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(54) **Swellable apparatus and method**

(57) The invention provides an apparatus and method for a sand control completion in a wellbore. The apparatus has a body comprising a swellable material configured to surround a wellbore tubular which defines a primary flow path for wellbore fluids. The body is also configured to surround at least one secondary flow path

disposed externally of the wellbore tubular. The secondary flow path is configured for a carrier fluid containing particulate matter for a gravel pack. The body also comprises a longitudinal discontinuity which permits a radial opening to be formed on the body, through which the body is operable to be applied to the tubular.

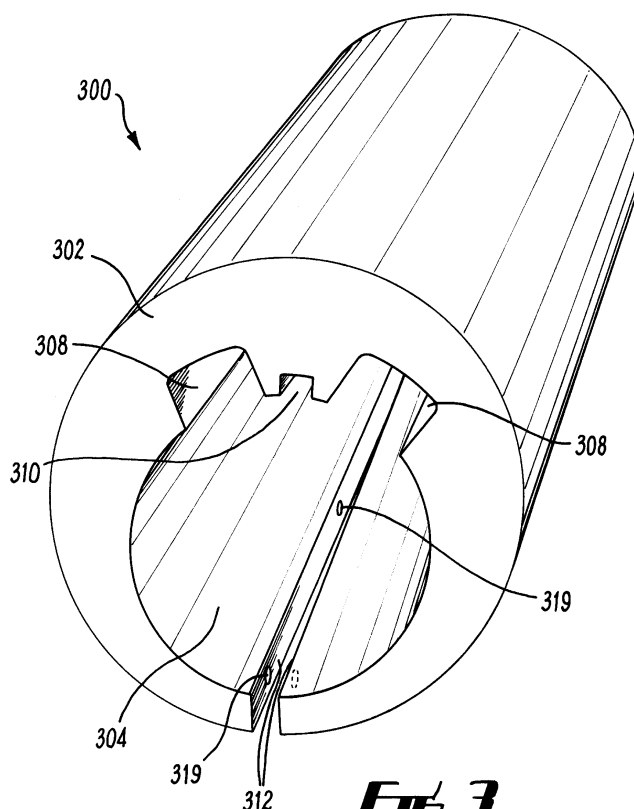


FIG. 3

Description

[0001] The present invention relates to an apparatus and method for use in wellbores for the hydrocarbon exploration and production industry. The invention relates particularly, although not exclusively, to an apparatus and method for use with alternate path sand control completions.

Background to the Invention

[0002] In the field of oil and gas exploration and production, multi-zone completion systems are used in the production of hydrocarbons from wells which penetrate different parts of a formation with different properties. An example of a multi-zone completion system is shown in Figure 1. The system, generally shown at 100, includes a production facility at surface, which in this case is a floating production storage and offloading (FPSO) vessel 102, coupled to a well 104 via subsea tree 106. The wellbore in this case is an inclined wellbore which extends through multiple production intervals 107a, 107b, 107c in the formation 108. The production tubing 110 provides a continuous flow path which penetrates through the multiple zones. The production tubing is provided with ports or inflow control devices (not shown) which allow production fluid to flow into the production tubing and out to the subsea tree 106. However, in order to provide control over the production process, the annulus 112 is sealed by packers 114 between the different production zones 107 to prevent fluid flowing in the annulus between the different zones.

[0003] Depending on the formation, the production tubing may be provided with sand control devices 116, to prevent solid particles from the formation entering the production tubing. The sand control devices 116 may for example be any suitable sand screen systems, including expandable screen systems. The sand control devices 116 may be used in conjunction with one or more gravel packs 118, which comprise gravel or other particulate matter around the sand control device to improve filtration and to provide additional support to the formation. Gravel packing requires a good distribution of gravel in the annulus at the sand control device. To improve the delivery of gravel, sand control devices have been provided with shunt tubes, which create alternate flow paths for the gravel and its carrier fluid. These alternate flow paths significantly improve the distribution of gravel in the production interval, for example by allowing the carrier fluid and gravel to be delivered through sand bridges that may be formed in the annulus before the gravel pack has been completed.

[0004] Figures 2A and 2B are schematic views of examples of sand screens provided with shunt tubes in a completion system 200. A first sand control device 202a is coupled to a second sand control device 202b, and each comprise base pipes 204 joined to define a production bore 206. Screens 208 including filter media sur-

round the base pipe 204 and are supported by ribs 210. The apparatus is provided with shunt tubes 212, which in this example are steel tubes having substantially rectangular cross-section. The shunt tubes 212 are supported on the exterior of the screen and provide a flow path 213 alternate to the main production bore 206. Jumper tubes 211 are used to provide fluid communication between shunt tubes of adjacent sand control devices. The shunt tubes 212 maintain a flow path 213, even if the annular space 214 is bridged, for example by a loss of integrity in a part of the formation 216. Examples of shunt tube arrangements can be found in US 4945991 and US 5113935. The shunt tubes may also be internal to the filter media, as described in US 5515915 and US 6227303.

[0005] A typical sand control apparatus comprises a main shroud 218 which extends completely over the filter media sand control device, and provides a protective sleeve for the filter media and shunt tubes. The shroud is provided with apertures to allow the throughflow of fluid. The main shroud terminates at an end ring 220, which supports an end of the shroud and comprises passages for shunt tubes. When the shunt tubes 212 are connected by the jumper tubes 211, an auxiliary shroud 222 is provided over the shunt tubes at the coupling. The auxiliary shroud is typically formed from part-cylindrical components which are assembled together to form the shroud. The auxiliary shroud extends between the end rings 220 of sand control devices, and functions to provide a continuous outer diameter to the assembly, and to protect the shunt tubes, jumper tubes, and any corresponding connectors. The auxiliary shroud covers the shoulders created by the end rings 220.

[0006] WO 05/090743 discloses a system for sealing an annular space around a control line used to actuate a valve. A seal layer has an inner surface provided with a recess for receiving a control line, and on an opposing side is provided with a slit which allows the seal layer to be opened for radial application to a tubular. The seal layer is formed from a material susceptible of swelling upon contact with a selected fluid. The disclosure relates exclusively to sealing around control lines.

[0007] It is an object of the invention to provide an apparatus and method which overcomes or mitigates at least one deficiency or drawback of the prior art. It is a further object of the invention to provide a wellbore completion and/or production system or method of use which incorporates such an apparatus or method.

[0008] It is a further object of the invention to provide an alternative apparatus and method for protection of components of sand control completion systems.

[0009] Further aims and objects of the invention will become apparent from reading the following description.

Summary of the Invention

[0010] According to a first aspect of the invention, there is provided an apparatus for a sand control completion

in a wellbore, the apparatus comprising: a body comprising a swellable material selected to increase in volume on exposure to at least one triggering fluid, the body configured to surround a wellbore tubular which defines a primary flow path and further configured to surround at least one secondary flow path disposed externally of the wellbore tubular, wherein the secondary flow path is configured for a carrier fluid containing particulate matter for a gravel pack, and the body comprises a longitudinal discontinuity which permits a radial opening to be formed on the body, through which the body is operable to be applied to the tubular.

[0011] The apparatus may be a protective shroud for an alternate path sand control completion system.

[0012] According to a second aspect of the invention, there is provided a sand control completion comprising: a tubular defining a primary fluid flow path; a first sand control device; a secondary fluid flow path for delivering a carrier fluid containing particulate matter for a gravel pack to the first sand control device; and a body comprising a swellable material selected to increase in volume on exposure to at least one triggering fluid disposed over the secondary flow path and the tubular, wherein the body comprises a longitudinal discontinuity which permits a radial opening to be formed on the body, through which the body is operable to be applied to the tubular.

[0013] According to a third aspect of the invention, there is provided method of forming a sand control completion, the method comprising:

forming a primary fluid flow path from a sand control device and a tubular;
 providing a secondary fluid flow path for delivering a carrier fluid containing particulate matter for a gravel pack;
 disposing a body comprising a swellable material selected to increase in volume on exposure to at least one triggering fluid over the secondary flow path and the tubular by applying the body to the tubular through a radial opening on the body.

[0014] Embodiments of the second or third aspects of the invention may include preferred or optional features of the first aspect of the invention.

Brief Description of the Drawings

[0015] To aid an understanding of the invention, there will now be described a number of example embodiments with reference to the following drawings:

Figure 1 shows schematically a multi-zone production system in accordance with various embodiments of the invention;

Figures 2A and 2B are respectively upper and cross-sectional views of a conventional alternate path

screen system;

Figure 3 is a perspective view of an apparatus in accordance with an embodiment of the invention;

Figure 3 is a perspective view of an apparatus in accordance with an embodiment of the invention;

Figures 5A and 5B are respectively part-longitudinal and cross-sectional views of an apparatus in accordance with an alternative embodiment of the invention; and

Figures 6A and 6B are respectively part-longitudinal and cross-sectional views of an apparatus in accordance with a further alternative embodiment of the invention.

Detailed Description

[0016] Figure 3 shows an apparatus 300 in accordance with a first embodiment of the invention. The apparatus may be used as an alternative to a conventional shroud for a shunt tube system, such as that shown in Figures 2A and 2B. The apparatus 300 comprises a body 302 of swellable material, selected to increase in volume on exposure to a triggering fluid. In this case, the body is formed from an EPDM rubber, selected to swell on exposure to a hydrocarbon fluid, although other swellable materials such as those which swell in water or those which swell in both water and hydrocarbons may be used. The body 302 is substantially cylindrical, and contains an internal bore 304 configured to receive a wellbore tubular. The bore 304 has a main bore portion 306 to receive a base pipe (not shown). It also has an internal profile which is shaped to accommodate a shunt tube arrangement, such as that illustrated in Figure 2A. The internal profile of the body 302 includes a pair of longitudinal recesses 308 shaped to accommodate shunt tubes or jumper tubes provided on the exterior of the base pipe. An optional third longitudinal recess 310 is provided for the accommodation of a control line which extends through the body.

[0017] The body 302 is formed in a single piece, and has a longitudinal discontinuity which defines a pair of longitudinal edges 312 extending along the length of the body. The body may be separated at the longitudinal edges to create a radial opening of sufficient size to place the body over a base pipe from a position at the side of the base pipe. The body 302 is resiliently deformable such that it can be opened to be fitted to the base pipe without the need to slide the body longitudinally on to the pipe. The body therefore forms a c-clamp arrangement which may be placed over a base pipe and shunt tube system. The body is provided with bores 319 which allow the body to be secured to the base pipe via bolts or pins.

[0018] An alternative embodiment is illustrated in Figure 4, which shows an apparatus 400 similar to the ap-

paratus 300 shown in Figure 3, with like parts indicated by like reference numerals incremented by 100. However, the apparatus 400 comprises a support structure 420 integral with and partially surrounded by the body 402. The support structure 420 is formed from a steel alloy, and comprises a tubular portion 422 extending longitudinally in the swellable body. The support structure 420 increases the integral strength of the apparatus and the clamping force that may be imparted to the apparatus when fixing to a base pipe. The tubular portion 422 is formed from two part-cylindrical members 423 which are hinged to allow the longitudinal edges 412 to be readily separated when applying the body to a tubular.

[0019] The support structure 420 also comprises upstanding formations which extend beyond the outer diameter of the body 402. The formations are in the form of resilient bow springs 424 which are connected to the tubular portions. The formations provide stand-off of the body from the surround wall of a casing or openhole wellbore. The support structure therefore performs a centralising function for the apparatus and the adjacent components in the string.

[0020] A further alternative embodiment is shown in Figures 5A and 5B, which show an apparatus 500 assembled on a tubular 530 between two sand control devices 540. Figure 5B is a section through line B-B' shown on Figure 5A. The apparatus 500 is similar to the apparatus 300 shown in Figure 3 with like parts indicated by like reference numerals incremented by 200. However, in this embodiment, the shunt tubes 542 terminate in manifolds 550 at each end of the body 502, and the secondary flow path is defined by a longitudinal recess 552 in the body 502 which extends between the manifolds. This embodiment includes a support structure 520 which is formed from two hinged part cylindrical members, in a similar manner to apparatus 400. However, the support structure 520 is internal to the body and only extends along a part of its length. It is disposed around the coupling between the two sand control devices, and improves the integral strength of the apparatus and the clamping force which may be imparted against the coupling.

[0021] A further alternative embodiment is shown at 600 in Figures 6A and 6B, with Figure 6B being a section through line B-B' shown on Figure 6A. The apparatus 600 is similar to the apparatus 500 shown in Figure 5 with like parts indicated by like reference numerals incremented by 100. However, the apparatus 600 differs in that the support structure includes upstanding formations which extend beyond the outer diameter of the body 602. The formations are in the form of resilient bow springs 624 which are connected to the tubular portions 622. As with the embodiment of Figure 5, the formations provide stand-off of the body from the surrounding wall of a casing or openhole wellbore. The support structure therefore performs a centralising function for the apparatus and the adjacent components in the string.

[0022] In an alternative embodiment (not shown), an

apparatus is formed from two or more part cylindrical components of a swellable material. The components are fitted over an arrangement of shunt tubes on a base pipe to provide a protective shroud. Two or more of the part cylindrical components may be hinged to one another to aid assembly.

[0023] Providing a swellable body which fits over the secondary flow path and base pipe assembly is a convenient way to protect exposed portions of shunt tubes, including shoulders, jumper tubes, and couplings in a variety of sand control applications.

[0024] In the embodiment of Figures 5 and 6, the apparatus extends between end rings of sand control devices. In other embodiments, the apparatus may be disposed between a sand control device and an annular barrier or isolation packer, which may be formed from a swellable material. In particular, the invention may be used in conjunction with the apparatus and methods described in WO 2007/092082 and WO 2007/092083, which relate to providing packers with alternate path mechanisms that may be used to provide zonal isolation between gravel packs in a well.

[0025] The invention provides an apparatus and method for a sand control completion in a wellbore. The apparatus has a body comprising a swellable material configured to surround a wellbore tubular which defines a primary flow path for wellbore fluids. The body is also configured to surround at least one secondary flow path disposed externally of the wellbore tubular. The secondary flow path is configured for a carrier fluid containing particulate matter for a gravel pack. The body also comprises a longitudinal discontinuity which permits a radial opening to be formed on the body, through which the body is operable to be applied to the tubular.

[0026] Variations to the above described embodiments are within the scope of the invention herein intended, and the invention extends to combinations of features other than those expressly claimed.

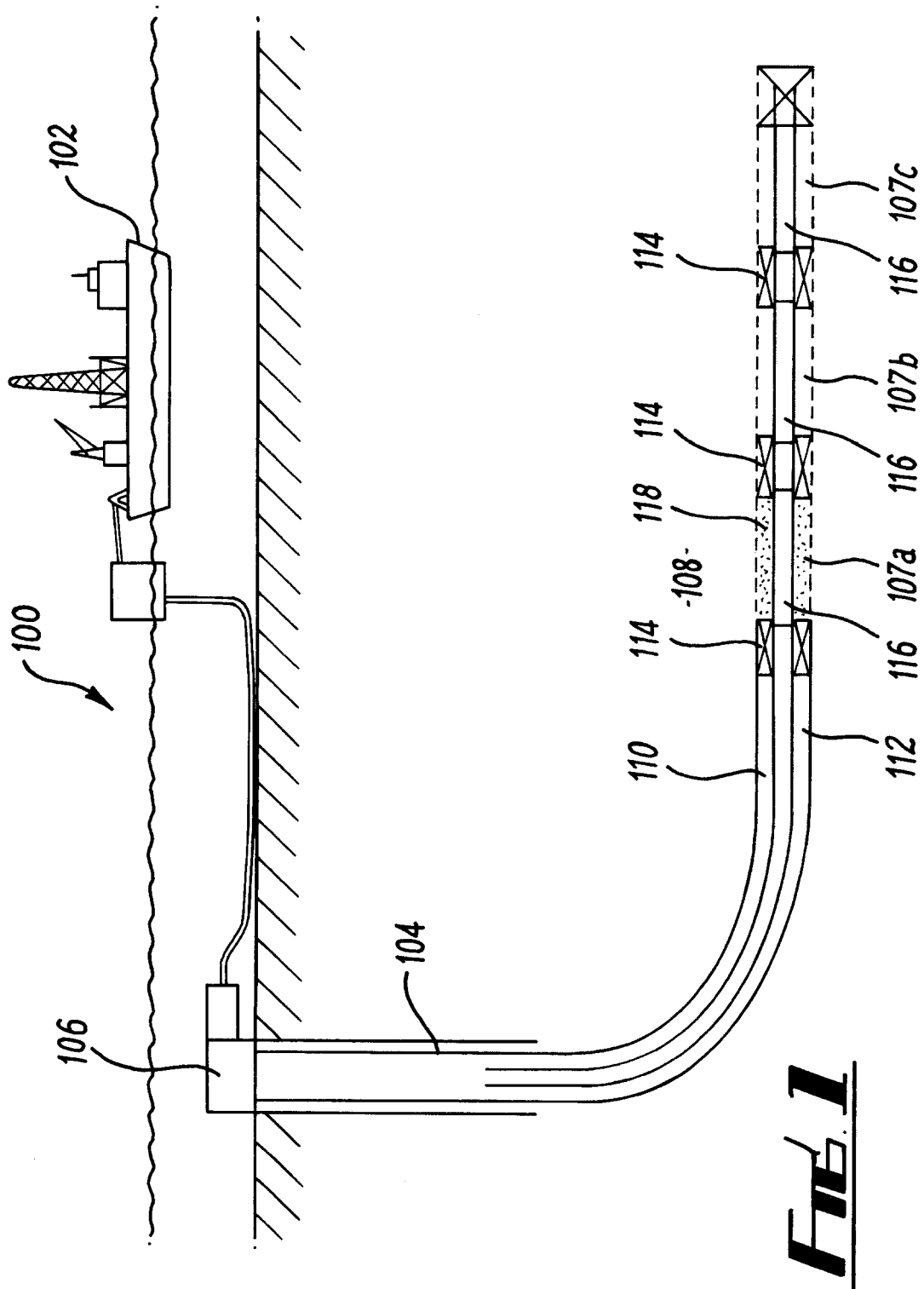
Claims

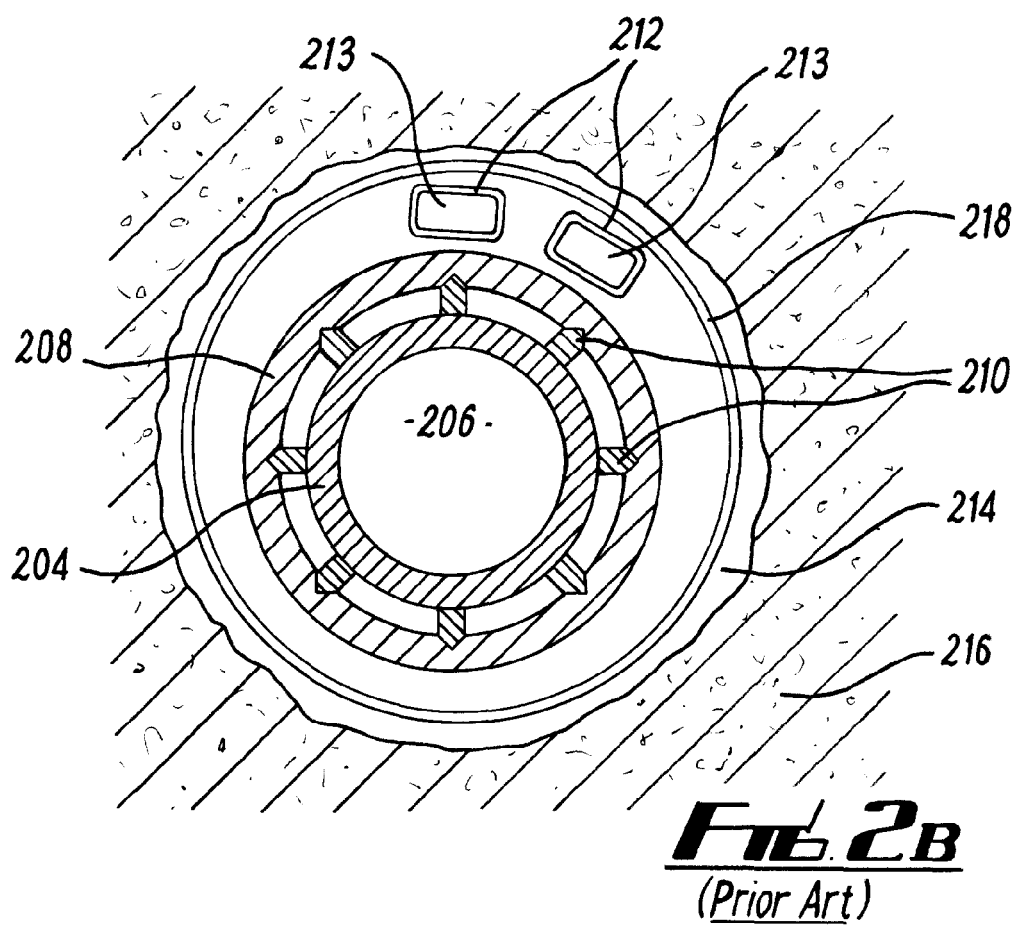
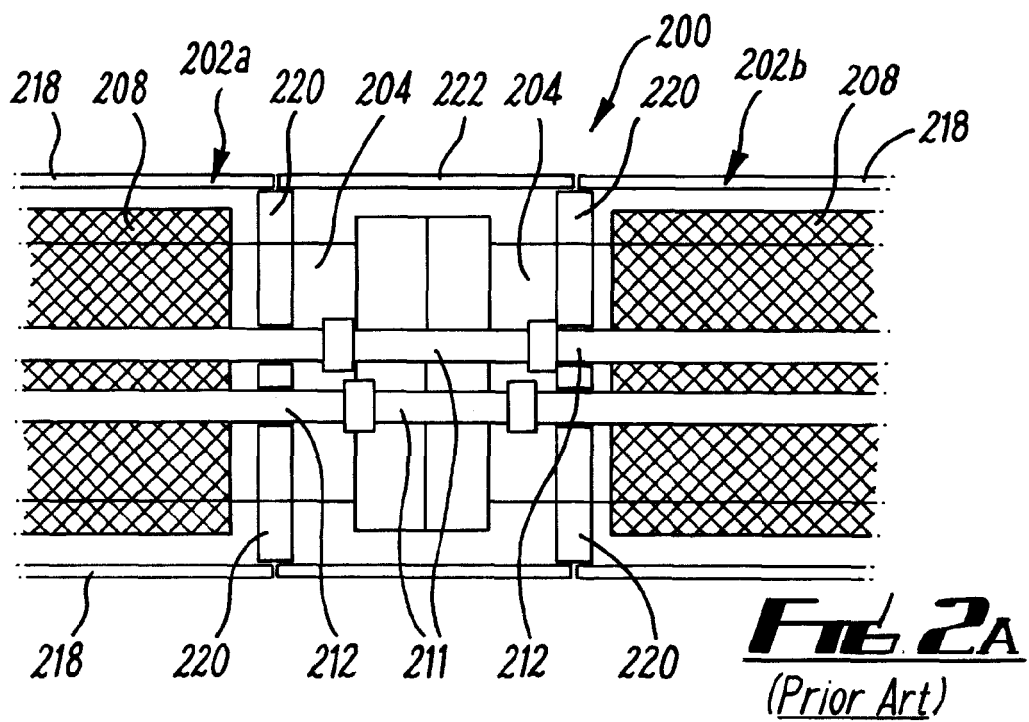
1. An apparatus for a sand control completion in a wellbore, the apparatus comprising:

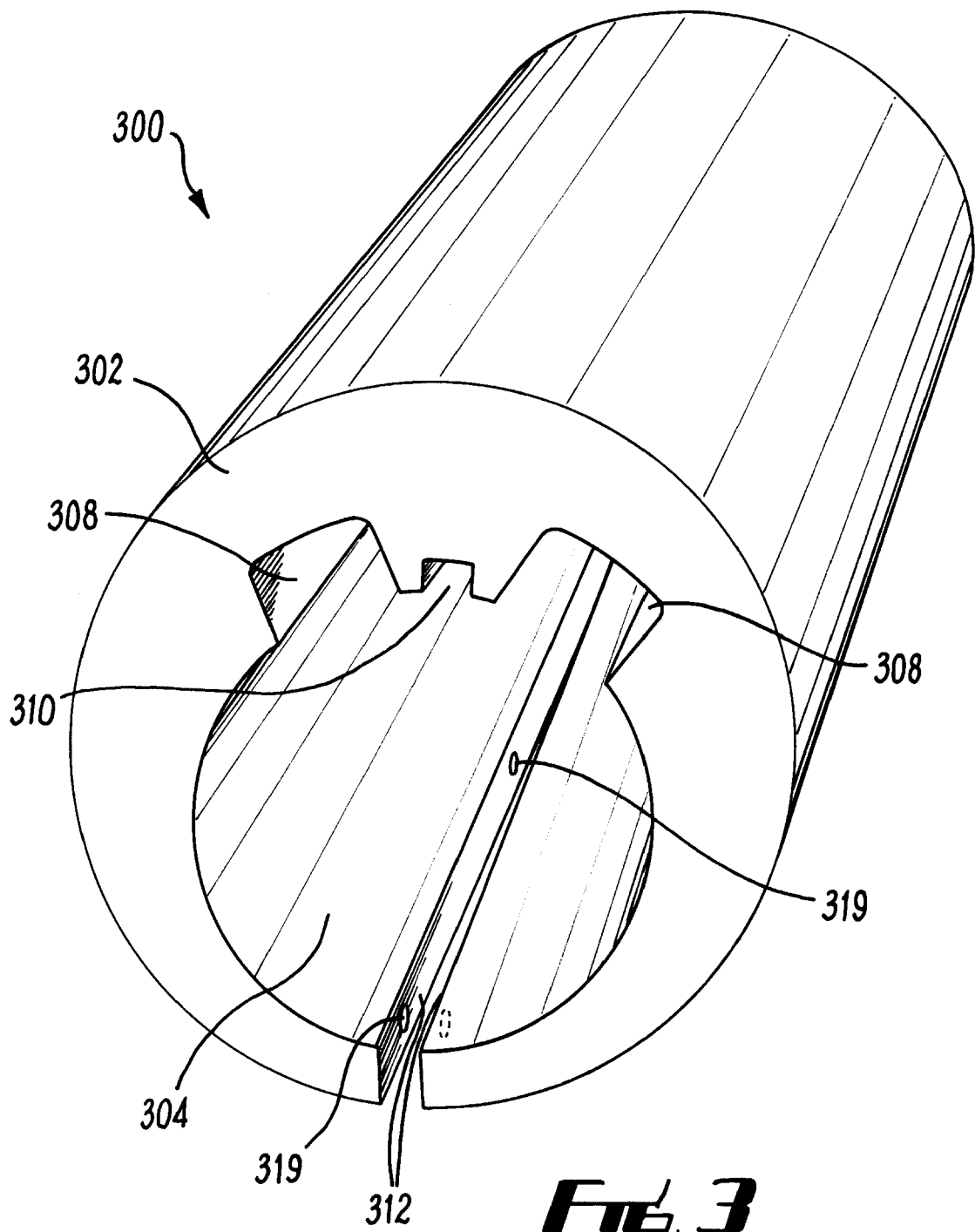
a body comprising a swellable material selected to increase in volume on exposure to at least one triggering fluid, the body configured to surround a wellbore tubular which defines a primary flow path and further configured to surround at least one secondary flow path disposed externally of the wellbore tubular, wherein the secondary flow path is configured for a carrier fluid containing particulate matter for a gravel pack, and the body comprises a longitudinal discontinuity which permits a radial opening to be formed on the body, through which the body is operable to be applied to the tubular.

2. The apparatus as claimed in claim 1 wherein the secondary flow path comprises a conduit and the body is configured to surround the conduit.
3. The apparatus as claimed in claim 2 wherein the conduit is a shunt tube or jumper tube. 5
4. The apparatus as claimed in any preceding claim wherein the apparatus comprises a longitudinal recess on an inner surface which defines the secondary flow path. 10
5. The apparatus as claimed in any preceding claim comprising a manifold in the secondary flow path. 15
6. The apparatus as claimed in any preceding claim wherein the body comprises a support structure.
7. The apparatus as claimed in claim 6 wherein the support structure is resilient. 20
8. The apparatus as claimed in claim 6 or claim 7 wherein the support structure is integral with the body.
9. The apparatus as claimed in claim 8, wherein the body at least partially surrounds the support structure. 25
10. The apparatus as claimed in claim any of claims 6 to 9 wherein at least a portion of the support structure upstands from an outer surface of the body. 30
11. The apparatus as claimed in claim 10, wherein the support structure is configured to provide stand-off to the apparatus in use. 35
12. A protective shroud for an alternate path sand control completion system comprising the apparatus of any preceding claim. 40
13. A sand control completion comprising: a tubular defining a primary fluid flow path; a first sand control device; a secondary fluid flow path for delivering a carrier fluid containing particulate matter for a gravel pack to the first sand control device; and a body comprising a swellable material selected to increase in volume on exposure to at least one triggering fluid disposed over the secondary flow path and the tubular, wherein the body comprises a longitudinal discontinuity which permits a radial opening to be formed on the body, through which the body is operable to be applied to the tubular. 45 50
14. A method of forming a sand control completion, the method comprising: 55
 - forming a primary fluid flow path from a sand control device and a tubular;

providing a secondary fluid flow path for delivering a carrier fluid containing particulate matter for a gravel pack;
 disposing a body comprising a swellable material selected to increase in volume on exposure to at least one triggering fluid over the secondary flow path and the tubular by applying the body to the tubular through a radial opening on the body.







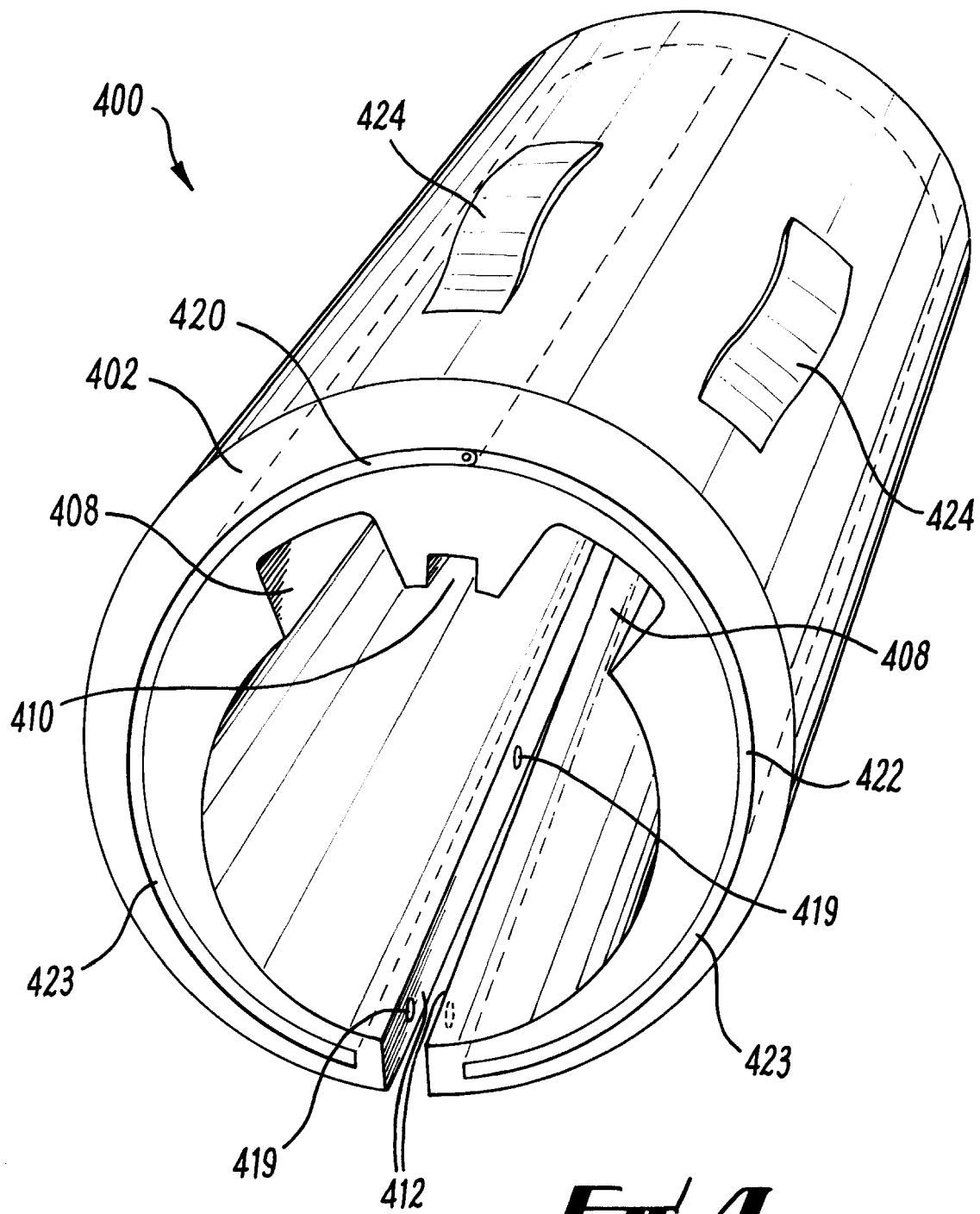
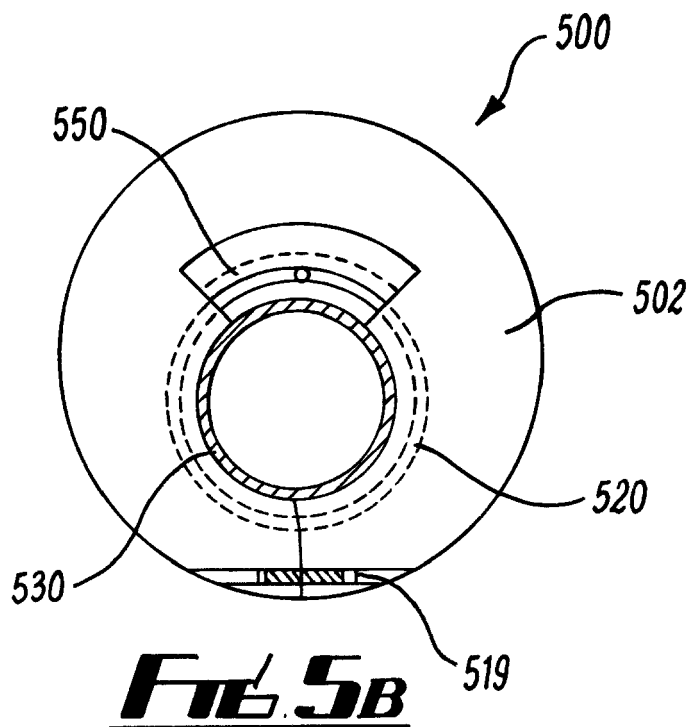
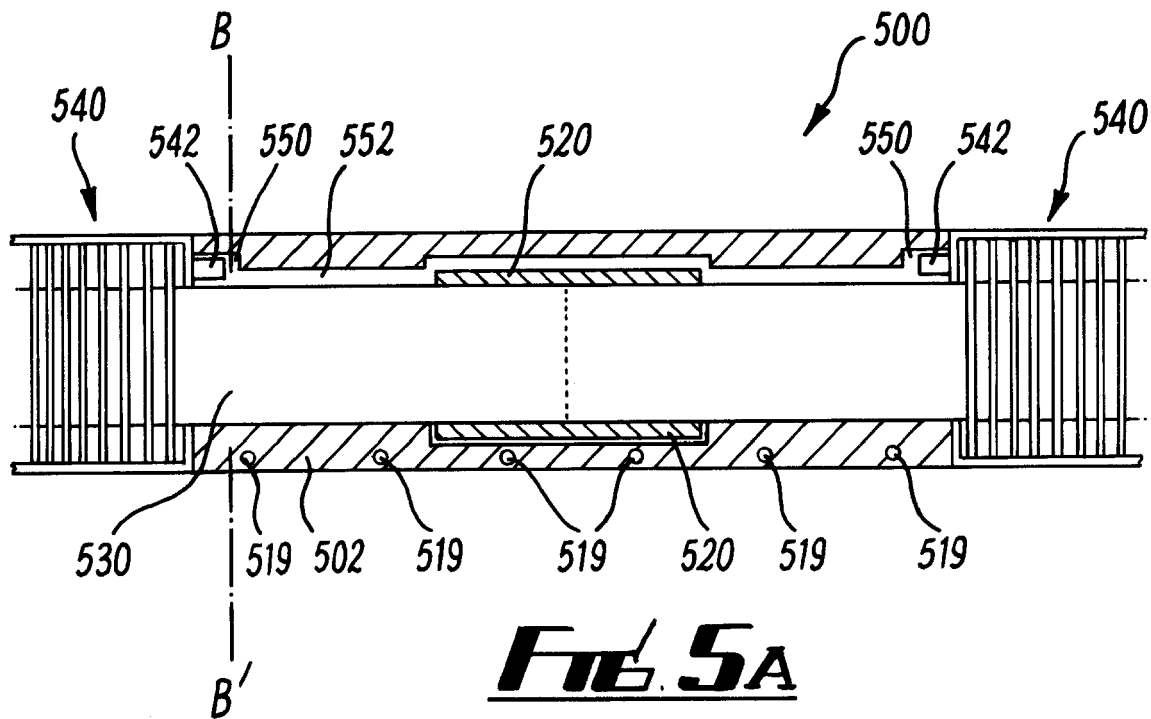
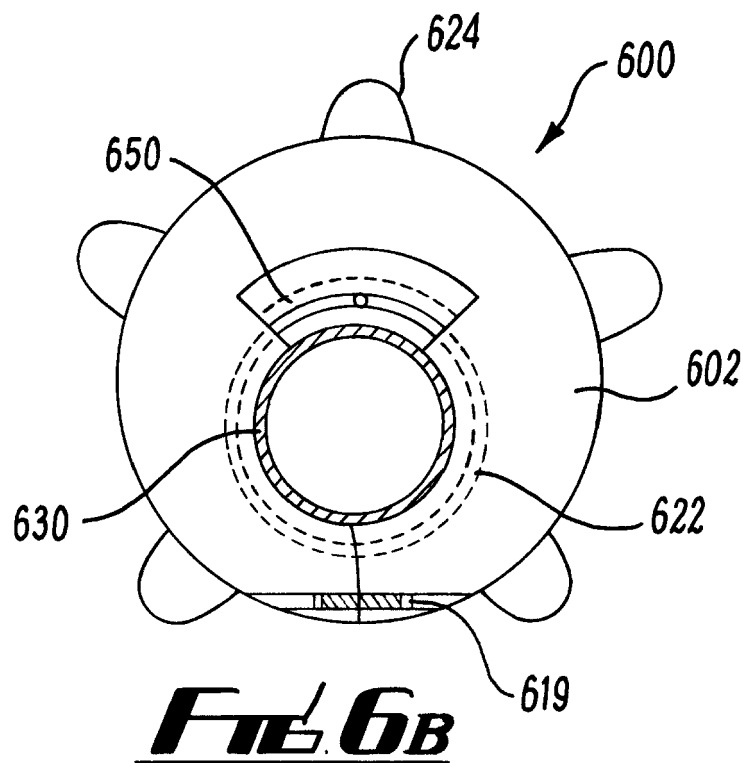
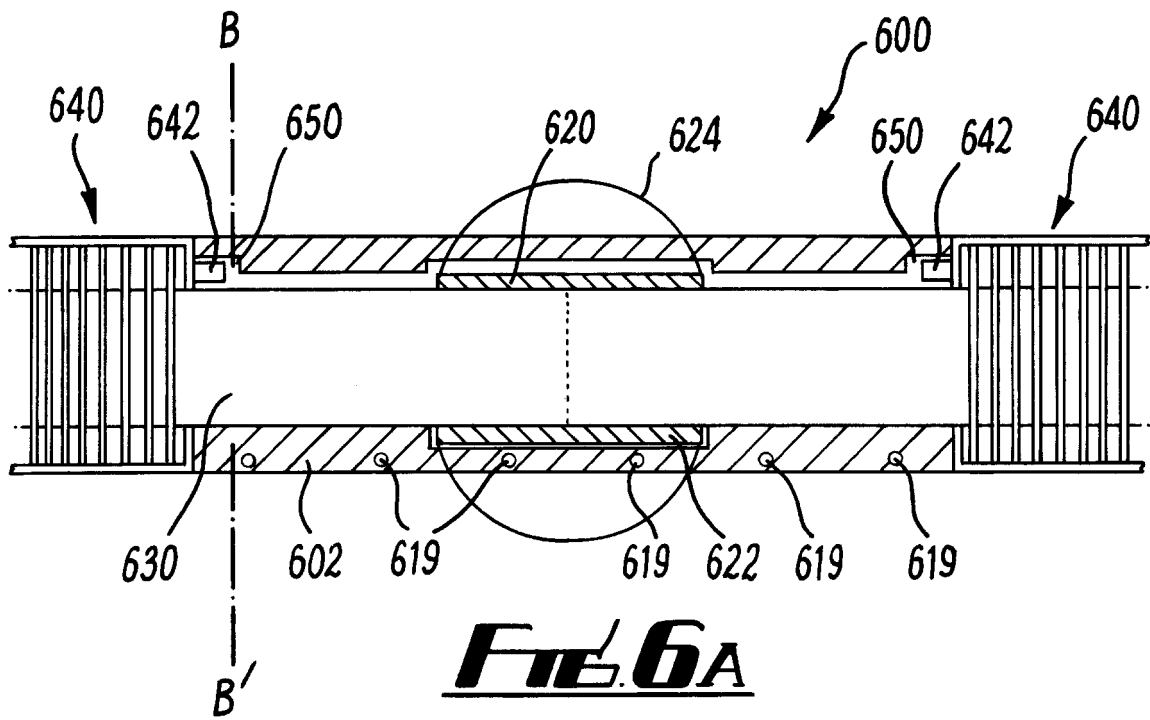


Fig. 4





REFERENCES CITED IN THE DESCRIPTION

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