(12) STANDARD PATENT (11) Application No. **AU 2005266956 B2**
(19) AUSTRALIAN PATENT OFFICE

(54) Title
Open hole expandable patch

(51) International Patent Classification(s)
E21B 29/10 (1970.01) ***E21B 43/10*** (1970.01)

(21) Application No: **2005266956** (22) Date of Filing: **2005.07.22**

(87) WIPO No: **WO06/012530**

(30) Priority Data

(31) Number	(32) Date	(33) Country
60/590,596	**2004.07.23**	**US**

(43) Publication Date: **2006.02.02**
(44) Accepted Journal Date: **2011.01.20**

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(56) Related Art
US 2003/0106696 A1
US 1233888 A
US 2003/0217865 A 1
US 2003/0047322 A

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
2 February 2006 (02.02.2006)

PCT

(10) International Publication Number
WO 2006/012530 A1

(51) International Patent Classification[7]: E21B 29/10, 43/10

(21) International Application Number: PCT/US2005/026076

(22) International Filing Date: 22 July 2005 (22.07.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/590,596 23 July 2004 (23.07.2004) US

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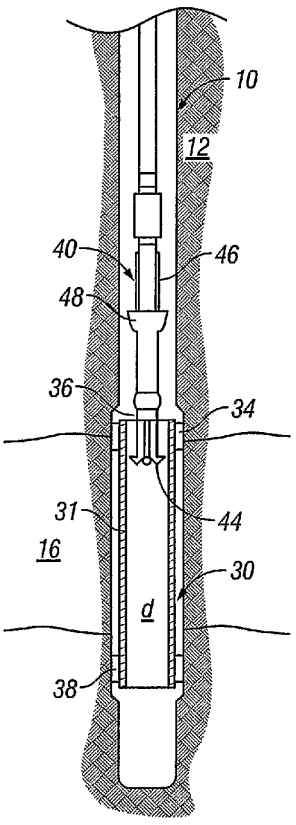
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

[Continued on next page]

(54) Title: OPEN HOLE EXPANDABLE PATCH



(57) Abstract: The invention discloses a patch for placement in a wellbore and associated methods. The patch has a longitudinal member and an anchor that is radially expanded to engage the wall of the borehole to secure the patch against axial and radial movement. The anchor is set using a running tool that radially expands the anchor and the longitudinal body. The anchor may include one or more elements that can be securely engaged within the wellbore. The longitudinal member and/or the anchor may include a sealing element to provide a seal between the wellbore inside and the earth formation surrounding the wellbore.

WO 2006/012530 A1

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

TITLE: OPEN HOLE EXPANDABLE PATCH

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BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates generally to devices and methods for securing a patch within a wellbore.

Description of the Related Art

[0002] Patches are used in uncased wellbores and wellbore sections to prevent collapse of the wellbore and/or preclude unintended fluid flow into or out of the wellbore. A patch is usually a tubular sleeve that is secured to the wall of the wellbore. The patch may be any desired length. The patch provides structural support and fluid sealing. There are two primary scenarios in which it is often desired to use a wellbore patch.

[0003] The first scenario occurs during drilling of a wellbore, particularly through unconsolidated earth. Because the wellbore is not yet lined with a casing, drilling mud and other fluids may undesirably flow into the surrounding earth formations from the wellbore. This not only results in the loss of fluids, but might contaminate production formations. In such an instance, a patch would provide the fluid sealing needed to prevent this fluid loss.

[0004] The second scenario occurs during production from an "open hole" wellbore, which lacks casing. In this situation, there is the danger that undesirable fluids, such as water, will migrate from the surrounding earth formation into the borehole. A patch could be placed along the wellbore in the

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area where fluid ingress occurs to block it.

[0005] In order to function correctly, a patch is secured against axial and rotary movement within the wellbore. Running of a drill string, for example, into the wellbore and through the patch will result in torsional and axial forces being imparted to the patch. The patch might be cemented into place. However, this operation is time consuming as the cement needs to be given time to set and later cure. Also, a cleaning tool is assembled and run into the wellbore to clean the excess cement from the patched area once the cement has been placed in the wellbore.

[0006] Currently there is not a relatively easy and acceptable method of securing a patch within a wellbore. The present invention addresses some of the above- noted problems of the prior art.

[0006a] Reference to any prior art in the specification is not, and should not be taken as, an acknowledgment or any form of suggestion that this prior art forms part of the common general knowledge in Australia or any other jurisdiction or that this prior art could reasonably be expected to be ascertained, understood and regarded as relevant by a person skilled in the art.

[0006b] As used herein, except where the context requires otherwise the term 'comprise' and variations of the term, such as 'comprising', 'comprises' and 'comprised', are not intended to exclude other additives, components, integers or steps.

SUMMARY OF THE INVENTION

[0007] The invention advantageously provides improved devices and methods for securing a patch within an open hole wellbore. In preferred embodiments the patch is provided with one of a number of types of anchors that is radially expanded to engage the wall of the borehole to secure the patch against axial and radial movement. The anchors are preferably set using a swaging tool that radially expands anchor and the patch. Advantageously the action of radially expanding the patch actuates the anchor.

[0008] In one aspect, the invention provides a patch for use within an uncased section of a wellbore comprising:

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(a) a generally longitudinal patch body that is radially expandable from a first, reduced dimension to a second, enlarged dimension, the body having a deformable radially reduced channel;

(b) an anchor positioned in the radially reduced channel, the anchor being radially expandable to bitingly engage a wall of the uncased section of the wellbore; and

(c) a sealing member radially outward of and surrounding the anchor, the sealing member and anchor being configured to anchor and seal the patch body.

[0009] In another aspect, the invention provides a method of placing a patch in a wellbore having an internal dimension, comprising:

conveying the patch into the wellbore using a running tool having a shoe on which the patch rests, wherein the patch comprises

a generally longitudinal patch body that is radially expandable from a first, reduced dimension to a second, enlarged dimension, the body having a deformable radially reduced channel;

an anchor positioned in the radially reduced channel, the anchor being is radially expandable to bitingly engage a wall of the uncased section of the wellbore; and

a sealing member radially outward of and surrounding the anchor, the sealing member and anchor being configured to anchor and seal the patch body;

positioning the patch at a selected location in an uncased section of the wellbore, said patch having a longitudinal body that is radially expandable and an associated anchor that is engageable to a wellbore wall;

engaging the anchor to a wall of the wellbore in the uncased section in a manner that enables the longitudinal body of the patch to remain at the selected location; and

expanding the patch to have an internal dimension that is at least the same as a dimension of the uncased section of the wellbore.

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[0009a] In another aspect, the invention provides a method of patching an uncased section of a wellbore, comprising:

(a) positioning a radially expandable tubular at the uncased section of the wellbore, wherein the radially expandable tubular comprises;

a generally longitudinal body that is radially expandable from a first, reduced dimension to a second, enlarged dimension, the body having a deformable radially reduced channel;

an anchor positioned in the radially reduced channel, the anchor being is radially expandable to bitingly engage a wall of the uncased section of the wellbore; and

a sealing member radially outward of and surrounding the anchor, the sealing member and anchor being configured to anchor and seal the body;

(b) anchoring the radially expandable tubular to a wall of the wellbore in the uncased section; and

(c) expanding the radially expandable tubular to have an internal diameter that is at least the same as a diameter of the uncased section of the wellbore.

[0010] The patch may be made from any suitable material and in any desired form. It may be a solid metallic tubular, a metallic longitudinal mesh, or a member made from a composite or hybrid material. The anchor may include one or more radially expandable member which can securely engage with the wellbore wall. The anchor is engaged with the borehole wall in a manner that will cause the longitudinal section to remain in the desired location in the wellbore. The longitudinal member and/or the anchor may be made from a suitable material, such as a rubber or another elastomeric material to provide seal between the wellbore well and the longitudinal member to prevent fluid flow between the formation and the earth formation surrounding the wellbore.

[0011] Examples of the more important features of the invention have been summarized rather broadly in order that the detailed description thereof that follows may be better understood, and in order that the contributions to the art maybe appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form the subject of the claims appended hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The advantages and further aspects of the invention will be appreciated by those of ordinary skill in the art as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings in which like reference characters designate like or similar elements throughout the several figures of the drawing and wherein:

Figure 1 is a side, cross-sectional view of an exemplary wellbore during drilling;

Figure 2 depicts the wellbore shown in Figure 1 subsequently being underreamed;

Figure 3 shows the wellbore of Figures 1 and 2 now with a wellbore patch having been disposed therein by a running and setting tool;

Figure 4 shows the wellbore of Figures 1-3 after the patch has been set within the wellbore;

Figure 5 illustrates subsequent running of a drilling string into the wellbore;

Figure 6 is side, cross-sectional view of a production wellbore showing a patch being set by a running and setting tool;

Figure 7 is a partial side cross-sectional view of a first, exemplary anchor portion, in accordance with the present invention, shown before setting;

Figure 8 is a partial, side cross-sectional view of the anchor portion shown in Figure 7, now in a set position;

Figure 9 is an end view of the anchor portion shown in Figures 7 and 8;

Figure 10 is a partial, side cross-sectional view of an alternative exemplary anchor portion before setting;

Figure 11 is a partial, side cross-sectional view of the anchor portion shown in **Figure 10** after setting;

Figure 12 is a partial, side cross-sectional view of a further alternative anchor portion in an unset condition;

Figure 13 depicts the anchor portion of Figure 12 now in a set condition;

Figure 14 is an axial cross-section of the anchor portion shown in Figures 12 and 13;

Figure 15 is a partial, side cross-sectional view of a further alternative anchor portion in an unset position;

Figure 16 shows the anchor portion of Figure 15 now in a set position;

Figure 17 is a partial, side cross-sectional view of a further alternative anchor portion in an unset position; and

Figure 18 shows the anchor portion of Figure 15 in a set position.

Figure 19 shows a cone or swaging tool that is for use in enlarging the patch in retracted position.

Figure 20 shows the swaging tool of Figure 19 after activation in an enlarged position.

DETAILED DESCRIPTION OF THE INVENTION

[0013] **Figures 1-5** depict an exemplary wellbore **10** that has been drilled through the earth **12**. The wellbore **10** is an open hole wellbore that lacks casing. The surrounding earth **12** contains a permeable zone **16** into which drilling fluids might flow during the drilling operations. It is desired to seal the zone **16** off from fluid communication with the wellbore **10**. **Figure 1** depicts a drill string **18** disposed within the wellbore **10** for initial drilling of the wellbore **10**. The drill string **18** includes a tubing that may be made of interconnected drill pipe members **20**, and a drill bit **22** at the lower end. As those of skill in the art understand, during drilling, drilling mud (not shown) is pumped down the string of drill pipe members **20**, flows out of the drill bit **22** and returns up the annulus **23** to the surface of the wellbore **10**. In this situation, it is desired to prevent the drilling mud from escaping into the permeable zone **16** by setting a patch within the wellbore **10**. To accomplish this, an underreaming tool **24**, of a type known in the art, is deployed, as shown in **Figure 2**, to radially enlarge the section of wellbore proximate the permeable zone **16**. The underreamer **24** cuts a radially enlarged wellbore portion **26**.

[0014] Once underreaming has been done, the drill string **18** is withdrawn from the wellbore **10**, and a patch **30** is disposed into the wellbore **10**, as **Figure 3** illustrates. In **Figure 3**, the patch **30** is in a radially reduced configuration. The patch **30** itself has a patch body **31** that includes a tubular section of radially expandable metal or other material. The patch body may be a solid tubular or a mesh. The patch body **31** is typically fashioned of a highly ductile material, such as annealed steel, but may be made for any suitable alloy or a non-metallic or by hybrid material. As noted previously, the patch **30** may be made to any suitable

length. In this case, the length of the patch **30** is chosen to ensure complete coverage and fluid sealing across the permeable zone **16**. The patch **30** includes an associated anchor or anchor portion, shown schematically at **34**. Various configurations for the anchor portion **34** are described in detail later. The anchor portion **34** is shown to be located proximate the upper axial end **36** of the patch **30**. Alternatively, it should be understood that the anchor portion might, in fact, be located at any point along the axial length of the patch **30**. If desired, additional anchor portions **38** may also be incorporated into the patch **30**. The purpose of the anchor portions **34**, and **38** is to engage the uncased wall of the wellbore **10** and to secure the patch against axial and radial movement with respect to the wellbore **10**.

[0015] The patch **30** is run into the wellbore **10** by a running and setting tool **40**. The exemplary running and setting tool **40** shown in **Figures 3** and **4** is suspended by coiled tubing **42**, but may be run into the wellbore **10** using a drill pipe or other suitable conveying member known in the art. The running and setting tool **40** includes an engagement shoe **44** at its lower end, upon which the patch **30** rests. Piston **46** and expansion swaging tool **48** are driven by a hydraulic pump **50**. Hydraulic fluid may be supplied to the pump **50** from the surface through tubing **42**. The running and setting tool **40** may comprise a catEXX™ brand tool, which is available commercially from Baker Oil Tools of Houston, Texas. To set the patch **30** within the wellbore **10**, the piston **46** and swaging tool **48** are driven downwardly through the patch **30**, radially enlarging it and bringing the anchor portions **34**, **38** into engaging contact with the wall of the wellbore **10**.

[0016] **Figure 4** illustrates the patch **30** after it has been expanded radially, forcing the anchor portions **34** and **38** to engage the wall, thus securing the patch

30 to the wall of the wellbore 10. With the patch 30 set, the running and setting tool 40 may be withdrawn from the wellbore 10. Subsequently, as **Figure 5** illustrates, a drill string 18 may be reintroduced to the wellbore 10 and the wellbore drilled to a greater depth.

[0017] It should be noted that the inside dimensions or the internal diameter of the patch body may be expanded to any desired dimension. The internal diameter may be the same less than or greater than the diameter of the wellbore 10 above or below the enlarged section 20.

[0018] **Figure 6** illustrates the setting of a patch 30 in a producing wellbore 60. The wellbore 60 has been partially lined with casing 62 and has an uncased portion 64. A water layer 66 is present in the surrounding earth 68, and water from the layer 66 is undesirably entering the wellbore 60. In **Figure 6**, the production assembly (not shown) has been removed from the wellbore 60 so that a patch 30 may be set within. The patch 30 has been lowered into the wellbore 60 on a running and setting tool 40, and is shown during the setting process. Once expanded and set, member 34 of the patch 30 creates a fluid seal at 31, as described later, within the wellbore 60 so that an undesirable fluid, such as water from the layer 66 no longer enters the wellbore 60. Following setting of the patch 30, the running and setting tool 40 is removed from the wellbore 60 and the production assembly (not shown) can be reintroduced to the wellbore 60 to continue production.

[0019] Turning now to **Figures 7-9**, there is illustrated a first exemplary anchor assembly 70 which may be used as the anchor portion 34 or 38 on patch 30. The anchor assembly 70 includes a generally cylindrical body member 72 fashioned of a deformable metal or other material. The body member 72 may actually be a

portion of the body of the patch **30**. A radially reduced channel **74** is formed into the member **72**. A plurality of engagement teeth **76** are affixed to the member **72** within the channel **74**. Preferably, the teeth **76** are radially spaced about the circumference of the member **72**, as shown in **Figure 9**.

[0020] During running in, the anchor portion **70** is in the position shown in **Figure 7**. When set by the running and setting tool **30**, the swaging tool **48** deforms the channel **74** outwardly, so that the body member **72** assumes the shape shown in **Figure 8**. Deformation of the channel **74** also urges the teeth **76** into biting engagement with the wall of the surrounding wellbore **10, 60**. This biting engagement secures the patch **30** within the wellbore against axial and rotational movement. If desired, the channel **74** may be omitted altogether, and the teeth **76** brought into biting engagement with the wall of the wellbore **10, 60** merely by radial expansion of the body member **72** via the swaging tool **48**.

[0021] Figures 10-11 depict an alternative anchor portion **80** which includes a tubular body member **82** with a plurality of malleable engagement strips **84** secured thereto. Preferably, the engagement strips **84** are disposed in a circumferentially spaced arrangement about the body member **82** in same manner as teeth **76** were. Each of the engagement strips **84** has a pair of axial ends **86, 88** that are welded or otherwise securely affixed to the outer surface of the member **82**. Each strip also features a central portion **90** that is unaffixed to the member **82**. In the unset position, shown in **Figure 10**, the strips **84** are in a substantially linear, unbent condition.

[0022] Setting of the anchor portion 80 relies upon the fact that the patch **30**, and anchor portion **80**, become axially shorter as it is expanded radially. When the swaging tool **48** is urged through the anchor portion **80**, the axial shortening of

the body member **82** causes the ends **86, 88** of each engagement strip **84** to be moved closer together resulting in the strips **84** bowing outwardly as **Figure 11** depicts. This outward bowing, together with the radial enlargement of the diameter of anchor portion **80** brings the engagement strips **84** into biting engagement with the wall of the wellbore **10, 60**.

[0023] Figures 12-14 illustrate a further alternative exemplary anchor portion **92** that features a generally cylindrical body member 94 which has a number of longitudinal slots **96** cut therein. As the cross-sectional view of **Figure 14** illustrates, the slots **96** define a set of body strips **98** therebetween. **Figures 12** and **14** depict the anchor portion **92** prior to its being set. When the swaging tool **48** is run through the patch **30**, axial shortening of the body member **94** will cause the strips **98** to bow outwardly, as **Figure 13** shows, thereby bringing them into biting engagement with the wall of the wellbore **10, 60**.

[0024] Figures 15-16 illustrate yet a further alternative anchor portion **100**. The anchor portion **100** has a body member **102** with an upper slotted portion **104**. The slotted portion **104** includes a plurality of longitudinal slots **106** that define engagement fingers **108** therebetween. Each of the fingers **108** preferably includes an outwardly projecting engagement lip **110**. In the unset position, shown in **Figure 15**, the fingers **108** extend in the axial direction. However, the swaging tool **48** causes the fingers **108** to bend outwardly, as depicted in **Figure 16** so that they are brought into engagement with the wall of the wellbore **10, 60**.

[0025] Figures 17 and **18** depict still a further alternative anchor portion **120**. Anchor portion **120** includes a generally cylindrical body member **122** that features an outwardly protruding stop ledge **124**. A C-ring **126** surrounds the

body member **122** and is located above the stop ledge **124**. A sloped face **128** also projects outwardly from the body member **122** and is located above the C-ring **126**. **Figure 17** shows the anchor portion **120** in an unset position. In this position, the sloped face **128** is just above the C-ring **126**. When the swaging tool **48** is pushed through the anchor portion **120**, the body member **122** becomes axially shortened, causing the sloped face **128** to be moved closer to the stop ledge **124**. The sloped face **128** then urges the C-ring radially outwardly, as shown in **Figure 18**, and into engagement with the wall of the borehole **10, 60**.

[0026] The anchor also may be made wherein one member moves linearly to cause another member to move out radially to engage the wellbore. The linearly moveable member may be hydraulically operated as noted above or may be mechanically operated or by a combination thereof.

[0027] It is noted that the anchor portions described above might be coated or covered with elastomer, or another sealing material, to provide a fluid sealing capability as well as biting engagement of the wall of the wellbore **10, 60**. Additionally, components making up the anchor portions might be fashioned from shape memory material, either metal or composite, the material making up the anchor portion might be initially formed into the set position. The memory effect provided by the material would increase the anchoring effect.

[0028] Figure 19 shows a retrievable tool **140** for use in enlarging the patch. The tool **140** includes a mandrel **150** that can be run into the wellbore. A radially expandable swage **150** is disposed around the mandrel **150** between a shoulder member **152** and a linearly movable member **156** to radially enlarge or expand the swage **152**, the member **156** is moved linearly toward the swage which moves a force application member **158** toward the swage, causing the swage **152**

to move radially outwards as shown in **Figure 20**. The member **156** may be moved hydraulically or mechanically or by any other suitable mechanism to retrieve the tool **140** from the wellbore. The member **156** is moved away from the swage **152** which allows the swage **152** to retract. The linear motion of the member **156** controls the rate and the extent of the radial movement of the member **152**.

[0029] For the sake of clarity and brevity, descriptions of most threaded connections between tubular elements, elastomeric seals, such as o-rings, and other well-understood techniques are omitted in the above description. The foregoing description is directed to particular embodiments of the present invention for the purpose of illustration and explanation. It will be apparent, however, to one skilled in the art that many modifications and changes to the embodiment set forth above are possible without departing from the scope and the spirit of the invention.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A patch for use within an uncased section of a wellbore comprising:

(a) a generally longitudinal patch body that is radially expandable from a first, reduced dimension to a second, enlarged dimension, the body having a deformable radially reduced channel;

(b) an anchor positioned in the radially reduced channel, the anchor being radially expandable to bitingly engage a wall of the uncased section of the wellbore; and

(c) a sealing member radially outward of and surrounding the anchor, the sealing member and anchor being configured to anchor and seal the patch body.

2. The patch of claim 1 wherein the anchor comprises a tooth configured to engage the wall of the uncased section of the wellbore.

3. The patch of claim 1 wherein the anchor comprises a plurality of radially outwardly extending teeth configured to engage the wall of the uncased section of the wellbore.

4. The patch of claim 1 wherein the anchor is formed of metal.

5. The patch of claim 1 wherein the anchor is formed of composite material.

6. The patch of claim 1 wherein the sealing member comprises one of (i) a rubber material; (ii) an elastomeric sealing portion; (iii) a swelling material; and (iv) a memory material.

7. A method of placing a patch in a wellbore having an internal dimension, comprising:

conveying the patch into the wellbore using a running tool having a shoe on which the patch rests, wherein the patch comprises

a generally longitudinal patch body that is radially expandable from a first, reduced dimension to a second, enlarged dimension, the body having a deformable radially reduced channel;

an anchor positioned in the radially reduced channel, the anchor being is radially expandable to bitingly engage a wall of the uncased section of the wellbore; and

a sealing member radially outward of and surrounding the anchor, the sealing member and anchor being configured to anchor and seal the patch body;

positioning the patch at a selected location in an uncased section of the wellbore, said patch having a longitudinal body that is radially expandable and an associated anchor that is engageable to a wellbore wall;

engaging the anchor to a wall of the wellbore in the uncased section in a manner that enables the longitudinal body of the patch to remain at the selected location; and

expanding the patch to have an internal dimension that is at least the same as a dimension of the uncased section of the wellbore.

8. The method of claim 7, wherein the selected location includes a portion of the uncased section of the wellbore that has an enlarged inside dimension, the method further comprising expanding the longitudinal body of the patch to a dimension that is selected from a group consisting of (i) less than the enlarged inside dimension of the uncased section of the wellbore; (ii) substantially the same as the enlarged inside dimension of the uncased section of the wellbore and (iii) less than the dimension of the uncased section of the wellbore above or below the enlarged wellbore dimension.

9. The method of claim 7, further comprising: drilling the wellbore; and enlarging at least a portion of the drilled wellbore adjacent the selected location prior to engaging the anchor with the wellbore wall.

10. The method of claim 9 further comprising drilling the wellbore after placing the patch in the wellbore.

11. The method of claim 7, further comprising expanding the longitudinal body of the patch to a size that is greater than the internal dimension of the uncased section of the wellbore.

12. The method of claim 7, wherein and the enlarging of the anchor provides a fluid seal between a formation surrounding the patch and the wall of the wellbore.

13. The method of claim 7, wherein the anchor comprises one of (i) a tooth that bitingly engages the wall of the wellbore; (ii) a plurality of radially outwardly extending teeth that bitingly engage the wall of the wellbore; (iii) a composite material; (iv) a rubber sealing material; and (v) a memory material.

14. The method of claim 7, wherein engaging the anchor includes radially expanding the anchor with a retractable tool.

15. The method of claim 14, wherein the retractable tool is selected from a group consisting of (i) a hydraulically operated tool; (ii) a mechanically operated tool; (iii) a hydro-mechanical tool.

16. A method of patching an uncased section of a wellbore, comprising:

(a) positioning a radially expandable tubular at the uncased section of the wellbore, wherein the radially expandable tubular comprises;

a generally longitudinal body that is radially expandable from a first, reduced dimension to a second, enlarged dimension, the body having a deformable radially reduced channel;

an anchor positioned in the radially reduced channel, the anchor being is radially expandable to bitingly engage a wall of the uncased section of the wellbore; and

a sealing member radially outward of and surrounding the anchor, the sealing member and anchor being configured to anchor and seal the body;

(b) anchoring the radially expandable tubular to a wall of the wellbore in the uncased section; and

(c) expanding the radially expandable tubular to have an internal diameter that is at least the same as a diameter of the uncased section of the wellbore.

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17. The method of claim 16 further comprising sealing at least a portion of the uncased section of the wellbore from fluid communication from a formation intersected by the wellbore.

18. The method of claim 16 further comprising: drilling the wellbore, and under-reaming at least a portion of the uncased section of the wellbore.

19. The method of claim 16 further comprising positioning a production string in the wellbore after anchoring the radially expandable tubular at the uncased section of the wellbore.

20. The method of claim 16 further comprising drilling another section of the wellbore after anchoring the radially expandable tubular at the uncased section of the wellbore.

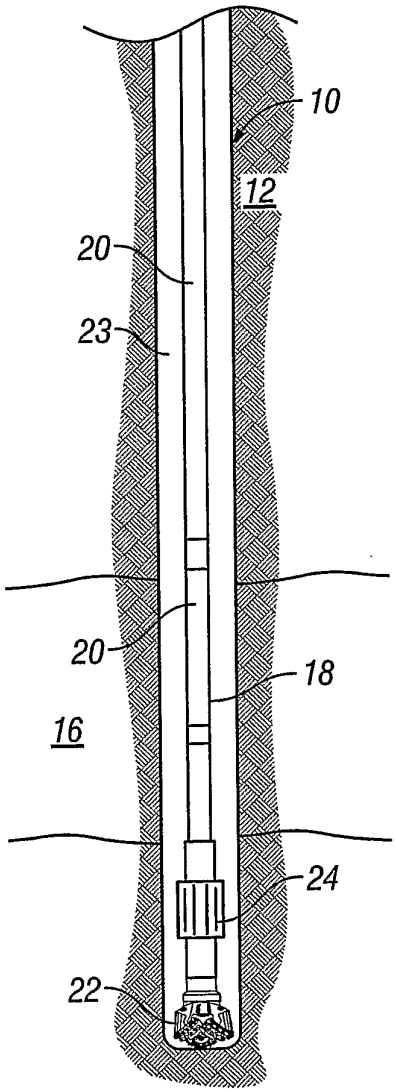

FIG. 1

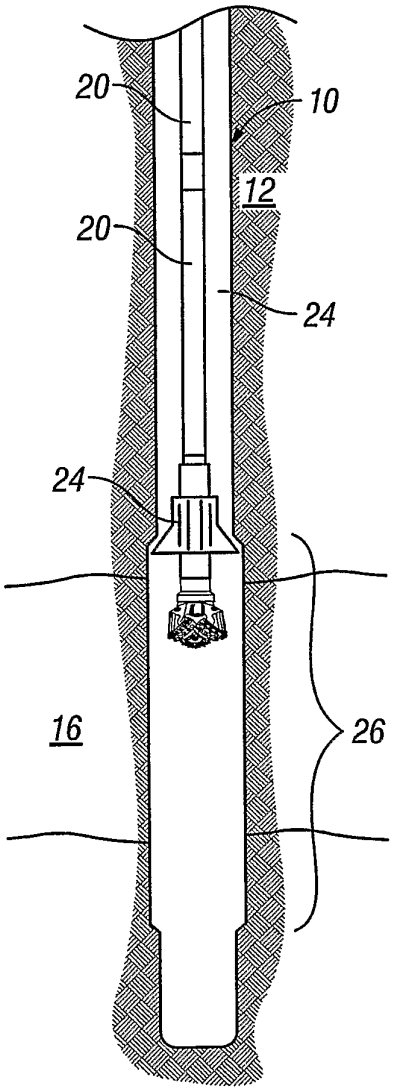

FIG. 2

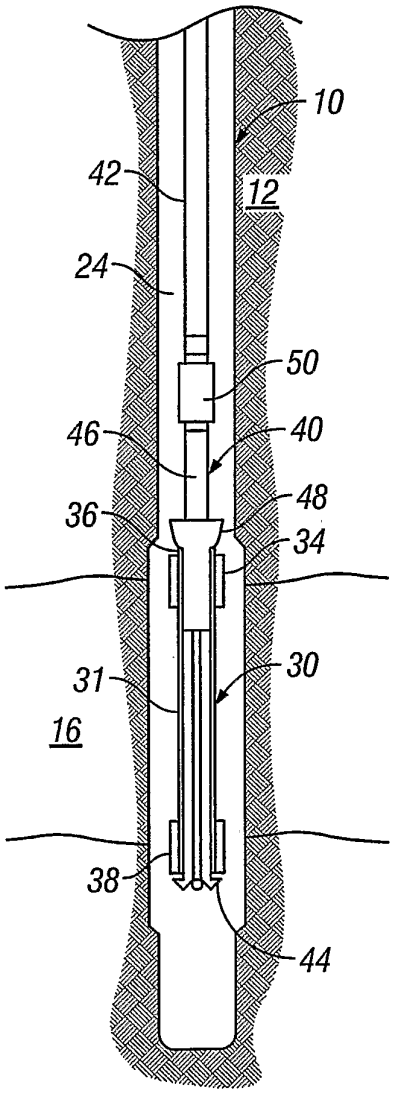
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FIG. 3

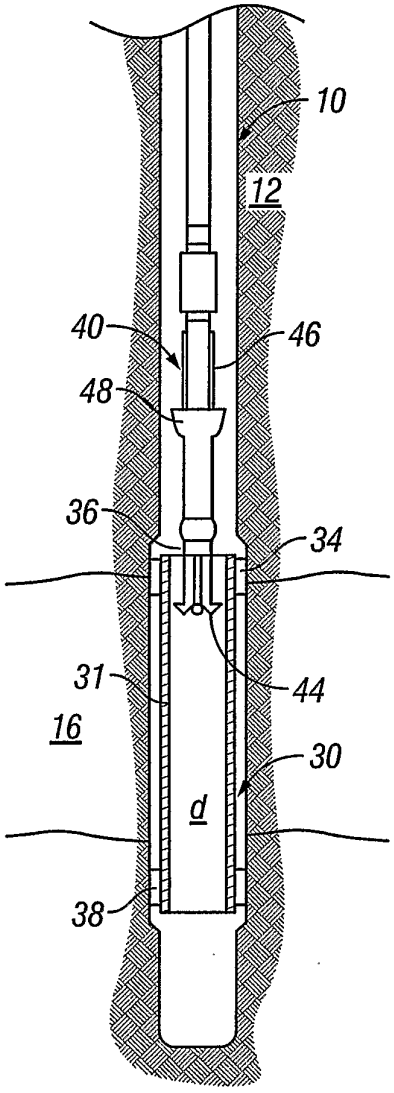
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FIG. 4

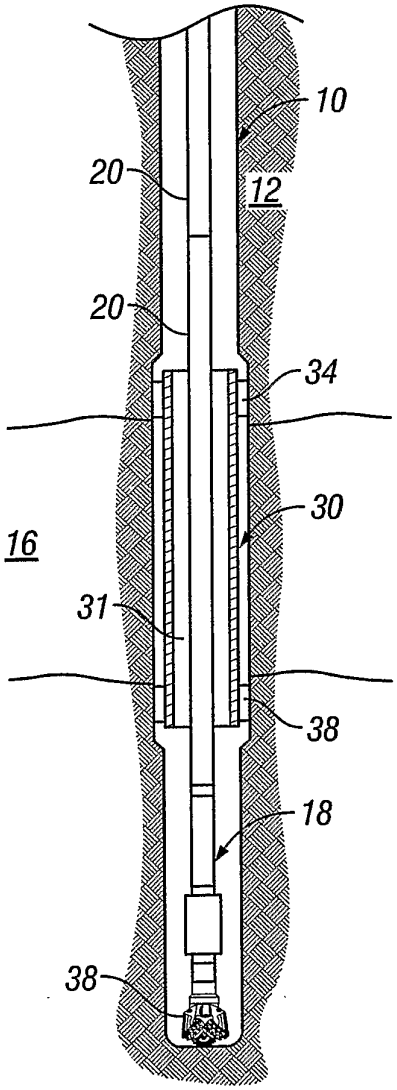

FIG. 5

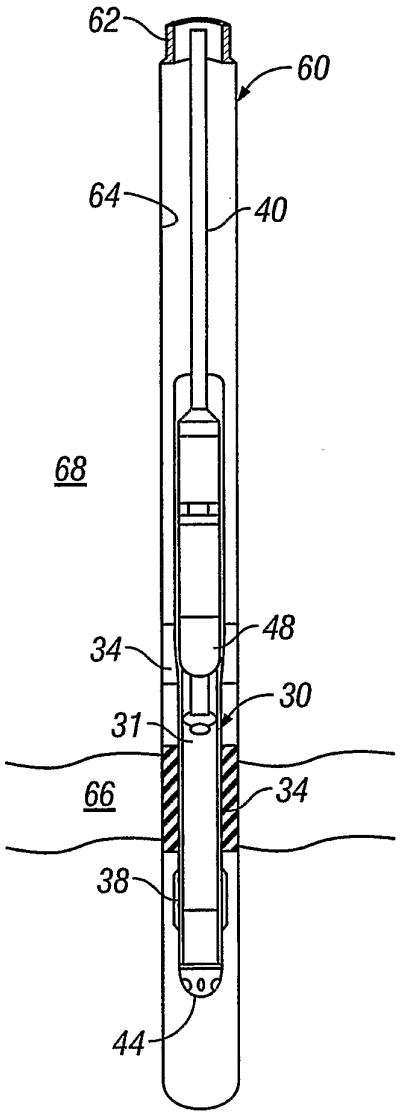

FIG. 6

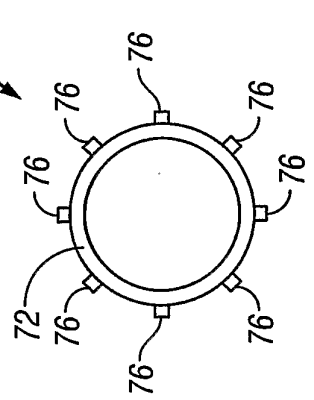

FIG. 9

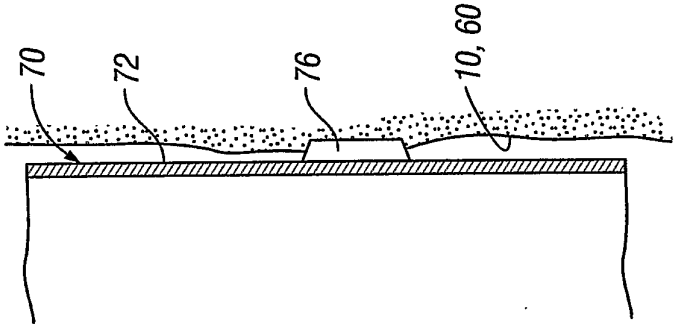

FIG. 8

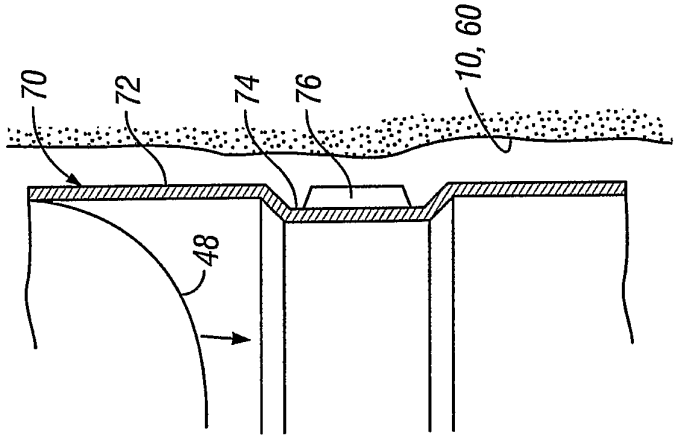

FIG. 7

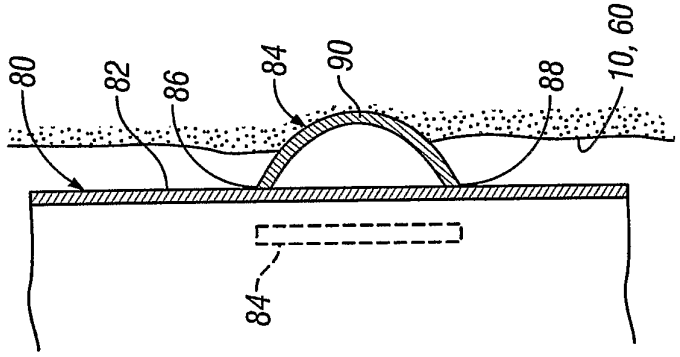

FIG. 11

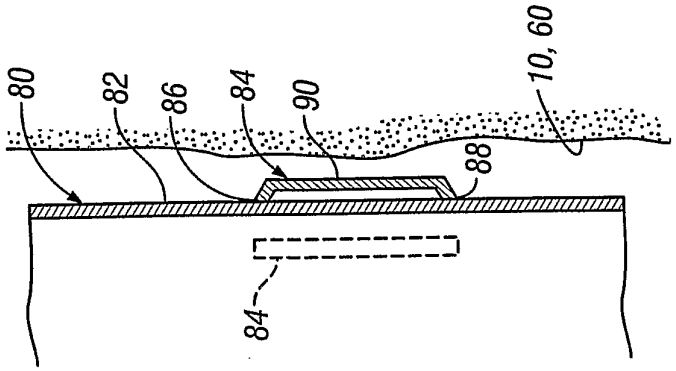

FIG. 10

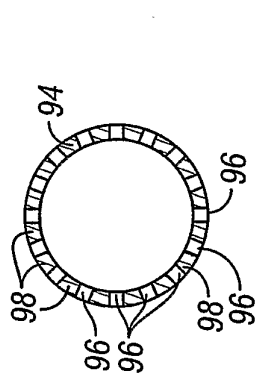

FIG. 14

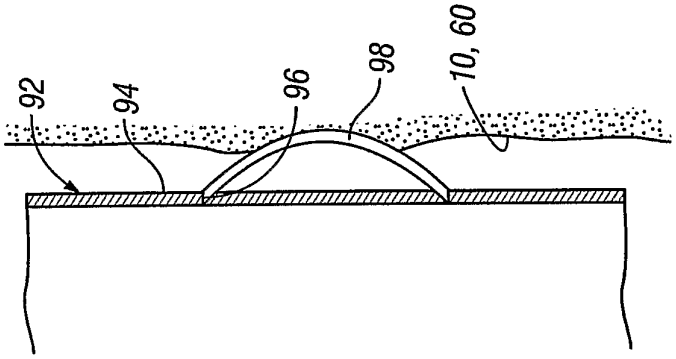

FIG. 13

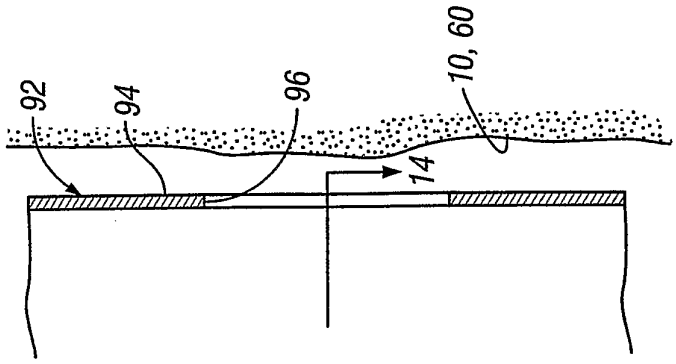

FIG. 12

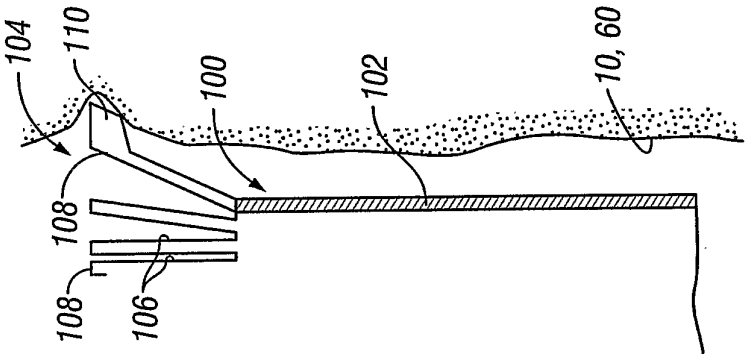
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FIG. 16

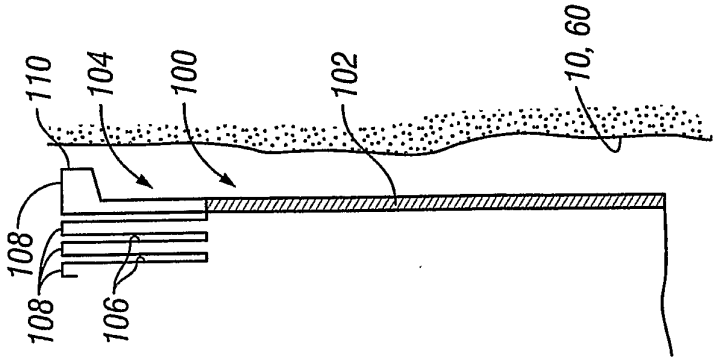
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FIG. 15

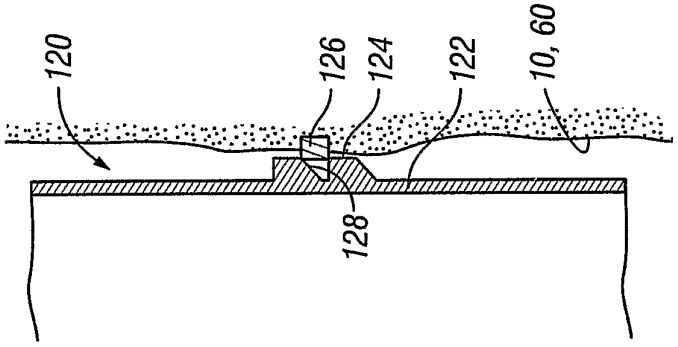

FIG. 18

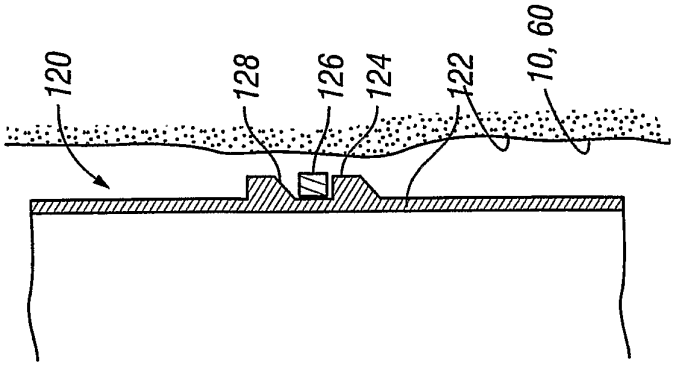

FIG. 17

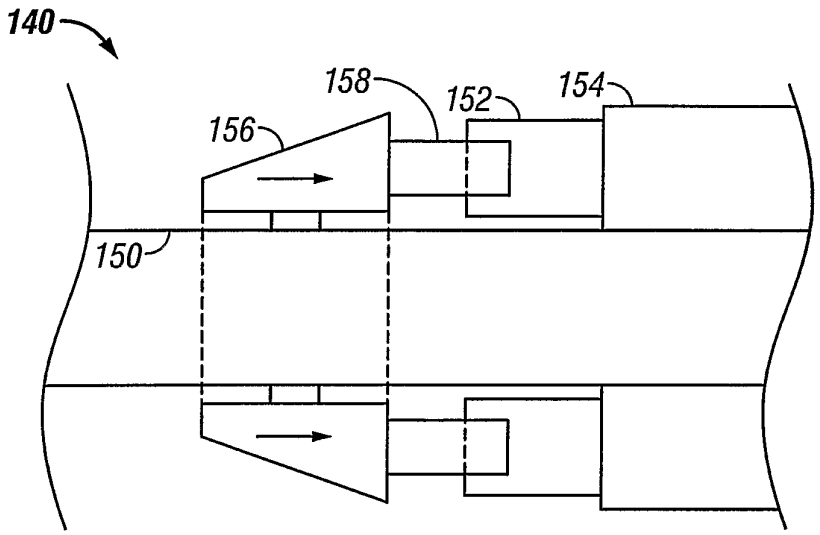

FIG. 19

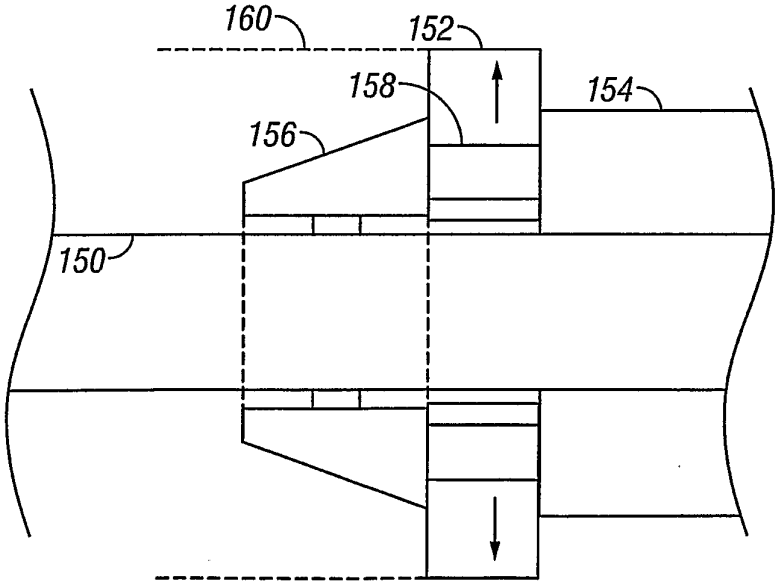

FIG. 20