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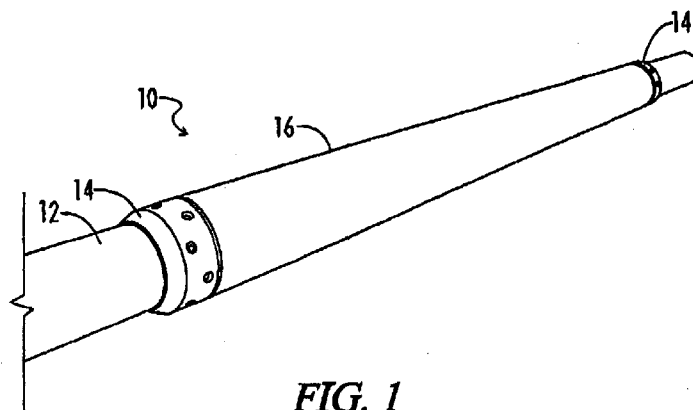


FIG. 1

(57) Abstract: Wellbore packer 10 includes base pipe 12, pair of end rings 14, swellable material 16 connected to the base pipe 12 in between pair of end rings 14, and non swellable end caps 18 connected to swellable material 16, and base pipe 12 in between swellable material 16 and pair of end rings 14. A method of making packer 10 includes the steps of providing base pipe 12, applying swellable material 16 to base pipe 12, connecting curing rings 28 to base pipe 12; connecting non swellable end caps 18 to base pipe 12 between swellable material 16 and curing rings 28; co-vulcanizing swellable material 16 and non swellable end caps 18 until they bond to one another; removing curing rings 28; and connecting end rings 14 to base pipe 12 adjacent to non swellable end caps 18.

WO 2017/156129 A1

DESCRIPTION

WELLBORE PACKER AND METHOD OF MAKING SAME

TECHNICAL FIELD

[0001] The present invention relates generally to wellbore packers for oil wells. More specifically, this invention pertains to a wellbore packer that has improved swelling characteristics and a method for manufacturing that packer.

BACKGROUND ART

[0002] The present invention relates generally to wellbore packers for oil wells. More specifically, this invention pertains to a wellbore packer that has improved swelling characteristics and a method for manufacturing that packer.

[0003] Wellbore packers are known in the art. These devices are designed to be inserted into wellbores and to swell when exposed to oil or water to seal off fluids and pressures within the wellbores. Prior art packers, however, do not always swell evenly when exposed to fluids because the ends of the swellable material included in these devices can swell and seal off the rest of the swellable material from the fluids causing the swelling. These prior art devices also do not swell as large as possible because prior art designs allow the swellable materials included in these devices to expand along the length of, rather than perpendicularly outward from, these devices. In some cases, the swellable material extends into a gap formed between the base pipe and end rings used in these prior art devices and that creates a potential failure point when in use. Thus, what is needed, is a new wellbore packer with improved swelling characteristics that addresses these issues.

DISCLOSURE OF THE INVENTION

[0004] The present invention addresses this need by providing a wellbore packer having improved swelling characteristics in oil and/or water and a design that prevents

the swellable material included with the device from expanding along the length of the device and allows the swellable material to swell in a more uniform and complete manner. In one exemplary embodiment, the wellbore packer includes a base pipe, a pair of end rings connected to opposite ends of the base pipe, a swellable material connected to the base pipe between the pair of end rings, and a pair of non swellable end caps connected to the base pipe and the swellable material between the swellable material and the pair of end rings. The swellable material may be an oil swellable material, a water swellable material, or a hybrid material that swells in oil and water. The pair of non swellable end caps prevent the swellable material from expanding along the length of the packer. The non swellable end caps also prevent the ends of the swellable material from swelling in a manner that prevents the rest of the swellable material from coming in contact with fluid and allows the swellable material to swell in a more uniform and complete manner.

[0005] An exemplary embodiment of a method of making a wellbore packer of the present invention includes the steps of providing the base pipe; applying a layer of swellable material to the base pipe; connecting a pair of curing rings to opposite ends of the base pipe; connecting a pair of non swellable end caps to the base pipe in between the swellable material and the curing rings; co-vulcanizing the swellable material and non swellable end caps so the end caps bond with the swellable material; and replacing the curing rings with end rings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Fig. 1 is a perspective view showing an exemplary embodiment of a wellbore packer of the present invention.

[0007] Fig. 2 is a side view of another exemplary embodiment of a wellbore packer of the present invention.

[0008] Fig. 3 is a perspective view showing a sandblasted pipe used in one embodiment of the present invention.

[0009] Fig. 4 is a perspective view showing primer added to the pipe shown in Fig. 3.

[0010] Fig. 5 is a perspective view showing bonding agent added to the primer and pipe shown in Fig. 4.

[0011] Fig. 6 is a perspective view showing the base pipe, swellable material, non swellable end caps, and curing rings used with one embodiment of the present invention.

[0012] Fig. 7 is enlarged perspective view showing one end of the packer shown in Fig. 6.

[0013] Fig. 8 is a perspective view showing one embodiment of the non swellable end caps used with the present invention.

[0014] Fig. 9 is a perspective view showing the assembly from Fig. 6 wrapped in nylon prior to curing.

[0015] Fig. 10 is a perspective view showing one embodiment of end rings used with the present invention.

[0016] Reference will now be made in detail to optional embodiments of the invention, examples of which are illustrated in accompanying drawings. Whenever possible, the same reference numbers are used in the drawing and in the description referring to the same or like parts.

BEST MODE FOR CARRYING OUT THE INVENTION

[0017] While the making and using of various embodiments of the present invention are discussed in detail below, it should be appreciated that the present invention provides many applicable inventive concepts that can be embodied in a wide variety of specific contexts. The specific embodiments discussed herein are merely illustrative of specific ways to make and use the invention and do not delimit the scope of the invention.

[0018] To facilitate the understanding of the embodiments described herein, a number of terms are defined below. The terms defined herein have meanings as commonly understood by a person of ordinary skill in the areas relevant to the present invention. Terms such as “a,” “an,” and “the” are not intended to refer to only a singular

entity, but rather include the general class of which a specific example may be used for illustration. The terminology herein is used to describe specific embodiments of the invention, but their usage does not delimit the invention, except as set forth in the claims.

[0019] The phrase “in one embodiment,” as used herein does not necessarily refer to the same embodiment, although it may. Conditional language used herein, such as, among others, “can,” “might,” “may,” “e.g.,” and the like, unless specifically stated otherwise, or otherwise understood within the context as used, is generally intended to convey that certain embodiments include, while other embodiments do not include, certain features, elements and/or states. Thus, such conditional language is not generally intended to imply that features, elements and/or states are in any way required for one or more embodiments.

[0020] Figs. 1 and 2 show exemplary embodiments of a wellbore packer 10 of the present invention. The packer 10 includes a base pipe 12, a pair of end rings 14 connected to opposite end portions of the base pipe 12, swellable material 16 (or swellable element 16) connected to the base pipe 12 intermediate the pair of end rings 14, and a pair of non swellable end caps 18 connected to the base pipe 12 intermediate the swellable material 16 and the end rings 16. The non-swellable end caps 18 act as stops at the ends of the swellable material 16 and prevent well fluids from flowing in between the swellable material 16 and the base pipe 12 and causing a failure. Because of the non-swellable nature of the end caps 18, they also act like an anchor on the ends of the swellable material 16 (once they are co-vulcanized and cross-linked to that material) and limit the amount of swell that can occur in these areas. This, in turn, allows well fluids to reach the center of the swellable material 16 and cause it to swell more uniformly and completely.

[0021] The swellable material 16 may be rubber and may be bonded to the base pipe 12. The non swellable end caps 18 may be bonded to each end of the swellable material 16 and may also be bonded to the base pipe 12. The base pipe 12 may include threaded portions 20 (Fig. 2) located on opposite ends of the base pipe 12.

[0022] Swellable material 16 may be an oil or water swellable material, such as FSC-06 or FSC-11, both manufactured and sold by Tam International, Inc., or may be a material that swells in both oil and water. The end rings 14 may be connected to the base pipe 12 using set screws.

[0023] Non-swellable end caps 18 may be manufactured out of any non swellable material that does not swell in the presence of oil and/or water. In one embodiment, the non-swellable end caps 18 are manufactured out of a novel rubber compound that will co-vulcanize with (or cross-link to) swellable compounds. The compound includes a base polymer mixed with various optimized amounts of other components described in detail below.

[0024] The “base” polymer may be a polychloroprene rubber (CR) and/or any other polymer that can be compounded in such a way to co-vulcanize with a swellable material. The compound may also include fillers, activators, antioxidants, process aids, plasticizers and curatives. Suitable fillers include, but are not necessarily limited to, carbon black, silica, clays, calcium carbonate, bentonite and the like, and combinations thereof. The proportion of filler may range between 25 and 60 PHR (parts per hundred rubber).

[0025] Suitable activators include, but are not necessarily limited to, magnesium oxide (MgO), zinc oxide (ZnO), zinc stearate, stearic acid and the like and combinations thereof. The proportion of activator may be in the range of 1-10 PHR. Suitable antioxidants include, but are not necessarily limited to, any of the diphenylamines (e.g. Naugard antioxidants) or any of the mercaptobenzimidazoles (e.g. Vanox ZMTI from R.T. Vanderbilt Company) and the like and combinations thereof.

[0026] Suitable process aids include, but are not necessarily limited to waxes (e.g. Vanfre waxes from R.T. Vanderbilt Company), or process aids such as WB-16 and HPS-11 from Struktol and the like and combinations thereof. The process aids and the antioxidants may each be in the range of .5 to 5 PHR. Suitable plasticizers may come from the naphthenic process oil family, paraffinic process oil family, Oleate or Ester family of plasticizers. The proportion of plasticizer may range from 2 to 25 PHR.

[0027] Suitable curatives or curing agents may include, but are not necessarily limited to sulfur, peroxide and their co-agents (such as Vulcup 40 KE and triallyl isocyanurate (TAIC)) and the like and accelerators. Suitable sulfur accelerators include, but are not necessarily limited to, mercapto compounds, sulfonamides, thiurams, guanadines and the like and combinations thereof. Non-limiting examples of more specific mercapto accelerators include 2-mercaptobenzothiazole (MBT), mercaptobenzothiazyl disulfide (MBTS), sulfonamides such as benzothiazyl-2-t-butyl sulfonamide (TBBS), thiurams such as tetramethyl thiuram di sulfide (TMTD), guanadines such as diphenyl guanidine (DPG) and combinations thereof. Suitable curatives and accelerators may be each present in the range from .2 to 3 PHR except in the case of polychloroprene where zinc oxide can be considered a curing agent and may range from 2 to 7 PHR.

[0028] In one embodiment, the base pipe 12 may be a Grade P110 oil well drilling casing pipe having an outer diameter of 4.5 inches and a length of 14 feet, the swellable element 16 may have a length of 72 inches (may be 5 feet or 60 inches in other embodiments) and a thickness of 1.125 inches (causing the resulting outer diameter of the base pipe 12 and the swellable element 16 to be 5.625 inches), and the end rings 14 may be manufactured out of metal and have an outer diameter of 5.75 inches.

[0029] The end caps 18 (Fig. 4) may be annular in shape (O-ring shaped) with a gap 22 (which allows easy connection to the base pipe 12 by twisting the end caps until the gap is wide enough to slip over the base pipe and then slipping the end caps over the base pipe), and substantially flat having a thickness of 1/4 inch (the thickness may vary from one embodiment to another), an inner diameter of 4.5 inches, and an outer diameter of 5.75 inches. In other embodiments, the finished packer 10 may have an outer diameter ranging from 5.690 inches to 5.720 inches. All dimensions are approximate and can vary from one embodiment to another.

[0030] Referring to Figs. 3-10, an exemplary method for making the packer 10 shown in Fig. 1 includes the steps of: providing the base pipe 12; sandblasting (with sand, metal shot, or another suitable sandblasting material; sandblasted pipe is shown in Fig. 3) the base pipe 12 so it has a surface suitable for receiving a primer; cleaning the pipe

with isopropyl alcohol and allowing it to dry; applying a layer of primer 24 (Fig. 4) to the base pipe 12 (by hand painting in one embodiment, although it could be sprayed on or applied with other methods in other embodiments); allowing the pipe to dry for 30 minutes or until the primer is dry; applying a layer of bonding agent 26 (or adhesive 26; Fig. 5) to the layer of primer 24, allowing the pipe to dry for 30 minutes or until the bonding agent is dry; securing the pipe in a lathe (Fig. 6); building the swellable element 16 on the primer and bonding agent coated base pipe 12 using a rubber compound, i.e., applying or connecting the swellable material 16 to the base pipe 12; connecting curing rings 28 (Figs. 6-7) to the base pipe 12 adjacent to the ends of the swellable material 16; inserting the pair of end caps 18 (Fig. 8) in between the swellable element 16 and the curing rings 28 (Fig. 7), applying 3 layers of nylon tape 30 (Fig. 9) at approximately 30 pounds of tension (the amount of tension may vary from one embodiment to another) to the swellable element 16, end caps 18, and curing rings 28; securing the nylon with heat tape; vulcanizing the resulting assembly until the end caps 18 co-vulcanize with the swellable element 16 and bond to the base pipe 12, and the swellable element 16 bonds to the base pipe 12; removing the nylon and curing rings after the packer has cooled; and connecting end rings 14 (Figs. 1 and 10) to the base pipe 12 adjacent to the end caps 18.

[0031] Non swellable end caps 18 prevent swellable element 16 from swelling along the length of base pipe 12 and into gaps between the curing rings 28 and the base pipe 12. They also prevent the ends of the swellable element 16 from swelling (to some extent anchoring the ends of the swellable element 16) and preventing fluid from reaching the rest of the swellable element 16 so the swellable element 16 swells in a more uniform and complete manner. Primer 24 may be Chemlok 205 primer and bonding agent 26 may be Chemlok 236A adhesive, both of which are manufacturing by Lord Corporation. The curing rings 28 may be connected to the base pipe using set screws.

[0032] In one embodiment, the packer 10 may be cured in an autoclave for 4 hours at 300 degrees Fahrenheit. After that time, the autoclave is allowed to depressurize (the

autoclave may be pressurized and the pressure can vary from one embodiment to another; in one embodiment, the pressure is 70 psi and in another the pressure ranges from 60-85 psi), the packer is removed and allowed to cool, and the nylon is unwrapped from the packer. The curing process, including the time, duration, and pressure, may vary from one embodiment to another.

[0033] As shown in Fig. 10, end rings 14 have cylindrical main bodies 13, beveled sides (or ends) 15, which facilitate insertion into boreholes, substantially flat sides 11 opposite the beveled sides 15, and threaded set screw openings 17 (mounting openings 17) disposed in the end rings 14 in an alternating pattern to create a more stable connection to the base pipe 12.

[0034] This written description uses examples to disclose the invention and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

[0035] It will be understood that the particular embodiments described herein are shown by way of illustration and not as limitations of the invention. The principal features of this invention may be employed in various embodiments without departing from the scope of the invention. Those of ordinary skill in the art will recognize numerous equivalents to the specific procedures described herein. Such equivalents are considered to be within the scope of this invention and are covered by the claims.

[0036] All of the structures, compositions and/or methods disclosed and claimed herein may be made and/or executed without undue experimentation in light of the present disclosure. While the structures, compositions and methods of this invention have been described in terms of the embodiments included herein, it will be apparent to those of ordinary skill in the art that variations may be applied to the structures,

compositions and/or methods and in the steps or in the sequence of steps of the methods described herein without departing from the concept, spirit, and scope of the invention. All such similar substitutes and modifications apparent to those skilled in the art are deemed to be within the spirit, scope, and concept of the invention as defined by the appended claims.

[0037] Thus, although there have been described particular embodiments of the present invention of a new and useful WELLBORE PACKER AND METHOD OF MAKING SAME it is not intended that such references be construed as limitations upon the scope of this invention except as set forth in the following claims.

CLAIMS

What is claimed is:

1. A wellbore packer, comprising:
 - a base pipe;
 - a pair of end rings connected to opposite end portions of the base pipe;
 - a swellable material connected to the base pipe intermediate the pair of end rings; and
 - a pair of non swellable end caps connected to the base pipe and the swellable material intermediate the swellable material and the pair of end rings.
2. The packer of claim 1, wherein the base pipe is a sandblasted Grade P110 oil well drilling casing pipe having an outer diameter of 4.5 inches and a length of 14 feet.
3. The packer of claim 1, further comprising a coating of primer between the swellable material and the base pipe.
4. The packer of claim 3, further comprising a coating of bonding agent between the coating of primer and the swellable material.
5. The packer of claim 1, wherein each end ring is substantially O-shaped, has a beveled portion on one side, and has a plurality of threaded set screw openings defined therein.
6. The packer of claim 5, wherein the plurality of threaded set screw openings form an alternating pattern with threaded set screw openings adjacent to the beveled portion and adjacent to a side of the end ring opposite the side with the beveled portion.
7. The packer of claim 1, wherein:
 - each end ring has a cylindrical main body having threaded openings defined therein and extending perpendicularly therethrough, a conical portion extending outward from one side of the main body, and a substantially flat portion on a side of the main body opposite to the side with the conical portion;
 - the main body has a length; and
 - the conical portion has a length that is substantially shorter than the length of the main body.

8. The packer of claim 1, wherein the swellable material is a water swellable elastomer, an oil swellable elastomer, or a hybrid material that swells in oil and water.
9. The packer of claim 1, wherein the non swellable end caps are non swellable elastomer end caps.
10. The packer of claim 1, wherein the non swellable end caps comprise polychloroprene rubber, a filler ranging from 25 to 60 parts per hundred rubber, an activator ranging from 1-10 parts per hundred rubber, an antioxidant ranging from 0.5 to 5 parts per hundred rubber, a process aid ranging from 0.5 to 5 parts per hundred rubber, a plasticizer ranging from 2 to 25 parts per hundred rubber, and a curative ranging from 0.2 to 3 parts per hundred rubber.
11. The packer of claim 1, wherein each non swellable end cap is a substantially flat, annular ring having a gap defined therein.
12. A method of making a wellbore packer, comprising the steps of:
 - providing a base pipe;
 - applying a swellable material to the base pipe;
 - connecting a pair of curing rings to the base pipe adjacent to opposite ends of the swellable material;
 - connecting a pair of non swellable end caps to the base pipe intermediate the swellable material and the pair of curing rings;
 - co-vulcanizing the swellable material and the pair of non swellable end caps until the swellable material bonds to the non swellable end caps and the base pipe; and
 - replacing the curing rings with end rings.
13. The method of claim 12, further comprising the step of sandblasting the base pipe with sand or metal shot and cleaning the base pipe with isopropyl alcohol.
14. The method of claim 13, wherein the step of connecting the pair of curing rings includes the step of connecting the pair of curing rings using set screws.

15. The method of claim 14, wherein the step of connecting the pair of non swellable end caps includes the step of inserting the pair of end caps into gaps between the swellable material and the pair of curing rings.

16. The method of claim 14, wherein the step of connecting the pair of non swellable end caps includes the steps of manipulating each end cap so that gaps included in the end caps become wide enough to slip over the base pipe and slipping the end caps over the base pipe in gaps between the swellable material and the pair of curing rings.

17. The method of claim 16, wherein the step of replacing the curing rings includes the step of replacing the curing rings with end rings having cylindrical main bodies and beveled portions extending perpendicularly outward from one side of the cylindrical main bodies.

18. A wellbore packer, comprising:

a base pipe;

a pair of end rings connected to opposite end portions of the base pipe, each end ring having a cylindrical main body and a beveled portion extending outward therefrom, the cylindrical main body including a plurality of alternating mounting openings disposed therein and extending therethrough;

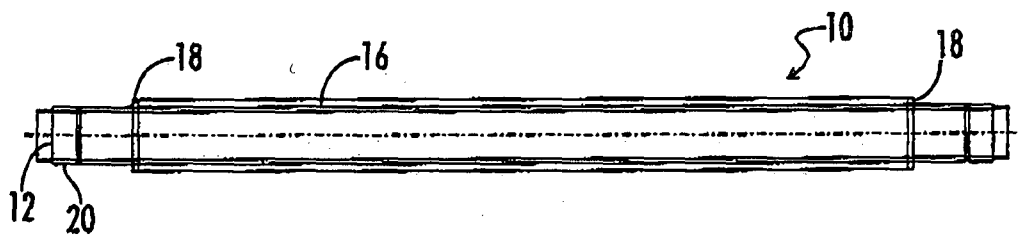
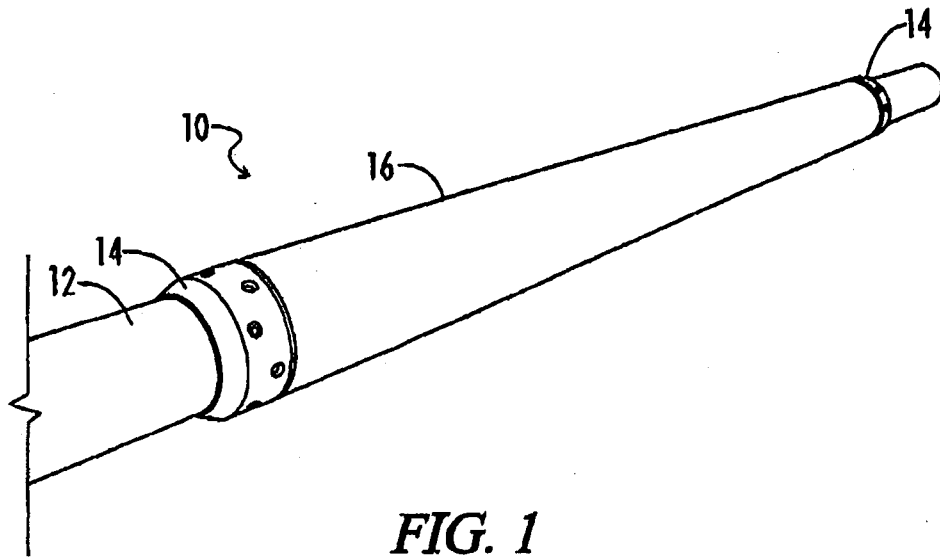
a swellable material bonded to the base pipe intermediate the pair of end rings, the swellable material comprising a water swellable elastomer, an oil swellable elastomer, or a material that swells in both oil and water; and

a pair of non swellable end caps bonded to the base pipe and the swellable material intermediate the swellable material and the pair of end rings.

19. The packer of claim 18, wherein the base pipe is a sandblasted base pipe having a coating of primer and a coating of bonding agent applied thereto.

20. The packer of claim 18, wherein the non swellable end caps comprise polychloroprene rubber, a filler ranging from 25 to 60 parts per hundred rubber, an activator ranging from 1-10 parts per hundred rubber, an antioxidant ranging from 0.5 to 5 parts per hundred rubber, a process aid ranging from 0.5 to 5 parts per hundred

rubber, a plasticizer ranging from 2 to 25 parts per hundred rubber, and a curative ranging from 0.2 to 3 parts per hundred rubber.



2/6

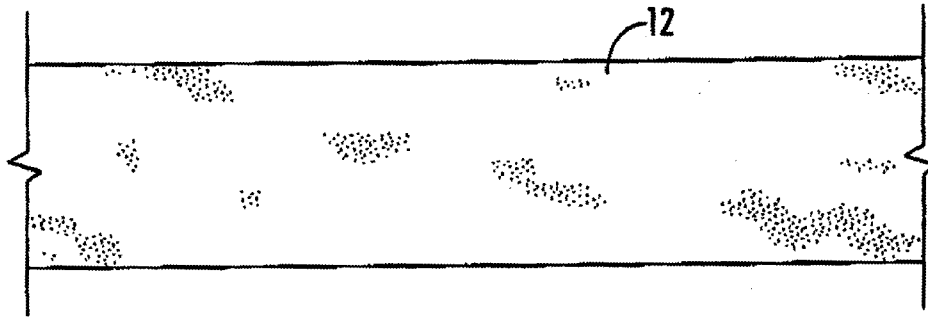


FIG. 3

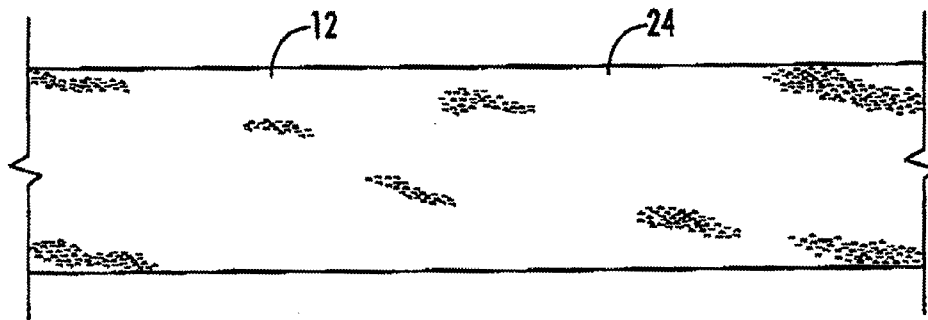


FIG. 4

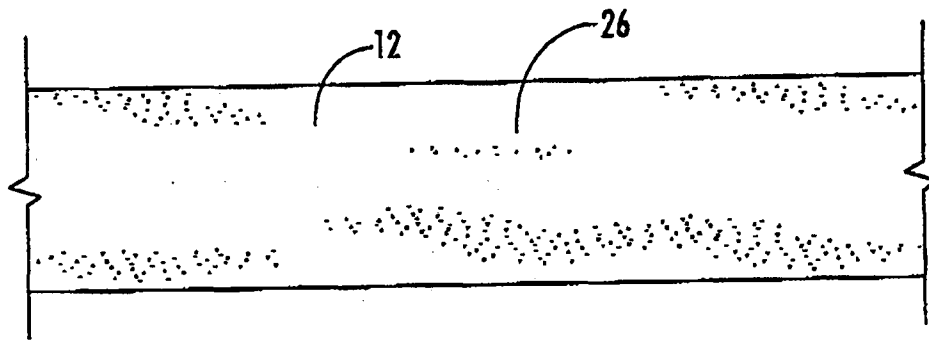


FIG. 5

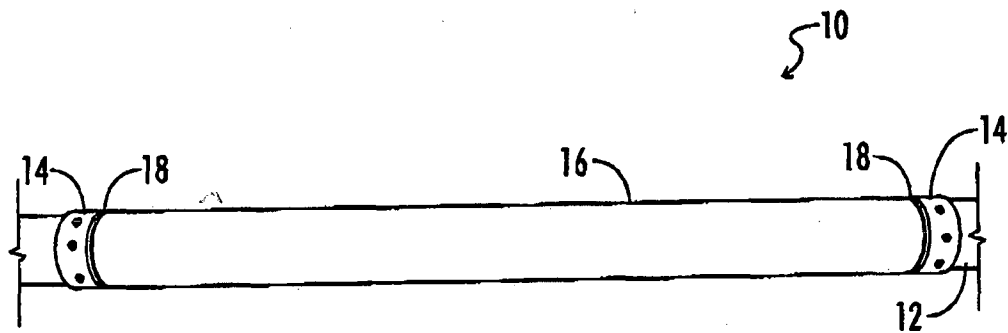


FIG. 6

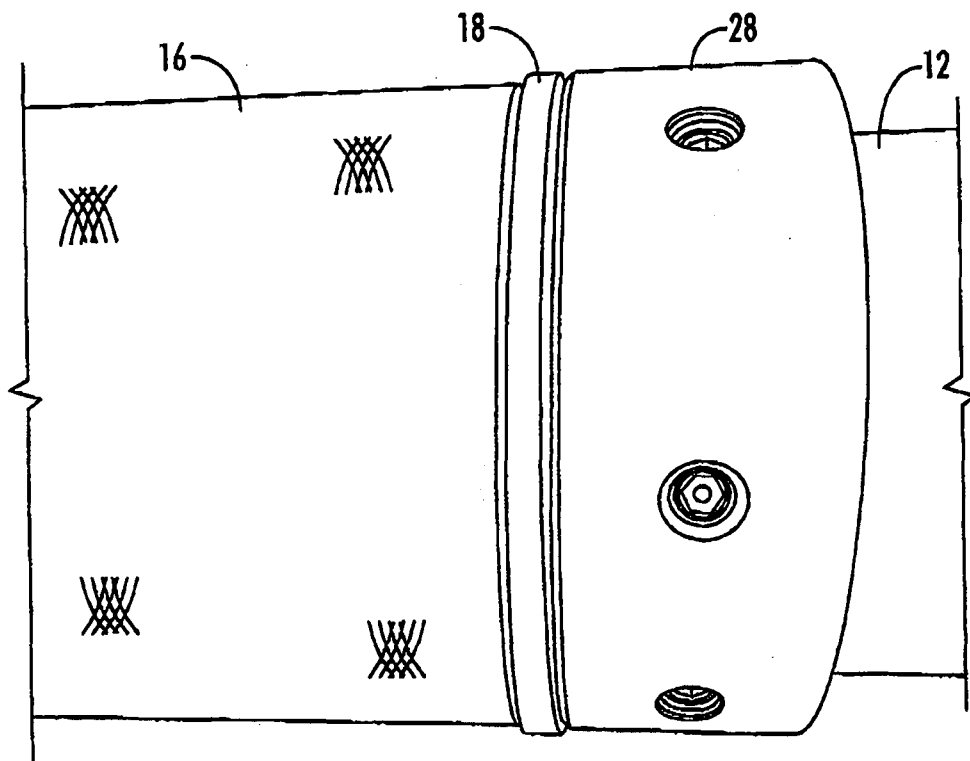


FIG. 7

5/6

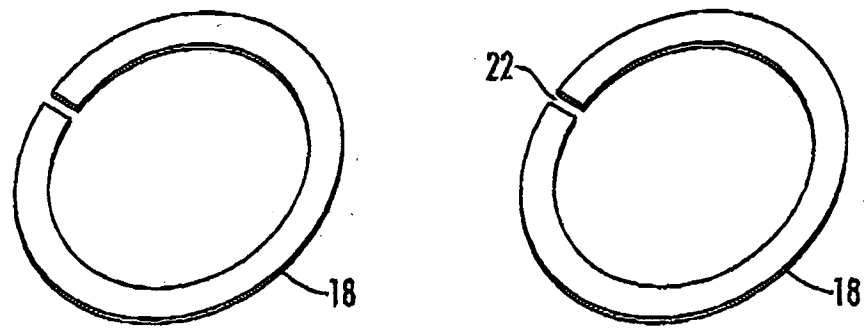


FIG. 8

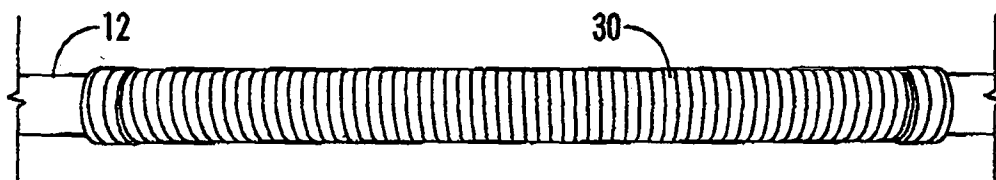


FIG. 9

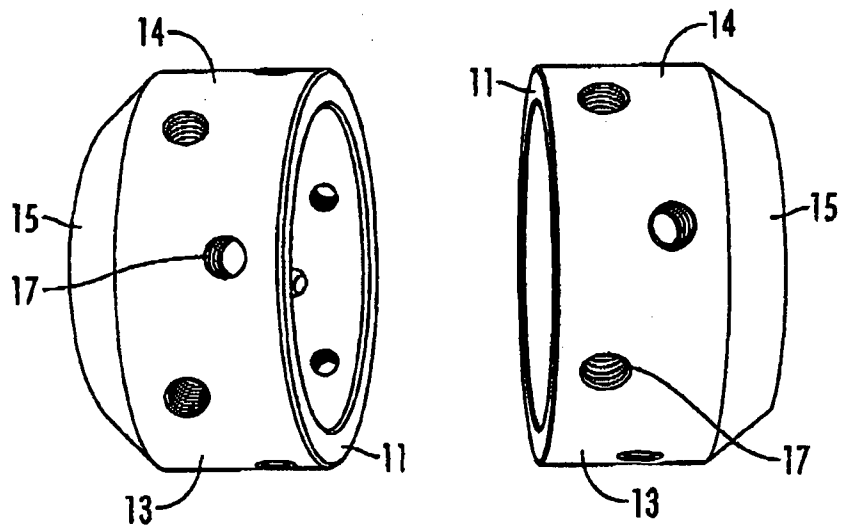


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2017/021364**A. CLASSIFICATION OF SUBJECT MATTER****E21B 33/127(2006.01)i, E21B 33/12(2006.01)i, E21B 17/00(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHEDMinimum documentation searched (classification system followed by classification symbols)
E21B 33/127; B25B 27/10; E21B 33/12; E21B 33/1295; E21B 19/16; E21B 17/00Documentation 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 modelsElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords: wellbore packer, base pipe, swellable material, end ring, end cap, curing, screw and vulcanization**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 9267352 B1 (LB ENTERPRISES, L.L.C.) 23 February 2016 See column 1, lines 39-41, column 3, line 35 - column 8, line 34 and figures 1-7.	1-2, 5-11, 18, 20
Y		3-4, 12-17, 19
Y	US 2015-0008646 A1 (MCROBB, GRAEME) 08 January 2015 See paragraphs [0027], [0070]-[0073] and figures 1-2.	3-4, 12-17, 19
Y	US 2014-0034334 A1 (ANTELOPE OIL TOOL&MFG. CO., L.L.C.) 06 February 2014 See paragraph [0019].	13-17
A	US 2013-0277069 A1 (SWELLTEE LIMITED) 24 October 2013 See paragraphs [0076]-[0083] and figures 1-2.	1-20
A	US 2012-0018143 A1 (LEMBCKE, JEFFREY J.) 26 January 2012 See paragraphs [0015]-[0037] and figures 1-3.	1-20

 Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

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"&" document member of the same patent family

Date of the actual completion of the international search

15 June 2017 (15.06.2017)

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