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[Continued on next page]

(54) Title: CONFORMABLE SCREEN, SHAPE MEMORY STRUCTURE AND METHOD OF MAKING THE SAME

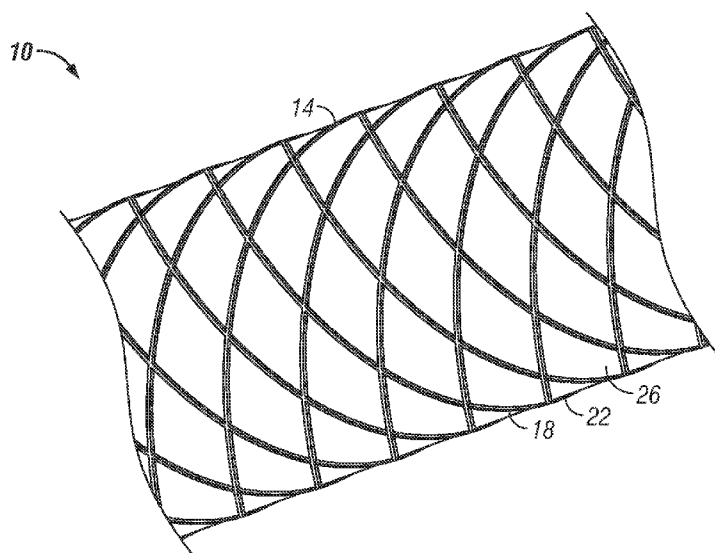


FIG. 1

(57) Abstract: A shape memory structure includes, an elastic material, and a viscoelastic material commingled with the elastic material. The shape memory structure is reformable from a first shape to a second shape upon exposure to a change in environment that softens the viscoelastic material thereby allowing the shape memory structure to creep under stress stored in the elastic material.



- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*
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CONFORMABLE SCREEN, SHAPE MEMORY STRUCTURE AND METHOD OF MAKING THE SAME

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Application No. 13/029729, filed on February 17, 2011, which is incorporated herein by reference in its entirety.

BACKGROUND

[0001] Filtering contaminants from flowing fluids is a common exercise in systems involved in transportation of fluids. Many such systems employ screens as the filtering mechanism. Screens that expand to substantially fill an annular gap, for example, between concentric tubulars, is another common practice. Some of these systems use swaging equipment to radially expand the screen. Although such equipment serves its purpose it has limitations, including a limited amount of potential expansion, complex and costly equipment and an inability to expand to fill a nonsymmetrical space. Apparatuses that overcome these and other limitations with existing systems are therefore desirable to operators in the field.

BRIEF DESCRIPTION

[0002] Disclosed herein is a shape memory structure. The structure includes, an elastic material, and a viscoelastic material commingled with the elastic material. The shape memory structure is reformable from a first shape to a second shape upon exposure to a change in environment that softens the viscoelastic material thereby allowing the shape memory structure to creep under stress stored in the elastic material.

[0003] Further disclosed herein is a conformable screen. The screen includes, a structure having, an elastic material and a viscoelastic material commingled with the elastic material, a filter material, and a permeable tubular. The structure is reformable from a first shape to a second shape upon exposure to a first environment that softens the viscoelastic material to thereby allow the structure to creep under stress stored in the elastic material. The filter material is positioned within the structure and is compressible such that the filter material is maintained in a smaller volume when the structure is in the first shape than when the structure is in the second shape. The permeable tubular is in operable communication with the structure such that fluid flowable through one of the filter material and permeable tubular are subsequently flowable through the other of the filter material and the permeable tubular

[0004] Further disclosed herein is a method of making a shape memory structure. The method includes, commingling elastic material with viscoelastic material, and forming a structure with the commingled materials. Altering a shape of the structure, altering an environment the structure is exposed to, to lock in the altered shape of the structure via hardening of the viscoelastic material until the structure is exposed to another environment that softens the viscoelastic material.

[0005] Further disclosed herein is a method of making a conformable screen. The method includes, commingling elastic material with viscoelastic material, forming a structure with the commingled materials, surrounding a permeable tubular with the structure, and positioning filter material within the structure. The method further includes, compacting the structure and the filter material into a compaction and altering an environment the compaction is exposed to, to maintain a volume of the compaction until the compaction is exposed to another environment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

[0007] FIG. 1 depicts a perspective view of a conformable screen disclosed herein;

[0008] FIG. 2 depicts a perspective view of the conformable screen of FIG. 1 with the filter material removed in an un-compacted configuration;

[0009] FIG. 3 depicts a perspective view of the conformable screen of FIG. 2 in a compacted configuration;

[0010] FIG. 4 depicts a partial cross sectional view of the conformable screen of FIG. 2 with the filter material present;

[0011] FIG. 5 depicts a partial cross sectional view of the conformable screen of FIG. 3 with the filter material present; and

[0012] FIG. 6 depicts a schematic view of commingled fibers of elastic and viscoelastic materials disclosed herein.

DETAILED DESCRIPTION

[0013] A detailed description of one or more embodiments of the disclosed apparatus and method are presented herein by way of exemplification and not limitation with reference to the Figures.

[0014] Referring to Figures 1-5, an embodiment of a conformable screen disclosed herein is illustrated at 10. The conformable screen 10 includes a structure 14 made of at least two commingled materials, an elastic material 18 and a viscoelastic material 22 (shown in greater detail in Figure 6). The structure 14, illustrated herein as a faceted structure, is reformable from a first shape, or compaction (as shown in Figures 3 and 5) to a second shape (as shown in Figure 2 and 4) upon exposure to an environment that softens the viscoelastic material 22 thereby allowing the faceted structure 14 to creep under stress stored in the elastic material 18. The conformable screen 10 further includes a filter material 26 positioned within the faceted structure 14. The filter material 26 may have a mat or foam structure, such as a polyester fiber batting or an open-cell polyurethane form, for example, although embodiments are not limited to these structures. The filter material 26 is volumetrically compactable or compressible and once compacted can be maintained at a smaller volume until allowed to return to its un-compacted larger volume. The filter material 26, being positioned within the faceted structure 14, can be maintained in the compacted condition by the faceted structure 14. The faceted structure 14 and the filter material 26 are positioned radially of a permeable tubular illustrated in this embodiment as a perforated tubular 30 of the conformable screen 10. As such, fluid is able to flow through perforations 34 in the perforated tubular 30 after flowing through the filter material 26, and being filtered in the process. Alternately, fluid flowing in a reverse direction could flow through the filter material 26 after flowing through the perforations 34.

[0015] Referring specifically to Figures 4 and 5, the conformable screen 10 is shown employed in a borehole 38 in an earth formation 42 such as when used in a hydrocarbon recovery application or a carbon dioxide sequestration application, for example. The conformable screen 10 is run into the borehole 38 when in the first shape, or compaction, wherein the faceted structure 14 is hardened and maintains the filter material 26 in the smaller volume configuration. The conformable screen 10 has a first radial dimension 46 when in the first shape and a second radial dimension 50 when in the second shape. The first radial dimension 46 is smaller than the second radial dimension 50, thereby providing radial clearance between the conformable screen 10 and the borehole 38 while running the conformable screen 10 therewithin. Once the conformable screen 10 is positioned at a selected location within the borehole 38, exposure of the conformable screen 10, and more particularly of the faceted structure 14, to an alternate environment causes a softening of the viscoelastic material 22 thereby allowing stresses within the elastic material 18 to cause the faceted structure 14 to change from the first shape to the second shape (it should be noted

that, although not required, the filter material can also provide loads that assist in returning the faceted structure 14 from the first shape to the second shape). In so doing the conformable screen 10 undergoes a change from the first radial dimension 46 toward the second radial dimension 50 resulting in contact between the filter material 26 and walls 54 of the borehole 38 in the process. The contact between the filter material 26 and the walls 54 minimizes or eliminates annular clearance 58 therebetween and erosion that could result due to fluid flow if the annular clearance 58 were allowed to exist. The contact between the filter material 26 and the walls 54 also provides support to the walls 54 lessening the potential for undesirable conditions such as collapses and voids in the formation 42, for example.

[0016] Referring to Figure 6, an embodiment illustrating how the elastic material 18 and the viscoelastic material 22 may be commingled is illustrated. In this embodiment the elastic material 18 and the viscoelastic material 22 are formed into fibers 62 or fibrils such that the fibers 62 of the viscoelastic material 22 effectively surround the fibers 62 of the elastic material 18. The commingled fibers 62 are formed into the faceted structure 14. The elastic material 18 has different chemical, mechanical and structural characteristics to provide the faceted structure 14 with the shape memory properties described above. The elastic material 18 may be one of aramid, glass, boron, basalt, carbon, graphite, quartz, liquid crystal polymer, aluminum, titanium and steel, for example that has a relatively high modulus to provide structure and memory of the original shape to the faceted structure 14.

[0017] The viscoelastic material 22 on the other hand may be a thermoplastic polymer such as polyether ether ketone (PEEK), for example, that melts around the fibers 62 of the elastic material 14 during fabrication. The viscoelastic material 22 provides the capacity to be softened in some environments and hardened in others. In the example of the thermoplastic polymer for the viscoelastic material 22 temperature is the changeable environment. As such, heating will soften the viscoelastic material 22 allowing it to creep under loads such as compaction loads applied to cause the faceted structure 14 to be reshaped from the second shape to the first shape. Cooling of the faceted structure 14 allows the viscoelastic material 22 to harden and lock in the first shape until the environment (temperature) is increased to again soften the viscoelastic material 22 thereby allowing it to again creep under load. By configuring the faceted structure 14 and in particular the elastic material 18 therewithin to undergo only elastic deformation when reshaped from the second shape to the first shape, the elastic material 18 will maintain a load on the viscoelastic material 22 all the while that the structure is locked in the first shape. It is this stress locked in the elastic material 18 that allows the faceted structure 14 to creep back from the first

shape to the second shape once the viscoelastic material 22 has again been softened by the increase in temperature.

[0018] Although the embodiment illustrated herein employs a thermoplastic polymer as the viscoelastic material 22 that hardens and then softens in response to changes in temperature, alternate embodiments could be employed that use other changes in environment to cause the viscoelastic material 22 to harden and soften. Examples include materials that respond to changes in humidity and changes in available plasticizers.

[0019] While the invention has been described with reference to an exemplary embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the claims. Also, in the drawings and the description, there have been disclosed exemplary embodiments of the invention and, although specific terms may have been employed, they are unless otherwise stated used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention therefore not being so limited. Moreover, the use of the terms first, second, etc. do not denote any order or importance, but rather the terms first, second, etc. are used to distinguish one element from another. Furthermore, the use of the terms a, an, etc. do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item.

CLAIMS:

1. A shape memory structure, comprising:
an elastic material; and
a viscoelastic material commingled with the elastic material, the shape memory structure being reformable from a first shape to a second shape upon exposure to a change in environment that softens the viscoelastic material thereby allowing the shape memory structure to creep under stress stored in the elastic material.
2. The shape memory structure of claim 1, wherein the stress stored in the elastic material is generated in the elastic material by a mechanical load and maintained therein by the viscoelastic material being exposed to a change in environment that hardens the viscoelastic material thereby preventing the shape memory structure from creeping under the stress stored in the elastic material.
3. The shape memory structure of claim 1, wherein the elastic material is from the group consisting of aramid, glass, boron, basalt, carbon, graphite, quartz, liquid crystal polymer, aluminum, titanium and steel.
4. The shape memory structure of claim 1, wherein the viscoelastic material is a polymer.
5. The shape memory structure of claim 1, wherein the viscoelastic material is polyether ether ketone.
6. The shape memory structure of claim 1, wherein at least one of the viscoelastic material and the elastic material is in the form of a fiber.
7. The shape memory structure of claim 1, wherein the shape memory structure is formable into a faceted structure.
8. The shape memory structure of claim 1, wherein the change in environment includes at least one of a change in temperature, a change in humidity and a change in plasticizer.
9. A conformable screen, comprising:
a structure comprising:
an elastic material;
a viscoelastic material commingled with the elastic material, the structure being reformable from a first shape to a second shape upon exposure to a first environment that softens the viscoelastic material thereby allowing the structure to creep under stress stored in the elastic material; and

a filter material positioned within the structure being compressible such that the filter material is maintained in a smaller volume when the structure is in the first shape than when the structure is in the second shape; and

a permeable tubular in operable communication with the structure such that fluid flowable through one of the filter material and permeable tubular are subsequently flowable through the other of the filter material and the permeable tubular.

10. The conformable screen of claim 9, wherein the structure radially surrounds the permeable tubular.

11. The conformable screen of claim 9, wherein the filter material is one of a mat structure and foam.

12. The conformable screen of claim 9, wherein the filter material has shape memory to return it to a larger volume when the structure ceases to retain the filter material to a smaller volume.

13. The conformable screen of claim 9, wherein the structure extends radially further from the permeable tubular when in the second shape than when in the first shape.

14. The conformable screen of claim 9, wherein the permeable tubular is a perforated tubular.

15. A method of making a shape memory structure, comprising:
commingling elastic material with viscoelastic material;
forming a structure with the commingled materials;
altering a shape of the structure;
altering an environment the structure is exposed to, to lock in the altered shape of the structure via hardening of the viscoelastic material until the structure is exposed to another environment that softens the viscoelastic material.

16. A method of making a conformable screen, comprising:
commingling elastic material with viscoelastic material;
forming a structure with the commingled materials;
surrounding a permeable tubular with the structure;
positioning filter material within the structure;
compacting the structure and the filter material into a compaction;
altering an environment the compaction is exposed to, to maintain a volume of the compaction until the compaction is exposed to another environment.

17. The method of making a conformable screen of claim 16, further comprising hardening the viscoelastic material with one of the altering the environment and softening the viscoelastic material with the exposing the compaction to another environment.

18. The method of making a conformable screen of claim 16, wherein the altering the environment includes at least one of increasing temperature and decreasing temperature.

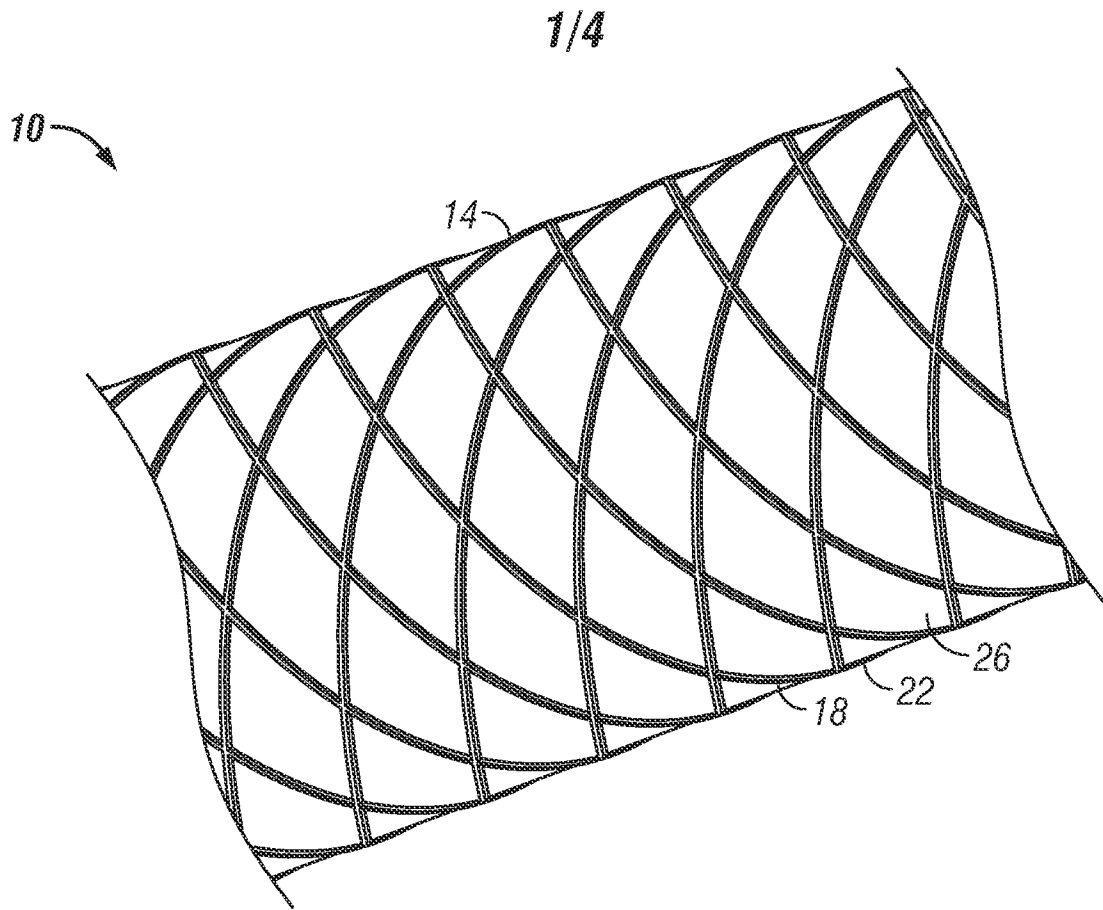


FIG. 1

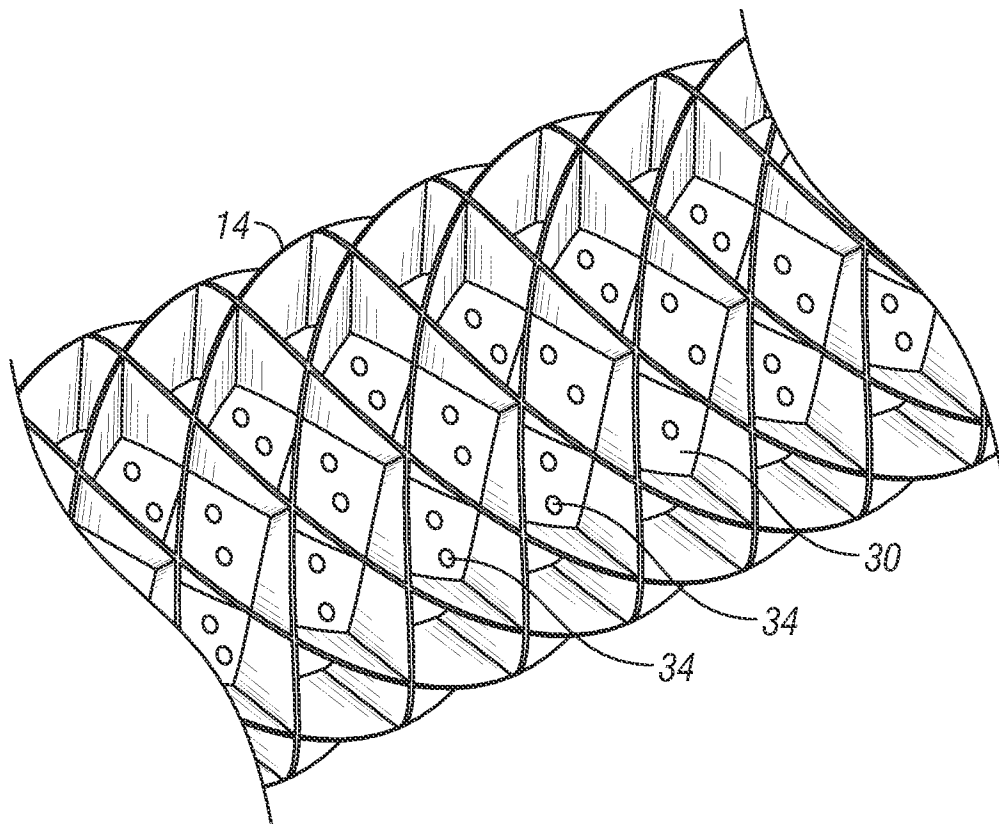


FIG. 2

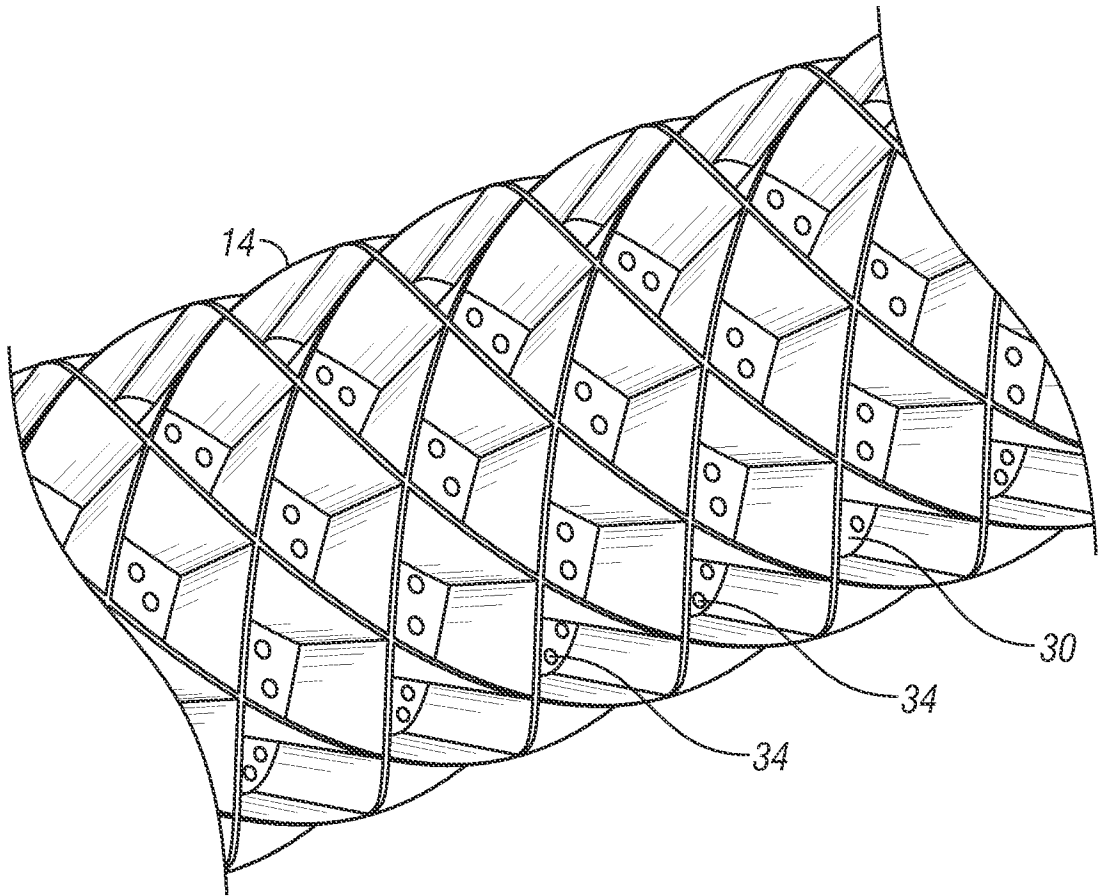


FIG. 3

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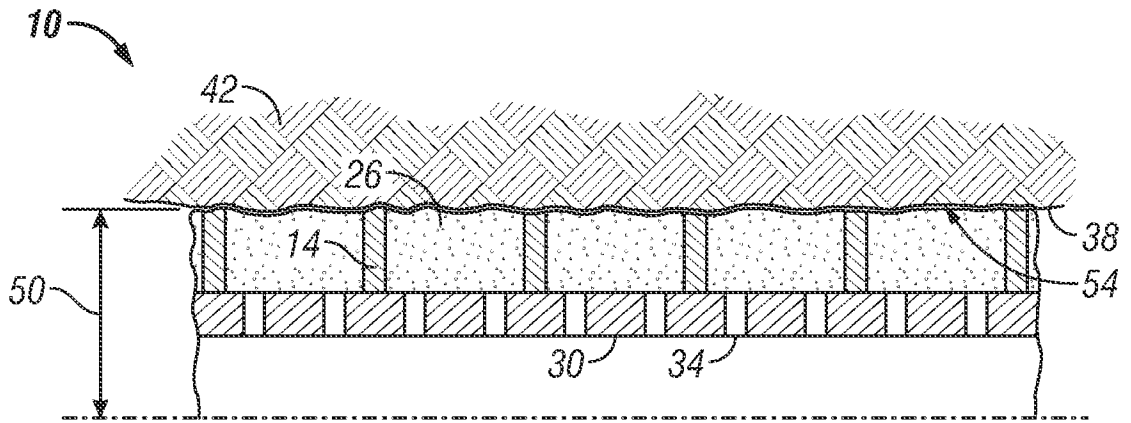


FIG. 4

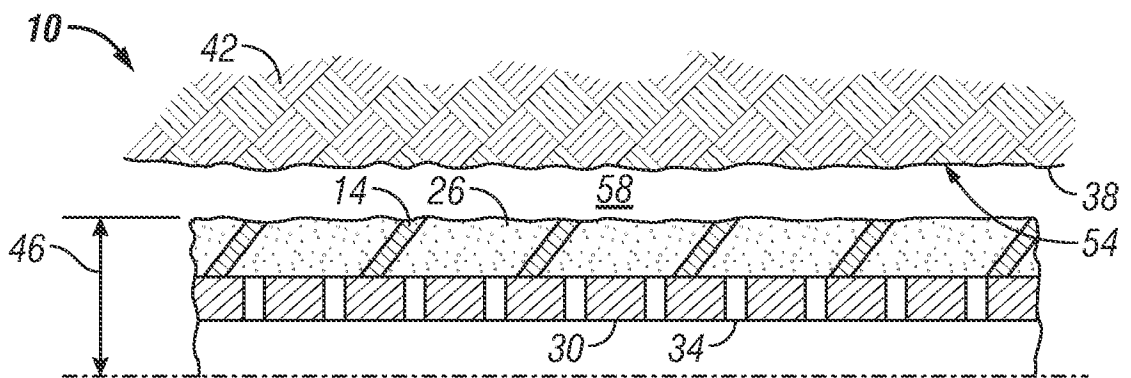


FIG. 5

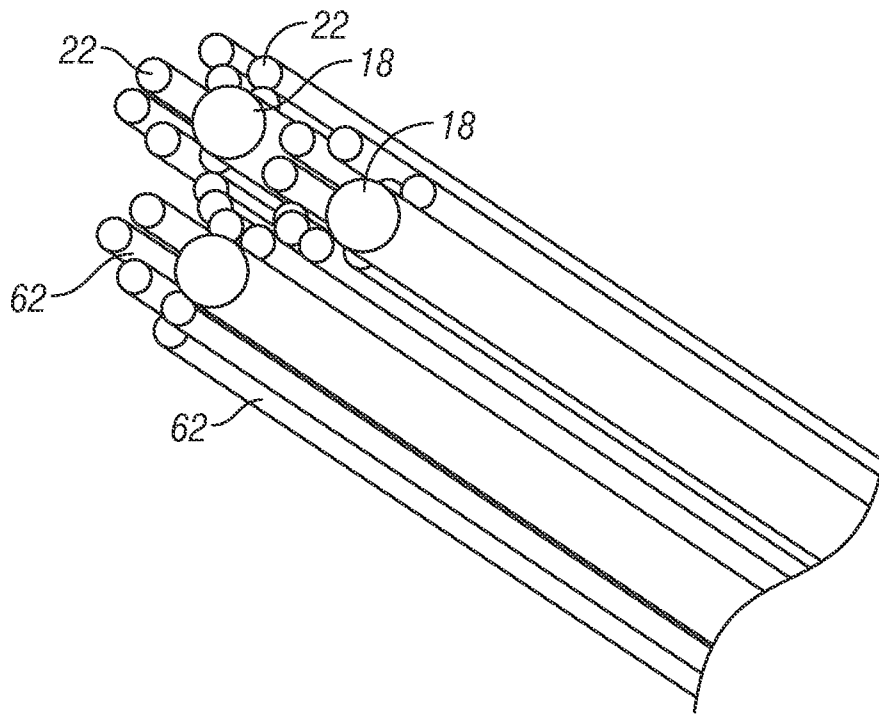


FIG. 6