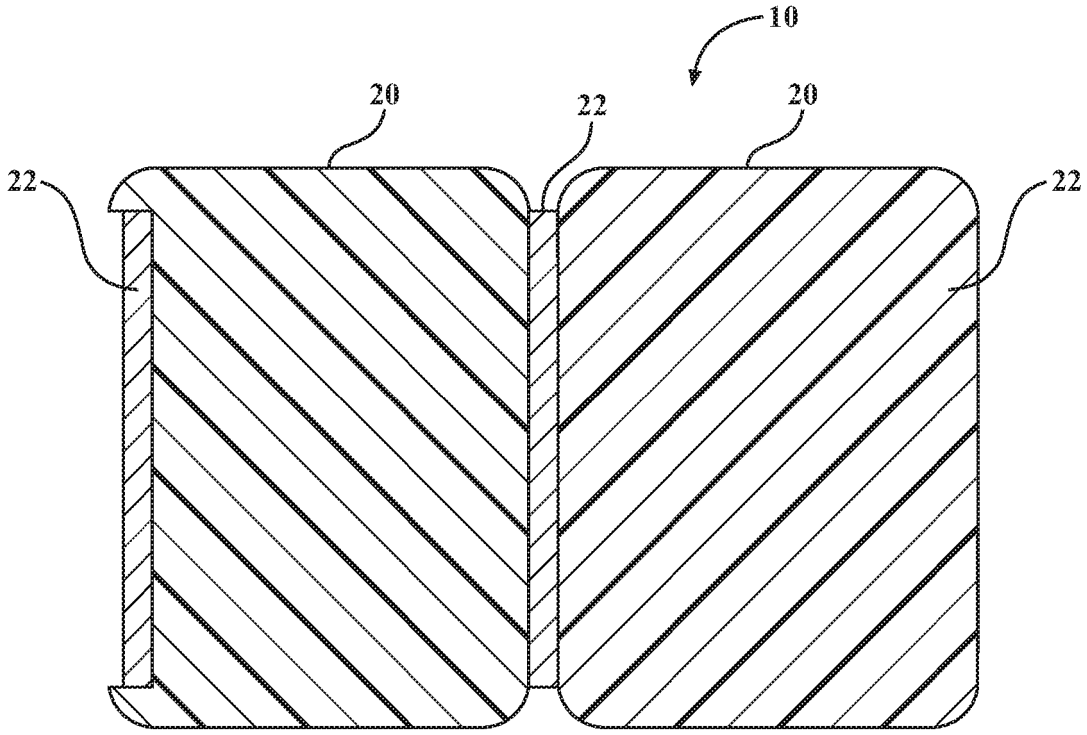


FIG. 21

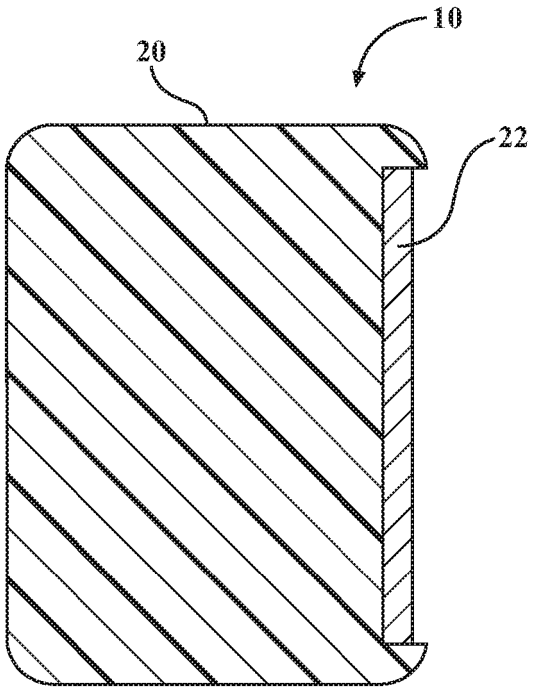


FIG. 22

REFERENCES CITED IN THE DESCRIPTION

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