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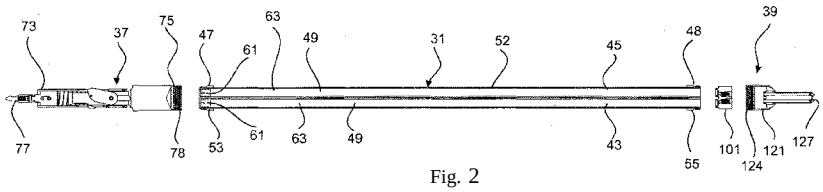


Fig. 2

(57) Abstract: A grout delivery system (10) for delivery of grout to a downhole location within a borehole. The grout comprising a settable mixture of first and second fiowable components. The grout delivery system (10) is adapted to be conveyed to the location within the borehole to which grout is to be delivered and to be subsequently retrieved. The delivery system (10) comprises a delivery head (39), a first reservoir (43) for receiving a charge of the first component, and a second reservoir (45) for receiving a charge of the second component. The delivery system (10) is operable to cause supplies of the first and second components to be conveyed to a mixing zone (127) at the delivery head (39) where they are mixed to form the grout and delivered into the borehole.

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**Grout Delivery**

TECHNICAL FIELD

[0001] This invention relates to a system and method for delivery of a flowable substance as a mixture comprising first and second components.

[0002] The invention has been devised particularly, although not necessarily solely, for delivery of grout into a borehole.

BACKGROUND ART

[0003] The following discussion of the background art is intended to facilitate an understanding of the present invention only. The discussion is not an acknowledgement or admission that any of the material referred to is or was part of the common general knowledge as at the priority date of the application.

[0004] Exploration diamond drilling is used in the mining industry to drill boreholes for geological surveying. Specifically, the drilling process provides core samples for geological analysis.

[0005] Core drilling is typically conducted with a core drill comprising outer and inner tube assemblies. The inner tube assembly comprises a core inner tube. A cutting head is attached to the outer tube assembly so that rotational torque applied to the outer tube assembly is transmitted to the cutting head. A core is generated during the drilling operation, with the core progressively extending along the core inner tube as drilling progresses. When a core sample is required, the core within the core inner tube is fractured. The inner tube assembly and the fractured core sample contained therein are then retrieved from within the drill hole, typically by way of a retrieval cable (which is commonly referred to as a wire line) lowered down the drill hole. Once the inner tube assembly has been brought to ground surface, the core sample can be removed from the core inner tube and subjected to the necessary analysis.

[0006] In borehole drilling operations, drilling fluid (commonly referred to a drilling mud) is used for cleaning and cooling a drill bit during the drilling process and for conveying drilling cuttings to the ground surface.

[0007] In certain circumstances, an underground area through which the borehole is being drilled can be unstable or otherwise vulnerable to development of fractures through which drilling fluid can escape. The loss of drilling fluid is undesirable, both in economic terms and also as it can lead to a reduction in fluid pressure within the borehole.

[0008] With a view to preventing or at least inhibiting the loss of drilling fluid, it is known to deliver grout to the vulnerable location within the borehole in order to seal fractures though which may otherwise escape.

[0009] The present invention seeks to provide a system and method for delivery of grout to a location within a borehole. However, the invention need not be limited to such an application and may be applicable to delivery of other flowable substances at remote locations.

SUMMARY OF INVENTION

[0010] According to a first aspect of the invention there is provides a delivery system for delivery of a flowable substance as a mixture comprising first and second components at a location to which the delivery system is conveyed, the delivery system comprising a delivery head, a first reservoir for receiving a charge of the first component, a second reservoir for receiving a charge of the second component, and actuation means operable to cause supplies of the first and second components to be conveyed to the delivery head at which they are mixed and delivered at the location.

[001 1] With this arrangement, the flowable substance comprises a fluid mixture of the first and second components. The mixture is fluid in the sense that it can flow for delivery to the intended location. Typically, the flowable substance is intended to harden or set once at the delivery location.

[0012] Preferably, the first and second reservoirs are configured as chambers of variable volume, whereby volume contraction of the chambers causes the first and second components to be expelled therefrom and conveyed to the delivery head.

[0013] Preferably, each variable volume chamber is defined by a piston and cylinder arrangement, with the piston being selectively moveable within the cylinder to effect volume variation of the chamber.

[0014] Preferably, the actuation means is responsive to fluid pressure to cause volume contraction of the chambers.

[0015] Preferably, the actuation means includes the pistons, the arrangement being that the pistons are responsive to fluid pressure exerted on the sides thereof opposed to the chambers to move within the respective cylinders and thereby cause volume contraction of the chambers.

[0016] Preferably, the delivery system further comprises a control valve means for controlling the supply of fluid pressure to the pistons to cause movement thereof along the cylinders, the control valve means being configure to allow admission of fluid under pressure in response to a fluid pressure supply exceeding a prescribed level.

[0017] Typically, the fluid pressure supply comprises fluid delivered into a drill string in the borehole, the arrangement being that the delivery system is configured to be accommodated within the drill string and exposed to the fluid within the drill string.

[0018] Preferably, the delivery system comprises a further control valve means for preventing.entry of fluid from borehole into the reservoirs through the delivery head.

[0019] Preferably, the further control valve means is disposed between the delivery head and the reservoirs and is configured to allow fluid flow between the reservoirs and the delivery head upon the fluid pressure in the reservoirs exceeding a prescribed level.

[0020] Preferably, the delivery head defines a mixing zone at which the first and second components are brought together for mixing to form the fluid mixture. The mixing zone may comprise a mixing chamber.

[0021] Preferably the delivery head comprises a body and the mixing zone is defined within the confines of the body.

[0022] Preferably the mixing zone is bounded by first and second faces disposed in opposed angular relation to each other and diverging outwardly towards an outlet opening.

[0023] Preferably, the outlet opening is provided at the periphery of the body.

[0024] Preferably, the body includes a first flow path and a second flow path, the first flow path being for communication with the first reservoir and opening onto the first face, and the second flow path being for communication with the second reservoir and opening onto the second face.

[0025] The invention according to the first aspect of the invention is particularly suitable for delivery of a flowable substance in the form of grout into a borehole during the drilling process to seal any fractures through which drilling fluid may escape from the borehole. Typically, when unstable or other ground which would be vulnerable to leakage of drilling fluid is encountered, the drilling process is temporarily halted and the delivery system according to the invention is introduced into the borehole to deliver grout for sealing the unstable ground area. Prior to introduction of the delivery system, the drilling head retracted partially to expose the vulnerable area of ground to which the grout is to be delivered. After the grout has been delivered and has set, the drilling procedure is recommenced and the grouted section of ground is drilled.

[0026] With such an arrangement, the delivery system may be conveyed to the location within the borehole at which the grout is to be delivered in any suitable manner. A particularly convenient arrangement for conveying the delivery system to the delivery location within the borehole, and also subsequently retrieving the delivery system, is by way of a wire line system of the type well known in borehole drilling practices.

[0027] The grout constitutes a settable mixture of first and second flowable components which are brought together at the time of delivery. Accordingly, it is possible to employ grouts that otherwise might not be possible to use for sealing a borehole (particularly a borehole which contains water), including latex grout and urethane grout. The arrangement is particularly suitable for grouts which are activated upon mixing of components thereof together.

[0028] The invention according to the first aspect of the invention is particularly suitable for delivery of water-activated grout, as the grout can be isolated from water within the borehole until such time as it is delivered whereupon it can be activated upon contact with the water.

[0029] Typically, the first and second components of the flowable mixture comprise different material which are mixed together and interact to provide the flowable mixture. However, in certain applications, the first and second components of the flowable mixture may comprise the same material, in which case the first and second reservoirs each hold the same type of material.

[0030] According to a second aspect of the invention there is provides a grout delivery system for delivery of grout comprising a settable mixture of first and second flowable components into a borehole, the delivery system comprising a delivery head, a first reservoir for receiving a charge of the first component, a second reservoir for receiving a charge of the second component, and actuation means operable to cause a supplies of the first and second components to be conveyed to the delivery head at which they are mixed and delivered into the borehole.

[0031] The grout delivery system according to the second aspect of the invention may have any one or more of the features referred to above of the delivery system according to the first embodiment

[0032] . According to a third aspect of the invention there is provided a method of delivery of a flowable substance as a flowable mixture comprising first and second components, the method comprising use of a delivery system according to the first aspect of the invention..

[0033] According to a fourth aspect of the invention there is provided a method of delivery of grout as a settable flowable mixture comprising first and second components into a borehole, the method comprising use of a grout delivery sytem according to the second aspect of the invention.

[0034] According to a fifth aspect of the invention there is provided a method of delivery of a flowable substance as a flowable mixture comprising first and second components from a first location to a second location spaced from the first location, the

method comprising conveying a charge of the first component and a charge of the second component separated from each other from the first location to the second location, mixing the first and second components to form the flowable mixture, and discharging the flowable mixture at the second location.

[0035] According to a sixth aspect of the invention there is provided a method of delivery of grout as a settable flowable mixture comprising first and second components into a borehole, the method comprising conveying a charge of the first component and a charge of the second component separated from each other into the borehole, mixing the first and second components to form the flowable mixture, and discharging the flowable mixture into the borehole.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0036] Further features of the present invention are more fully described in the following description of a non-limiting embodiment thereof. This description is included solely for the purposes of exemplifying the present invention. It should not be understood as a restriction on the broad summary, disclosure or description of the invention as set out above. The description will be made with reference to the accompanying drawings in which:

Figure 1 is a schematic perspective view of an embodiment of a grout delivery system according to the invention, the grout delivery system comprising an elongate assembly shown in an exploded condition;

Figure 2 is a side view of the arrangement shown in Figure 1;

Figure 3 is a schematic side view, on an enlarged scale, of a piston and cylinder arrangement providing reservoirs within the elongate assembly;

Figure 4 is a fragmentary schematic perspective view of an upper section of the grout delivery system in an exploded condition;

Figure 5 is a side view of the arrangement shown in Figure 4;

Figure 6 is a side view of the upper section of the grout delivery system in an assembled condition;

Figure 7 is a fragmentary schematic view illustrating a fluid flow path within the upper section of the grout delivery system;

Figure 8 is a fragmentary schematic perspective view of a lower section of the grout delivery system in an exploded condition;

Figure 9 is a side view of the arrangement shown in Figure 8;

Figure 10 is a fragmentary schematic perspective view of the lower section of the grout delivery system in an assembled condition;

Figure 11 is a fragmentary schematic sectional view of the lower section of the grout delivery system, illustrating in particular a one-way flow control valve arrangement in a closed condition;

Figure 12 is a view similar to Figure 11 except that the one-way flow control valve arrangement in an open condition in response for flow; and

Figure 13 is a view similar to Figure 12 illustrating flow paths of grout components within the upper section of the grout delivery system.

[0037] The figures depict an embodiment of the invention. The embodiment illustrates certain configurations; however, it is to be appreciated that the invention can take the form of many configurations, as would be obvious to a person skilled in the art, whilst still embodying the present invention. These configurations are to be considered within the scope of this invention.

DESCRIPTION OF EMBODIMENTS

[0038] Referring to the drawings, there is shown an embodiment of a grout delivery system 10 according to the invention for use in a core drilling operation in a borehole survey operation. The core drilling operation is performed with a core drill (not shown) fitted as a bottom end assembly to a series of drill rods which together constitute a drill string. The core drill comprises an inner tube assembly, which includes a core tube, for core retrieval. The core drill also comprises an outer tube assembly.

[0039] The inner tube assembly further comprises a backend assembly which configured for engagement with overshot assembly attached to a wire line, as is well-

known in core drilling practices. With this arrangement, the inner tube assembly can be lowered into, and retrieved from, the outer tube assembly and the drill string in which the outer tube assembly is incorporated.

[0040] If during the drilling operation an underground area is encountered which is unstable or otherwise vulnerable to development of fractures through which drilling fluid can escape, there may be a need to stabilise that area with grout in order to seal fractures against the escape of drilling fluid. The grout delivery system 10 is provided for that purpose. The grout delivery system 10 is adapted to be conveyed to the location within the borehole to which the grout is to be delivered, and to be subsequently retrieved, by deployment of the overshot assembly attached to the wire line as used with the inner tube assembly.

[0041] In this embodiment, the grout delivery system 10 is adapted to deliver the grout as a flowable substance which can set after delivery. The flowable substance comprising a mixture of two grout components which chemically react when mixed together to facilitate setting of the grout. The two grout components are mixed together at the location of delivery within the borehole and then delivered as a highly viscous fluid mixture.

[0042] - The grout delivery system 10 comprises an elongate assembly 20 having a bottom end 21 and a top end 23. The elongate assembly 20 is configured for deployment as a unit inside the drill string, with the top end 23 being adapted for engagement with the overshot assembly (not shown) so that the assembly 20 can be lowered down the drill string and hauled up the drill string using the wire line.

[0043] The elongate assembly 20 comprises an elongate body 31 having opposed ends 33, 35. A back end assembly 37 is connected to end 33 of the elongate body 31. A delivery head assembly 39 is connected to end 35 of the elongate body 31.

[0044] The back end assembly 37 defines the top end 23 of the elongate assembly 20 and the delivery head assembly 39 defines the bottom end 21 of the elongate assembly 20.

[0045] The elongate body 31 comprises two reservoirs 43, 45 for receiving respective charges of the two grout components. More particularly, the elongate body

31 comprises an upper end section 47, a lower end section 48, and two ducts 49 which are disposed in side-by-side relation and which extend between the ends sections 47, 48. The end sections 47, 48 each define an end face 50 onto which the ducts 49 open.

[0046] The reservoirs 43, 45 are defined within the ducts 49, as will be described in more detail later. In this way, the charges of the two grout components are isolated from each other while in the reservoirs.

[0047] In the arrangement shown, the two ducts 49 are defined by conduits 51 which cooperate to provide an integrated body structure 52 in conjunction with the upper and lower end sections 47, 48.

[0048] The upper end section 47 of the elongate body 31 is configured for connection to the back end assembly 37, and the lower end section 48 is configured for connection to the delivery head assembly 39, as will be explained in more detail later. More particularly, upper end section 47 comprises a threaded coupling configured as a threaded male coupling section 53, and lower end section 48 also comprises a threaded coupling configured as threaded male coupling section 55. The two end sections 47, 48, including the threaded male coupling sections 53, 55 are in fact of similar configuration, and so the elongate body 31 can be use in either orientation.

[0049] A piston 61 is slidably and sealingly received in each duct 49; that is, each duct 49 constitutes a cylinder 63 in which the respective piston 61 is accommodated for movement back and forth therein.

[0050] Each piston 61 and cylinder 63 cooperate to define two opposed chambers 65, 67 which vary in volume with movement of the piston within the cylinder. The chamber 65 will hereinafter be referred to as the bottom chamber and the chamber 67 will hereinafter be referred to as the top chamber. In Figure 2, the pistons 61 are depicted at the top ends of the cylinders 63 and in Figure 3 the pistons 61 are depicted further along the cylinders so as to form the bottom chambers 65 and top chambers 67 on opposed sides of the pistons.

[0051] With this arrangement, the bottom chambers 65 have outlet ends 66 opening onto end face 50 of the lower end section 48 and the and the top chambers 67 have inlet ends 68 opening onto end face 50 of the upper end section 47.

[0052] The two bottom chambers 65 communicate with the delivery head assembly 39 and define the respective reservoirs 43, 45 for receiving the charges of the two grout components. The outlet ends 66 of the bottom chambers 65 define sockets 69, the purpose of which will be explained later. With this arrangement, the sockets 69 are disposed at the outlet ends of the reservoirs 43, 45.

[0053] The two top chambers 67 communicate with the back end assembly 37. As will be explained in more detail later, the back end assembly 37 is adapted to selectively admit fluid under pressure into the two top chambers 67 to exert fluid pressure onto the pistons 61 and thereby drive the pistons along their respective cylinders 63, causing volume contraction of the two bottom chambers 65. The volume contraction of each bottom chamber 65 serves to expel at least part of the charge of the grout component contained within the respective reservoir 43, 45.

[0054] The back end assembly 37 comprises a body 71 having an upper end 73 and a lower end 75. The body 71 is of modular construction comprising a series of body sections 72 connected one to another, including a first intermediate body section 72a having a side wall 76 and a second intermediate body section 72b.

[0055] The upper end 73 of the back end assembly 37 is adapted for engagement with the overshot assembly (not shown), as mentioned above, so that the elongate assembly 20 can be lowered down the drill string and hauled up the drill string using the wire line. In the arrangement illustrated, the back end assembly 37 includes a landing collar 76 and a spearpoint 77 configured for engagement with the overshot assembly. The overshot assembly includes a latch head retractor mechanism releasably engagable with the spearhead point 77.

[0056] The lower end 75 of the back end assembly 37 is adapted to be coupled to the upper end section 47 of the elongate body 31. In the arrangement illustrated, the lower end 75 of the back end assembly 37 comprises a threaded coupling configured as threaded female coupling section 78 adapted to threadingly mate with the male coupling section 53 at the upper end section 47 of the elongate body 31. The female coupling section 78 includes a coupling cavity 79 to receive the upper end section 47 of the elongate body 31.

[0057] As mentioned, the back end assembly 37 is adapted to selectively admit fluid under pressure into the two top chambers 67 to exert fluid pressure onto the pistons 61 and thereby drive the pistons along their respective cylinders 63. For this purpose, the body 71 of the back end assembly 37 includes a fluid flow path 81 extending between the exterior of the back end assembly 37 and the coupling cavity 79. The fluid flow path 81 is depicted by flow lines identified by reference numeral 82 in Figure 7.

[0058] The fluid flow path 81 comprise an inlet end section 83 comprising inlet ports 84 incorporated in the side wall 76 of the intermediate body section 72a. The fluid flow path 81 also comprises an outlet end section 85 comprising an outlet port 86 opening onto the coupling cavity 79. The fluid flow path 81 further comprises an intermediate section 87 incorporating a flow control valve 89 operable to allow fluid flow along fluid flow path 81. In the arrangement shown, the flow control valve 89 is accommodated in the second intermediate section 72b. The flow control valve 89 comprises a valve seat 91 and a valve member 92 movable into and out of sealing engagement with the valve seat in response to fluid pressure. The flow control valve 89 is closed against fluid flow when the valve member 92 is in sealing engagement with the valve seat 91 and is open to permit fluid flow when the valve member 92 is out of sealing engagement with the valve seat The valve member 92 comprises a valve body 93 which guidingly received and supported within the body section 72b for reciprocatory movement into and out of sealing engagement with the valve seat 91. The valve member 92 is biased into sealing engagement with the valve seat 91 by a valve spring 94 and presents a valve face 95 which is exposed to fluid pressure, whereby the valve member is caused to move out of sealing engagement with the valve seat 91 when the fluid pressure rises to a level which can overcome the biasing influence of the valve spring 94. The valve body 93 incorporates bypass ports 96 through which fluid can flow to pass around and through the valve body and proceed towards the outlet port 86 when the flow control valve 89 is open.

[0059] With this arrangement, the flow control valve 89 is configure to allow fluid flow along the fluid flow path 81 into the coupling cavity 79 , and thereby admission of fluid under pressure into the two top chambers 67 which are in communication with the coupling cavity 79, in response to a fluid pressure supply exceeding a prescribed level. In this embodiment, the flow control valve 89 is responsive to a fluid supply pressure exceeding 100 psi; that is, the valve is caused to open to allow fluid flow along the fluid

flow path 81 when the fluid pressure on the intake side of the valve exceeds 100psi. It will, of course, be understood that the prescribed pressure can be selected at any appropriate level and need not be limited to 100 psi.

[0060] In this embodiment, the source which is used to supply fluid pressure to actuate the grout delivery system 10 comprises water which is pumped into the drill string. With this arrangement, water under pressure flows into the back end assembly 37 and into the entry side of the flow path 81. If the water pressure exceeds the prescribed level (which in this embodiment is 100psi), the pressure-responsive control valve means is caused to open and thereby allow water flow along the fluid path 81 and into the two top chambers 67. The resultant water pressure exerted onto the pistons 61 moves the pistons along their respective cylinders 63, causing volume contraction of the two bottom chambers 65.

[0061] The delivery head assembly 39 comprises a valve assembly 101 and a delivery nozzle 103.

[0062] The valve assembly 101 is adapted to prevent entry of water from borehole into the two reservoirs 43, 45. By way of explanation, it is often the case that a borehole being drilled contains water through which the grout delivery system 10 needs to descend as it moves to the location at which the grout is to be delivered. In certain circumstances, it is important that there be no water ingress into the two reservoirs 43, 45 while the grout delivery system 10 is immersed in the water. It can be particularly important that there be no water ingress in circumstances where the reservoirs 43, 45 contain a water-activated grout material.

[0063] In the absence of the valve assembly 101, the grout delivery system 10 could possibly be vulnerable to ingress of water into the reservoirs 43, 45, particularly during the descent in water within the borehole owing to the forces likely to be exerted on it during the descent.

[0064] The valve assembly 101 comprises a valve body 105 incorporating two flow passages 107, each adapted to communicate with a respective one of the reservoirs 43, 45. More particularly, the flow passages 107 have inlet ends 109 configured as spigots 111 adapted to be sealingly received in the corresponding socket 69 at the outlet ends of the reservoirs 43, 45. Further, the flow passages 107 have outlet ends 113

configured as sockets 115 for connection to the delivery nozzle 103, as will be explained later.

[0065] The valve body 105 accommodates a further control valve means 116 comprising two one-way valves spring-loaded disc valves 117 each associated with one of the flow passages 107.

[0066] The two spring-loaded disc valves 117 are effectively one-way valves, allowing grout material to be dispensed from the reservoirs 43, 45 in the manner described previously but inhibiting flow of water in the reverse direction from the borehole into the reservoirs. In this embodiment, the two spring-loaded disc valves 117 are set to open in response to a prescribed pressure exerted by the grout component material as it is expelled from its respective reservoir 43, 45. The prescribed pressure for opening of each spring-loaded disc valves 117 is 10psi in this embodiment. It will, of course, be understood that the prescribed pressure can be selected at any appropriate level and need not be limited to 10 psi. The two spring-loaded disc valves 117 are shown in a closed condition in Figure 11 and in an open condition in Figure 12.

[0067] The delivery nozzle 103 comprises a nozzle body 121 having an inner end 123 and an outer end 125.

[0068] The nozzle body 121 comprises a threaded coupling at the inner end 123 configured as threaded female coupling section 124 adapted to threadingly mate with the male coupling section 55 at the lower end section 48 of the elongate body 31. The female coupling section 124 includes a coupling cavity 126 to receive the upper end section 47 of the elongate body 31.

[0069] The nozzle body 121 further comprises a cavity 128 contiguous with the coupling cavity 126 for accommodating the valve body 105.

[0070] The nozzle body 121 further comprises a mixing zone 127 adjacent the outer end 125 at which the two grout component materials emanating from the reservoirs 43, 45 are brought together for mixing to form the grout for delivery as a highly viscous fluid mixture.

[0071] The nozzle body 121 incorporates two flow passages 129, each adapted to communicate at one end with a respective one of the flow passages 107 in the valve assembly 101 and to communicate at the other end with the mixing zone 127. More particularly, each flow passage 129 has an inlet end 131 configured as a spigot 133 adapted to be sealingly received in the corresponding sockets 115 at the outlet ends 113 of the flow passages 107 in the valve assembly 101. The spigots 133 extend into the cavity 128 in which the valve body 121 is accommodated. Further, each flow passage 129 has an outlet end 135 opening onto the mixing zone 127.

[0072] In the arrangement shown, each flow passage 129 is defined by first section 136 communicating with the inlet end 131, a second section 137 communicating with the outlet end 135, and an intervening third section 138 accommodating a reduction in the cross-section flow area from the first section 136 to the second section 137. In the arrangement shown, the outlet end 135 is configured as an array of outlet ports 139, and each second section 137 comprising a plurality of flow galleries (not shown) extending to the mixing zone 127 and opening onto the mixing zone via the array of outlet ports.

[0073] The mixing zone 127 is defined within the confines of the body 121 and is bounded by first and second faces 141, 142 disposed in opposed angular relation to each other and diverging outwardly towards an outlet opening 137 through which the grout is discharged into the borehole. The outlet ends 135 of the flow passages 129 open onto the first and second faces 141, 142. With this arrangement, the mixing zone 127 comprises a mixing chamber 143 defined between the first and second faces 141, 142. The mixing chamber 143 is open and thereby also defines an outlet 145 through which the grout can be discharged.

[0074] The angular relationship between the trajectories of the streams of grout component materials issuing from the outlet ports 139 into the mixing zone 127 facilities mixing of the grout component materials to form the grout before discharge of the grout as a viscous fluid mixture from the mixing zone 127 adjacent the outer end 125. In particular, the streams of grout component materials issuing from the outlet ports 139 intersect within the mixing zone 127 to create shear which enhances mixing efficiency.

[0075] In operation, the reservoirs 43, 45 are charged with the grout component materials by loading through the lower end section 48 of the elongate body 31. The delivery head assembly 39 is then installed in position on the elongate body 31.

[0076] When a section of the borehole being drilled required grouting, the drilling string is partially retracted to expose the area to be grouted, and the loaded grout delivery system 10 is lowered down the drill string using the overshot assembly (not shown) attached to the wire line. During the descent of the loaded grout delivery system 10, the two spring-loaded disc valves 107 function to prevent the ingress of any water within the borehole into the reservoirs 43, 45 as previously explained. When the loaded grout delivery system 10 is at the desired location, water is pumped into the drill string and pressurised. The pressurised water flows into the back end assembly 37 and into the entry side of the flow path 81. Once the water pressure exceeds the prescribed level (which in this embodiment is 100psi), the pressure-responsive flow control valve 89 is caused to open and thereby allow water to flow along the fluid path 81 and into the two top chambers 67. The resultant fluid pressure exerted onto the pistons 61 moves the pistons along their respective cylinders 63, causing volume contraction of the two bottom chambers 65. This expels grout component material from the reservoirs 43, 45 and causes the expelled material to flow along the respective flow passages 107 in the valve assembly 101. The respective flows of expelled material exert pressure on the two spring-loaded disc valves 107 which open when the pressure exceeds the prescribed level (which is 10psi in this embodiment). The respective flows of expelled material enter the nozzle body 121 and pass along the flow passage 129 to the mixing zone 127. The flows of expelled material enter the mixing zone 127 and mix to react chemically to form the grout. The flow path of the expelled material is depicted in Figure 13 by flow lines identified by reference numeral 147. The grout so formed is depicted schematically in Figure 13 and identified by reference numeral 150. As alluded to above, the flows of expelled material emerging from the outlet ports 139 intersect in the mixing zone 127 to create shear which enhances mixing efficiency. The resultant grout 150 is discharged as a viscous fluid mixture through the outlet 145 defined at the outer end 125 of the nozzle body 121 and delivered into the borehole. At the completion of the grout delivery process, the delivery of pressurized water into the borehole is terminated and the grout delivery system 10 retrieved by raising it to the ground surface using the using the overshot assembly (not shown) attached to the wire line.

[0077] From the foregoing, it is evident that the present embodiments provide a system and method for delivering grout component materials to a location within a bore hole, at which the grout component materials are mixed together to form the grout and deliver the grout as a flowable substance which can set after delivery. It is a particular feature of the embodiment that the grout components are mixed together at the location of delivery within the borehole and then delivered into the borehole.

[0078] In the embodiments described, the two reservoirs 43, 45 were described as being used to contain charges of two grout component materials which react chemically to form the grout. The two reservoirs,43, 45 may, of course contain other types of grout materials.

[0079] Further, the two reservoirs may in fact be charged with the same type of material. With this arrangement, the two reservoirs would simply provide increased holding capacity for that material.

[0080] Further, the delivery system may comprise more than two reservoirs to facilitate mixing of more than two components to form the flowable substance to be delivered.

[0081] It should be appreciated that the scope of the invention is not limited to the scope of the embodiment described.

[0082] In another embodiment, which is not shown, the nozzle body 121 may comprise first potion configured as a disposal unit and a second portion configured as a retaining member (such as a bezel or other mount) to releasably secure the first potion to the valve assembly 101. In this embodiment, the mixing chamber may be defined by a zone within the first portion. With this arrangement, the first portion can be discarded after use and thereby avoid the need for cleaning after use.

[0083] While the embodiment has have been described with particular reference to delivery of grout into a borehole, it should be understood that the invention need not necessarily be limited to that application. The invention may be applicable to delivery of other flowable substances into boreholes or to other remote locations. By way of example, the invention may find application in the delivery of flowable substances into a

distant section of pipeline which is not otherwise readily accessible for the purpose of repairing or blocking that section of pipeline.

[0084] Modifications and improvements may be made without departing from the scope of the invention.

[0085] Reference to positional descriptions, such as lower and upper, are to be taken in context of the embodiments depicted in the figures, and are not to be taken as limiting the invention to the literal interpretation of the term but rather as would be understood by the skilled addressee.

[0086] , Throughout this specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

CLAIMS

1. A deliver/ system for delivery of a flowable substance as a mixture comprising first and second components at a location to which the delivery system is conveyed, the delivery system comprising a delivery head, a first reservoir for receiving a charge of the first component, a second reservoir for receiving a charge of the second component, and actuation means operable to cause a supplies of the first and second components to be conveyed to the delivery head at which they are mixed and delivered at the location.

2. The delivery system according to claim 1 wherein the first and second reservoirs are configured as chambers of variable volume, whereby volume contraction of the chambers causes the first and second components to be expelled therefrom and conveyed to the delivery head.

3. The delivery system according to claim 2 wherein each variable volume chamber is defined by a piston and cylinder arrangement, with the piston being selectively moveable within the cylinder to effect volume variation of the chamber.

4. The delivery system according to claim 2 or 3 wherein the actuation means is responsive to fluid pressure to cause volume contraction of the chambers.

5. The delivery system according to claim 3 or 4 wherein the actuation means includes the pistons, the arrangement being that the pistons are responsive to fluid pressure exerted on the sides thereof opposed to the chambers to move within the respective cylinders and thereby cause volume contraction of the chambers.

6. The delivery system according to claim 4 or 5 wherein the delivery system further comprises a control valve means for controlling the supply of fluid pressure to the pistons to cause movement thereof along the cylinders, the control valve means being configure to allow admission of fluid under pressure in response to a fluid pressure supply exceeding a prescribed level.

7. The delivery system according to claim 4, 5 or 6 wherein the fluid pressure supply comprises fluid delivered into a drill string in the borehole, the arrangement being that

the delivery system is configured to be accommodated within the drill string and exposed to the fluid within the drill string.

8. The delivery system according to claim 7 further comprising a further control valve means for preventing entry of fluid from borehole into the reservoirs through the delivery head.

9. The delivery system according to claim 8 wherein the further control valve means is disposed between the delivery head and the reservoirs and is configured to allow fluid flow between the reservoirs and the delivery head upon the fluid pressure in the reservoirs exceeding a prescribed level.

10. The delivery system according to any one of the preceding claims wherein the delivery head defines a mixing zone at which the first and second components are brought together for mixing to form the fluid mixture.

11. The delivery system according to claim 10 wherein the mixing zone comprises a mixing chamber.

12. The delivery system according to claim 11 wherein the delivery head comprises a body and the mixing zone is defined within the confines of the body.

13. The delivery system according to claim 10, 11 or 12 wherein the mixing zone is bounded by first and second faces disposed in opposed angular relation to each other and diverging outwardly towards an outlet opening.

14. The delivery system according to claim 13 wherein the outlet opening is provided at the periphery of the body.

15. The delivery system according to claim 13 or 14 wherein the body includes a first flow path and a second flow path, the first flow path being for communication with the first reservoir and opening onto the first face, and the second flow path being for communication with the second reservoir and opening onto the second face.

16. A grout delivery system for delivery of grout comprising a settable mixture of first and second flowable components into a borehole, wherein the grout delivery system

comprises a delivery system according to any one of the preceding claims and wherein the first and second flowable components comprise said first and second components.

17. A grout delivery system for delivery of grout comprising a settable mixture of first and second flowable components into a borehole, the delivery system comprising a delivery head, a first reservoir for receiving a charge of the first component, a second reservoir for receiving a charge of the second component, and actuation means operable to cause a supplies of the first and second components to be conveyed to the delivery head at which they are mixed and delivered into the borehole.

18. A method of delivery of a flowable substance as a flowable mixture comprising first and second components, the method comprising use of a delivery sytem according to any one of claims 1 to 15.

19. A method of delivery of grout as a settable flowable mixture comprising first and second components into a borehole, the method comprising use of a grout delivery system according to claim 16 or 17.

20. A method of delivery of a flowable substance as a flowable mixture comprising first and second components from a first location to a second location spaced from the first location, the method comprising conveying a charge of the first component and a charge of the second component separated from each other from the first location to the second location, mixing the first and second components to form the flowable mixture, and discharging the flowable mixture at the second location.

21. A method of delivery of grout as a settable flowable mixture comprising first and second components into a borehole, the method comprising conveying a charge of the first component and a charge of the second component separated from each other into the borehole, mixing the first and second components to form the flowable mixture, and discharging the flowable mixture into the borehole.

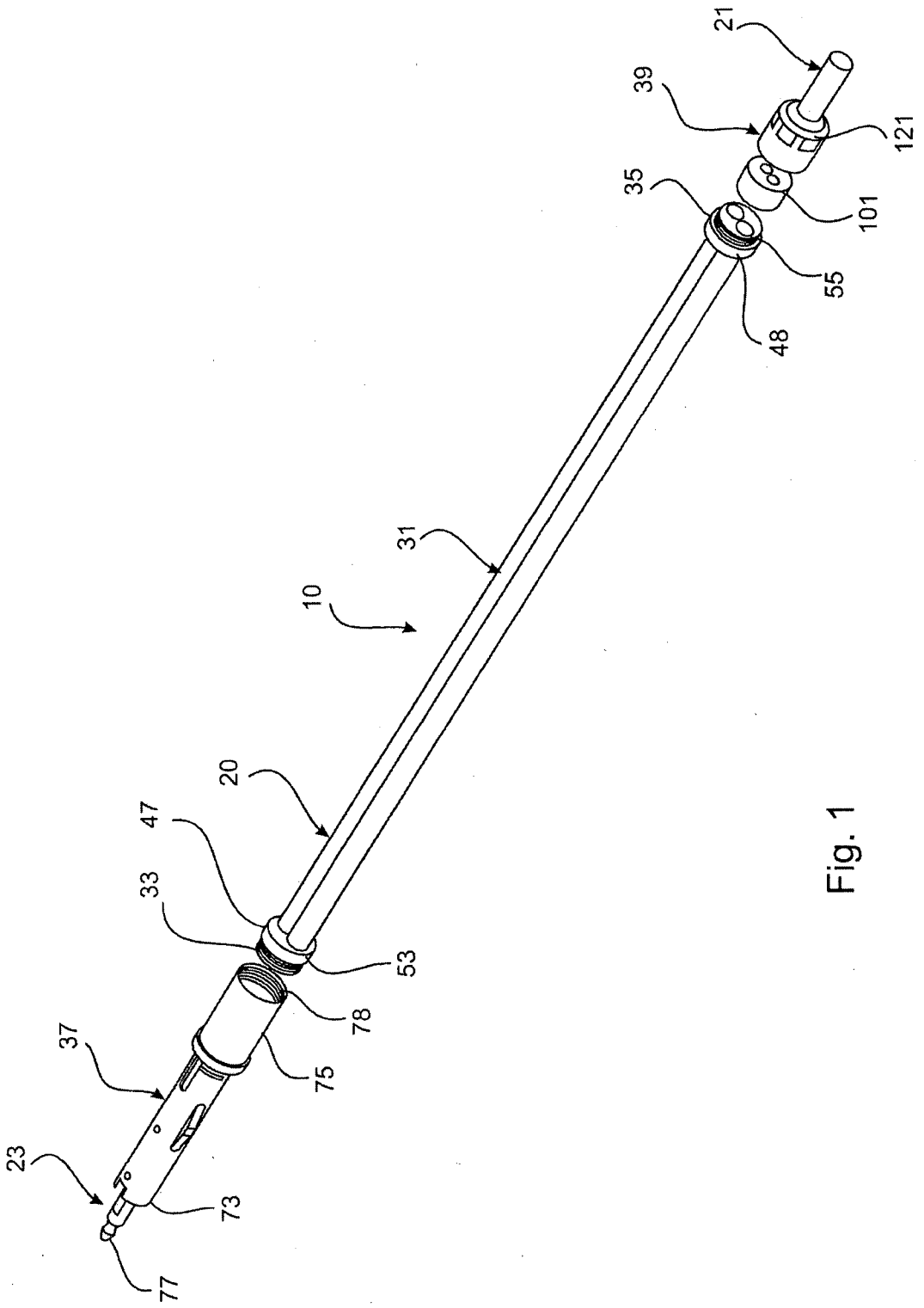


Fig. 1

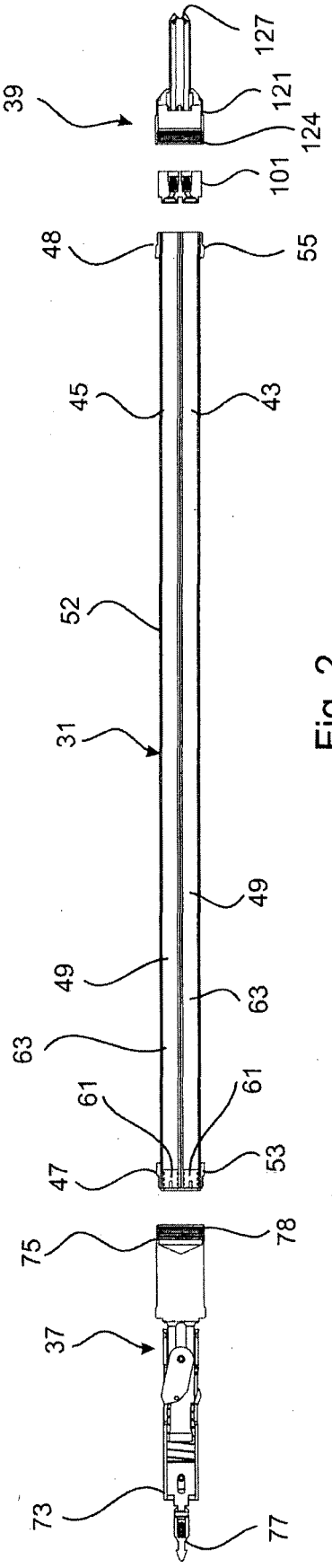
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Fig. 2

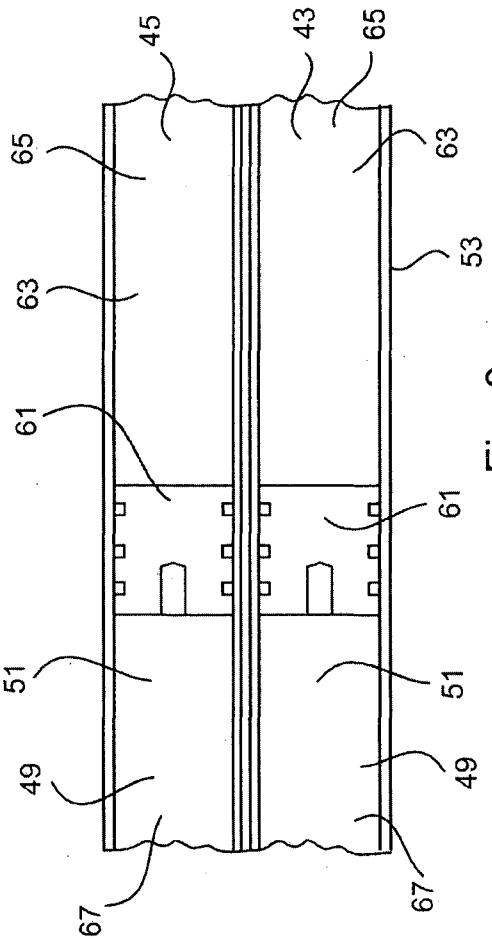
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Fig. 3

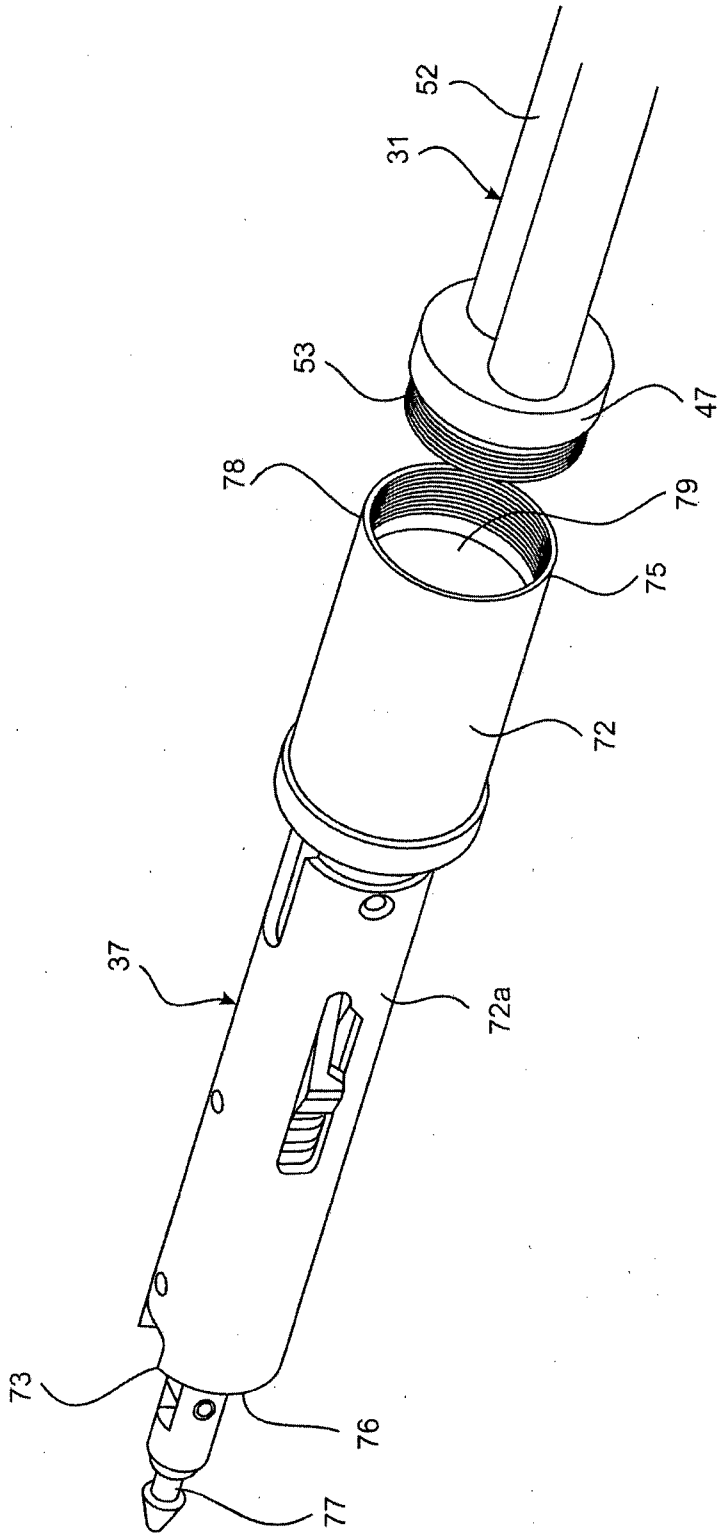


Fig. 4

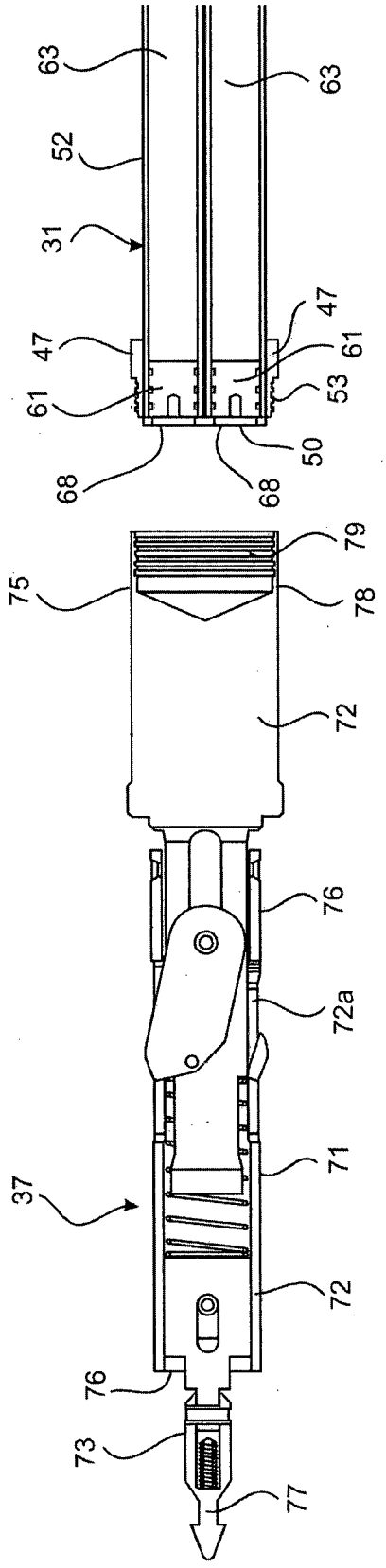


Fig. 5

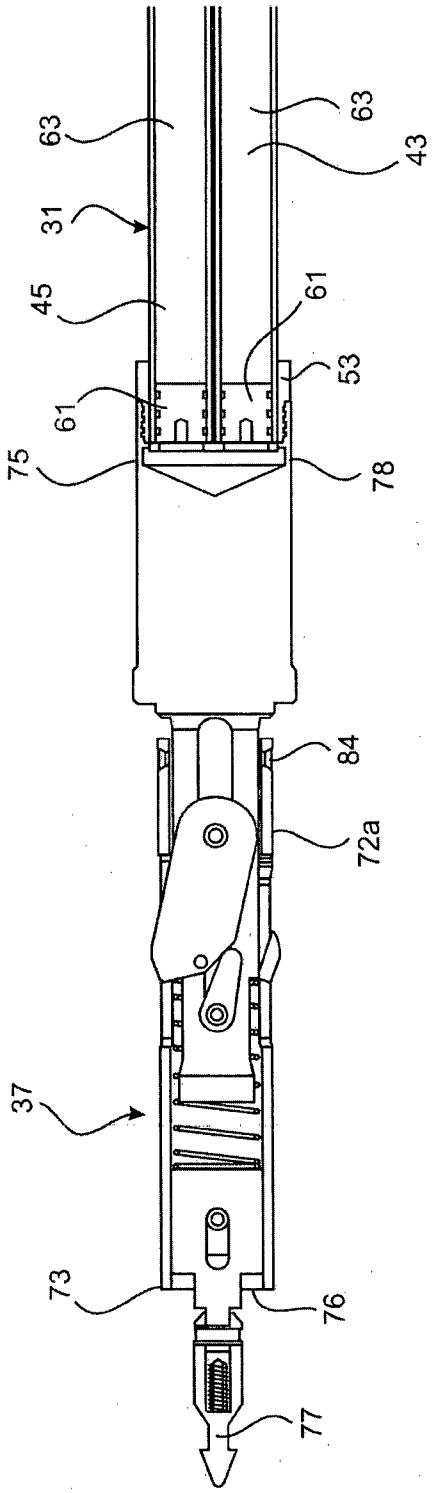


Fig 6

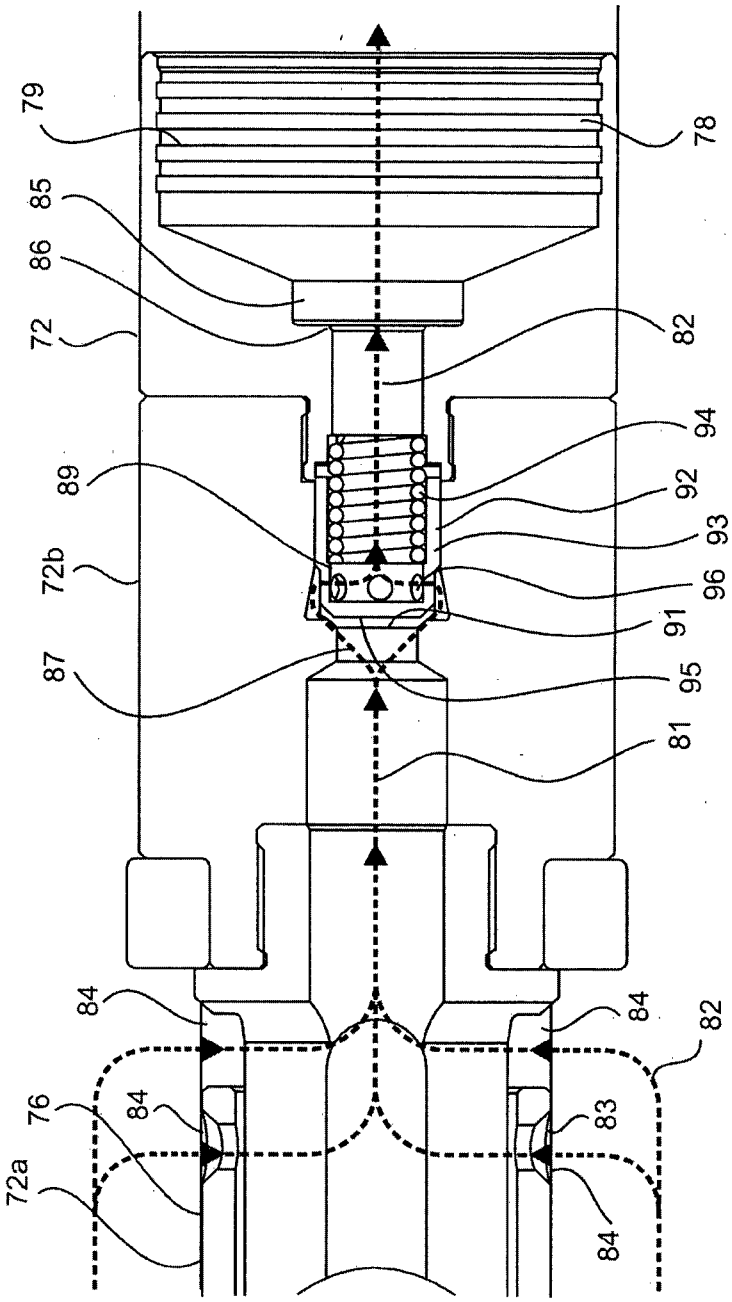
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Fig. 7

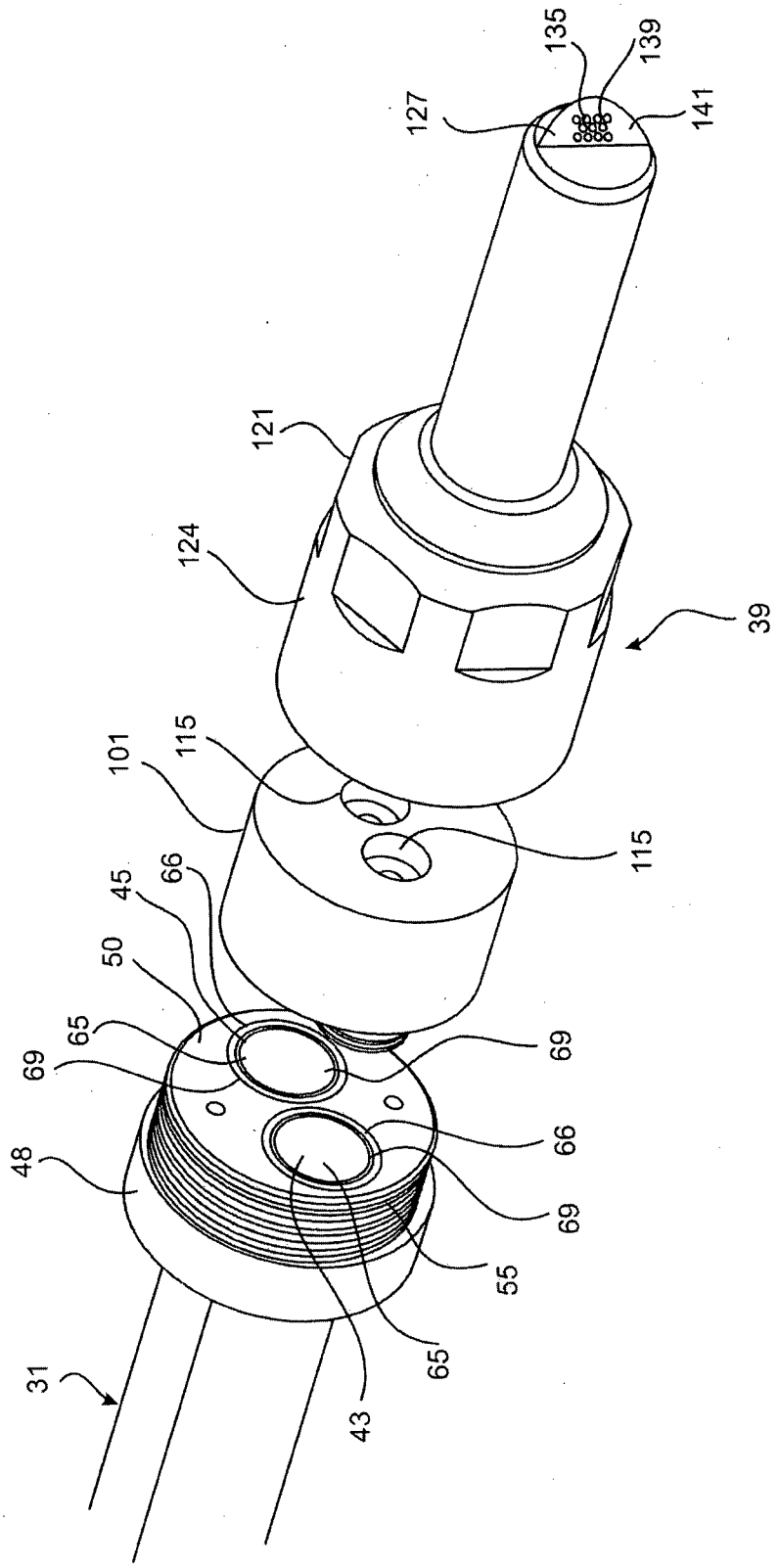
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Fig. 8

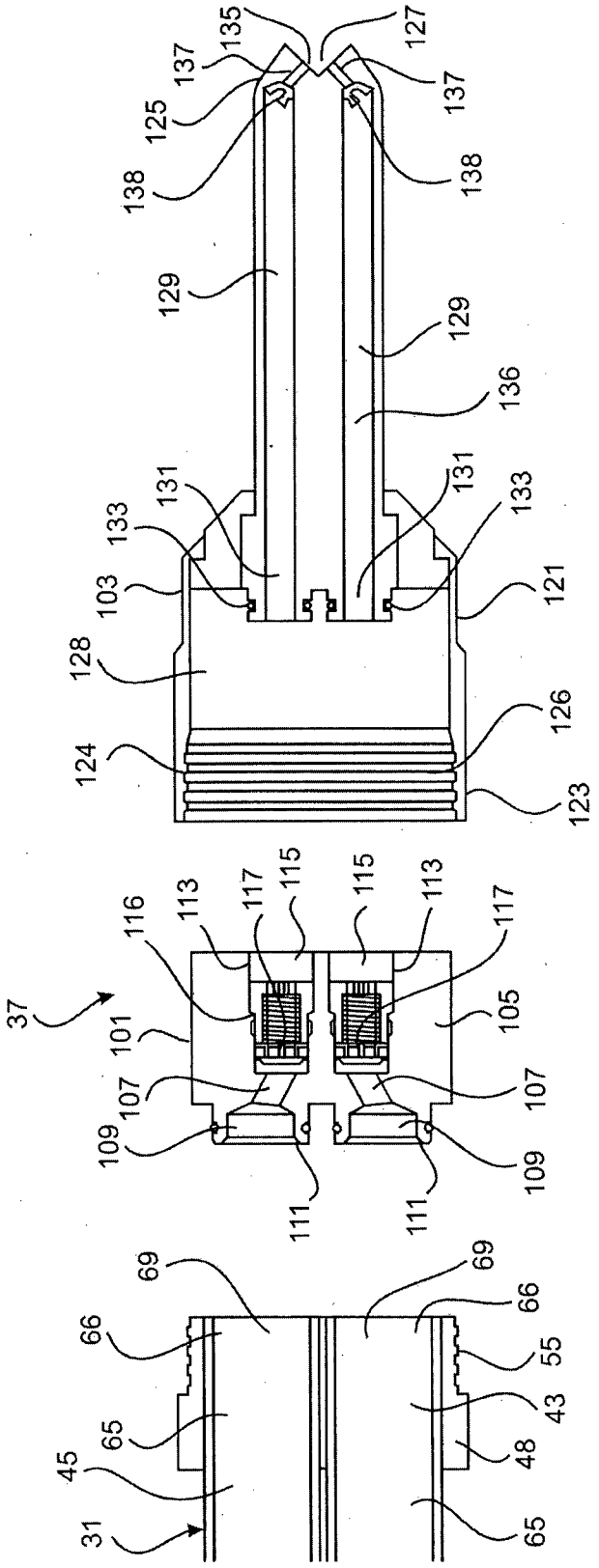
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Fig. 9

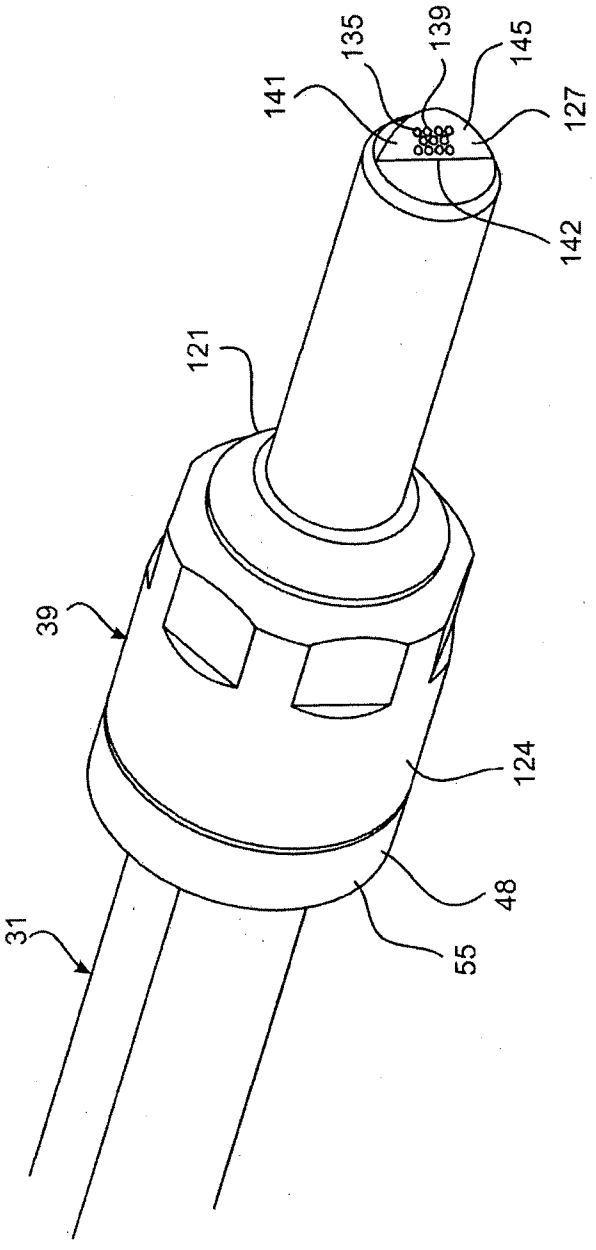


Fig. 10

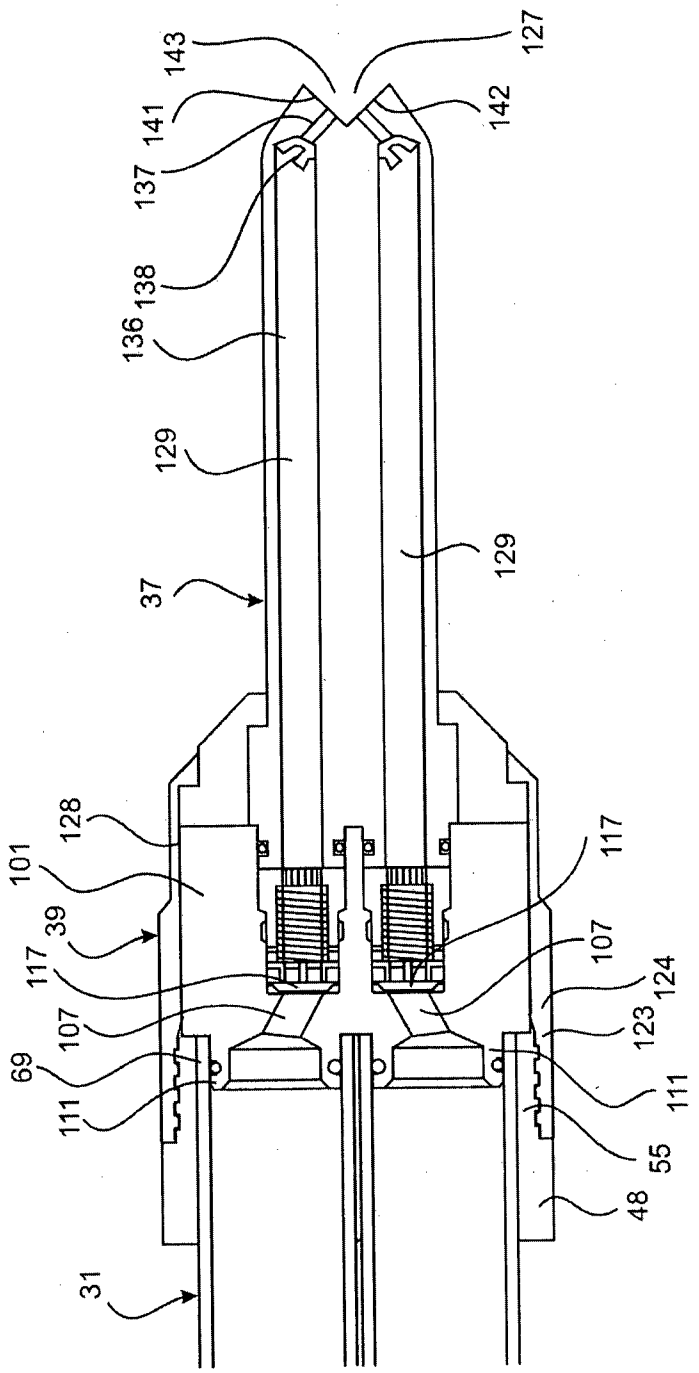
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Fig. 11

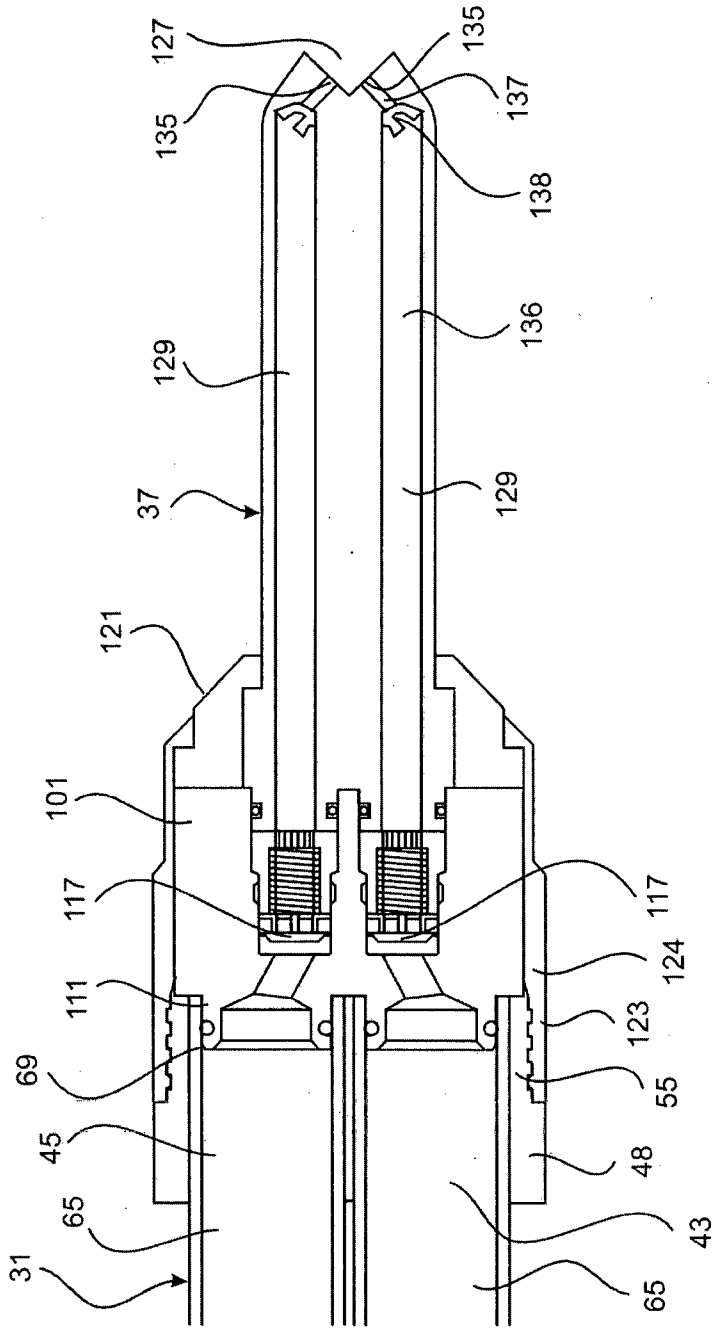
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Fig. 12

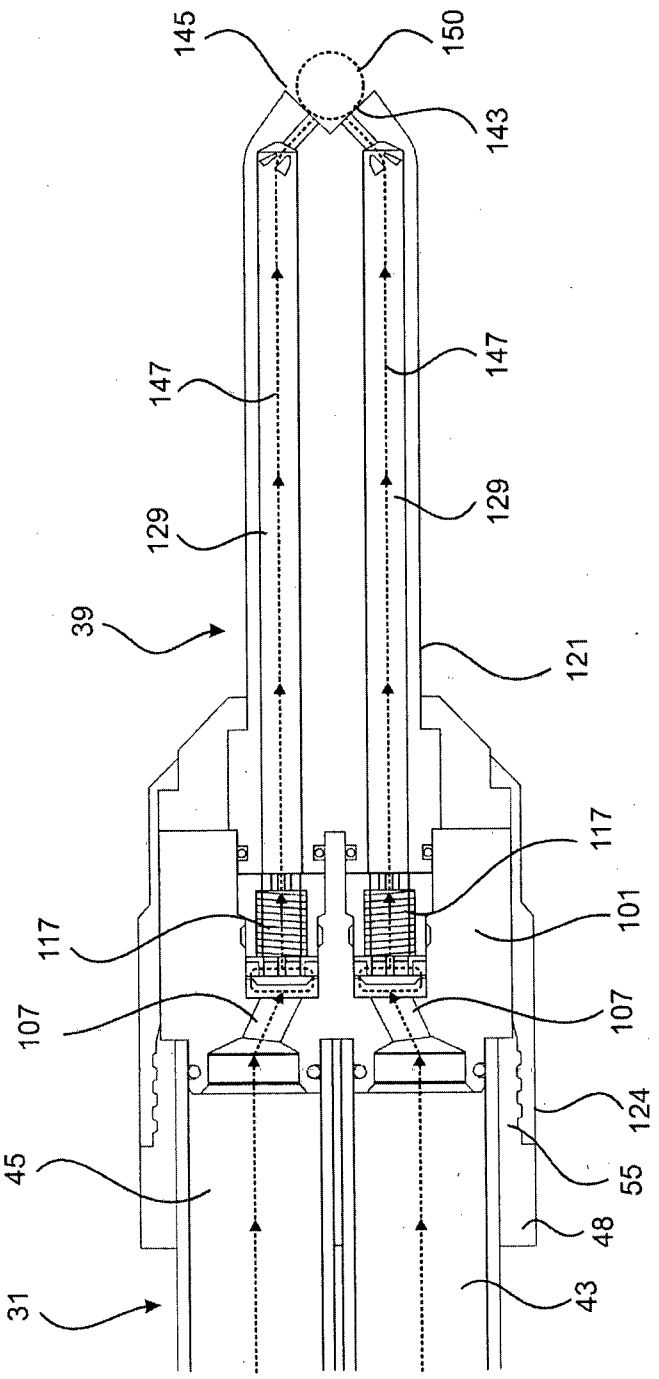
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Fig. 13

**INTERNATIONAL SEARCH REPORT**

**International application No.**
**PCT/AU2012/001468**

**A. CLASSIFICATION OF SUBJECT MATTER**

***E21B 33/138 (2006.01) E21D 20/02 (2006.01) BOSB 7/26 (2006.01) B05C 9/06 (2006.01)***

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

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPODOC, WPI: IPC Marks B05B7/low, B05C9/low, E21B33/low, E21D20/02/low and TXTEN: Full text search with key words- inject+, deliver+, dispens+, grout+, cement+, seal+, plug+, +resin+, first, second, two, multiple, actuate, operat+, regulat+, borehole?, well?, mine+, mix+, blend+, piston?, cylinder?, compression

Google Patents: Borehole, Cement, Dispenser, Two/ Dual

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| | **Documents are listed in the continuation of Box C** | |

[X] **Further documents are listed in the continuation of Box C** [X] **See patent family annex**

* Special categories of cited documents:

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"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" documentor particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

| **Date of the actual completion of the international search** | **Date of mailing of the international search report** |
|---|---|
| **12 February 2013** | **12 February 2013** |
| **Name and mailing address of the ISA/AU** | **Authorised officer** |
| **AUSTRALIAN PATENT OFFICE**<br>**PO BOX 200, WODEN ACT 2606, AUSTRALIA**<br>**Email address: pct@ipaustralia.gov.au**<br>**Facsimile No.:** +61 2 6283 7999 | **Pathma Fernando**<br>**AUSTRALIAN PATENT OFFICE**<br>**(ISO 9001 Quality Certified Service)**<br>**Telephone No.** 0262837948 |

| INTERNATIONAL SEARCH REPORT<br>C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT | | International application No.<br>**PCT/AU2012/001468** |
|---|---|---|
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| X | US 2008/0093077 A1 (DACCORD et al.) 24 April 2008<br>paragraphs [0009]-[0015]; figs 1-7C | 1, 10-21 |
| X | US 5242082 A (GIANNUZZI) 07 September 1993<br>Abstract; figs 1-4 | 1-3, 10-15, 18, 20 |
| X | US 5064098 A (HUTTER, III et al.) 12 November 1991<br>Abstract; figs 1-3 | 1-5, 10-15, 18, 20 |
| X | US 4067479 A (MOLINE) 10 January 1978<br>Abstract; figs 1, 2 | 1-5, 10-15, 18, 20 |
| X | US 5582251 A (BAILEY et al.) 10 December 1996<br>column 2, line 10-column 3, line 43; claims; 1, 11, 12, 22, 24; figs 1A-4A | 1-21 |

| INTERNATIONAL SEARCH REPORT<br>Information on patent family members | International application No.<br>**PCT/AU2012/001468** |
|---|---|

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

| **Patent Document/s Cited in Search Report** | | **Patent Family Member/s** | |
|---|---|---|---|
| **Publication Number** | **Publication Date** | **Publication Number** | **Publication Date** |
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| | | EP 1653042 A1 | 03 May 2006 |
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**End of Annex**

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.