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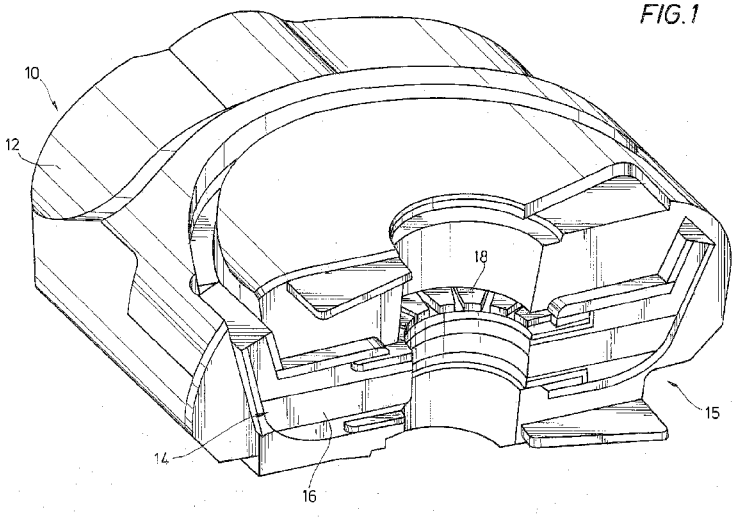
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(54) Title: REINFORCED VARIABLE RAM PACKER USING FABRIC

FIG.1



(57) Abstract: A variable ram assembly for use in a blowout preventer (BOP) stack includes a packer element. The packer element includes an elastomeric body having a contact surface configured with a curved recess for sealing engaging a tubular. Fibers are included in the body adjacent the contact surfaces that exert a restraining force to prevent extrusion of the elastomeric body when it is forced against the tubular. The fibers are integrally formed in the body and may be woven into a fabric, which is disposed into a packer element mold along with uncured elastomer before forming the body. The fabric can be coated with an elastomer to bond with the body during the forming process.

WO 2014/105629 A2

REINFORCED VARIABLE RAM PACKER USING FABRIC

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and the benefit of co-pending U.S. Provisional Application Serial No. 61/747,576 filed on December 31, 2012, the full disclosure of which is hereby incorporated by reference herein for all purposes.

BACKGROUND

FIELD OF INVENTION

[0002] The present disclosure relates in general to a variable ram packer for use with a blowout preventer (BOP) mounted on a wellhead. More specifically, the present disclosure relates to a variable ram packer with a packer element having a reinforcement material on its contact surface.

Description of Prior Art

[0003] Wellbores in hydrocarbon bearing subterranean formations are formed by rotating a drill bit mounted on a lower end of a drill string. Typically, a wellhead housing is installed at the earth's surface and through which bit and string are inserted. A blow out preventer (BOP) stack usually mounts on top of the wellhead housing that provides pressure control of the wellbore, and often includes rams to shut in the wellbore should pressure in the wellbore become uncontrollable. Additional rams are often included with BOP stacks that are for shearing the string within the BOP stack, and also for pressure testing within the BOP. Further typically included with BOP stacks are flow lines and valves to allow fluid flow through the BOP stack for remediating overpressure in the wellbore.

[0004] One type of BOP ram for pressure testing within a BOP stack is a variable ram packer. Variable ram packers usually include a pair of hydraulically powered rams on opposing lateral sides of the BOP stack, which are selectively forced radially inward into compressive engagement with the tubular. An elastomer packer element is typically provided with the variable ram packers for engaging the tubular, and has a curved recess on its engaging surface for receiving the tubular. The curved recesses on the pair of packers form a seal in the bore and around the tubular so pressure in the wellbore can be verified. Adjacent the curved recess, each packer element often has a planar surface that defines an edge at the interface between the recess and planar surface. During operation of the variable ram packers, compressive stresses in the recess transfer to the unsupported edge portion and extrude it outward. Over time, the edge portion is susceptible to damage from these multiple extrusion cycles, especially during exposure to varying low and high temperatures.

SUMMARY OF THE INVENTION

[0005] Provided herein are embodiments of a variable ram for use with a blowout preventer (BOP) and a method of making. In one example, a variable ram is disclosed that includes a ram block selectively moveable within a BOP, and a ram packer disposed in the ram block. In this example, the ram packer is made of an elastomer body with a contact surface along one of its lateral sides. A recess portion is provided on a mid-portion of the contact surface; and which projects radially into the body. The recess portion is in selective sealing engagement with a tubular in the BOP, and fibers in the body adjacent the contact surface, so that when the ram block is moved radially inward into sealing contact with the tubular, the fibers exert a force that oppose extrusion of the body. The fibers can be made from a polyester, a polyamide, a cellulose fiber, cotton, para-aramid synthetic fiber, neoprene, nitrile rubber, hydrogenated nitrile rubber, carboxylated nitrile rubber, and combinations thereof. In one example, a portion of the contact surface, adjacent an end of the recess portion, is at an angle with respect to the recessed portion; where the angle defines an edge on the contact surface, and wherein the fibers extend adjacent the edge. The fibers comprise can be lateral fibers that extend laterally along the body. Optionally, the fibers can be axial fibers that extend axially in the body. In another example, the fibers are lateral fibers that extend laterally along the body and axial fibers in the body adjacent the contact surface that are generally coplanar with the lateral fibers and oriented at an angle with the lateral fibers. The fibers can be woven into a planar fabric and rubber coated to define a rubberized fabric. In an example, at least some of the fibers extend adjacent to one of an upper surface and a lower surface of the body that respectively adjoin opposing upper and lower ends of the contact surface. The elastomer body can be more elastic than the fibers. The elastomer body can be substantially solid.

[0006] Also disclosed herein is an example of a ram packer assembly for use in a BOP and which includes an elastomeric body selectively disposed in a ram block. The body has a contact surface with a curved recess that selectively seals against a tubular in the BOP. A fabric is integral in the body and adjacent the contact surface. Thus when the body is forced against the tubular, the fabric exerts a force that opposes extrusion of the body. A series of interlocking inserts can be included that selectively slide with respect to one another on a radial surface of the body when the body is radially compressed. The fabric can include fibers made of one or more of a polyester, a polyamide, a cellulose fiber, cotton, para-aramid synthetic fiber, neoprene, nitrile rubber, hydrogenated nitrile rubber, and a carboxylated nitrile rubber. In an example, the fabric is provided along an interface between an end of the curved recess and an adjacent planar portion of the contact surface. The portion of the body adjacent the fabric can be stiffer than a portion of the body distal from the fabric.

[0007] A method of forming a ram packer assembly is provided herein, where the ram packer assembly has a contact surface and that is for use in a BOP. One example of the method includes providing an uncured elastomer and disposing it into a ram packer assembly mold. Fibers are strategically disposed in the mold to be adjacent the contact surface. The uncured elastomer is cured to form a body with the fibers integrally set in the body. Sliding plates are optionally provided in the mold that mount on opposing surfaces of the body. In one example, the fibers are made from one of a polyester, a polyamide, a cellulose fiber, cotton, para-aramid synthetic fiber, neoprene, nitrile rubber, hydrogenated nitrile rubber, and combinations thereof. The fibers can be woven into a fabric and coated with an elastomer that adheres with the body.

BRIEF DESCRIPTION OF DRAWINGS

[0008] Some of the features and benefits of the present invention having been stated, others will become apparent as the description proceeds when taken in conjunction with the accompanying drawings, in which:

[0009] FIG. 1 is a perspective view of an example of a variable ram having an embodiment of a packer element in accordance with an embodiment of the present invention.

[0010] FIG. 2 is a side partial sectional view of an example of the variable ram of FIG. 1 included in a blowout preventer stack in accordance with an embodiment of the present invention.

[0011] FIG. 3 is a perspective view of an example of a packer element of FIG. 1 in accordance with an embodiment of the present invention.

[0012] FIG. 4 is a plan view of an alternate embodiment of the packer element of FIG. 1 in accordance with an embodiment of the present invention.

[0013] FIG. 5 is a plan view of an example of molding an embodiment of the packer element of FIG. 1 in accordance with an embodiment of the present invention.

[0014] While the invention will be described in connection with the preferred embodiments, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications, and equivalents, as may be included within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF INVENTION

[0015] The method and system of the present disclosure will now be described more fully hereinafter with reference to the accompanying drawings in which embodiments are shown. The method and system of the present disclosure may be in many different forms and should not be construed as limited to the illustrated embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey its scope to those skilled in the art. Like numbers refer to like elements throughout.

[0016] It is to be further understood that the scope of the present disclosure is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents will be apparent to one skilled in the art. In the drawings and specification, there have been disclosed illustrative embodiments and, although specific terms are employed, they are used in a generic and descriptive sense only and not for the purpose of limitation.

[0017] Figure 1 provides a perspective view of an example embodiment of a variable ram 10, which includes a ram block 12 which houses a ram packer assembly 14. A recess 15 in the ram block 12 is configured to receive the ram packer assembly 14. The recess 15 intersects with a forward facing end of the ram block 12, and extends partially across the width and length of the ram block 12. In the example of Figure 1, the ram block 12 is a substantially metallic member that is generally rectangular shaped, and where its length and width exceed its height. A packer element 16 makes up part of the packer assembly 14, which in an example is made at least in part from an elastomeric material. Inserts 18 shown set on an upper radial surface of the packer element 16 and arranged in a semi-circle with its outer radius projecting into the recess 15. Brackets at opposing terminal ends of the semi-circle are coupled to the forward facing end of the packer element 16, but the individual inserts 18 are laterally moveable on the radial surface of the packer element 16. Inserts 18 are interlocked on their respective adjoining edges, but slideable towards one another so the semi-circle compresses when the packer element 16 is laterally compressed.

[0018] An example of a blowout preventer (BOP) 20 is shown in a side sectional view in Figure 2 and which includes an embodiment of the variable ram 10. The BOP 20 includes a body 21 for housing a pair of variable rams 10; the variable rams 10 can be selectively actuated laterally in and out of body 21. BOP 20 is shown mounted on an upper end of a wellhead housing 22 that anchors on a surface 24, where surface 24 may be subsea or on land. A main bore 26 through wellhead assembly 22 and BOP 20 is shown registering with a wellbore 28 that is being formed through the surface 24 by a drill string 30. In the example, the drill string 30 extends through the main bore 26 and the wellbore 28, and includes a drill bit (not shown) on its lower end, that when rotated by drill string 30 excavates wellbore 28. As illustrated in the example of Figure 2, variable rams 10 project radially inward from opposing bodies 21 into sealing engagement with an outer surface of tubular 30. In one example, sealingly engaging the tubular 30 with variable ram allows a pressure test to be performed in wellbore 28.

[0019] A perspective view of an example of packer assembly 14 is provided in Figure 3 wherein opposing lateral ends of packer assembly 14 are shown angled upward away from an upper radial surface. A contact surface 32 is defined on the side of the packer element 16 that projects

outward from the ram block 12 (Figure 1) and which includes a curvedrecess 34, which can be shaped as semi-circular or semi-elliptical member. The curved recess 34 is shown formed along a mid-portion of the contact surface 32 and projects radially inward and follows a generally curved path with its outer radius set adjacent inner radius of the inserts 18. In an example, when the variable ram 10 is urged radially inward as illustrated in Figure 2, the contact surface 32 is compressed against outer surface of drill string 30. Strategically profiling the curved recess 34 in combination with compressing the contact surface 32 against the drill string 30 forms a sealing surface between packer element 16 and tubular 30 to define an axial pressure barrier in the main bore 26. Adjacent opposing ends of the curved recess 34, the contact surface 32 is disposed in a plane generally parallel within axis of drill string 30 (Figure 2) thereby defining flats 36 on lateral ends of the curved recess 34.

[0020] Further illustrated in the example of Figure 3 is a reinforcing compound 38 embedded within the body of the packer element 16 and adjacent the contact surface 32. The reinforcing compound 38 is shown made up of individual fibers 39 that extend laterally along at least a portion of the length of the contact surface 32. Optional fibers 39 are shown that extend axially between opposing upper and lower radial surfaces of the packer element 16. Alternate embodiments exist, wherein reinforcing compound 38 includes only fibers that run either laterally, or vertically, but not both. Further, the reinforcing compound 38 is shown extending over an interface 40 on the contact surface 32 where curved recess 34 transitions into flat 36. In an example, interface 40 is defined as an edge where the contact surface 32 angles in a radial direction at the boundary between flat 36 and curved recess 34. Providing the reinforcing compound 38 across the interface 40 further enhances and/or provides an advantage against extrusion of the packer element 16 when set in sealing contact with drill string 30 (Figure 2).

[0021] In an embodiment, the reinforcing compound 38 is made up of a fabric of the fibers 39. Example materials for the fiber 39 include polyester, nylon, rayon, cotton, polyamide, neoprene, nitrile rubber, hydronated nitrile rubber, carboxylated nitrile rubber, and combinations thereof. Moreover, the fiber 39 can have an end per inch value of 10x10, 15x15, 20x20, 30x30, and all values there between. Exemplary values for a gauge of the fibers 39 include 0.22 inch, 0.50 inch, 0.10 inch, 0.20 inch, and all values there between. Additionally, example materials for the packer element 15 include rubber, neoprene, nitrile rubber, hydrogenated nitrile rubber, carboxylated nitrile rubber, natural rubber, butyl rubber, ethylene-propylene rubber, epiclorohydrin, chlorosulfunated polyethylene, fluororelastomers, and combinations thereof.

[0022] Figure 4 illustrates an alternate embodiment of the packer assembly 14 shown in a plan view, wherein the reinforcing compound 38 extends onto the upper radial surface 42. More specifically, in the example of Figure 4, the reinforcing compound extends a distance D from a

contact surface 32 of packer assembly 14. Further, the reinforcing compound 38 is provided along substantially all of the curved recess 34 and approximately to a midpoint between terminal ends of the packer assembly 14 along the flat portion 36. Optionally however, embodiments exist wherein the reinforcing compound 38 is concentrated at or adjacent to the interface 40 between the curved recess 34 and flat 36. In another optional embodiment, the reinforcing compound 38 extends along the entire or substantially entire surface of contact surface 32. Further illustrated in Figure 4 is a rearward surface 44 of the packer assembly 14 that is curved and projects radially outward from the contact surface 32.

[0023] One example of forming a packer element 16 is shown in Figure 5. In this example, a mold 46 is provided having sidewalls 48 that approximate the outer periphery of the packer element 16 (Figure 3). In this example, an amount of uncured elastomer 50 is provided within the mold 46, and in an amount to substantially fill the mold 46 when cured in the mold. Included with the uncured elastomer 50 is an example of a reinforcing compound 38 shown set along an inside of sidewall 48 adjacent where the contact surface 32 (Figure 3) will be located on completion of the formation process. As is known, the mold 46 is enclosed and subjected to increased temperature and/or pressure for a period of time until the uncured elastomer 50 cures and transforms into the packer element 16. Disposing the reinforcing compound 38 along with the uncured elastomer 50 allows the reinforcing compound 38 to be integrally formed with the packer element 16 after the curing process is complete. Thus in one example, the reinforcing compound 38 is coated with a material that bonds with the elastomer making up the packer element 16 during the curing process. An elastomer, such as rubber, is one example of a bonding material for coating the reinforcing compound 38. Furthermore, the process illustrated in Figure 5 can in one example create a substantially solid packer element 16. Examples exist wherein the reinforcing compound 38 is formed from a material having a greater stiffness than the material making up packer element 16.

[0024] The present invention described herein, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned, as well as others inherent therein. While a presently preferred embodiment of the invention has been given for purposes of disclosure, numerous changes exist in the details of procedures for accomplishing the desired results. These and other similar modifications will readily suggest themselves to those skilled in the art, and are intended to be encompassed within the spirit of the present invention disclosed herein and the scope of the appended claims.

CLAIMS

What is claimed is.

1. A variable ram comprising:
a ram block selectively moveable within a blowout preventer (BOP); and
a ram packer disposed in the ram block comprising an elastomer body, a contact surface along a lateral side of the body, a recess portion on a mid-portion of the contact surface that projects radially into the body and that is in selective sealing engagement with a tubular in the BOP, and fibers in the body adjacent the contact surface, so that when the ram block is moved radially inward into sealing contact with the tubular, the fibers exert a force that oppose extrusion of the body.

2. The variable ram of claim 1, wherein the fibers comprise a material selected from the group consisting of a polyester, a polyamide, a cellulose fiber, cotton, para-aramid synthetic fiber, neoprene, nitrile rubber, hydrogenated nitrile rubber, carboxylated nitrile rubber, and combinations thereof.

3. The variable ram of claim 1, wherein the contact surface adjacent an end of the recess portion is at an angle with respect to the recessed portion to define an edge on the contact surface, and wherein the fibers extend adjacent the edge.

4. The variable ram of claim 1, wherein the fibers comprise lateral fibers that extends laterally along the body.

5. The variable ram of claim 1, wherein the fibers comprise axial fibers that extends axially in the body.

6. The variable ram of claim 1, wherein the fibers comprise lateral fibers that extend laterally along the body and axial fibers in the body adjacent the contact surface that are generally coplanar with the lateral fibers and oriented at an angle with the lateral fibers.

7. The variable ram of claim 1, wherein the fibers are woven into a planar fabric and rubber coated to define a rubberized fabric.

8. The variable ram of claim 1, wherein at least some of the fibers extend adjacent to one of an upper surface and a lower surface of the body that respectively adjoin opposing upper and lower ends of the contact surface.

9. The variable ram of claim 1, wherein the elastomer body is more elastic than the fibers.

10. The variable ram of claim 1, wherein the elastomer body is substantially solid.

11. A ram packer assembly for use in a blowout preventer (BOP) comprising:

a body comprising an elastomeric material and selectively disposed in a ram block;

a contact surface on the body having a curved recess that selectively seals against a tubular in the BOP; and

a fabric integral in the body and disposed adjacent the contact surface, so that when the body is forced against the tubular, the fabric exerts a force on that opposes extrusion of the body.

12. The ram packer assembly of claim 11, further comprising a series of interlocking plates that selectively slide with respect to one another on a radial surface of the body when the body is radially compressed.

13. The ram packer assembly of claim 11, wherein the fabric comprises fibers made of a material selected from the group consisting of a polyester, a polyamide, a cellulose fiber, cotton, para-aramid synthetic fiber, neoprene, nitrile rubber, hydrogenated nitrile rubber, carboxylated nitrile rubber, and combinations thereof.

14. The ram packer assembly of claim 11, wherein the fabric is provided along an interface between an end of the curved recess and an adjacent planar portion of the contact surface.

15. The ram packer assembly of claim 11, wherein a portion of the body adjacent the fabric is stiffer than a portion of the body distal from the fabric.

16. A method of forming a ram packer assembly having a contact surface and that is for use in a blowout preventer (BOP), the method comprising:

a. providing an uncured elastomer;

b. disposing the uncured elastomer into a ram packer assembly mold;

c. inserting the uncured elastomer into the mold;

d. strategically disposing fibers in the mold to be adjacent the contact surface; and

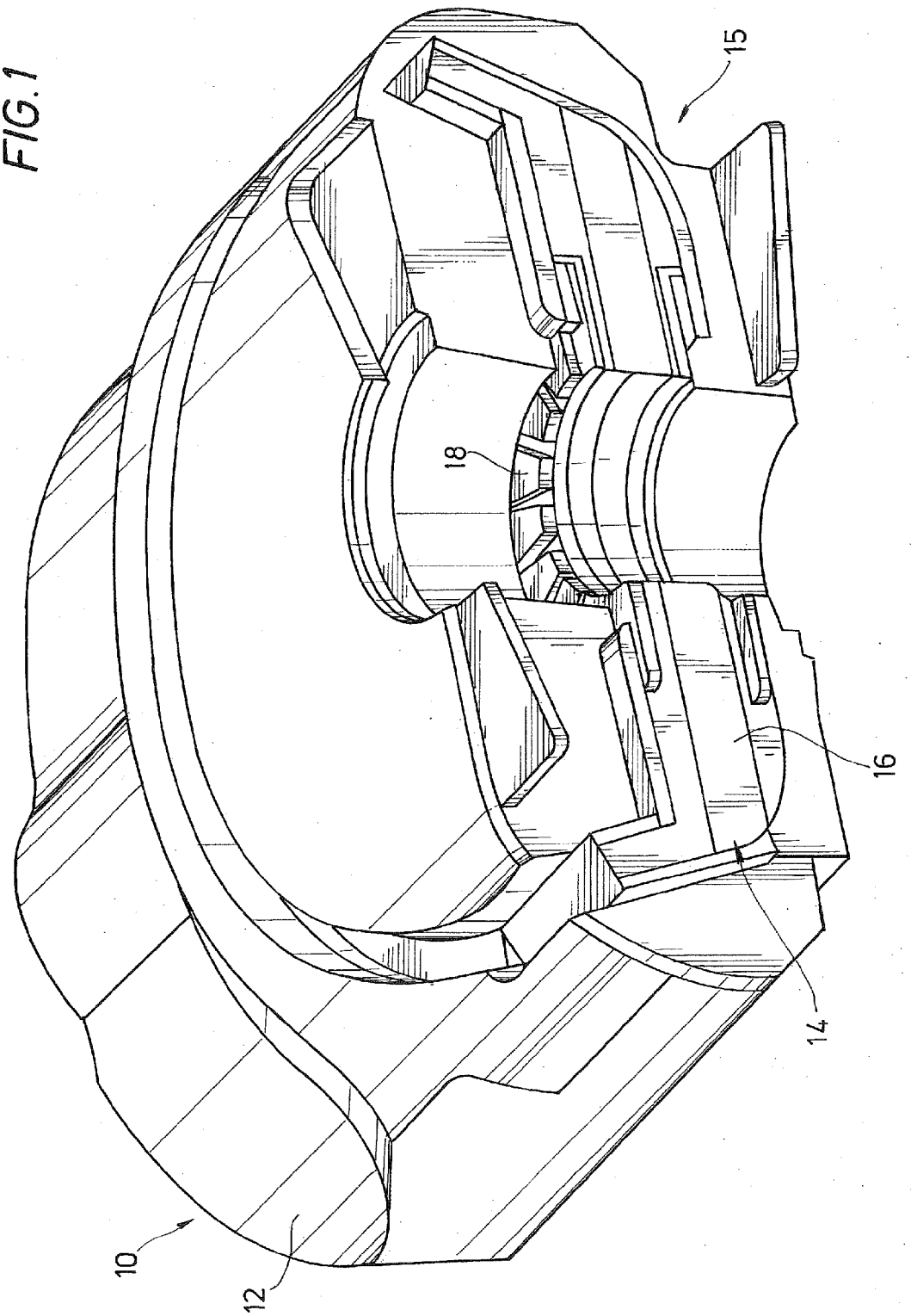
e. curing the uncured elastomer to form a body with the fibers integrally set in the body.

17. The method of claim 16, further comprising providing sliding plates in the mold that mount on opposing surfaces of the body.

18. The method of claim 16, wherein the fibers comprise a material selected from the group consisting of a polyester, a polyamide, a cellulose fiber, cotton, para-aramid synthetic fiber, neoprene, nitrile rubber, hydrogenated nitrile rubber, and combinations thereof.

19. The method of claim 16, wherein the fibers are woven into a fabric and coated with an elastomer that adheres with the body.

FIG.1



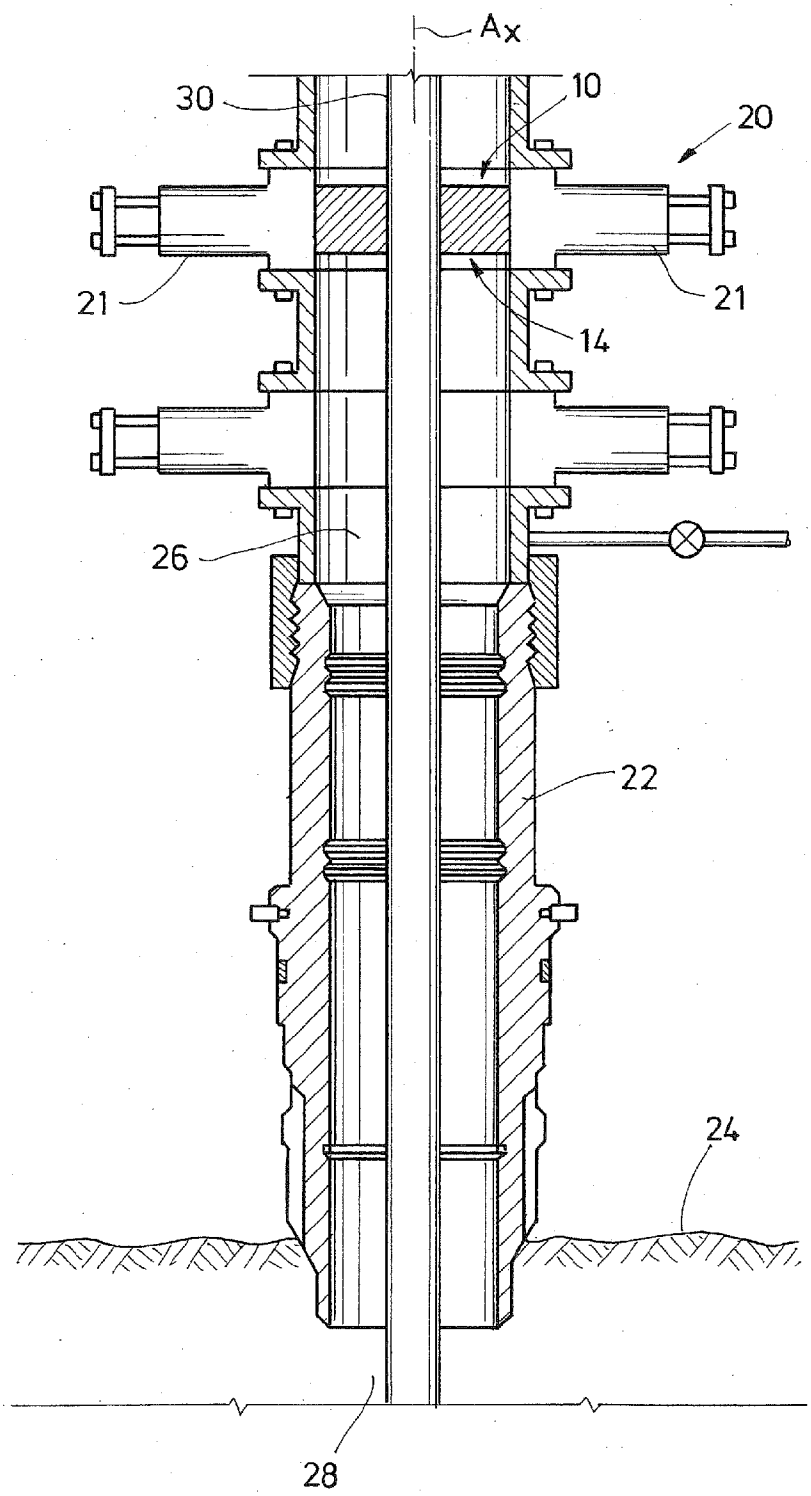


FIG. 2

FIG.3

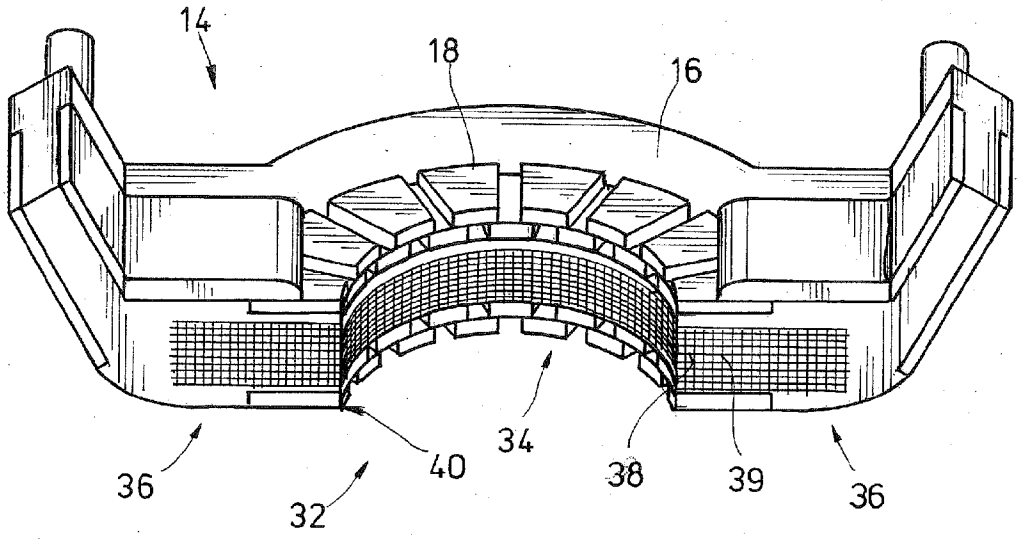


FIG.4

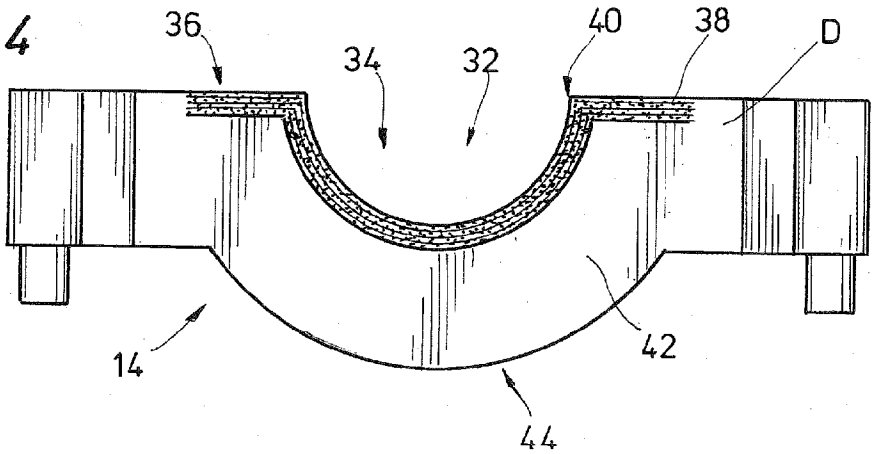


FIG.5

