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(54) Title: EXPANDABLE ELEMENT CONFIGURATION, METHOD AND SYSTEM

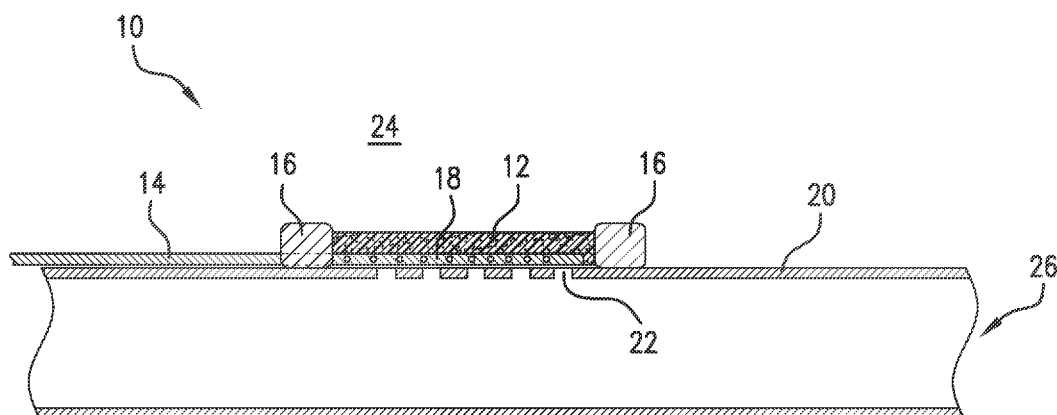


FIG. 1

(57) Abstract: A shape memory material element configuration including a shape memory material element, and a capillary line extending to the element and positioned to apply an activation fluid to the element.



EXPANDABLE ELEMENT CONFIGURATION, METHOD AND SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

5 [0001] This application claims the benefit of U.S. Application No. 17/384088, filed on July 23, 2021, which is incorporated herein by reference in its entirety.

BACKGROUND

10 [0002] In the resource recovery and fluid sequestration industries, deploying elements to filter fluids and support wellbore structure is common. Some of the elements deployed include shape memory attributes. These work well in general but sometimes there are complications in determining volume and application method for activation fluids that result in excess engineering and preparation time. These issues can also sometimes result in longer well downtime, which is always undesirable. Therefore the art will well receive alternatives that improve efficiency.

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SUMMARY

20 [0003] An embodiment of a shape memory material element configuration including a shape memory material element, and a capillary line extending to the element and positioned to apply an activation fluid to the element.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The following descriptions should not be considered limiting in any way. With reference to the accompanying drawings, like elements are numbered alike:

25 [0005] Figure 1 is a side view of a shape memory material element configuration in accordance with the instant disclosure in a run in position;

[0006] Figure 2 is the view of Figure 1 with an actuation fluid illustrated accessing the element;

[0007] Figure 3 is the view of Figure 1 with the element in a deployed position;

30 [0008] Figure 4 is a schematic view of the shape memory material element configuration in a target location near a formation feature;

[0009] Figure 5 is the view of Figure 4 with the element expanded into proximity with the formation feature; and

[0010] Figure 6 is a view of a wellbore system including the shape memory material element configuration disclosed herein.

DETAILED DESCRIPTION

[0011] 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.

[0012] Referring to Figure 1, a shape memory material element configuration 10 is illustrated. The configuration 10 includes a shape memory material element 12 and a capillary supply line 14 that may end at the element 12 or continue into the element 12. The shape memory material is, in an embodiment, a shape memory polymer and is a porous medium that act well as a filter. One example of a material that could form a portion of the element 12 is GeoForm shape memory polymer material commercially available from Baker Hughes, Houston Texas. The configuration 10 may also include end rings 16 to axially secure the element 12 and a manifold 18 in fluid communication with the line 14 and disposed within the element 12. As illustrated, the configuration 10 may be disposed upon a tubular 20 (that may be a part of a string in a borehole). The tubular 20 optionally includes one or more ports 22 through a wall thereof that fluidly connect an inside diameter surface of the tubular 20 with an outside surface of the tubular 20. In the embodiment as illustrated, the configuration 10 is located to be radially disposed relative to the ports 22 such that fluid transfer between a formation 24 outside of the element 12 and a fluid volume 26 inside of the tubular 20 is filtered by the element 12.

[0013] Regarding the line 14, in one embodiment where the line simply connects to the element 12, activation fluid injected through the line will either perfuse directly through the porous structure of the element 12 or may be distributed through the manifold 18. Manifold 18 is either formed by the material of the element 12 or made from another material and disposed within the element 12. The manifold 18 may be linear or branching or may simply be a bulbous void in the element 12, in embodiments. If the manifold 18 is of another material, then it is fluidly connected to the line 14 by suitable means. Where the manifold is another material, that material may be porous in nature or may have one or more openings therein to allow activation fluid injected through line 14 to reach and perfuse the element 12. This is illustrated in Figure 2. Once the element is perfused with the activation fluid, the element 12 expands as is illustrated in Figure 3.

[0014] A significant benefit of the presently disclosed configuration is that excess activation fluid is not required, as it would be in most downhole uses of shape memory material. Because a capillary line 14 is employed, activation fluid may be measured for

volume at surface and injected directly to the element. No dilution of the fluid would occur like it would in other uses of shape memory material downhole where a pill is pumped, for example. Prior art methods for delivering activation fluid to a tool that uses a shape memory material all result in dilution of the activation fluid which then requires more fluid than
5 actually needed for material shape change and tends to create other undesirable consequences in the borehole.

[0015] Referring to Figures 4, 5, and 6 a wellbore system 30 is illustrated. The system 30 includes a borehole 32 in the subsurface formation 24 (same as introduced above). A string 34 is disposed in the borehole 32. Disposed on the string is the configuration 10. It
10 will be appreciated that the configuration 10 is disposed near the formation 24 with which fluid exchange is to occur. Upon the configuration reaching this illustrated location, the activation fluid is injected through line 14 to the element 12, whereby element 12 expands into close proximity or contact with the borehole 32. This condition is illustrated in Figure 5. Once the Figure 5 condition of the element 12 is achieved, fluid transfer from or too the
15 formation 24 may commence while filtration through the element 12 is achieved.

[0016] Set forth below are some embodiments of the foregoing disclosure:

[0017] Embodiment 1: A shape memory material element configuration including a shape memory material element, and a capillary line extending to the element and positioned to apply an activation fluid to the element.

[0018] Embodiment 2: The configuration as in any prior embodiment, wherein the shape memory material is a shape memory polymer.

[0019] Embodiment 3: The configuration as in any prior embodiment, wherein the element is permeable.

[0020] Embodiment 4: The configuration as in any prior embodiment, wherein the line extends into the element.

[0021] Embodiment 5: The configuration as in any prior embodiment, wherein a portion of the line extending into the element includes a plurality of orifices therein.

[0022] Embodiment 6: The configuration as in any prior embodiment, wherein a portion of the line extending into the element is porous to activation fluid.

[0023] Embodiment 7: The configuration as in any prior embodiment, further comprising a manifold in fluid connection with the line.

[0024] Embodiment 8: The configuration as in any prior embodiment, wherein the manifold is a separate structure from the element but disposed therein.

[0025] Embodiment 9: The configuration as in any prior embodiment, wherein the manifold is a created within the element.

[0026] Embodiment 10: The configuration as in any prior embodiment, wherein the manifold is an activation fluid distribution pathway within the element.

[0027] Embodiment 11: The configuration as in any prior embodiment, wherein the pathway is a branching pathway.

[0028] Embodiment 12: The configuration as in any prior embodiment, wherein the element expands upon exposure to the activation fluid.

[0029] Embodiment 13: A method for deploying a shape memory material element configuration as in any prior embodiment including injecting a volume of activating fluid through the capillary line, and infusing the shape memory material with the activating fluid.

[0030] Embodiment 14: The method as in any prior embodiment, further including regulating the volume of activating fluid such that the volume is sufficient to activate the element while avoiding excess activating fluid escape to an environment outside of the element.

[0031] Embodiment 15: The method as in any prior embodiment, further including contacting a borehole wall with the element and filtering fluid passing between a formation surrounding the borehole wall and an inside diameter surface of the element.

[0032] Embodiment 16: A method for deploying a shape memory material element configuration as in any prior embodiment including preparing a volume of activating fluid needed to deploy the element to be supplied to the element, and supplying the volume to the element without dilution or loss of the volume.

[0033] Embodiment 17: A wellbore system including a borehole in a subsurface formation, a string in the borehole, and a shape memory material element configuration as in any prior embodiment disposed within or as a part of the string.

[0034] The use of the terms “a” and “an” and “the” and similar referents in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. Further, it should be noted that the terms “first,” “second,” and the like herein do not denote any order, quantity, or importance, but rather are used to distinguish one element from another. The terms “about”, “substantially” and “generally” are intended to include the degree of error associated with measurement of the particular quantity based upon the equipment available at the time of filing the application. For

example, “about” and/or “substantially” and/or “generally” can include a range of $\pm 8\%$ or 5% , or 2% of a given value.

[0035] The teachings of the present disclosure may be used in a variety of well operations. These operations may involve using one or more treatment agents to treat a formation, the fluids resident in a formation, a wellbore, and / or equipment in the wellbore, such as production tubing. The treatment agents may be in the form of liquids, gases, solids, semi-solids, and mixtures thereof. Illustrative treatment agents include, but are not limited to, fracturing fluids, acids, steam, water, brine, anti-corrosion agents, cement, permeability modifiers, drilling muds, emulsifiers, demulsifiers, tracers, flow improvers etc. Illustrative well operations include, but are not limited to, hydraulic fracturing, stimulation, tracer injection, cleaning, acidizing, steam injection, water flooding, cementing, etc.

[0036] 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.

What is claimed is:

1. A shape memory material element configuration (10) characterized by:
a shape memory material element (12); and
a capillary line (14) extending to the element (12) and positioned to apply an activation fluid to the element (12).
2. The configuration (10) as claimed in claim 1 wherein the shape memory material is a shape memory polymer.
3. The configuration (10) as claimed in claim 1 wherein the element (12) is permeable.
4. The configuration (10) as claimed in claim 1 wherein the line (14) extends into the element (12).
5. The configuration (10) as claimed in claim 4 wherein a portion of the line (14) extending into the element (12) includes a plurality of orifices therein.
6. The configuration (10) as claimed in claim 4 wherein a portion of the line (14) extending into the element (12) is porous to activation fluid.
7. The configuration (10) as claimed in claim 1, further comprising a manifold (18) in fluid connection with the line (14).
8. The configuration (10) as claimed in claim 7 wherein the manifold (18) is a separate structure from the element (12) but disposed therein.
9. The configuration (10) as claimed in claim 7 wherein the manifold (18) is a created within the element (12).
10. The configuration (10) as claimed in claim 7 wherein the manifold (18) is an activation fluid distribution pathway within the element (12).
11. The configuration (10) as claimed in claim 10 wherein the pathway is a branching pathway.
12. The configuration (10) as claimed in claim 1 wherein the element (12) expands upon exposure to the activation fluid.
13. A method for deploying a shape memory material element configuration (10) as claimed in claim 1 characterized by:
injecting a volume (26) of activating fluid through the capillary line (14); and
infusing the shape memory material with the activating fluid.
14. The method as claimed in claim 10 further including regulating the volume (26) of activating fluid such that the volume (26) is sufficient to activate the element (12) while avoiding excess activating fluid escape to an environment outside of the element (12).

15. The method as claimed in claim 10 further including contacting a borehole (32) wall with the element (12) and filtering fluid passing between a formation (24) surrounding the borehole (32) wall and an inside diameter surface of the element (12).

16. A method for deploying a shape memory material element configuration (10) as claimed in claim 1 characterized by:

preparing a volume (26) of activating fluid needed to deploy the element (12) to be supplied to the element (12); and

supplying the volume (26) to the element (12) without dilution or loss of the volume (26).

17. A wellbore system (30) characterized by:

a borehole (32) in a subsurface formation (24);

a string (34) in the borehole (32); and

a shape memory material element configuration (10) as claimed in claim 1 disposed within or as a part of the string (34).

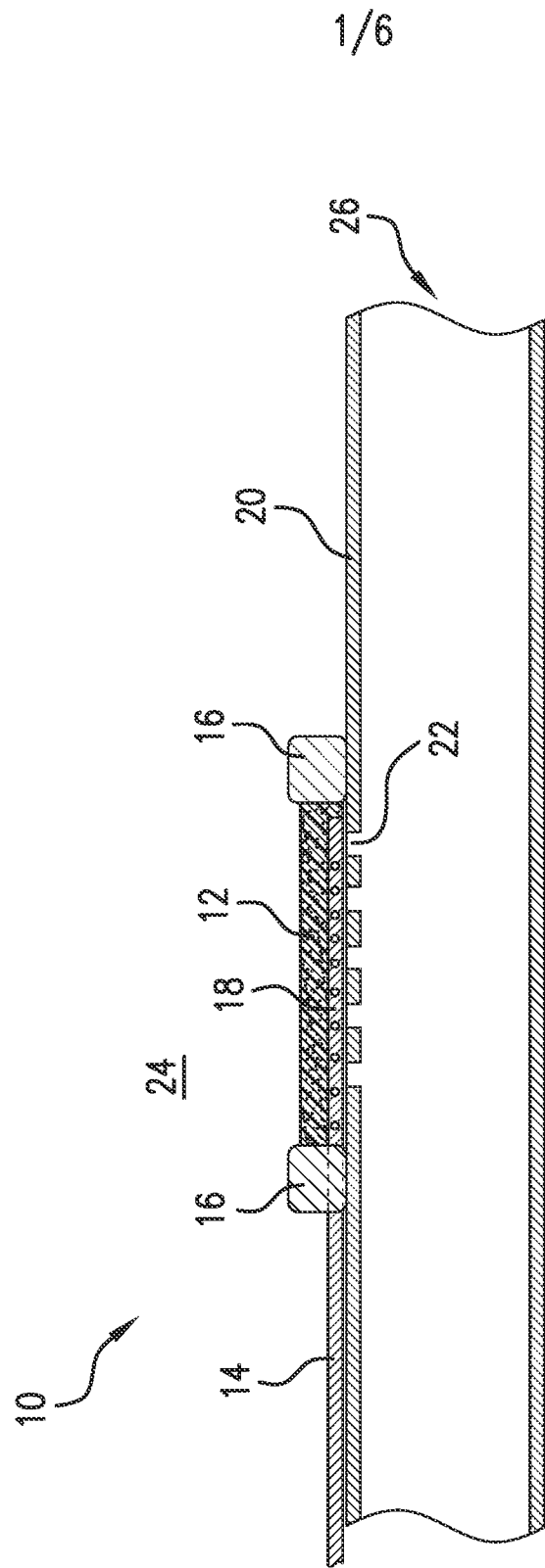


FIG.1

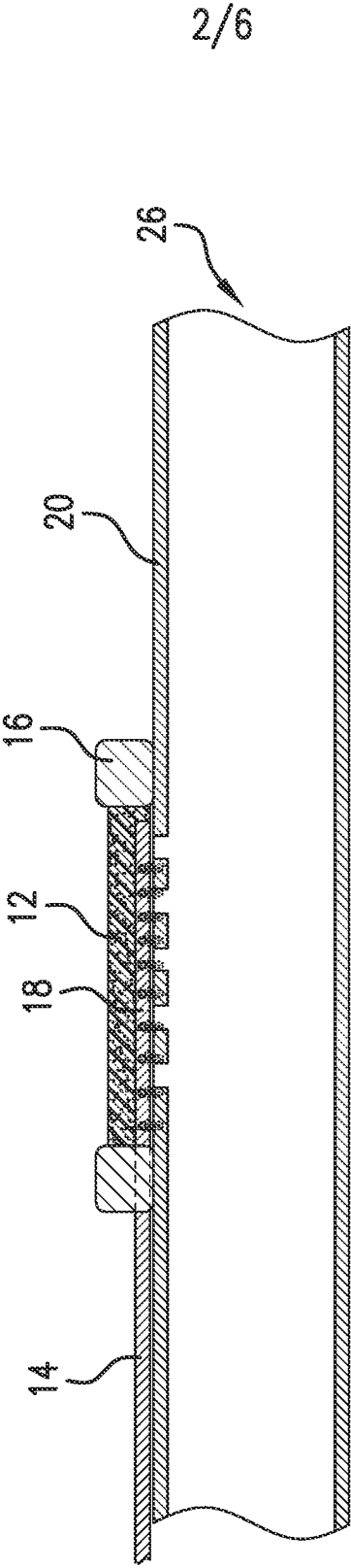


FIG.2

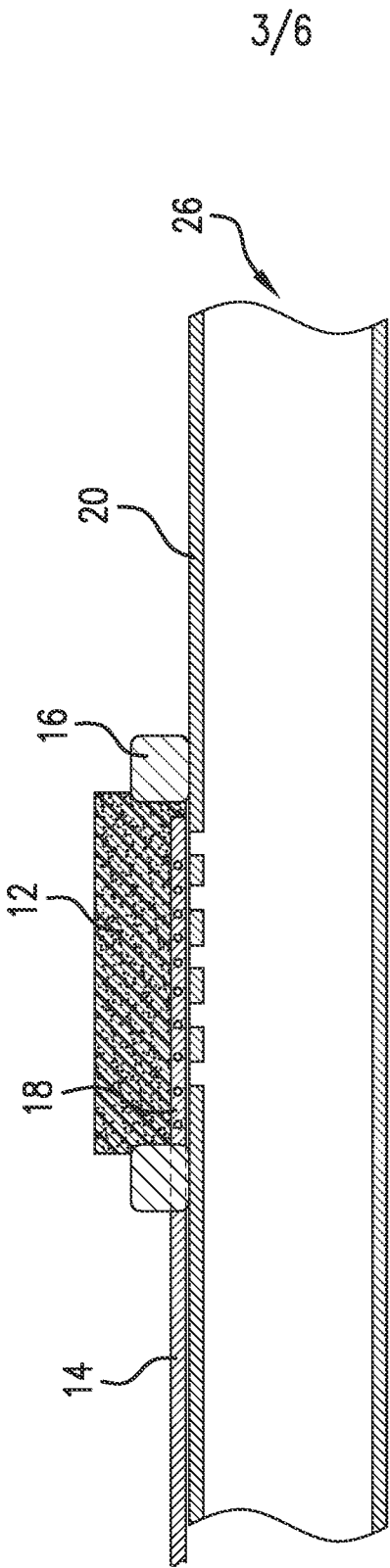


FIG. 3

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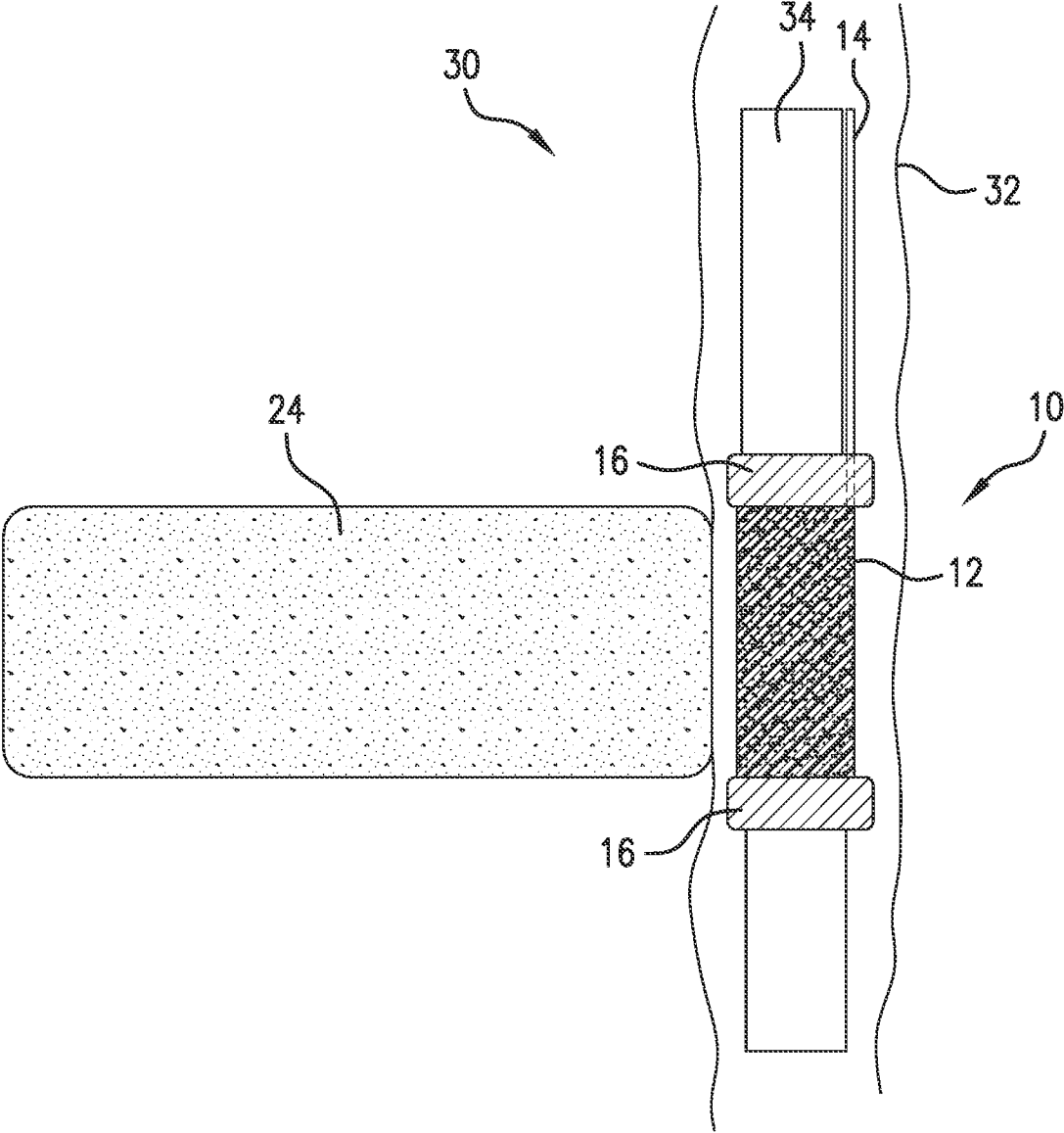


FIG. 4

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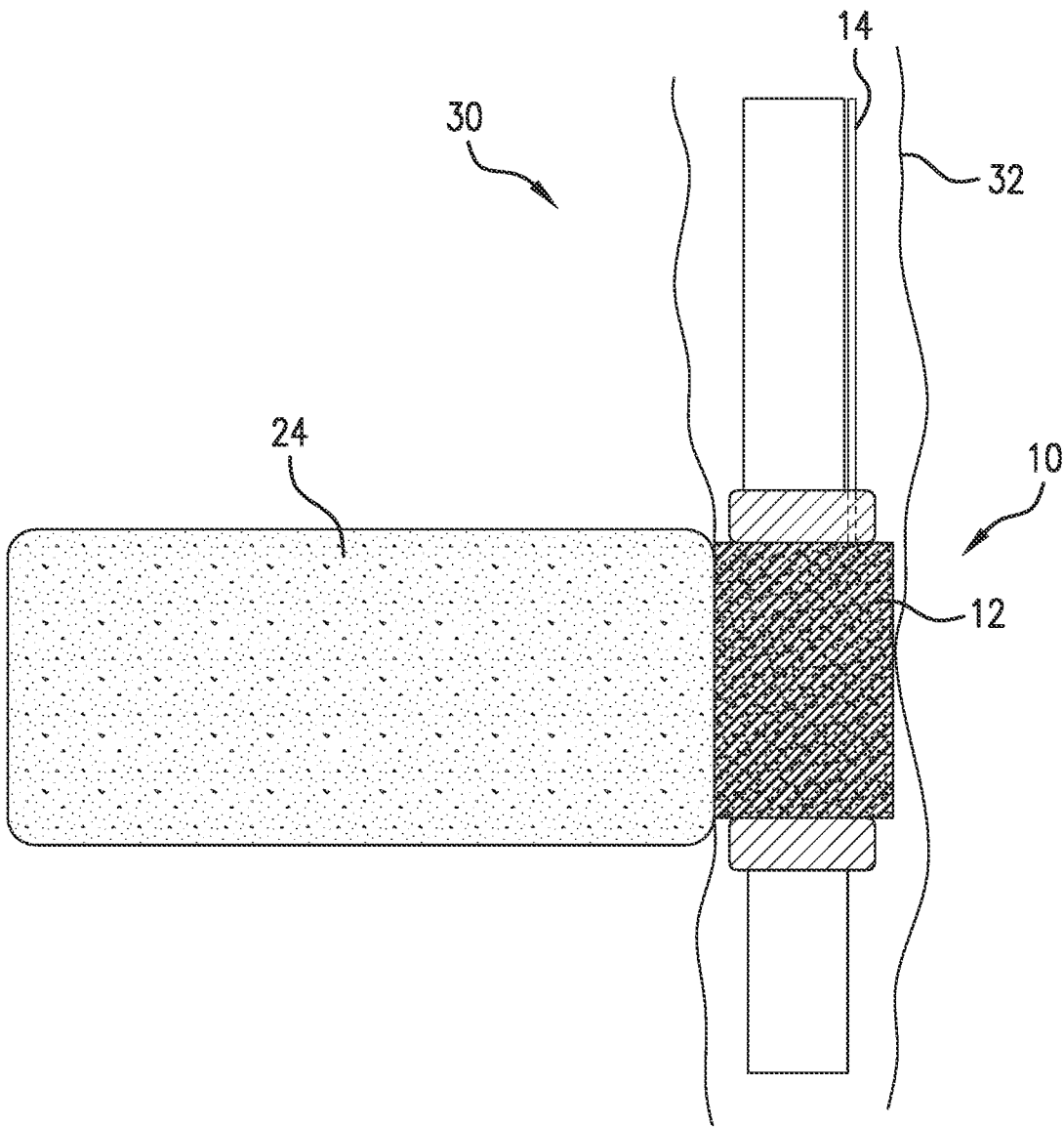


FIG.5

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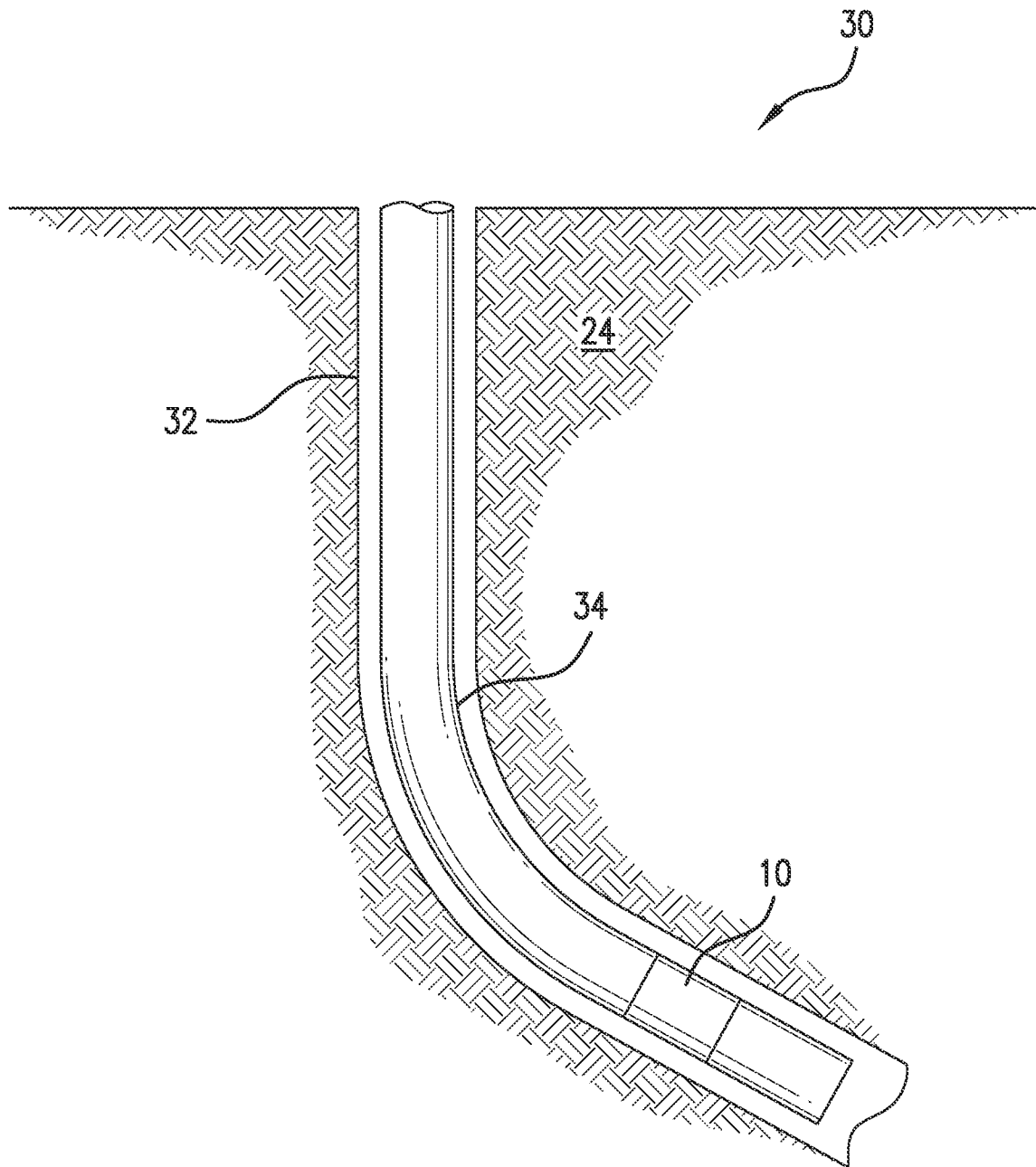


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.

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A. CLASSIFICATION OF SUBJECT MATTER E21B 33/124(2006.01)i; E21B 33/127(2006.01)i; E21B 43/10(2006.01)i; E21B 23/06(2006.01)i According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) E21B 33/124(2006.01); C08J 9/36(2006.01); C09K 8/44(2006.01); E21B 37/00(2006.01); E21B 43/02(2006.01); E21B 43/08(2006.01); F16L 55/00(2006.01); F16L 9/14(2006.01) Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean utility models and applications for utility models Japanese utility models and applications for utility models Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) eKOMPASS(KIPO internal) & Keywords: shape memory material element, capillary line, activation fluid, manifold, orifice		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "D" document cited by the applicant in the international application "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 04 November 2022		Date of mailing of the international search report 04 November 2022
Name and mailing address of the ISA/KR Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon 35208, Republic of Korea Facsimile No. +82-42-481-8578		Authorized officer PARK, Tae Wook Telephone No. +82-42-481-3405

INTERNATIONAL SEARCH REPORT
Information on patent family members

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