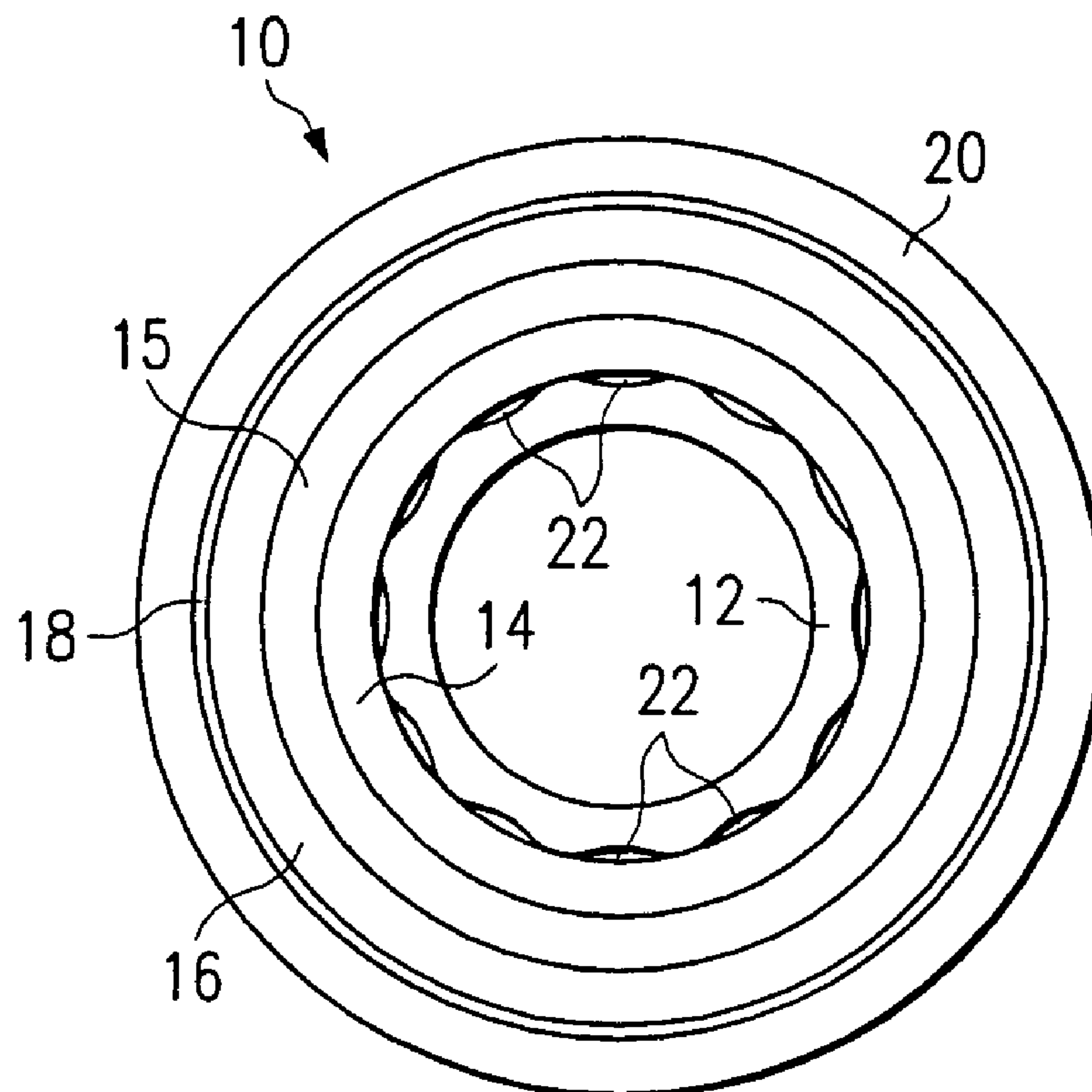




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(54) Title: FLEXIBLE PIPE INCLUDING VENT PASSAGE AND METHOD OF MANUFACTURING SAME



(57) Abrégé/Abstract:

The present invention provides a flexible multi-layer pipe comprising an inner tubular layer defining an inner longitudinal passage and at least one longitudinally extending tube embedded in the inner layer and extending for the length of the inner layer, the tube adapted to receive any gases permeating through or into the inner tubular layer and vent the gases from the pipe.

ABSTRACT OF THE DISCLOSURE

The present invention provides a flexible multi-layer pipe comprising an inner tubular layer defining an inner longitudinal passage and at least one longitudinally extending tube embedded in the inner layer and extending for the length of the inner layer, the tube adapted to receive any gases permeating through or into the inner tubular layer and vent the gases from the pipe.

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FLEXIBLE PIPE INCLUDING VENT PASSAGE AND METHOD OF MANUFACTURING SAME

This invention relates to a flexible pipe according to which the pipe is formed by multiple layers of different materials, one of which has a vent passage.

Brief Description of the Drawing

Fig. 1 is a longitudinal sectional view of a flexible pipe according to an embodiment of the present invention.

Fig. 2 is an end view of the pipe of Fig. 1.

10 Detailed Description

With reference to Fig. 1, a flexible pipe according to an embodiment of the present invention is shown, in general by the reference numeral 10. The pipe 10 is formed by an inner layer 12, preferably in the form of an extruded plastic sheath, for conveying fluid through its bore. As shown in Fig. 2, the outer surface of the layer 12 is undulated thus forming a series of ridges and valleys for reasons to be described. The layer 12 may be formed in a conventional manner using polymers, or the like.

A layer 14 extends around the layer 12 and provides resistance to internal pressure, hydrostatic collapse and crush. The layer 14 is formed by helically wrapping a continuous metal strip, preferably formed of carbon steel, with adjacent windings being interlocked, to form a flexible layer that provides significant hoop and axial strength. The layer 14 is marketed by the assignee of the present invention, Wellstream, Inc., under the "Flexlok" trademark. Alternatively, the layer 14 can be of another type.

A seal layer 15, preferably in the form of an extruded plastic sheath, is provided over the layer 14 to increase the resistance to hydrastatic compression, and assist in limiting the moisture that permeates from the bores of the layer 12.

A layer' 16 of wrapped wires extends over the layer 15 and

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consists of a series of wires 16a helically wrapped around the exterior of the layer 15 to form a first tensile layer, and an additional series of wires 16b wrapped around the first series of wires 16a to form a second tensile layer extending over the first
5 tensile layer. The wires 16a and 16b have a circular cross section, and are wound at a relatively high lay angle to provide significant hoop strength and axial strength. Preferably, at least a portion of the wires 16a and 16b are formed by carbon steel with a plastic or anodic coating. It is noted that the layers 14 and 15 prevent the
10 expansion of the layer 12 into gaps formed between the wires of the tensile layers 16a and 16b.

A layer 18 is formed by helically wrapping tape over the layer 16. The tape forming the layer 18 can be plastic or metal and can be reinforced with glass, metal or a different type of plastic.
15 Although not shown in the drawings, it is understood that the tape layer 18 can also extend between the layer 14 and the layer 16, and between the series of wires 16a and 16b.

A protective outer layer 20, in the form of an insulative sheath, extends over the tape layer 18 and is preferably in the form
20 of an extruded plastic sheath that extends over the tape layer in a conventional manner, with the tape providing a smooth surface for the extrusion. The layer 20 is optional and is required only when the tape layer is inadequate to protect the remaining components of the pipe 10.

25 In operation, when the pipe 10 is put into service the ridges formed by the undulating outer surface of the layer 12, and the corresponding inner surface of the layer 14, form passages 22 for venting any gases that might permeate through the layer 12. These passages extend for the length of the pipe 10 and can discharge into
30 atmosphere at one of the ends of the pipe.

Variations

1. Additional tensile layers of wires can be provided in addition to the series of wires 16a and 16b.
2. The vent passages can be formed by longitudinal strips extending
35 over the outer surface of the layer 12.
3. A plurality of longitudinal tubes could be imbedded in one or

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more of the layers 12, 14, 15, 16, 18, and 30 to provide the vent passages.

4. Rather than providing the sheath 12 with an undulating outer surface, longitudinal grooves or slots can be provided in the outer surface to form the vent passages.

5. The seal layer 15 can extend over the layer 16 or between the tensile layers formed by the wires 16a and 16b, in which case the venting would be between the adjacent wires 16a.

6. The adjacent windings of the strip forming the layer 14 do not have to be interlocked.

7. The cross section of the wires 16a and 16b can be rectangular as disclosed in the above cited application.

8. In extremely hostile environments, an outer layer similar to the layer 14 can be placed around the sheath 20 for added protection.

It is understood that spatial references, such as "under", "over", "between", "outer", "inner" and "surrounding" are for the purpose of illustration only and do not limit the specific orientation or location of the layers described above.

Since other modifications, changes, and substitutions are intended in the foregoing disclosure, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

Claims:

1. A flexible pipe comprising an inner tubular layer defining an inner longitudinal passage; at least one longitudinally extending tube embedded in the inner layer and extending for the length of the inner layer, the tube adapted to receive any gases permeating through or into the inner tubular layer and vent the gases from the pipe; and an outer layer extending over the inner layer.
2. The pipe of claim 1 wherein a plurality of openings are formed through the tube to receive the gases.
3. The flexible pipe of claim 1 wherein a plurality of tubes is angularly spaced around the axis of the inner layer.
4. The flexible pipe of claim 1 wherein the outer layer comprises a metal strip layer helically wound over the inner layer.
5. The flexible pipe of claim 4 further comprising a seal layer extending over the metal strip layer.
6. The flexible pipe of claim 5 further comprising at least one wire wrapped around the exterior of the seal layer to form a tensile layer.
7. The flexible pipe of claim 6 further comprising at least one wire wrapped around the tensile layer to form an additional tensile layer.
8. The flexible pipe of claim 1 wherein the outer layer comprises at least one wire wrapped around the exterior of the inner layer to form a tensile layer.
9. The flexible pipe of claim 8 wherein the outer layer further comprises at least one wire wrapped around the ensile layer to form an additional tensile layer.

10. The flexible pipe of claim 1, 4, 5, 6, 7, 8 or 9 further comprising a layer of wound tape extending between adjacent layers.
11. A method of manufacturing a flexible pipe, comprising forming at least one tube, embedding the tube along the length of an inner tubular layer defining an inner longitudinal passage so that any gases received by the layer and permeating through or into the layer pass into the tube for discharge through an end of the tube, and disposing an outer layer over the inner layer.
12. The method of claim 11 further comprising forming a plurality of openings through the tube to receive the gases.
13. The method of claim 11 wherein the tubes are angularly spaced around the axis of the inner layer.
14. The method of claim 11 wherein the step of disposing comprises wrapping a metal strip layer over the inner layer.
15. The method of claim 14 further comprising disposing a seal layer over the metal strip layer.
16. The method of claim 15 further comprising wrapping at least one wire around the exterior of the seal layer to form a tensile layer.
17. The method of claim 16 further comprising wrapping at least one wire around the tensile layer to form an additional tensile layer.
18. The method of claim 11 wherein the step of disposing comprises wrapping at least one wire around the exterior of the inner layer to form a tensile layer.

19. The method of claim 18 wherein the step of disposing further comprises wrapping at least one wire around the tensile layer to form an additional tensile layer.
20. The method of claim 11 and 14, 15, 16, 17, 18 or 19 further comprising wrapping a
5 tape between adjacent layers.
21. A flexible pipe, comprising:
an inner tubular member defining an inner longitudinal passage and having an undulating outer surface forming a series of ridges and valleys; and
10 a metal strip helically wound over the tubular member wherein the ridges and a corresponding inner surface of the layer formed by the wound metal strip form a plurality of vent passages, the vent passages venting to an end of the tubular member any fluids that may permeate through the tubular member.
- 15 22. The pipe of claim 21 further comprising a seal layer, in the form of an extruded plastic sheath, extending over the metal strip.
23. The pipe of claim 22 further comprising at least one layer of wires wrapped helically around the seal layer.
20
24. The pipe of claim 23 wherein there are two layers of wires.
25. The pipe of claim 23 wherein the wires of one layer of wires are wrapped in an opposite direction to the wires of the other layer of wires.
25
26. The pipe of claim 23 wherein a plurality of vent passages are formed between adjacent wires of each layer of wires.
27. The pipe of claim 23 further comprising at least one layer of tape extending over at
30 least one layer of wires.

28. The pipe of claim 27 further comprising an insulative layer, in the form of an extruded plastic sheath, extending over the layer of tape.
29. The pipe of claim 21 further comprising at least one layer of wires wrapped helically
5 around the metal strip.
30. The pipe of claim 29 wherein there are two layers of wires.
31. The pipe of claim 29 further comprising a seal layer extending over at least one
10 layer of wires.
32. The pipe of claims 31 further comprising an additional layer of wires wrapped helically around the seal layer.
- 15 33. The pipe of claim 32 wherein the wires of one of the layers of wires are wrapped in an opposite direction to the wires of the other layer of wires.
34. The pipe of claim 29 wherein a plurality of vent passages are formed between adjacent wires of each layer of wires.
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35. The pipe of claim 32 further comprising a seal layer, in the form of an extruded plastic sheath, extending over the additional layer of wires.
36. The pipe of claim 31 or 35 further comprising at least one layer of tape extending
25 over the seal layer.
37. The pipe of claim 36 further comprising an insulative layer, in the form of an extruded plastic sheath, extending over the layer of tape.
- 30 38. A method of manufacturing a flexible pipe, comprising:

forming an undulating outer surface on an inner tubular member so that the outer surface forms a series of ridges and valleys; and

winding a metal strip over the tubular member to form a layer around the outer surface of the tubular member whereby the ridges and a corresponding inner surface of the layer form a plurality of vent passages so that any fluids that may permeate through the tubular member are vented through the vent passages to an end of the tubular member.

39. The method of claim 38 further comprising providing a seal layer, in the form of an extruded plastic sheath, over the metal strip.

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40. The method of claim 39 further comprising wrapping at least one layer of wires around the seal layer.

41. The method of claim 40 wherein there are two layers of wire.

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42. The method of claim 41 wherein the wires of one of the layers of wire are wrapped in an opposite direction to the wires of the other layer of wires.

43. The method of claim 40 wherein a plurality of vent passages are formed between adjacent wires of each layer of wires.

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44. The method of claim 40 further comprising wrapping at least one layer of tape over at least one layer of wires.

45. The method of claim 44 further comprising providing an insulative layer, in the form of an extruded plastic sheath, over the layer of tape.

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46. The method of claim 38 further comprising wrapping at least one layer of wires around the metal strip.

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47. The method of claim 46 wherein there are two layers of wires.

48. The method of claim 46 further comprising providing a seal layer over the at least one layer of wires.

5 49. The method of claim 48 further comprising wrapping an additional layer of wires around the seal layer.

50. The method of claim 47 wherein the wires of one of the layers of wires are wrapped in an opposite direction to the wires of the other layer of wires.

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51. The method of claim 47 wherein a plurality of vent passages are formed between adjacent wires of each layer of wires.

15 52. The method of claim 51 further comprising providing a seal layer, in the form of an extruded plastic sheath, extending over the additional layer of wires.

53. The method of claim 51 further comprising wrapping at least one layer of tape extending over the seal layer.

20 54. The method of claim 53 further comprising providing an insulative layer, in the form of an extruded plastic sheath, over the layer of tape.

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