SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO

RAD: 14-117057- -5 **FECHA**: 2015-07-16 11:29:31
DEP: 2020 DIRECCION DE NUEVAS CREACIONES **EVE:** 379 FASE NACIONAL INCLUIDO CAPITULO II
TRA: 11 PCT-PATENTE DE INVENCION CAPITULOS I Y II **FOLIOS**: 8
ACT: 430 REQUERSOLICITA

DIRECCIÓN DE NUEVAS CREACIONES

2020
Bogotá, D.C.,

Abogado(a)/Señor(a)
LUZ CLEMENCIA DE PÁEZ

Asunto: Radicación: 14-117057- -5
Trámite: 11
Evento: 379
Actuación: 430
Oficio: 8223
Folios: 8

Patente de Invención	**X**			Patente de Modelo de Utilidad	
Vía Nacional					
Vía PCT (Fase Nacional)	**X**	Capítulo I		Capítulo II	**X**
No. Solicitud Internacional	PCT/AU2012/001468				
Fecha de Presentación Internacional	30/11/2012				

Como resultado del examen de fondo realizado, con fundamento en el Artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se comunica:

1. Documentos estudiados

Descripción:	Rad. N° 14-117057-00000-0000	30/Mayo/2015
Reivindicaciones:	Rad. N° 14-117057-00000-0000	30/Mayo/2015
	Rad. N° 14-117057-00001-0000	06/Junio/2014
Dibujos:	Rad. N° 14-117057-00001-0000	06/Junio/2014
Prioridad:	AU 2011904985	30/Noviembre/2011

2. Análisis de la Prioridad

Se acepta la reivindicación de prioridad porque ésta solicitud fue presentada dentro del plazo establecido (Art. 9 D 486) y su contenido técnico corresponde con el de la prioridad reivindicada.

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3. Objeto de la invención

De acuerdo con lo establecido en el numeral 1.2.2.2 del Capítulo Primero del Título X de la Circular Única para efectos del examen de patentabilidad, se tendrá en cuenta la tasa pagada por el solicitante al momento de comenzar el examen para las reivindicaciones adicionales; esto es que cuando la solicitud contenga más de diez (10) reivindicaciones y no se haya pagado la tasa complementaria, sólo se estudiarán las cubiertas por la tasa pagada. Por lo tanto, se estudiaran las reivindicaciones 1 a 16.

Título de la solicitud: *"Suministro de mortero"* (Fl. 1).

El problema planteado en esta solicitud consiste en lograr un sistema y método para el suministro de mortero a una ubicación dentro de una perforación, con los que se minimize el desarrollo de fracturas y a la vez se evite o se inhiba la perdida de fluido de perforación.

Para resolver este problema técnico, la solicitud en estudio propone un sistema y un método de suministro de una sustancia fluidizable que comprende un cabezal de suministro, un primer deposito, un segundo depósito y un medio de accionamiento operable.

El objeto de la presente solicitud se relaciona con la Clasificación Internacional de Patentes (CIP): E 21B 33/138, 34/00; B 05 B 7/26; B 05 C 9/06; E 21 D 20/02.

4. Reivindicaciones relativas a un uso o a un segundo uso (Art 14 y 21 D 486)

El uso de las reivindicaciones 10 y 11 no es patentable, de acuerdo con el Art 14.

Las reivindicaciones 9 y 13 no son claras, toda vez que se enfocan en la mezcla fraguable, lo cual hace referencia a la forma de utilizar el producto reclamado, toda vez que dicha mezcla no hace parte estructural integral del sistema de suministro. Por lo tanto, esta oficina considera que la mezcla es un objeto ajeno al objeto que en la solicitud actualmente estudiada se quiere reclamar.

Adicionalmente, al hacer referencia a que: el mencionar que la mezcla comprende un primer y segundo componente fluidizable o un primer componente de mortero y un segundo componente de mortero es de carácter general, ya que nunca se especifica cuáles son dichos componentes.

Teniendo en cuenta todo lo expuesto, se considera que las reivindicaciones 9 a 11 y 13 no contienen materia que pueda ser objeto de protección y, por lo tanto, se sugiere al solicitante eliminarlas.

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5. De la solicitud de patente

Titulo

El título es de carácter general. Se sugiere al solicitante modificar el título de tal manera que exponga el objeto de la solicitud, haciendo referencia a las características constructivas de la creación reclamada, por ejemplo: "Dispositivo y método para la mezcla y suministro de mortero con cámaras independientes para los componentes de la mezcla".

Reivindicaciones (Art 30 D 486, Art 22 PCT)

Las reivindicaciones no son claras porque:

- La reivindicación 4 y Las expresiones: *"…el sistema de suministro esta configurado para estar alojado dentro de la sarta de perforación...", "…para recibir una carga del primer componente fluidizable…", "…para recibir una carga del segundo componente fluidizable…", "…para hacer que los suministros del primer y segundo componente fluidizable sean transportados (…) desde el fluido suministrado en la sarta de perforación en la perforación…", "…para controlar el suministro de presión de fluido al medio de accionamiento, donde la válvula de control (…) de fluido que excede un nivel prescrito…", "…para evitar la entrada de fluido desde la perforación en los depósitos a través del cabezal de suministro…", "…y es operable para permitir que el fluido fluya (…) en los depósitos excede un nivel prescrito."* (reivindicación 1), *"…por lo que la contracción de volumen de las cámaras hace que el primer y segundo componente sean expulsados desde estas u transportados al cabezal de suministro."* (reivindicación 2), *"…donde le pistón se puede mover selectivamente dentro del cilindro para producir la variación de volumen de la cámara."* (reivindicación 3), "*…donde la disposición consiste en que los pistones responden a la presión de fluido ejercido en los lados de los mismo opuestos a las cámaras moviéndose dentro de los respectivos cilindros y provocar así la contracción de volumen de las cámaras."* (reivindicación 5), *"…en la cual el primer y segundo componente se unen para mezclarlos para formar una mezcla fluida fluidizable"* (reivindicación 6), *"…destinada a almacenar residuos de fusibles fundidos."* (reivindicación 10), *"…para controlar el suministro de presión de fluido al medio de accionamiento…", "…configurada para estar expuesta al fluido dentro de la sarta de perforación…", "…configurada para comunicación con los pistones para ejercer presión de fluido y a través de esta abrir el medio de válvula de control."* (reivindicación 15), *"…que se puede mover hacia dentro y fuera del enganche sellador con el asiento de válvula que se puede mover hacia dentro y fuera del enganche sellador con el asiento de válvula en respuesta al suministro de presión de fluido que excede dicho nivel prescrito."* (reivindicación 16); describen funciones, efectos, ventajas o resultados a alcanzar, los cuales no son aspectos susceptibles de patente. Para mayor claridad, el producto reclamado se debe definir técnicamente mediante sus características estructurales. Se sugiere al solicitante la reivindicación y las expresiones citadas.

- La reivindicación 14 no cumple con lo establecido en el artículo 30 de la Decisión 486, por cuanto carece de concisión, toda vez que las características estructurales en ella incluidas ya habían sido reclamadas en la reivindicación 1 de la solicitud estudiada. En consecuencia, se sugiere al solicitante eliminar la reivindicación 14.

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Descripción (Art 28 D 486)

Se sugiere hacer la conversión de unidades, ya que se mencionan unidades en PSI (Fl. 26; Pág. 21), al Sistema Internacional.

6. Determinación del Estado de la Técnica

El estado de la técnica se determinó con base en la fecha de presentación de la solicitud de prioridad: noviembre 30 de 2011, y se encontraron los siguientes documentos que anticipan el objeto de esta solicitud:

Ítem	Documento	Título	Fecha de Publicación
D1	US 2008/0093077	'Injection apparatus for injecting and activated fluid into a well-bore and related injection method'	24/Abril/2008
D2	US 5'582.251	'Downhole mixer'	10/Diciembre/1996

El documento D1[1] divulga un aparato de inyección para inyectar un fluido en un pozo que comprende un reservorio, un arreglo de válvulas y un arreglo de dosificación y mezclado (resumen).

El documento D2[2] divulga un aparato para almacenar uno o más componentes en una herramienta de pozo. Los componentes son segregados hasta que la herramienta es accionada (resumen).

7. Examen de Patentabilidad (Art 14 D486)

Novedad (Art 16 D486)

La reivindicación 1 consiste en: "*Sistema de suministro para el suministro de una sustancia fluidizable como una mezcla de un primer y segundo componente...*" (Ver página 5 del radicado Nº 14-117057-00001-0000).

Comparación de las características técnicas esenciales, con las del estado de la técnica:

Características esenciales	D1
Sistema de suministro caracterizado por:	Aparato de inyección caracterizado por:
Un cabezal de suministro.	Un cabezal de suministro (Fig. 5B).
Un primer depósito.	Un primer depósito (9) (Fig. 2).
Un segundo depósito.	Un segundo depósito (3) (Fig. 2).
Un medio de accionamiento operable.	Un medio de accionamiento operable (3B) (Fig. 2).
Un medio de válvula de control.	Un medio de válvula de control

1 http://docs.google.com/viewer?url=patentimages.storage.googleapis.com/pdfs/US20080093077.pdf

2 https://docs.google.com/viewer?url=patentimages.storage.googleapis.com/pdfs/US5582251.pdf

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	(CS2) (Figs. 6B y 6C)
Otro medio de válvula de control dispuesto entre el cabezal del suministro y los depósitos.	Otro medio de válvula de control (2) dispuesto entre el cabezal del suministro y los depósitos (Fig. 2).

De acuerdo con la tabla anterior, las características esenciales del sistema de la reivindicación 1 habían sido divulgadas previamente en el documento D1, por lo tanto, la materia reivindicada no es nueva.

La reivindicación 12 consiste en: "*Un método de suministro de una sustancia fluidizable como una mezcla fluidizable que comprende un primer y segundo componente a una primera ubicación...*" (Ver páginas 6 y 7 del radicado Nº 14-117057-00001-0000).

Comparación de las características técnicas esenciales, con las del estado de la técnica:

Características esenciales	**D1**	**D2**
Un método de suministro de una sustancia fluidizable como una mezcla fluidizable que comprende un primer y segundo componente a una primera ubicación profunda dentro de una perforación caracterizado por:	Un método para inyectar una mezcla química activada en un pozo caracterizado por:	Un método para transporte y mezcla de sustituyentes en una herramienta de pozo caracterizado por:
Transportar una carga del primer componente y una carga del segundo componente separados entre si desde una primera ubicación hasta una segunda ubicación en la ubicación profunda, mezclando el primer y segundo componente.	Inyectar una mezcla de fluido en un pozo, con un aparato cuyo arreglo de válvulas activa y controla la dosificación y mezcla para inyectar cierta cantidad del fluido de activación en el primer fluido (Párr. [0009]).	Un aparato que almacena unos componentes de mezcla separados unos de los otros hasta que el aparato es activado. En ese momento, los componentes son llevados de su posición de almacenamiento y mezclados posteriormente (Col. 1, líneas 46 a 55).
Descargar la mezcla fluidizable en la perforación.		La mezcla resultante es dirigida al lugar donde finalmente será dispuesta para su solidificación (Col. 1, líneas 46 a 55).

De acuerdo con la tabla anterior, las características esenciales del método de la reivindicación 12 habían sido divulgadas previamente en los documentos D1 y D2, por lo tanto, la materia reivindicada no es nueva.

Nivel inventivo (Art18 D486)

En cuanto a la reivindicación 2 se tiene:

Reivindicaciones	**Características esenciales**	**D1**	**D2**
Reivindicación 1.	Sistema de suministro caracterizado por:	Aparato de inyección caracterizado por:	Herramienta de pozo caracterizada por:
	Un cabezal de suministro.	Un cabezal de suministro (Fig. 5B).	Un cabezal (10) con un tubo de suministro (12) (Fig. 1A).
	Un primer depósito.	Un primer depósito (9)	Un primer depósito (34)

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		(Fig. 2).	(Fig. 1B).
	Un segundo depósito.	Un segundo depósito (3) (Fig. 2).	Un segundo depósito (36) (Fig. 1B).
	Un medio de accionamiento operable.	Un medio de accionamiento operable (3B) (Fig. 2).	Un pistón (38) (Fig. 1A).
	Un medio de válvula de control.	Un medio de válvula de control (CS2) (Figs. 6B y 6C)	No menciona.
	Otro medio de válvula de control dispuesto entre el cabezal del suministro y los depósitos.	Otro medio de válvula de control (2) dispuesto entre el cabezal del suministro y los depósitos (Fig. 2).	No menciona.
Reivindicación 2.	El primer y el segundo depósito están configurados como cámaras de volumen variable.	No menciona.	El primer y el segundo depósito (34) y (36) están configurados como cámaras de volumen variable (Fig. 1B).

Los documentos D1 y D2 se consideran el estado de la técnica cercano a la invención definida en las reivindicaciones 1 y 2 porque divulgan un aparato de inyección y una herramienta de pozo.

La diferencia entre la invención, definida en las reivindicaciones 1 y 2 y el aparato de D1 consiste en que el primer y el segundo depósito están configurados como cámaras de volumen variable.

La diferencia entre la invención, definida en las reivindicaciones 1 y 2 y la herramienta de D2 consiste en el medio de válvula de control y el otro medio de válvula de control dispuesto entre el cabezal del suministro y los depósitos.

El efecto que logra que el primer y el segundo depósito están configurados como cámaras de volumen variable es que mediante la contracción de volumen de estas cámaras el primer y el segundo componente son expulsados desde éstas y transportados al cabezal de suministro.

Por lo tanto, el problema técnico objetivo que pretende resolver esta invención se puede formular así: “¿cómo modificar el aparato conocido en D1 para que mediante la contracción de volumen de estas cámaras el primer y el segundo componente sean expulsados desde éstas y transportados al cabezal de suministro?”.

Sin embargo, la utilización de una cámara de volumen variable en el primer y segundo depósito para que mediante la contracción de volumen de estas cámaras el primer y el segundo componente sean expulsados desde éstas y transportados al cabezal de suministro, ya está divulgada en el documento D2 que se refiere a un pistón (38) dispuesto en los depósitos (34) y (36) de la herramienta, lo que hace que dichos depósitos sean de volumen variable (Fig. 1A).

En consecuencia, la persona del oficio normalmente versada en la materia, incluiría un pistón (38) dispuesto en los depósitos (34) y (36) de la herramienta del documento D2 en

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la herramienta divulgada en el documento D1 para llegar así al objeto de las reivindicaciones 1 y 2 de la solicitud. Por lo cual se considera obvia.

Asimismo, los documentos antecedentes divulgan las características de las reivindicaciones dependientes así:

- Reivindicación 2, 3, 5: un pistón (38) dispuesto en los depósitos (34) y (36) de la herramienta (D2: Fig. 1A).

- Reivindicación 6, 7, 8: El arreglo de mezclado (5) comprende una cámara de pre-mezclado (35) y una cámara de mezclado final (36) (D1: Párr. [0070]). Una cámara de mezclado (64), a la que le sigue un plato de mezclado (64), después del plato hay otra zona de mezclado (66) (D2: Col. 2, líneas 52 a 56).

- Reivindicación 15: Arreglo de válvulas (2) incorporada en una vía de flujo que comprende una sección de extremo de entrada y una sección de salida en comunicación con los pistones (D1: Fig. 2).

- Reivindicación 16: El arreglo de válvula (2) comprende una camisa deslizante (21) y los elementos (23), (27) y (28) (D1: Párrs. [0055] a [0062]).

Las reivindicaciones 2, 3, 5 a 8, 15 y 16 no aportan ningún efecto sorprendente al objeto reclamado por lo que no cumplen con el requisito de nivel inventivo (Art. 18).

De otra parte, las reivindicaciones 4, 9, 10, 11 y 13 ya habían sido afectadas en los numerales 4 y 5 de la presente comunicación.

8. Conclusión

Los requisitos de Patentabilidad de la presente solicitud están afectados así:

Ítem	Documento	Reivindicaciones afectadas	Requisito que afecta
D1	US 2008/0093077	1, 12 2, 3, 5 a 8, 15 y 16	Novedad/Nivel Inventivo Nivel Inventivo
D2	US 5’582.251	12 2, 3, 5 a 8, 15 y 16	Novedad/Nivel Inventivo Nivel Inventivo

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En cumplimiento del artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se le indica que debe dar respuesta dentro del término de sesenta (60) días contados a partir del día siguiente de la fecha de notificación de la presente comunicación. En caso de no dar respuesta al presente requerimiento, o si a pesar de la respuesta subsistieran los impedimentos para la concesión, se denegará la patente.

Se invita al solicitante se sirva indicar, si así lo considera, su renuncia al término faltante de sesenta (60) días para dar respuesta a este requerimiento y presentarla por escrito.

Finalmente, se le recuerda al solicitante que si como respuesta a este requerimiento llegara a modificar el capítulo reivindicatorio y éste contenga más de diez (10) reivindicaciones, no pagará la tasa de modificación voluntaria pero sí la correspondiente al pago por reivindicación adicional.

Notifíquese el presente oficio conforme a lo dispuesto en el numeral 5.2, literal e), del capítulo quinto del título primero de la Circular Única No. 10 de 2001.

JOSÉ LUIS SALAZAR LÓPEZ
Director de Nuevas Creaciones (c)

El anterior requerimiento fue notificado por fijación en lista, de fecha 2015-07-21

Elaboró: Monica Andrea Gutierrez Almonacid
Revisó: Rachid Ponce Vergel

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US 20080093077A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2008/0093077 A1**

Daccord et al. (43) **Pub. Date: Apr. 24, 2008**

(54) **INJECTION APPARATUS FOR INJECTING AN ACTIVATED FLUID INTO A WELL-BORE AND RELATED INJECTION METHOD**

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(21) Appl. No.: **11/576,708**

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(86) PCT No.: **PCT/EP05/11000**

§ 371(c)(1),
(2), (4) Date: **Dec. 13, 2007**

(30) **Foreign Application Priority Data**

Oct. 12, 2004 (EP) 04292412.6

Publication Classification

(51) **Int. Cl.**
E21B 43/00 (2006.01)

(52) **U.S. Cl.** **166/310**; 166/90.1

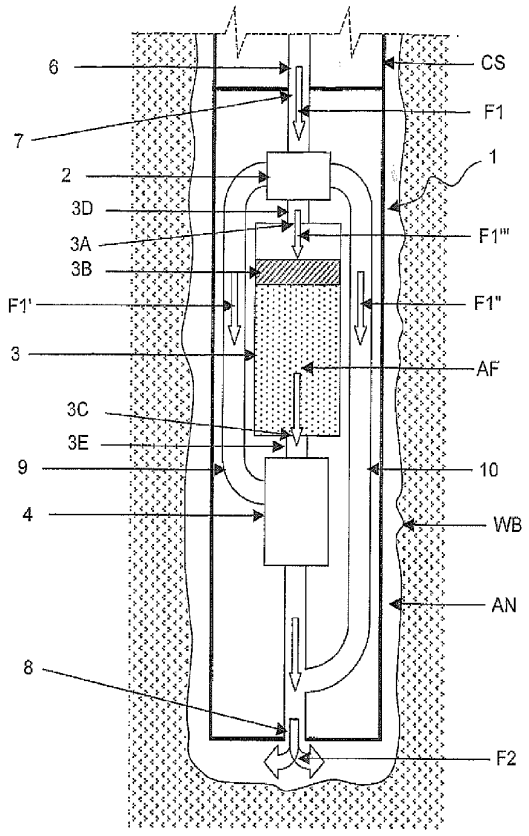
(57) **ABSTRACT**

An injection apparatus for injecting an activated fluid into a well-bore comprises a reservoir **3, 103, 203, 303** containing an activation fluid AF. The injection apparatus further comprises:

- a valve arrangement **2, 102, 202, 302** adapted to be coupled to a pipe **6, 106**, CS1, CS3 for receiving a first fluid F1 flow,
- a dosing and mixing arrangement **4, 104, 204, 304** coupled to the reservoir **3, 103, 203, 303** and to the valve arrangement **2, 102, 202, 302.**

The valve arrangement has a rest configuration in which the injection apparatus provides a non-activated fluid mixture F1"and an activated configuration in which the injection apparatus provides an activated fluid mixture F2.

The dosing and mixing arrangement comprises an engine part **31, 131, 231, 331** mechanically coupled to a pumping part **32, 132, 232, 332**. The engine part runs the pumping part and the pumping part sucks the activation fluid AF of the reservoir when the valve arrangement is in the activated configuration. The dosing and mixing arrangement mixes the activation fluid AF with the first fluid and provides an activated fluid mixture flow F2 at an outlet **8, 108", 208, 308.**



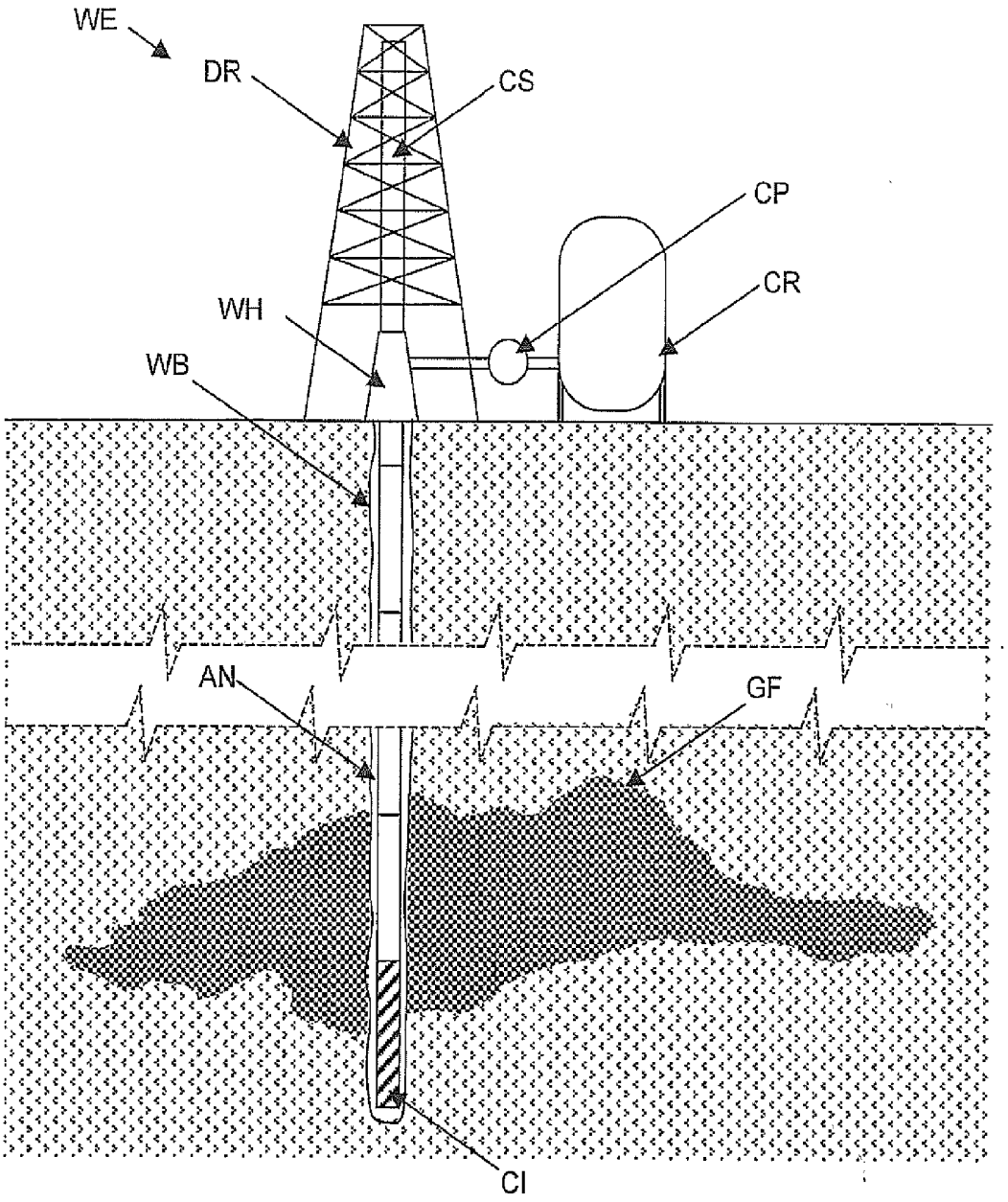


Figure 1

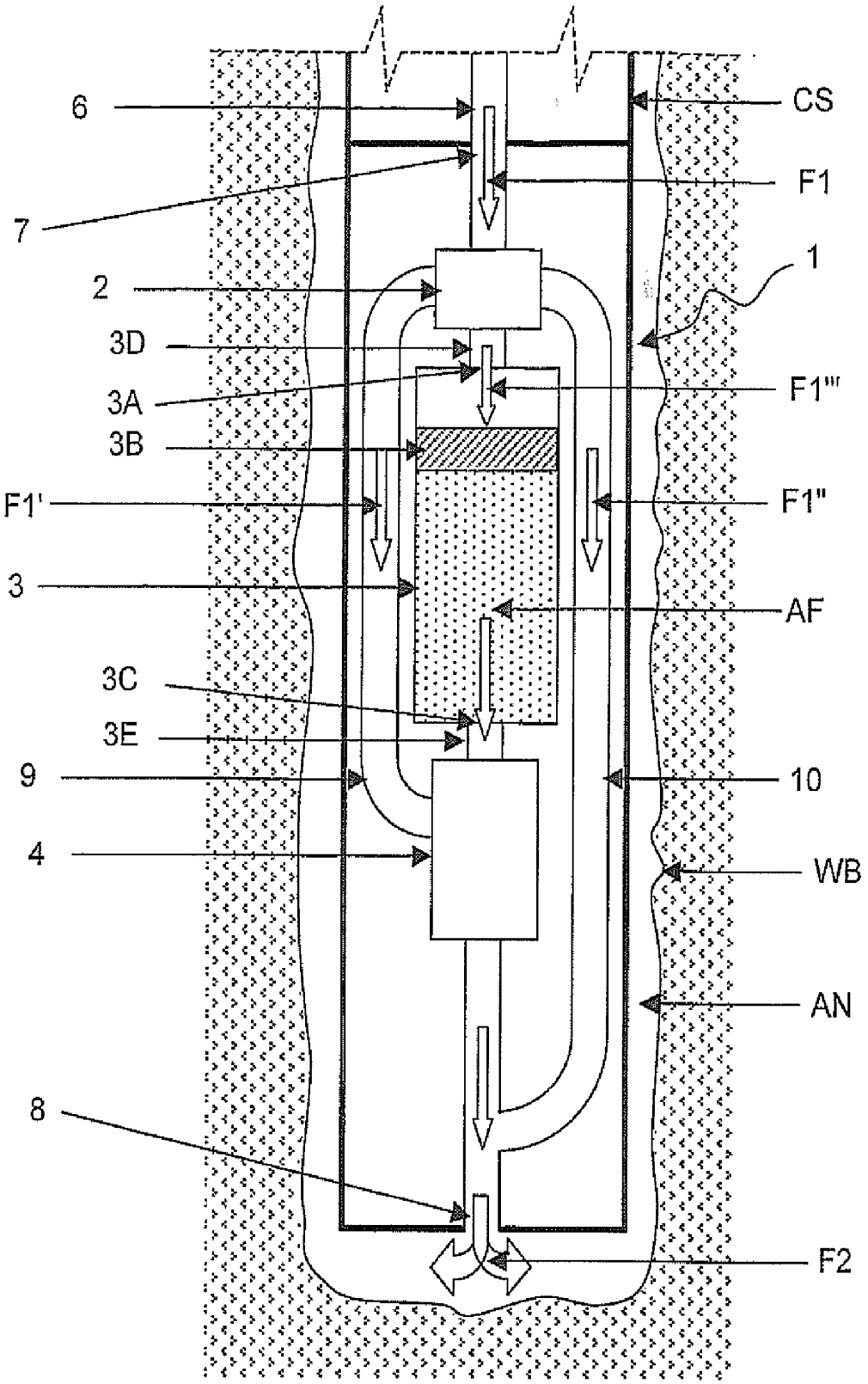


Figure 2

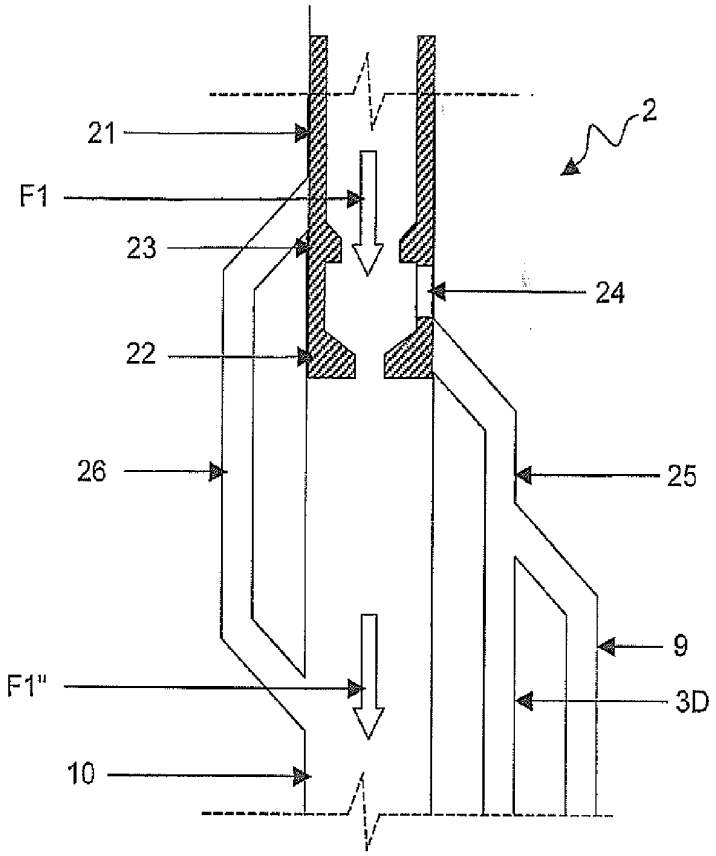


Figure 3.A

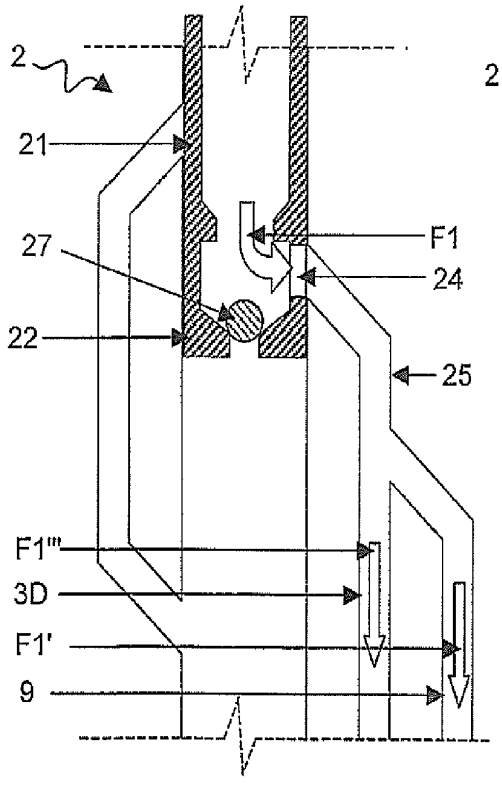


Figure 3.B

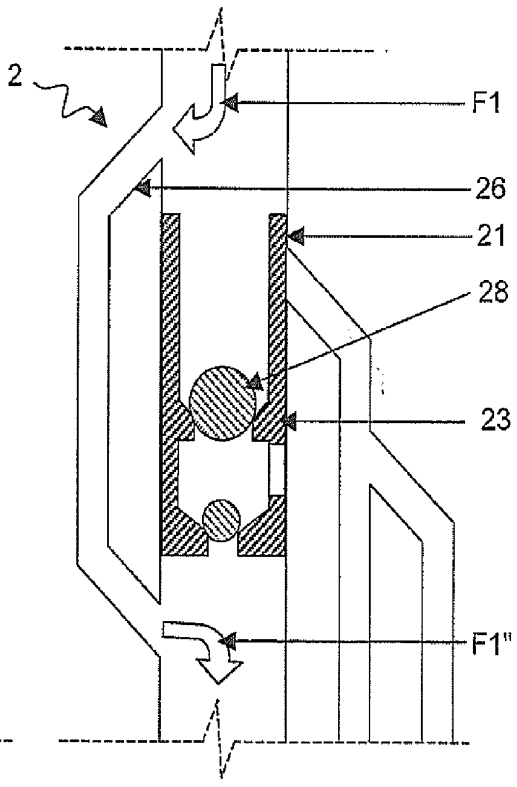


Figure 3.C

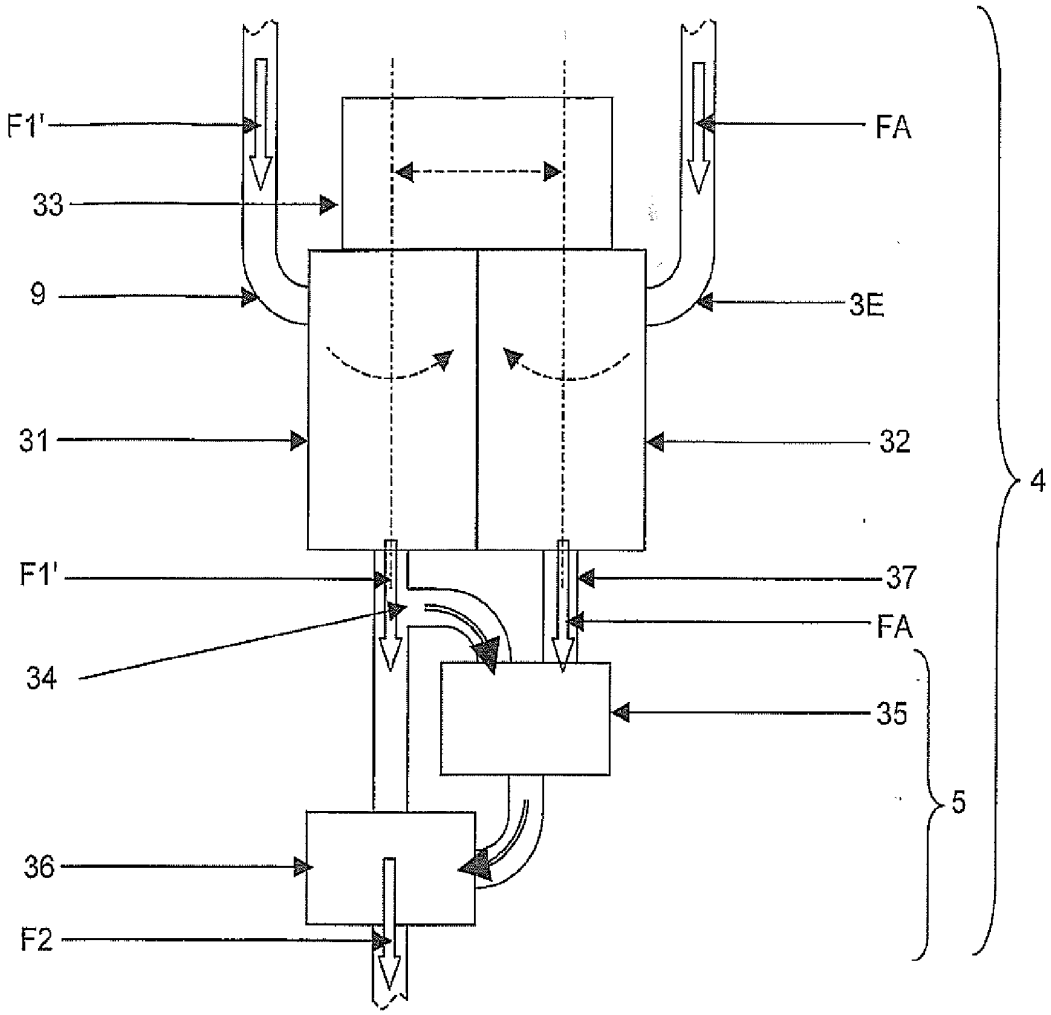


Figure 4.A

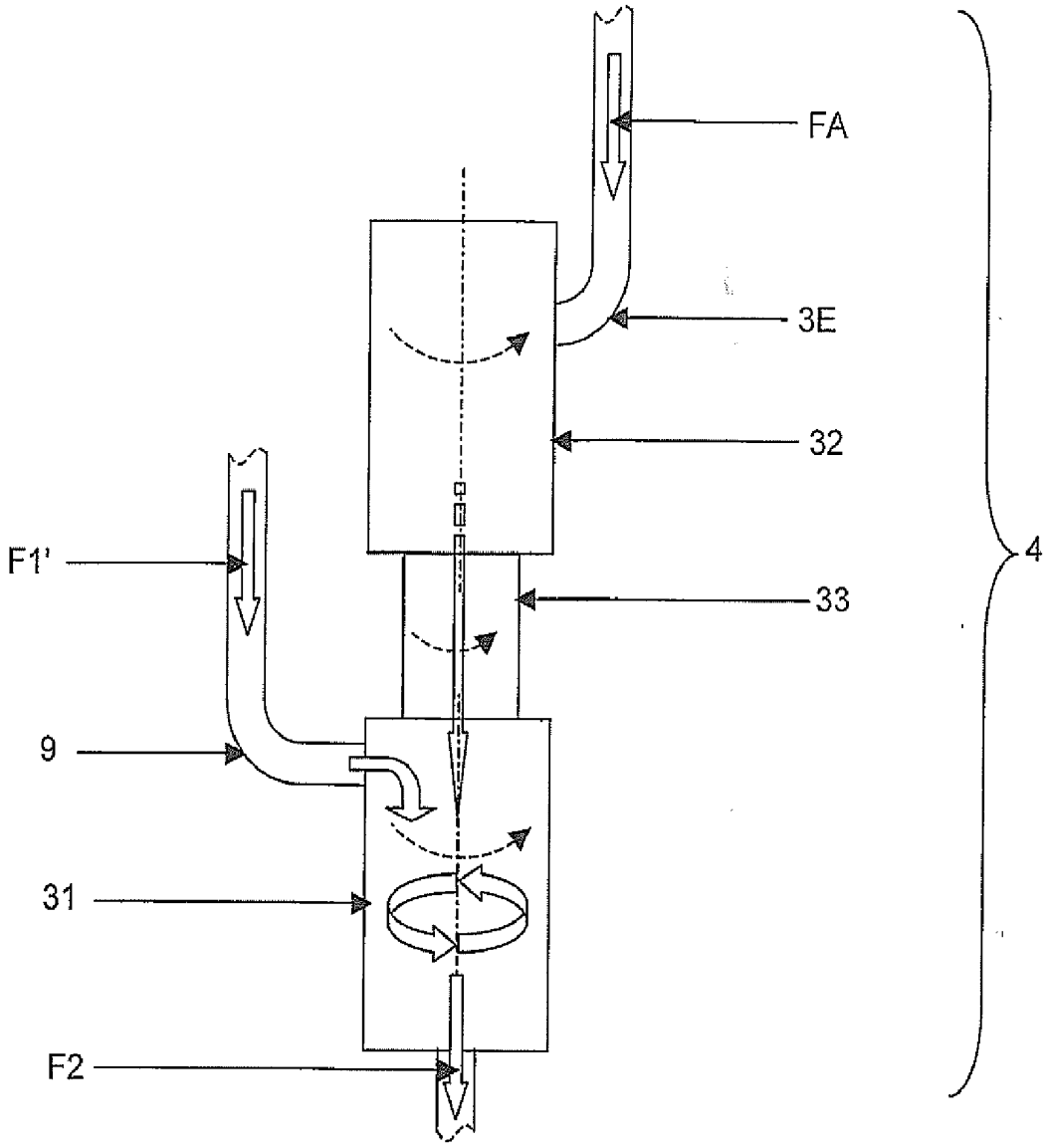


Figure 4.B

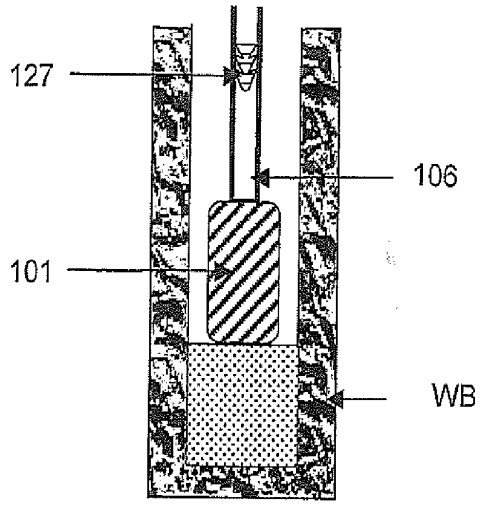


Figure 5.A

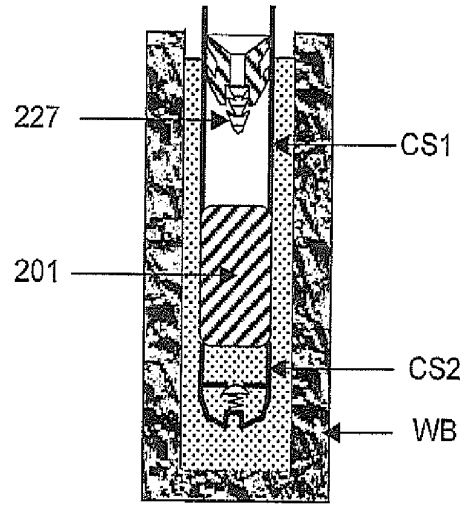


Figure 6.A

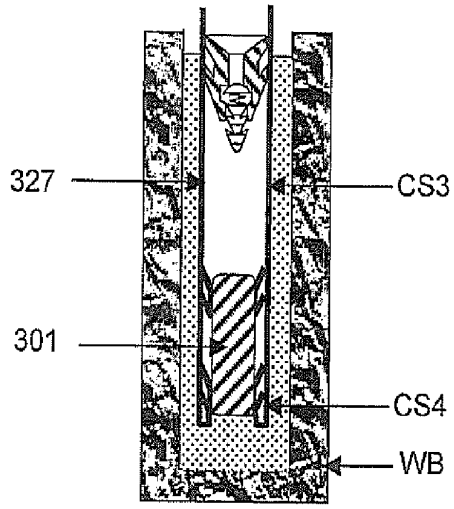


Figure 7.A

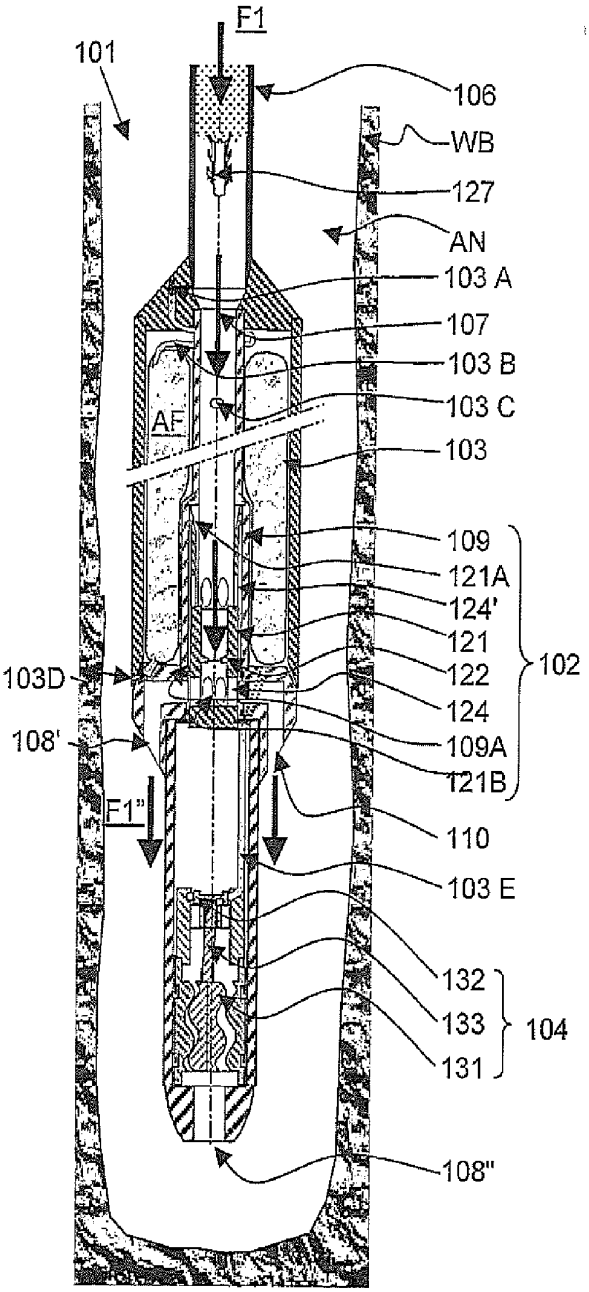


Figure 5.B

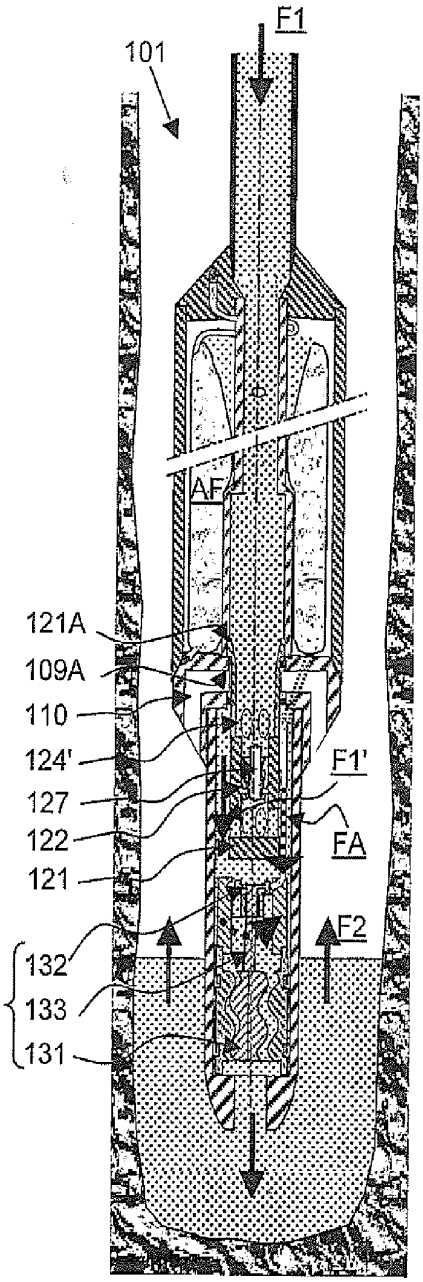


Figure 5.C

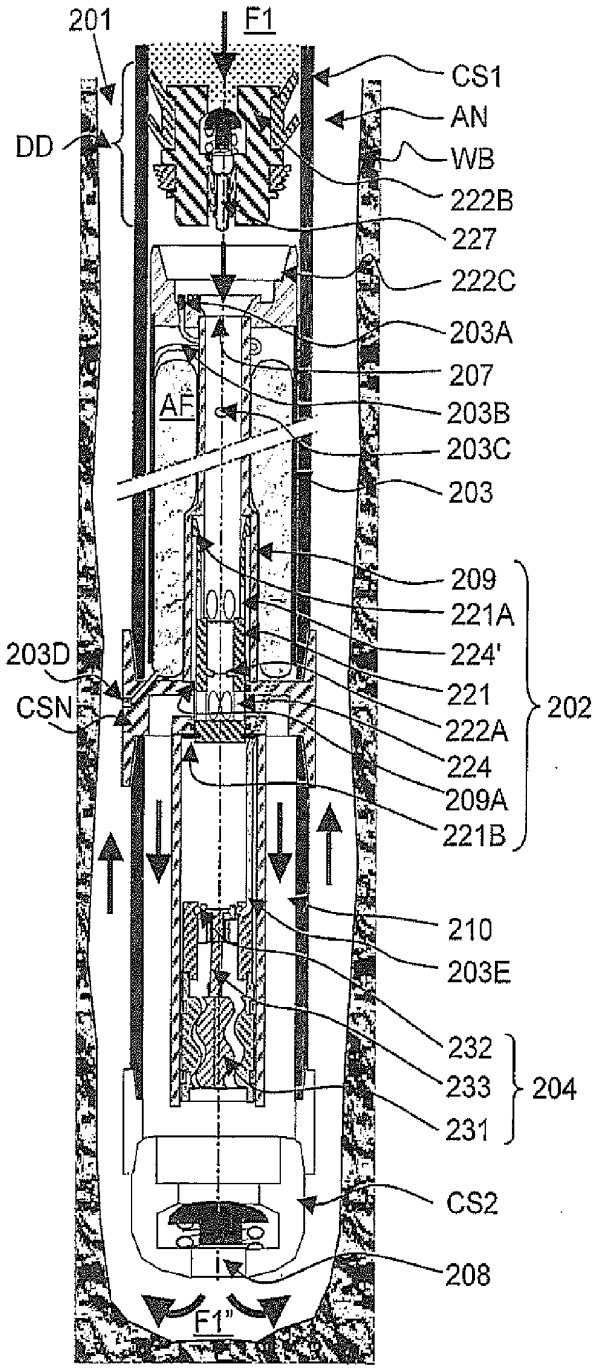


Figure 6.B

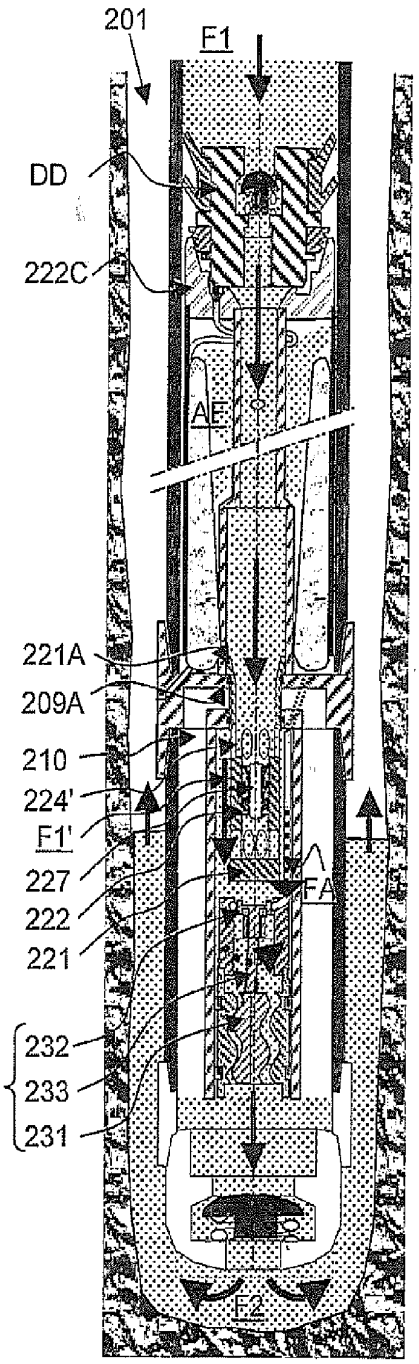


Figure 6.C

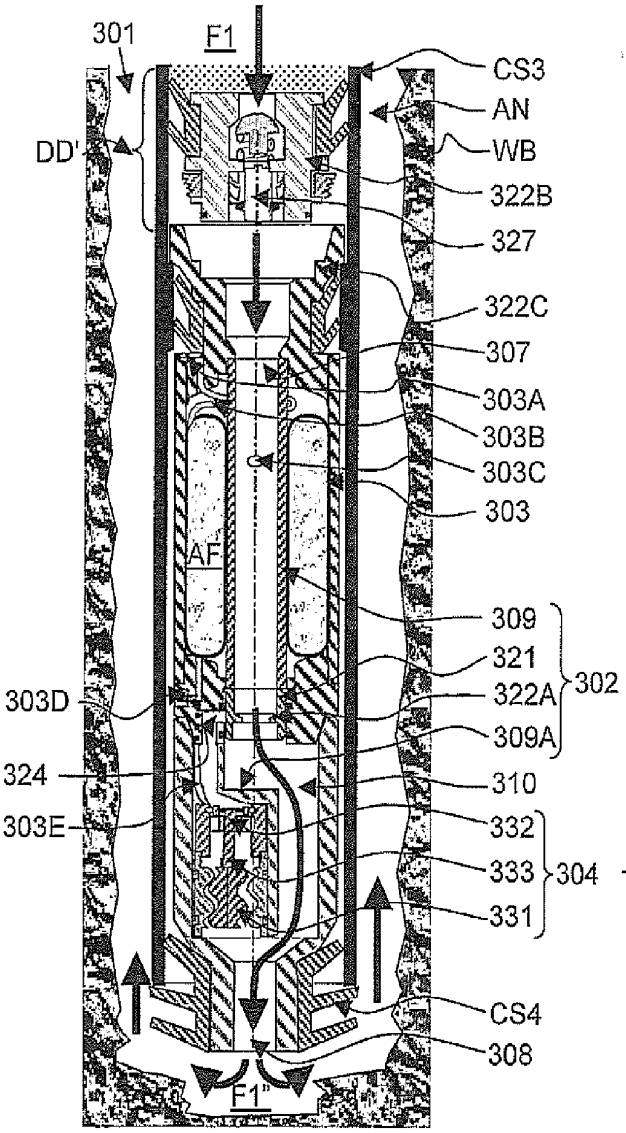


Figure 7.B

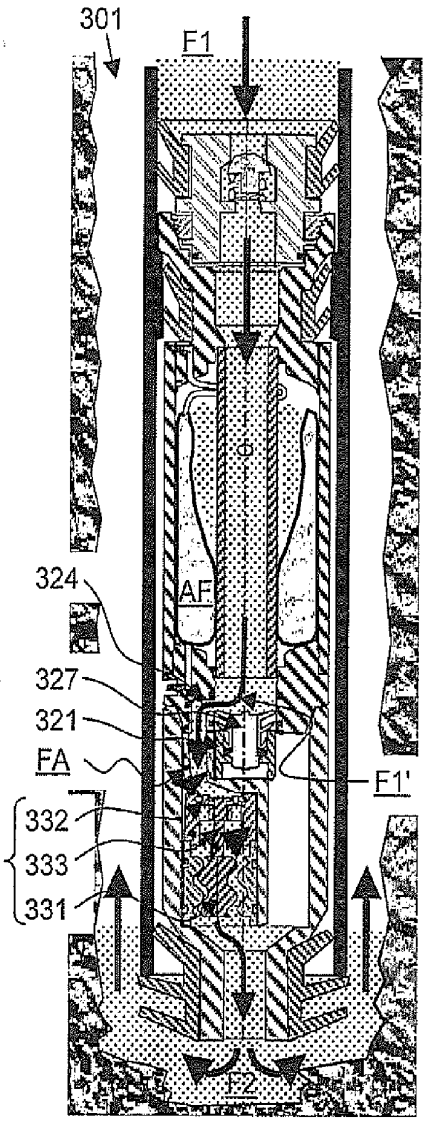


Figure 7.C

INJECTION APPARATUS FOR INJECTING AN ACTIVATED FLUID INTO A WELL-BORE AND RELATED INJECTION METHOD

FIELD OF THE INVENTION

[0001] The invention relates to an injection apparatus for injecting an activated fluid (e.g. an activated chemical fluid mixture) into a well-bore. The invention also relates to an injection method for injecting an activated fluid into a well-bore.

[0002] A particular application of the invention relates to the oilfield industry, for example in cementing operation.

BACKGROUND OF THE INVENTION

[0003] During a hydrocarbon well drilling operation and after a hydrocarbon well has been drilled, various fluid injecting operations are generally carried out. The fluid injecting operations serves various purposes, for example delivering a chemical mixture into a fluid present in the borehole for consolidation purpose or fracturing purpose, or delivering a chemical mixture into a cement slurry for borehole cementing operation. These operations are well known in the oilfield industry and are described for example in U.S. Pat. No. 3,273,647, U.S. Pat. No. 4,415,269 and patent application EP 1223303. FIG. **1** schematically shows a typical onshore hydrocarbon well location and equipments WE above a hydrocarbon geological formation GF after drilling operation has been carried out and after a casing string CS has been run. At this stage, the well-bore WB is a bore-hole generally filled with various fluid mixtures (e.g. the drilling mud or the like). The equipment WE comprises a drilling rig DR for running the casing string CS in the bore-hole, cementing equipment comprising cement silo CR and pumping arrangement CP, and a well head and stuffing box arrangement WH providing a sealing for deploying the casing string CS or pumping down the cement into the generally pressurized well-bore WB.

[0004] Subsequently, cementing operations are generally undertaken to seal the annulus AN (i.e. the space between the well-bore WB and the casing CS where fluid can flow). A first application is primary cementing which purpose is to achieve hydraulic isolation around the casing. Other applications are remedial cementing which purposes are to stabilize the well-bore, to seal a lost circulation zone, to set a plug in an existing well or to plug a well so that it may be abandoned. The cement may be pumped into the well casing through a casing shoe CI near the bottom of the bore-hole or a cementing valve installed in the casing so that the cement is positioned in the desired zone.

[0005] Cementing engineers prepare the cementing operations by determining the volume and physical properties of cement slurry and other fluids pumped before and after the cement slurry. In many situations, chemical additives are mixed with the cement slurry in order to modify the characteristics of the slurry or set cement. Cement additives may be broadly categorized as accelerators (i.e. for reducing the time required for the set cement to develop sufficient compressive strength to enable further operations to be carried out), retarders (i.e. for increasing the thickening time of cement slurries to enable proper placement), dispersants (i.e. for reducing the cement slurry viscosity to improve fluid-flow characteristics), extenders (i.e. for decreasing the density or increasing the yield of a cement slurry), weighting agents (i.e. for increasing or lightening the slurry weight), fluid-loss or lost-circulation additives (i.e. for controlling the loss of fluid to the formation through filtration) and special additives designed for specific operating conditions.

[0006] Because cement additives have an effect as soon as they are mixed with the cement slurry, it is important that cement additives are injected in the cement slurry at the proper time and at the desired location in the well-bore.

[0007] Apparatus for injecting cement additives are known. For example, U.S. Pat. No. 5,533,570 discloses an apparatus for injecting a fluid into a well-bore. This apparatus comprises a fluid holding chamber that is pumped down the well-bore, and a valve means for opening a port of the chamber and delivering the fluid at a desired time and location (for example through an opening of the casing shoe). However, this apparatus does not include an efficient additive dosing system. Further, the apparatus is non-retrievable.

SUMMARY OF THE INVENTION

[0008] One goal of the invention is to propose an apparatus for injecting an activated chemical fluid mixture into a well-bore that overcome at least one of the shortcomings of prior art apparatus.

[0009] According to the invention, the apparatus for injecting an activated chemical fluid mixture into a well-bore comprises a valve arrangement, an activation fluid reservoir and a dosing and mixing arrangement coupled to each other. The valve arrangement can be remotely activated from the surface. The apparatus is coupled to a standard drill-pipe string or a casing string in order to receive a flow of a first fluid and activation commands for the valve arrangement. The valve arrangement activates and controls the dosing and mixing arrangement so as to inject a determined quantity of activation fluid into the first fluid. The apparatus can be coupled to any casing, cementing or drilling equipments, and provides to these equipments a flow of a second fluid that may be constituted of an activated chemical fluid mixture.

[0010] More precisely, the present invention relates to an injection apparatus for injecting an activated fluid into a well-bore comprising a reservoir containing an activation fluid AF. The injection apparatus further comprises:

[0011] a valve arrangement adapted to be coupled to a pipe (drill-stem or casing string) for receiving a first fluid flow,

[0012] a dosing and mixing arrangement coupled to the reservoir and to the valve arrangement.

[0013] The valve arrangement has a rest configuration in which the injection apparatus provides a non-activated fluid mixture and an activated configuration in which the injection apparatus provides an activated fluid mixture.

[0014] The dosing and mixing arrangement comprises an engine part mechanically coupled to a pumping part. The engine part runs the pumping part and the pumping part sucks the activation fluid of the reservoir when the valve arrangement is in the activated configuration. The dosing and mixing arrangement mixes the activation fluid with the first fluid and provides an activated fluid mixture flow at an outlet.

[0015] Advantageously, the injection apparatus further comprises a pressure adjusting arrangement for adjusting the pressure inside the reservoir to the pressure inside the pipe (a reservoir comprising a piston or a reservoir comprising an equalization port).

[0016] Advantageously, the valve arrangement comprises a sliding sleeve having a first dart catcher for remotely activating the valve arrangement from the rest configuration to the activated configuration.

[0017] Other characteristics of the injection apparatus will be further described in the detailed description herein below.

[0018] The apparatus for injecting an activated chemical fluid mixture into a well-bore of the invention is adapted to be connected to a drill-string or a casing string. The apparatus is fully retrievable: it can be removed from the well-bore when operations are completed and re-used for subsequent operations. Alternatively, it can be drilled if rig-time needs to be saved. It enables a truly proportional dosing of an activation fluid into a fluid to be activated. Finally, it can be remotely controlled.

[0019] Consequently, the apparatus of the invention is flexible, cheap and efficient to use in various oilfield industry oriented applications.

[0020] In particular, the apparatus can be used in casing stab-in situation (i.e. injecting a chemical activator into a cement slurry directly at the casing shoe), in drilling situation (i.e. injecting a chemical activator into a reactive fluid pumped through the drill-string) for well-bore walls or plugs voids consolidation, in cement plug situation (i.e. injecting a chemical activator into a fluid for temporary of permanent sealing inside the well-bore), in casing-drilling situation, or in coiled-tubing operation (i.e. injecting a chemical activator into the main fluid for coiled tubing fracturing or remedial cementing).

[0021] The invention also relates to an injection method for injecting an activated fluid into a well-bore. The method comprises the steps of:

[0022] running the injection apparatus of the invention at a proper location in the well-bore, the valve arrangement being in a rest configuration,

[0023] letting flow a first fluid through the apparatus into the well-bore,

[0024] activating the valve arrangement of the injection apparatus in an activated configuration in which a first portion of the first fluid activates a pumping part sucking the activation fluid of the reservoir,

[0025] mixing the sucked activation fluid with the first portion of the first fluid, and

[0026] injecting an activated fluid mixture flow at an outlet.

[0027] Optionally, the method further comprises the steps of activating the valve arrangement of the injection apparatus in a by-pass position in which a second portion of the first fluid flows directly to the outlet (non activated fluid flow). Advantageously, the activating steps are remotely controlled from a surface equipment.

[0028] Thus, the invention provides an efficient apparatus and method which can be run at a desired location in a well-bore and remotely activated at a particular moment for injecting an additive contained in a reservoir into the well-bore.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The present invention is illustrated by way of example and not limited to the accompanying figures, in which like references indicate similar elements:

[0030] FIG. **1** schematically shows a typical onshore hydrocarbon well location and equipments;

[0031] FIG. **2** schematically illustrates an apparatus for injecting a chemical fluid mixture into a well-bore according to the invention;

[0032] FIGS. **3**.A, **3**.B and **3**.C schematically illustrate the valve arrangement of the apparatus of FIG. **2** and its various positions during operation;

[0033] FIG. **4**.A schematically illustrates a first embodiment of the dosing and mixing arrangement of the apparatus of FIG. **2**;

[0034] FIG. **4**.B schematically illustrates a second embodiment of the dosing and mixing arrangement of the apparatus of FIG. **2**;

[0035] FIG. **5**.A schematically illustrates a first application of the invention;

[0036] FIGS. **5**.B and **5**.C are detailed cross-section views of the first application of FIG. **5**.A;

[0037] FIG. **6**.A schematically illustrates a second application of the invention;

[0038] FIGS. **6**.B and **6**.C are detailed cross-section views of the second application of FIG. **6**.A;

[0039] FIG. **7**.A schematically illustrates a third application of the invention; and

[0040] FIGS. **7**.B and **7**.C are detailed cross-section views of the third application of FIG. **7**.A.

DETAILED DESCRIPTION OF THE INVENTION

[0041] FIG. **1** was already described in relation with the background of the invention.

[0042] FIG. **2** schematically illustrates an apparatus **1** for injecting an activated chemical fluid mixture into a well-bore.

[0043] The apparatus **1** for injecting a chemical fluid mixture is fitted into the casing CS. The apparatus is coupled by its upper part to a standard drill-pipe string **6**. The apparatus is coupled by its lower part to any equipment such as a standard float equipment of a stab-in casing, a casing drilling or casing shoe, or left as such for other drilling or cementing applications. The apparatus receives through an inlet **7** a flow of a first fluid F**1** from the drill-pipe string **6** and provides through an outlet **8** a flow of a second fluid F**2**.

[0044] The apparatus **1** for injecting a chemical fluid mixture comprises a valve arrangement **2**, a reservoir **3**, a dosing and mixing arrangement **4** and shunt tubes **9**, **10**.

[0045] The valve arrangement **2** is coupled to the drill-pipe string **6** or directly to a casing element of the casing

string and receives the flow of the first fluid F1. The valve arrangement is also coupled to the reservoir 3 through a first reservoir conduit 3D and to the dosing and mixing arrangement 4 through a first shunt tube 9. The valve arrangement may also be coupled directly after the mixing arrangement 5 through a second shunt tube 10. The valve arrangement can be remotely activated (i.e. opening or closing of valves and ports) from the surface. Depending on the configuration of the valve arrangement 2, the fluid F1 may be divided into a first portion F1' flowing through the shunt tube 9, or a second portion F1" flowing through the second shunt tube 10 and a third portion F1"' flowing though the reservoir conduit 3D.

[0046] The reservoir 3 contains an activation fluid AF. The activation fluid may be pressurized by means of a piston 3B when submitted to the pressure of the third flow portion F1"' flowing through the conduit 3D to an upper port 3A into an upper part of the reservoir. The activation fluid AF may flow through a lower port 3C and a second reservoir conduit 3E into the dosing and mixing arrangement 4. The piston 3B also acts as a mechanical plug separating the activation fluid AF from the third fluid portion F1"'. The reservoir has for example a cylindrical shape and the piston is a plug similar to the standard plugs used in primary cementing. The reservoir volume (diameter, length) can be very easily adapted to each situation of use of the apparatus, namely quantity of activation fluid to be injected or available place within the casing string, etc. . . .

[0047] Alternatively, the conduit 3D, the upper port 3A and the piston 3B may be replaced by an equalization port for automatically adjusting the pressure inside the reservoir 3 to the pressure inside the drill-pipe or the casing string. In this case, the reservoir may be a rubber bladder. The bladder membrane submitted to the tubing pressure through the equalization port plays the role of the piston relatively to the activation fluid.

[0048] The dosing and mixing arrangement 4 is coupled to the first shunt tube 9. It is also coupled to the lower port 3C of the reservoir by the conduit 3E and may receive a portion of the activation fluid AF contained in the reservoir. The dosing and mixing arrangement determines the ratio of activation fluid AF injected into the first fluid flow F1 (in fact into the first portion F1' of the first fluid flow).

[0049] The dosing and mixing arrangement 4 provides the second fluid flow F2 to the outlet 8. It insures a proper mixing of the injected activation fluid AF with the first portion F1' of the first fluid flow.

[0050] Alternatively, a complementary mixing arrangement may be coupled downstream to the dosing and mixing arrangement.

[0051] The second shunt tube 10 couples the valve arrangement directly to the outlet 8. It acts as a side conduit for providing, at the outlet 8, a second portion F1" of the first fluid flow that does not need to be activated by the activation fluid. In this case, the second fluid F2 flowing through the outlet 8 is chemically identical to the first fluid F1 flowing through the inlet 7.

[0052] The first and second shunt tubes 9, 10 are conduits by-passing the reservoir 3 and attached to its periphery. The shunt tubes can be designed with various diameters and lengths adapted to the various specific use of the apparatus.

[0053] The operation principle of the apparatus 1 for injecting an activated fluid mixture into a well-bore will be explained herein below in relation with FIGS. 3 and 4.

[0054] FIGS. 3.A, 3.B and 3.C schematically illustrate the valve arrangement 2 and its various positions during operation.

[0055] The valve arrangement 2 comprises a sliding sleeve 21. The sliding sleeve 21 is hollow so as to let flow the first fluid F1. It also comprises a side opening 24 for letting flow a portion of the first fluid F1. The sliding sleeve comprises a first dart catcher 22 and optionally a second dart catcher 23. The dart catcher can be remotely activated by a dart sent from the surface in the first fluid F1 through the drill-pipe string 6 or the casing string CS. This activation of the dart catcher determines different operating configuration or position of the valve arrangement.

[0056] The valve arrangement 2 comprises a first side conduit 25 connected to the first reservoir conduit 3D and the first shunt tube 9, and optionally a second side conduit 26.

[0057] According to another embodiment, the second shunt tube is omitted. This embodiment is advantageous when the apparatus does not need to be fastened to a casing shoe.

[0058] FIG. 3.A shows the valve arrangement 2 in a first configuration (rest configuration) before activation of the first dart catcher 22 by a first dart. In this configuration, the sliding sleeve closes the first 25 and second 26 side conduits, and the first fluid flows though the hollow sliding sleeve directly into the second shunt tube 10 as fluid flow F1".

[0059] FIG. 3.B shows the valve arrangement 2 in a second configuration (activated configuration) after activation of the first dart catcher 22 by a first dart 27. In this configuration, the sliding sleeve 21 opens the side opening 24 and the dart closes one end of the sliding sleeve so that the flow of the first fluid F1 is mainly diverted through the side opening 24 into the first side conduit 25. Subsequently, the first fluid flow F1 splits as a third portion F1"' flowing into the reservoir conduit 3D and a first portion F1' flowing into the first shunt tube 9. The third portion F1"' flowing into the reservoir conduit 3D pressurizes the reservoir 3 by acting on the piston 3B (see FIG. 2).

[0060] The first portion F1' flowing into the first shunt tube 9 activates the dosing and mixing arrangement 4 as it will be further described herein below.

[0061] FIG. 3.C shows the valve arrangement 2 in an optional third configuration (by-pass configuration) after activation of the second dart catcher 23 by a second dart 28. In this configuration, the sliding sleeve 21 opens the second side conduit 26 and closes the side opening 24 so that the first fluid F1 is mainly diverted through the second side conduit 26. The first fluid flows directly into the second shunt tube 10 as fluid flow F1" which corresponds to a non-activated fluid chemically identical to the first fluid F1.

[0062] The first and second darts and the corresponding dart catchers are sized so that the first dart activates the first dart catcher and cannot activate the second dart catcher. The first and second darts of the above described embodiment are of spherical shape. However, it will appear obvious for a man skilled in the art that others kinds of shape are

possible, and that others kinds of catcher (e.g. plug catcher) can also achieve the same remote activation function (e.g. see the application examples hereinafter).

[0063] FIGS. **4**.A and **4**.B schematically show the dosing and mixing arrangement **4** according to a first and a second embodiment respectively.

[0064] The dosing and mixing arrangement **4** comprises an engine part **31**, a pumping part **32** and a gearing part **33**.

[0065] The engine part **31** is coupled to the valve arrangement by the first shunt tube **9**. The pumping part **32** is coupled to the reservoir by the second reservoir conduit **3**E. When the valve arrangement is in the activated configuration, the flow of the first portion F**1**' of the first fluid activates the engine part **31**. The engine part **31** produces a mechanical movement that activates the pumping part **32** through the gearing part **33** (schematically illustrated by the dotted lines). When activated, the pumping part **32** sucks the activation fluid FA from the reservoir (that may be pressurized by the third portion F**1**'" of the first fluid flow). The gearing part **33** allows selecting the volume ratio of the two flows, namely the activation fluid FA and the first portion F**1**' of the first fluid.

[0066] Advantageously, the engine part and the pumping part are progressive cavity or helical rotor type pumps. These types of pump are also known as Moineau pump and consists of a helical rotor which rotates inside a helical stator. The geometry and dimensions of the rotor and stator are designed so that a double string of sealed cavities are formed when the rotor turns into the stator. The cavities progress axially from the suction to the discharge port of the pump, thus carrying the fluid. The rotation rate of the rotor is proportional to the fluid flow rate.

[0067] Alternatively, the pumping part may also form a peristaltic pump, the pumping part being coupled to a simple flexible tube compressed and released by the movement of the pumping part run by the engine part.

[0068] According to the first embodiment shown in FIG. **4**.A, the dosing and mixing arrangement **4** further comprises a complementary mixing arrangement **5**.

[0069] The first portion F1' of the first fluid flows out of the engine part **31**, while the activation fluid FA flows out of the pumping part **32**.

[0070] The complementary mixing arrangement **5** comprises a flow splitter **34**, a pre-mixing chamber **35** and a final-mixing chamber **36**. The mixing arrangement insures a proper mixing of the first fluid flowing out of the engine part with the activation fluid FA flowing out of the pumping part.

[0071] The first portion F**1**' flows through the flow splitter **34**. The flow splitter **34** is coupled to an inlet of the pre-mixing chamber **35** and to an inlet of the final-mixing chamber **36**.

[0072] The pre-mixing chamber **35** is also coupled to the pumping part through an injecting conduit **37**. It insures a first mixing of the split portion F**1**' of the first fluid with the activation fluid FA. For improving the mixing process, the injecting conduit may be a Venturi tube producing a jet of activation fluid in the pre-mixing chamber.

[0073] The final mixing chamber **36** is also coupled to outlet of the pre-mixing chamber. It insures a second mixing of the other split portion F**1**' of the first fluid with the pre-mixed fluid mixture. The outlet of the final mixing chamber delivers a second fluid flow F**2**, namely an activated fluid mixture.

[0074] The final mixing chamber outlet may include a float valve, preventing any back flow from the well-bore.

[0075] According to the second embodiment shown in FIG. **4**.B, the engine part **31** is positioned downstream of the pumping part **32**. The activation fluid flows FA into the engine part **31** by its superior part. Thus, the movement of the engine part insures a proper mixing of the fluid to be activated F**1**' with the activation fluid flow FA. In this embodiment, the complementary mixing arrangement is not necessary as mixing already occurred properly in the dosing and mixing arrangement **4**.

[0076] Three different applications will be described hereinafter in relation with FIGS. **5**, **6** and **7**.

[0077] FIGS. **5**.A, **5**.B and **5**.C relate to a first application of the invention corresponding to a cement plug located in a lost circulation zone (i.e. the activation fluid is used so that the fluid injected into the annulus can become thick enough, or the cement setting time can be shortened to limit losses). The injecting apparatus **101** is run at the bottom of the drill stem **106**. It is activated by a dart **127** sent from the surface into the drill stem. The injecting apparatus **101** can be retrieved at the end of the injection operation.

[0078] FIGS. **5**.B and **5**.C shows a detailed cross-section view of the injecting apparatus **101** in a rest configuration and in an activated configuration respectively.

[0079] The injecting apparatus **101** comprises a valve arrangement **102**, a reservoir **103** and a dosing and mixing arrangement **104**. The injecting apparatus **101** is installed inside a standard casing or a special housing. The length of the injecting apparatus should be almost the same as a casing length.

[0080] The valve arrangement **102** comprises a mandrel **109** and a sliding sleeve **121**.

[0081] The mandrel **109** is a tube having substantially the same diameter or less than the drill stem **106**. It is coupled by a top part to the drill stem and receives through the inlet **107** the fluid flowing through the drill stem. It is coupled by a bottom part to at least one shunt tube **110**. The bottom part also comprises an abutment **109**A. The sliding sleeve **121** is guided within the mandrel.

[0082] The sliding sleeve **121** comprises a dart catcher **122**, first **124** and second **124**' openings and a top part **121**A.

[0083] The valve arrangement can be in a rest configuration (FIG. **5**.B) or in an activated configuration (FIG. **5**.C).

[0084] In the rest configuration, the first openings **124** enable the fluid flowing into the mandrel to be diverted into the shunt tube **110**. The sliding sleeve **121** can be maintained in the rest position by, for example, a pin mechanism **121**B.

[0085] In the activated configuration, the second openings **124**' enable the fluid flowing into the mandrel to be diverted into the dosing and mixing arrangement **104**. The sliding sleeve **121** can be maintained in the activated configuration when, for example, the top part **121**A is in contact with the abutment **109**A.

[0086] The dart catcher **122** enables to activate the valve arrangement from the rest configuration to the activated configuration.

[0087] The reservoir **103** is an annular bladder. The annular bladder is installed around the mandrel **109**.

[0088] The top extremity of the bladder comprises a filling hose **103**B closed by a top plug **103**A. The bottom extremity of the bladder comprises an evacuation hose closed by a bottom plug **103**D. The extremities of these hoses are secured in the injecting apparatus near both extremities of the mandrel. The plugs can be removed to fill or flush the reservoir. The top plug **103**A or the bottom plug **103**D may be equipped with a relief valve for automatically venting the air trapped in the bladder.

[0089] The reservoir **103** is connected to the dosing and mixing arrangement **104** by a reservoir conduit **103**E.

[0090] The pressure of the reservoir **103** is automatically adjusted to the pressure inside the drilling stem (hydrostatic pressure plus surface pressure) and/or in the mandrel by means of at least one equalization port **103**C drilled in the mandrel **109**. The equalization port **103**C operates as follows: the fluid in the mandrel penetrates in the equalization port and exerts its pressure onto the reservoir, thus pressurizing the reservoir. When the reservoir is an annular bladder, it is deformed until the pressures outside and inside the reservoir are equilibrated.

[0091] The dosing and mixing arrangement **104** comprises an engine part **131** mechanically coupled to a pumping part **132**. Advantageously, the engine part **131** is a progressive cavity or helical rotor type pump and the pumping part **132** is a peristaltic pump. The progressive cavity pump is coupled to the peristaltic pump by a driving shaft **133**. The end of the reservoir conduit **103**E is a flexible tube coupled to the peristaltic pump. The engine part **131** namely the progressive cavity pump is driven by any fluid flowing through it. When a fluid flows through the engine part **131**, it makes the pumping part **132** namely the peristaltic pump to rotate. The rotation of the peristaltic pump alternatively compresses and releases the flexible tube of the reservoir conduit **103**E, thus sucking the activation fluid AF out of the reservoir.

[0092] The engine part **131** is positioned downstream of the pumping part **132** in order to ensure a better mixing of the fluid to be activated and the activation fluid.

[0093] The peristaltic pump is well adapted as long as the required activation fluid injection rate is a few percents of the main flow rate.

[0094] The activated fluid is injected into the well-bore through the outlet **108**" downstream of the engine part **131**.

[0095] The injecting apparatus **101** for the first application operates as follows.

[0096] In the rest configuration shown in FIG. **5**.B, the injecting apparatus **101** can be used to deliver a non activated fluid F**1**" into the well-bore. The sliding sleeve **121** of the valve arrangement **102** is positioned into the mandrel **109** so that the fluid flowing into the mandrel is diverted through the first openings **124** into the shunt tube **110** towards the shunt tube outlet **108**'.

[0097] In order to activate the valve arrangement, a dart **127** is launched from the surface and transported by the fluid that is to be activated.

[0098] In the activated configuration shown in FIG. **5**.C, the injecting apparatus **101** is used to deliver an activated fluid F**2** into the well-bore.

[0099] The dart catcher **122** of the sliding sleeve receives the dart transported by the fluid. The dart catcher **122** is for example a particular profile of the sliding sleeve (narrow area) for stopping and sealing the dart **127**. When the dart lands in the dart catcher, the sliding sleeve acts as a plug and blocks the fluid flow. Consequently, the upstream pressure rises, thus creating a downward load that moves the sleeve in the activated configuration. When the sliding sleeve is maintained in the rest configuration by a pin mechanism, the downward load shears the pins **121**B and releases the sliding sleeve. The sliding sleeve **121** slides downward in the mandrel and the top part **121** A of the sliding sleeve bumps into the abutment **109**A of the mandrel.

[0100] In this configuration, the sliding sleeve **121** simultaneously closes the shunt tube **110** and diverts the flow through the second opening **124**' towards the engine part **131**. The engine part **131** begins to rotate and makes the pumping part **132** to rotate, thus sucking the activation fluid AF out of the reservoir **103**.

[0101] The activation fluid flow FA and the fluid flow F**1**' to be activated mixes together downstream of the pumping part **132** (i.e. in the engine part **132**). An activated fluid flow F**2** is delivered in the annulus AN of the well-bore WB.

[0102] FIGS. **6**.A, **6**.B, **6**.C relate to a second application corresponding to a casing cementation (i.e. the activation fluid is used so that the cement setting time can be shortened to save rig time). The injecting apparatus **201** is incorporated between the two casing elements CS**1**, CS**2**. It is activated by a dart **227** sent from the surface through the casing. The injecting apparatus **201** may be drilled out at the end of the cementing operation.

[0103] FIGS. **6**.B and **6**.C shows a detailed cross-section view of the injecting apparatus **201** in a rest configuration and in an activated configuration respectively.

[0104] The injecting apparatus **201** comprises a valve arrangement **202**, a reservoir **203** and a dosing and mixing arrangement **204**. The injecting apparatus **201** is installed inside two standard casings between casing element CS**1** and CS**2** by means of a nipple CSN. The casing element CS**2** may be a casing shoe.

[0105] The valve arrangement **202** comprises a mandrel **209** and a sliding sleeve **221**.

[0106] The mandrel **209** is a tube having an inferior diameter than the casing CS**1**, CS**2** diameter. It receives the fluid flowing through the casing. Because of the significant difference between the casing internal diameter and the mandrel inside diameter, a double dart assembly DD is used for the activation operation. The mandrel **209** is coupled by a top part to a superior dart catcher **222**C having a size substantially corresponding to the internal size of the casing. The superior dart catcher **222**C is adapted to receive the double dart assembly DD transported by the fluid. The mandrel **209** is coupled by a bottom part to at least one shunt

tube **210**. The bottom part also comprises an abutment **209**A. The sliding sleeve **221** is guided within the mandrel.

[**0107**] The sliding sleeve **221** comprises a inferior dart catcher **222**A, first **224** and second **224'** openings and a top part **221**A.

[**0108**] The valve arrangement can be in a rest configuration (FIG. **6**.B) or in an activated configuration (FIG. **6**.C).

[**0109**] In the rest configuration, the first openings **224** enable the fluid flowing into the mandrel to be diverted into the shunt tube **210**. The sliding sleeve **221** can be maintained in the rest configuration by, for example, a pin mechanism **221**B.

[**0110**] In the activated configuration, the second openings **224'** enable the fluid flowing into the mandrel to be diverted into the dosing and mixing arrangement **204**. The sliding sleeve **221** can be maintained in the activated configuration when, for example, the top part **221**A is in contact with the abutment **209**A.

[**0111**] The inferior dart catcher **222**A enables to activate the valve arrangement from the rest configuration to the activated configuration.

[**0112**] The reservoir **203** is an annular bladder **203**. The annular bladder is installed around the mandrel **209**.

[**0113**] The top extremity of the bladder comprises a filling hose **203**B closed by a top plug **203**A. The bottom extremity of the bladder comprises an evacuation hose closed by a bottom plug **203**D. The extremities of these hoses are secured in the injecting apparatus near both extremities of the mandrel. The plugs can be removed to fill or flush the reservoir. The top plug **203**A or the bottom plug **203**D may be equipped with a relief valve for automatically venting the air trapped in the bladder.

[**0114**] The reservoir is connected to the dosing and mixing arrangement **204** by a reservoir conduit **203**E.

[**0115**] The pressure of the reservoir **203** is automatically adjusted to the pressure inside the casing and/or in the mandrel by means of at least one equalization port **203**C drilled in the mandrel **209**. The equalization port **203**C operates as follows: the fluid in the mandrel penetrates in the equalization port and exerts its pressure onto the reservoir, thus pressurizing the reservoir. When the reservoir is an annular bladder, it is deformed until the pressures outside and inside the reservoir are equilibrated.

[**0116**] The dosing and mixing arrangement **204** comprises an engine part **231** mechanically coupled to a pumping part **232**. Advantageously, the engine part **231** is a progressive cavity or helical rotor type pump and the pumping part **232** is a peristaltic pump. The progressive cavity pump is coupled to the peristaltic pump by a driving shaft **233**. The end of the reservoir conduit **203**E is a flexible tube coupled to the peristaltic pump. The engine part **231** is driven by any fluid flowing through it. When a fluid flows through the engine part **231**, it makes the pumping part **232** to rotate. The rotation of the peristaltic pump alternatively compresses and releases the flexible tube of the reservoir conduit **203**E, thus sucking the activation fluid AF out of the reservoir **203**. The engine part **231** is positioned downstream of the pumping part **232** in order to ensure a better mixing of the fluid to be activated and the activation fluid.

[**0117**] The activated fluid is injected into the well-bore through the outlet **208** downstream of the engine part **231** via for example a typical casing shoe CS**2**.

[**0118**] The injecting apparatus **201** for the second application operates as follows.

[**0119**] In the rest configuration shown in FIG. **6**.B, the injecting apparatus **201** can be used to deliver a non activated fluid F**1**" into the well-bore. The sliding sleeve **221** of the valve arrangement **202** is positioned into the mandrel **209** so that the fluid flowing into the mandrel is diverted through the first openings **224** into the shunt tube **210** towards the outlet **208**.

[**0120**] In order to activate the valve arrangement, a double dart assembly DD is launched from the surface and transported by the fluid that is to be activated.

[**0121**] In the activated configuration shown in FIG. **6**.C, the injecting apparatus **201** is used to deliver an activated fluid F**2** into the annulus AN of the well-bore WB.

[**0122**] The superior dart catcher **222**C receives the double dart assembly DD transported by the fluid. When the double dart assembly DD lands in the superior dart catcher, the double dart assembly acts as a plug and blocks the fluid flow. Consequently, the upstream pressure rises, thus creating a downward load that liberates a small dart **227**. The inferior dart catcher **222**A receives the dart **227** transported by the fluid. The dart catcher **222**A is for example a particular profile of the sliding sleeve (narrow area) for stopping and sealing the dart **227**. Once again, when the dart lands in the dart catcher **222**A, the sliding sleeve acts as a plug and blocks the fluid flow. Consequently, the upstream pressure rises, thus creating a downward load that moves the sleeve in the activated configuration. When the sliding sleeve is maintained in the rest configuration by a pin mechanism, the downward load shears the pins **221**B and releases the sliding sleeve. The sliding sleeve **221** slides downward in the mandrel and the top part **221** A of the sliding sleeve bump into the abutment **209**A of the mandrel.

[**0123**] In this configuration, the sliding sleeve **221** simultaneously closes the shunt tube **210** and diverts the flow through the second opening **224'** towards the engine part **231**. The engine part **231** begins to rotate and makes the pumping part **232** to rotate, thus sucking the activation fluid AF out of the reservoir **203**.

[**0124**] The activation fluid flow FA and the fluid flow F**1'** to be activated mixes together downstream of the pumping part **232**. An activated fluid flow F**2** is delivered in the annulus AN of the well-bore WB.

[**0125**] As shown on the Figures, the double dart assembly may comprise an additional valve avoiding the activated fluid (e.g. cement) in the annulus of greater density than fluid (generally mud) within the casing to flow back to the surface in the casing.

[**0126**] FIGS. **7**.A, **7**.B, **7**.C relate to a third application corresponding to a casing cementation in a casing-drilling configuration. The casing CS**3** is already in place and the injecting apparatus **301** is pumped through the casing and lands above the casing shoe CS**4**. The injecting apparatus **301** is activated by a dart **327** sent from the surface through the casing. The injecting apparatus **301** may be drilled out at the end of the cementing operation.

[0127] FIGS. 7.B and 7.C shows a detailed cross-section view of the injecting apparatus **301** in a rest configuration and in an activated configuration respectively.

[0128] The injecting apparatus **301** comprises a valve arrangement **302**, a reservoir **303** and a dosing and mixing arrangement **304**.

[0129] The valve arrangement **302** comprises a mandrel **309** and a sliding sleeve **321**.

[0130] The mandrel **309** is a tube having an inferior diameter than the casing CS3 diameter. It receives the fluid flowing through the casing via the inlet **307**. Because of the significant difference between the casing internal diameter and the mandrel inside diameter, a double dart assembly DD' is used. The mandrel **309** is coupled by a top part to a superior dart catcher **322**C having a size substantially corresponding to the internal size of the casing. The superior dart catcher **322**C is adapted to receive the double dart assembly DD' transported by the fluid. The mandrel **309** is coupled by a bottom part to a shunt tube **310**. The shunt tube comprises an abutment **309**A under the bottom part of the mandrel. The sliding sleeve **321** is guided within the mandrel. The sliding sleeve **321** comprises an inferior dart catcher **322**A.

[0131] The valve arrangement can be in a rest configuration (FIG. 7.B) or in an activated configuration (FIG. 7.C).

[0132] In the rest configuration, the fluid flowing into the mandrel flows through the sliding sleeve and is diverted into the shunt tube **310**. The sliding sleeve **321** can be maintained in the rest configuration by, for example, a pin mechanism or sealing mechanism.

[0133] In the activated configuration, enable the fluid flowing into the mandrel is diverted through an opening **324** into the dosing and mixing arrangement **304**. The sliding sleeve **321** is maintained in the activated configuration when it is in contact with the abutment **309**A.

[0134] The inferior dart catcher **322**A enables to activate the valve arrangement from the rest configuration to the activated configuration.

[0135] The reservoir **303** is an annular bladder, for example made in rubber material. The annular bladder is installed around the mandrel **309**.

[0136] The top extremity of the bladder comprises a filling hose **303**B closed by a top plug **303**A. The bottom extremity of the bladder comprises an evacuation hose closed by a bottom plug **303**D. The extremities of these hoses are secured in the injecting apparatus near both extremities of the mandrel. The plugs can be removed to fill or flush the reservoir. The top plug **303**A or the bottom plug **303**D may be equipped with a relief valve for automatically venting the air trapped in the bladder.

[0137] The reservoir is connected to the dosing and mixing arrangement **304** by a reservoir conduit **303**E.

[0138] The pressure of the reservoir **303** is automatically adjusted to the pressure inside the casing and/or in the mandrel by means of at least one equalization port **303**C drilled in the mandrel **309**. The equalization port **303**C operates as follows: the fluid in the mandrel penetrates in the equalization port and exerts its pressure onto the reservoir, thus pressurizing the reservoir. When the reservoir is an annular bladder, it is deformed until the pressures outside and inside the reservoir are equilibrated.

[0139] The dosing and mixing arrangement **304** comprises an engine part **331** mechanically coupled to a pumping part **332**. Advantageously, the engine part **331** is a progressive cavity or helical rotor type pump and the pumping part **332** is a peristaltic pump. The progressive cavity pump is coupled to the peristaltic pump by a driving shaft **333**. The end of the reservoir conduit **303**E is a flexible tube coupled to the peristaltic pump. The engine part **331** is driven by any fluid flowing through it. When a fluid flows through the engine part **331**, it makes the pumping part **332** to rotate. The rotation of the peristaltic pump alternatively compresses and releases the flexible tube of the reservoir conduit **303**E, thus sucking the activation fluid AF out of the reservoir **303**. The engine part **331** is positioned downstream of the pumping part **332** in order to ensure a better mixing of the fluid to be activated and the activation fluid. Thus the engine part **331** also acts as a mixing arrangement **305**.

[0140] The activated fluid is injected into the well-bore through the outlet **308** downstream of the engine part **331** via for example a typical casing shoe CS4.

[0141] The injecting apparatus **301** for the third application operates as follows.

[0142] In the rest configuration shown in FIG. 7.B, the injecting apparatus **301** can be used to deliver a non activated fluid F1" into the well-bore. The sliding sleeve **321** of the valve arrangement **302** is positioned at the bottom of the mandrel **309** so that the fluid flowing into the mandrel flow through the sliding sleeve into the shunt tube **310** towards the outlet **308**.

[0143] In order to activate the valve arrangement, a double dart assembly DD' is launched from the surface and transported by the fluid that is to be activated.

[0144] In the activated configuration shown in FIG. 7.C, the injecting apparatus **301** is used to deliver an activated fluid F2 into the annulus AN of the well-bore WB.

[0145] The superior dart catcher **322**C receives the double dart assembly DD' transported by the fluid. When the double dart assembly DD' lands in the superior dart catcher, F the double dart assembly acts as a plug and blocks the fluid flow. Consequently, the upstream pressure rises, thus creating a downward load that liberates a small dart **327**. The inferior dart catcher **322**A receives the dart **327** transported by the fluid. The dart catcher **322**A is for example a particular profile of the sliding sleeve (narrow area) for stopping and sealing the dart **327**. Once again, when the dart lands in the dart catcher **322**A, the sliding sleeve acts as a plug and blocks the fluid flow. Consequently, the upstream pressure rises, thus creating a downward load that moves the sleeve in the activated configuration. The sliding sleeve **221** slides downward and bumps into the abutment **309**A.

[0146] In this configuration, the sliding sleeve **321** simultaneously closes the shunt tube **310** and diverts the flow through the opening **324** towards the engine part **331**. The engine part **331** begins to rotate and makes the pumping part **332** to rotate, thus sucking the activation fluid AF out of the reservoir **303**.

[0147] The activation fluid flow FA and the fluid flow F1' to be activated mixes together downstream of the pumping

part **332**. An activated fluid flow F**2** is delivered in the annulus AN of the well-bore WB.

[**0148**] As shown on the Figures, the double dart assembly may comprise ah additional valve avoiding the activated fluid (e.g. cement) in the annulus of greater density than fluid (generally mud) within the casing to flow back to the surface in the casing.

[**0149**] It is to be noted that the peristaltic pump described in relation with the embodiments of FIGS. **5** to **7** may, alternatively, be equipped with several flexible tubes. In this case, the peristaltic pump may be designed to press simultaneously the several flexible tubes. Each tube may be fitted with a valve in order to adjust, for a given application, the activation fluid flow-rate to be injected in the fluid.

[**0150**] It is to be mentioned that the invention is not limited to onshore hydrocarbon well and can also be used in relation with offshore hydrocarbon well.

[**0151**] Also, a particular application of the invention relating to the oilfield industry has been described. However, the invention is also applicable to other kind of industry, e.g. the construction industry or the like.

[**0152**] The drawings and their description hereinbefore illustrate rather than limit the invention.

[**0153**] Any reference sign in a claim should not be construed as limiting the claim. The word "comprising" does not exclude the presence of other elements than those listed in a claim. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such element.

1. An injection apparatus for injecting an activated fluid into a well-bore, the apparatus comprising a reservoir for containing an activation fluid,

wherein the injection apparatus further comprises:

a valve arrangement adapted to be coupled to a pipe for receiving a first fluid flow,

a dosing and mixing arrangement coupled to the reservoir and to the valve arrangement

wherein:

the valve arrangement has a rest configuration in which the injection apparatus provides a non-activated fluid mixture and an activated configuration in which the injection apparatus provides an activated fluid mixture,

the dosing and mixing arrangement comprising an engine part mechanically coupled to a pumping part, the engine part running the pumping part and the pumping part sucking the activation fluid of the reservoir when the valve arrangement is in the activated configuration, and the dosing and mixing arrangement mixes the activation fluid with the first fluid and provides an activated fluid mixture flow at an outlet.

2. An injection apparatus according to claim 1, wherein the injection apparatus further comprises a pressure adjusting arrangement for adjusting the pressure inside the reservoir to the pressure inside the pipe.

3. An injection apparatus according to claim 1, wherein the pressure adjusting arrangement comprises a piston fitted in the reservoir, said piston pressurizing the activation fluid of the reservoir when the valve arrangement coupled to the reservoir submits the piston to a third portion of the first fluid.

4. An injection apparatus according to claim 1, wherein the pressure adjusting arrangement comprises a reservoir consisting of a bladder, said reservoir being coupled by at least one equalization port to a part of the injection apparatus submitted to the pressure inside the pipe.

5. An injection apparatus according to claim 4, wherein the part of the injection apparatus submitted to the pressure inside the pipe is the valve arrangement.

6. An injection apparatus according to claim 1, wherein the valve arrangement is coupled to the outlet by a second shunt tube and the valve arrangement further has a by-pass configuration in which a second portion of the first fluid flows directly to the outlet.

7. An injection apparatus according to claim 1, wherein the valve arrangement comprises a sliding sleeve having a first dart catcher for remotely activating the valve arrangement from the rest configuration to the activated configuration.

8. An injection apparatus according to claim 7, wherein the sliding sleeve has a second dart catcher for remotely activating the by-pass configuration of the valve arrangement.

9. An injection apparatus according to claim 1, wherein the engine part is coupled to the pumping part through a gearing part, the gearing part defining a volume ratio between the first portion of the first fluid and the activation fluid.

10. An injection apparatus according to claim 9, wherein the gearing part is a driving shaft.

11. An injection apparatus according to claim 1, wherein the engine part is a progressive cavity pump.

12. An injection apparatus according to claim 1, wherein the pumping part is a progressive cavity pump.

13. An injection apparatus according to claim 1, wherein the pumping part is a peristaltic pump.

14. An injection apparatus according to claim 1, wherein the dosing and mixing arrangement further comprises a complementary mixing arrangement comprising:

a pre-mixing chamber coupled to the engine part and the pumping part, and

a final mixing chamber coupled to the engine part and the pre-mixing chamber.

15. An injection apparatus for injecting an activated fluid mixture into a well-bore according to claim 14, wherein the pre-mixing chamber is coupled to the pumping part by a Venturi type injecting conduit.

16. An injection method for injecting an activated fluid into a well-bore, wherein the method comprises the following steps:

running an injection apparatus at a proper location in the well-bore, the injection apparatus comprising a reservoir for containing an activation fluid, a valve arrangement adapted to be coupled to a pipe, a dosing and mixing arrangement coupled to the reservoir and to the valve arrangement, the valve arrangement being in a rest configuration,

letting flow a first fluid through the apparatus into the well-bore,

activating the valve arrangement of the injection apparatus in an activated configuration in which a first portion of the first fluid activates a pumping part sucking the activation fluid of the reservoir,

mixing the sucked activation fluid with the first portion of the first fluid, and

injecting an activated fluid mixture flow at an outlet.

17. An injection method according to claim 16, wherein the method further comprises the steps of activating the valve arrangement of the injection apparatus in a by-pass position in which a second portion of the first fluid flows directly to the outlet.

18. An injection method according to claim 16, wherein the activating steps are remotely controlled from a surface equipment.

19. An injection method according to claim 16, comprising further a step of pressure adjusting for adjusting the pressure inside the reservoir to the pressure inside the pipe.

* * * * *

US005582251A

United States Patent [19]

Bailey et al.

[11] **Patent Number: 5,582,251**

[45] **Date of Patent: Dec. 10, 1996**

[54] **DOWNHOLE MIXER**

[75] Inventors: **J. Robert Bailey**, Missouri City; **Rustom K. Mody**, Houston; **Richard G. Van Buskirk**, Waller, all of Tex.

[73] Assignees: **Baker Hughes Incorporated**; **Exxon Production Research Company**, both of Houston, Tex.

[21] Appl. No.: **424,158**

[22] Filed: **Apr. 17, 1995**

[51] **Int. Cl.**[6] **E21B 33/132**; E21B 33/138

[52] **U.S. Cl.** **166/286**; 166/162; 166/317; 166/385

[58] **Field of Search** 166/286, 295, 166/294, 285, 300, 297, 298, 385, 162, 169, 168, 65.1, 317

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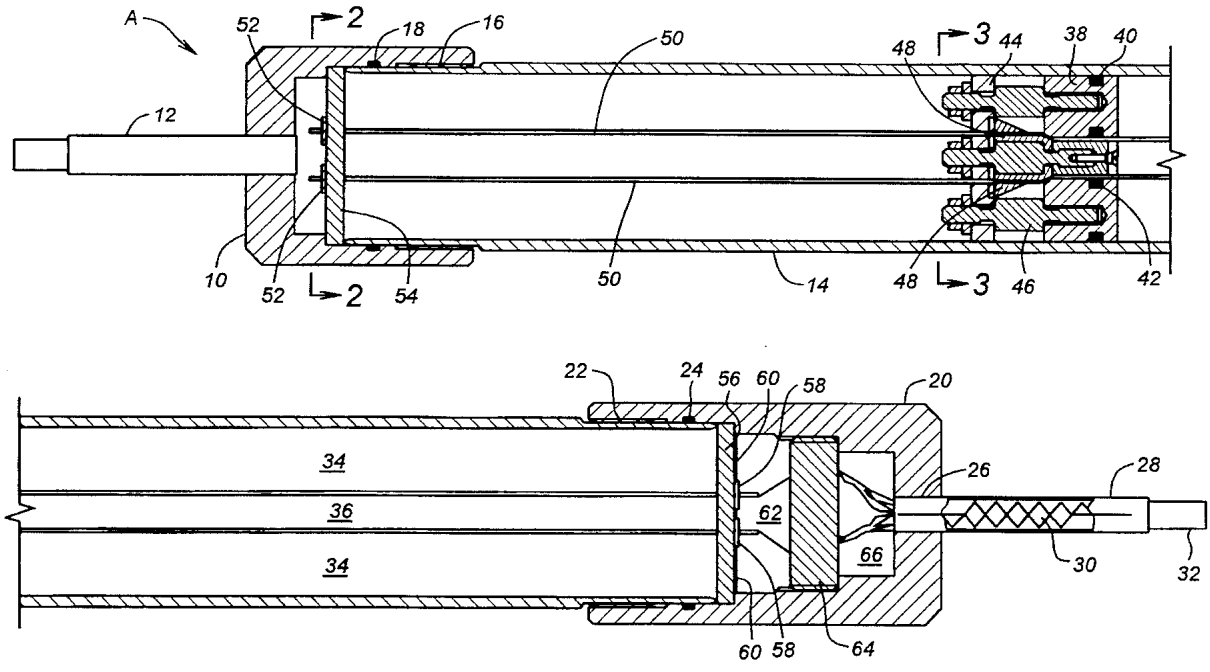
Primary Examiner—Stephen J. Novosad

Attorney, Agent, or Firm—Rosenblatt & Redano, P.C.

[57] **ABSTRACT**

The invention discloses an apparatus for storing one or more constituents in a downhole tool. The constituents are segregated from each other until such time as the tool is actuated. At that time, the constituents are forced from their storage position and mixed as they are pushed from their storage position. The resultant mix is then directed to the location where the mixture will finally be placed for eventual solidification. The apparatus and method are useful for inflation of bridge plugs or external casing packers, as well as other downhole applications. Significant time is provided for the surface operator prior to initiation of the constituent elements by segregating the ingredients until shortly before they are mixed and directed to their final destination. Should a problem arise prior to mixing, the unmixed ingredients can be withdrawn from the wellbore.

24 Claims, 3 Drawing Sheets



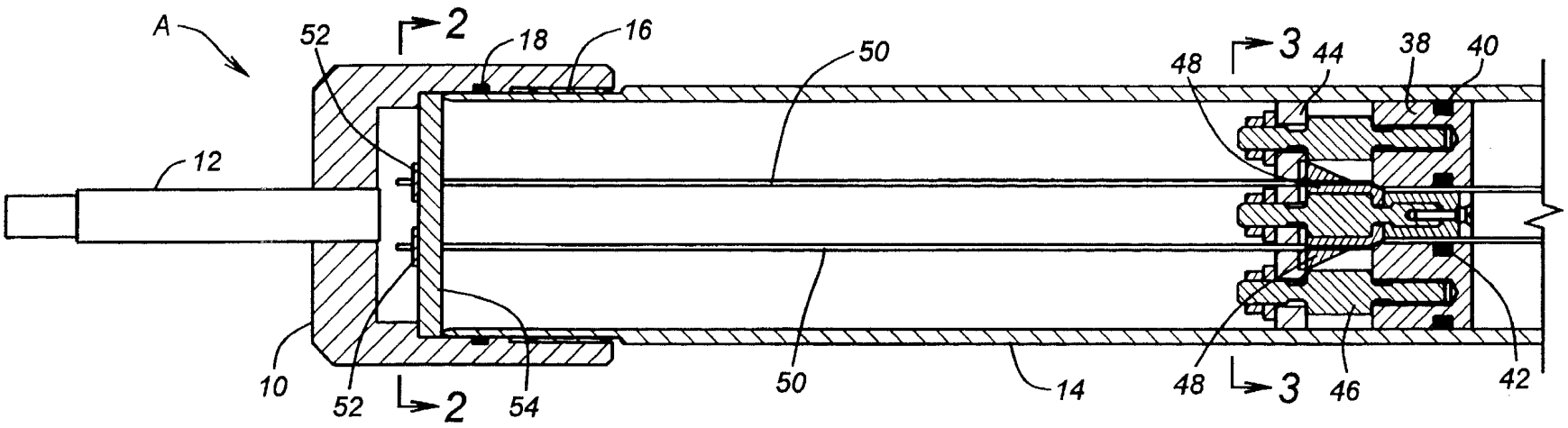

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FIG. 1A

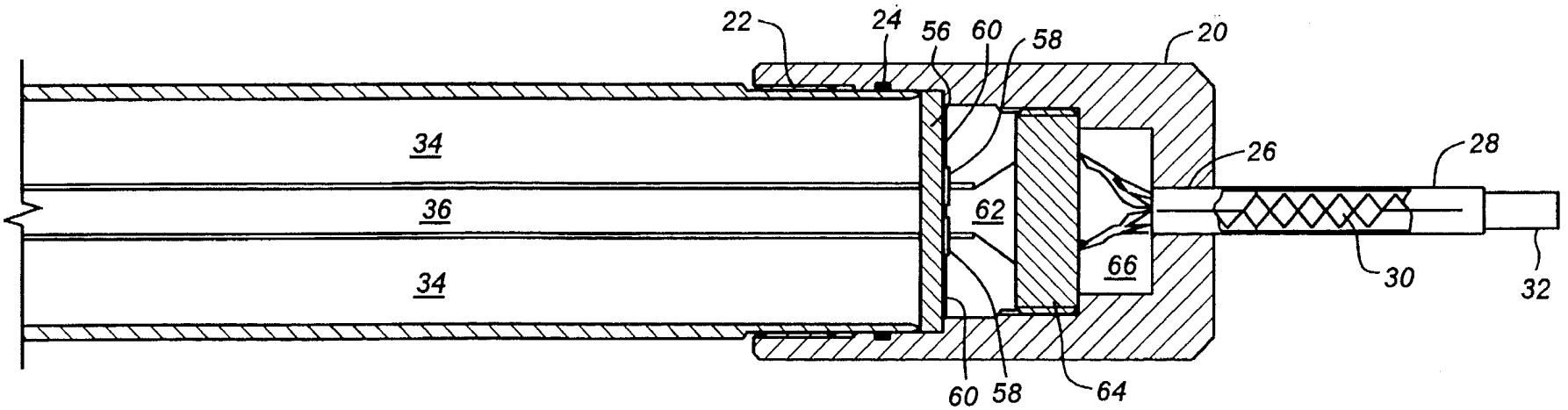
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FIG. 1B

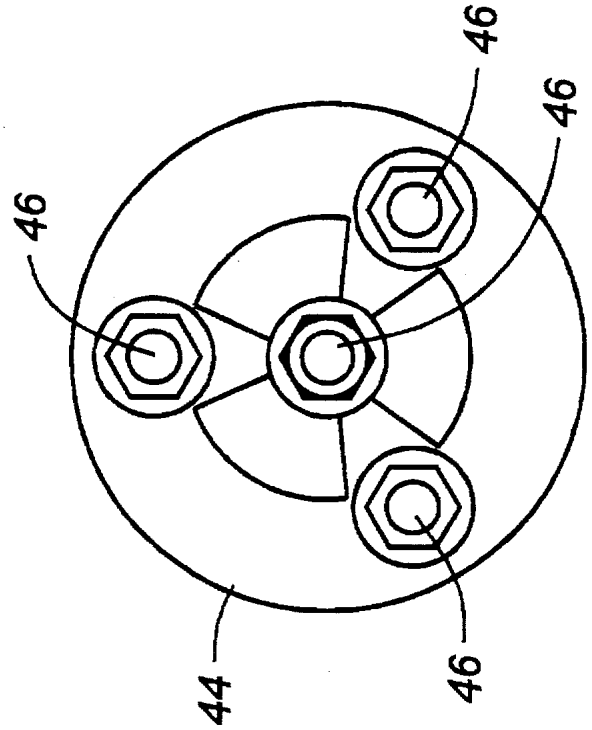

FIG. 3

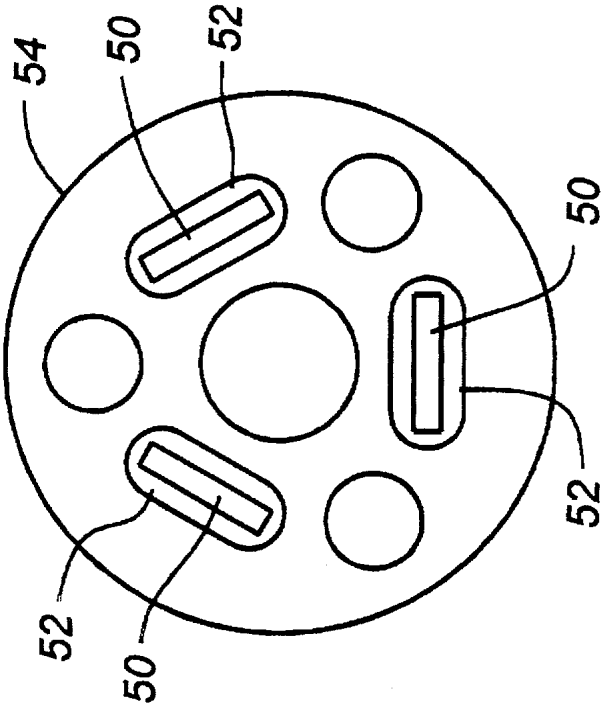

FIG. 2

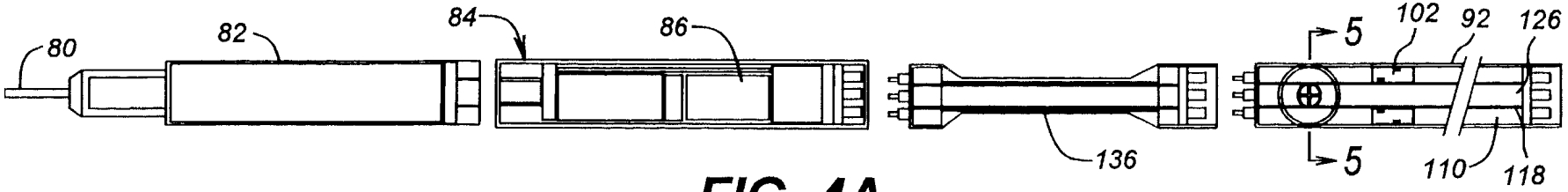

FIG. 4A

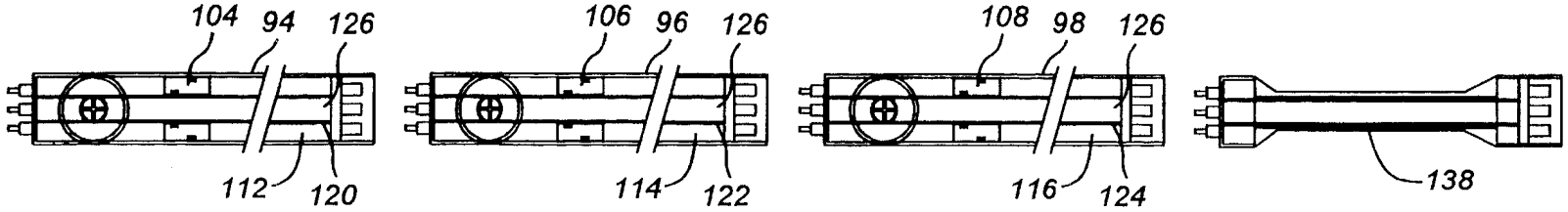

FIG. 4B

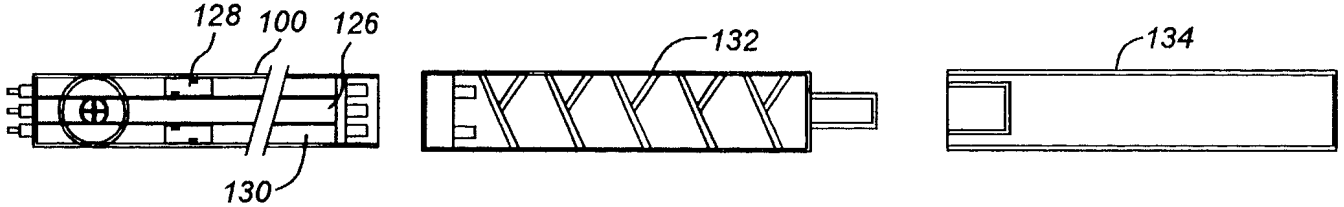

FIG. 4C

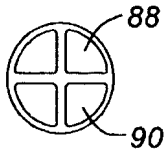

FIG. 5

DOWNHOLE MIXER

FIELD OF THE INVENTION

The field of this invention relates to mixing techniques and an apparatus for combining materials downhole.

BACKGROUND OF THE INVENTION

In the past, various materials have been used in cementing downhole. Cementing has involved not only the filling of or around casings downhole, but also inflatable plugs or external casing packers which are inflated with a cement material and are designed to be in place permanently. If the various materials making up the cement slurry are premixed at the surface and then spotted where needed downhole, sufficient time to properly spot the mixture may not be available before the slurry begins to solidify. This presents problems for the operator if any problems are encountered during run-in with the constituent components already premixed. If the slurry hardens before the job can be done, then time and money will be lost. For example, the inflating and setting medium for an inflatable bridge plug, if premixed at the surface, has a typical working time of 2–8 hours before it begins to harden to the point of unpumpability. Many other downhole applications, using materials which are initially pumpable and by design later solidify in locations desired by the operator, also create this time concern.

These time concerns of spotting the hardening material in the position necessary prior to its reaching a condition where it is difficult to move or pump are alleviated by the apparatus and method of the present invention. The apparatus and method allow for storage and separation of constituent components while positioning the apparatus adjacent the area where such materials are to be used. The apparatus and method then provide for mixing of the constituent components downhole. The mixing is not initiated until the constituent ingredients are properly located downhole and all systems are found to be in good working order. The apparatus and method contemplate the mixing of the ingredients and the directing of such ingredients to the particular location where the combination can solidify as desired.

SUMMARY OF THE INVENTION

The invention discloses an apparatus for storing one or more constituents in a downhole tool. The constituents are segregated from each other until such time as the tool is actuated. At that time, the constituents are forced from their storage position and mixed as they are pushed through an isostatic mixing tube to the inflatable tool. The resultant mix is then directed to the location where the mixture will finally be placed for eventual solidification. The apparatus and method are useful for inflation of bridge plugs or external casing packers, as well as other downhole applications. Significant process control is given to the surface operator prior to initiation of reaction of the constituent elements by holding separate the ingredients until shortly before they are mixed and directed to their final destination. Should a problem arise prior to mixing, the unmixed ingredients can be withdrawn from the wellbore without complication.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1***a–b* are sectional elevational views of the apparatus.

FIG. **2** is a section view along lines **2—2** of FIG. **1***a*.

FIG. **3** is a section view along lines **3—3** of FIG. **1***a*.

FIGS. **4***a–c* are sectional elevational views of an alternative embodiment suitable for wireline applications for downhole mixing.

FIG. **5** is a section along lines **5—5** of FIG. **4***a*.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The apparatus A is shown in FIGS. **1***a* and **1***b*. A top sub **10** has an inlet pipe **12** connected thereto. Top sub **10** is connected to body **14** at thread **16**. Seal **18** seals the connection between top sub **10** and body **14**. Body **14** is connected to bottom sub **20** at thread **22**. Seal **24** seals the threaded connection adjacent to thread **22**. Bottom sub **20** has an outlet **26** which is connected to an outlet tube **28**. A known in-line mixer **30** is integral to and within tube **28**. The mixed chemicals, schematically represented as **32**, exit the outlet tube **28** and are directed to that portion in the well where they will be allowed to set up, such as a bridge plug, an external casing packer, or another downhole application.

The apparatus A, as shown in FIGS. **1***a* and **1***b*, is configured for mixing of two elements but can be configured for mixing any number of elements without departing from the spirit of the invention. The first element is preferably placed at the surface into annular chamber **34**, while the second is similarly placed in tube **36**. A piston **38** is sealed against body **14** by seal **40** and against tube **36** by seal **42**. Piston **38** is essentially in pressure balance despite the depth of the apparatus A in the wellbore. Tube **36** is circumscribed by annular chamber **34** in the preferred embodiment, but other configurations of material storage involving discrete compartments may be used without departing from the spirit of the invention.

Support plate **44** is connected to piston **38** by a series of studs **46**. In the gap between support plate **44** and piston **38** are splitter blade or blades **48**. In the preferred embodiment, the blades are inclined with respect to the axis of tube **36**. Above piston **38** tube **36** is fragmented into segments **50**. As shown in FIG. **2**, in the preferred embodiment there are three segments **50** at 120° spacing. Each segment **50** is retained by a retainer **52** after it extends through end plate **54** (see FIG. **1**), and plate **54** is retained between top sub **10** and body **14**. Accordingly, the tube segments **50** are under tension between end plate **54** and piston **38**. The lower end of tube **36** extends through bottom plate **56** and is retained by retainers **58**. Bottom plate **56** can have temporary seals **60** to retain the constituent within tube **36** or annular chamber **34** until such time as they are ready to be mixed. Seals **60** can be rupture discs of a known type which can be prescored to break cleanly on increasing differential pressure. Below bottom plate **56** is a mixing chamber **62**, followed by a mixing plate **64**. Mixing plate **64** can be a plate with randomly located holes through which the material can flow. After the mixing plate is another mixing zone **66**, ultimately leading to the outlet **26**.

The components of the apparatus A now having been described, its operation will be reviewed. The apparatus A is fully assembled in the position shown in FIG. **1** by the initial addition of the compound or compounds to be mixed downhole. In a typical application, the annular space **34** may contain a cementitious material while the tube **36** may contain an expanding agent, such that upon mixing of the components from annular space **34** and tube **36**, the mixture will initiate expansion of the mixed medium. This can be particularly useful when using the mixture to inflate and

permanently set a packer or bridge plug. The expanding capability of the ingredients stored in tube **36** assists in maintaining the bridge plug or packer in the inflated condition as the material of the mixture sets up. The apparatus and method can be used to mix any materials, and the specific selection of materials is independent of the described invention.

Typically, the apparatus A is used in conjunction with a downhole pressure source, such as a motor and a fluid pump (not shown), whose output is connected to inlet pipe **12**. Ultimately, pressure builds on piston **38**. The studs **46** keep the support plate **44** at a fixed distance from the piston **38**. As previously stated, the support plate **44** also supports the blade or blades **48**. As the pressure arises above piston **38**, it will begin to move. Movement of piston **38** will result in a longitudinal cut or cuts in tube **36** as piston **38** progresses. These longitudinal cuts facilitate the downward movement of plate **44** whose initial movement begins on segments **50**. Accordingly, in order to avoid getting plate **44** into a bind, advancement of the piston **38** slices through tube **36**, which may itself be prescored to assist in the cutting operation of the blades **48**. To the extent there are temporary seals **60** employed adjacent the bottom plate **56**, downward movement of the piston **44** builds up pressure in annular space **34** and tube **36**. In response to the pressure build-up, the temporary seals **60** are broken and the material that is stored in annular space **34** and tube **36** is pushed outwardly through bottom plate **56** and mixing plate **64**. Mixing plate **64** can be a plate with a plurality of openings, all of which promote mixing of the constituents as they are pushed out from annular space **34** and tube **36**. Those skilled in the art can appreciate that a multiplicity of tubes can be deployed in the body **14** without departing from the spirit of the invention. The operation with a multiplicity of tubes would be similar to that shown in the apparatus A of FIGS. **1***a* & **1***b*, except that a greater number of elements could be mixed. The mixing plate **64** then further encourages mixing in the mix zone **66** before the mixture enters outlet **26**. Thereafter, an in-line static mixer **30** can be employed of a type well-known in the art to further ensure thorough mixing prior to conducting the mixture of chemicals **32** to the bridge plug, or external casing packer, or other zone in the wellbore for deposition and hardening.

Those skilled in the art will appreciate that the stroke of piston **38** displaces at a fixed volumetric ratio as between the tube **36** and the annular space **34**. While two unique areas for two discrete components have been described in FIGS. **1***a* and **1***b*, the apparatus A can be used to store a single constituent and then be further used to pump that constituent out of the body **14** by displacing piston **38** to introduce a single constituent into a bridge plug, packer, or other downhole use.

In one particular application of the apparatus A, the annular space **34** can contain a cement while the tube **36** contains a hardening/expanding additive and/or a liquid gas generator. The cementitious material in annular space **34** does not normally set up until several hours have elapsed. However, when mixed with the material in tube **36**, the cure time is reduced to only a few hours. However, since the mixing occurs downhole adjacent the point of use, a few hours is more than enough to adequately pump the mixture to the place of its final destination. On the other hand, if difficulties develop prior to the initiation of the mixing of the components, all the components can be withdrawn from the wellbore until such operational difficulties are repaired. Once the repairs are made, the same constituents (or newly prepared constituents) can be rerun into the wellbore and used as intended by employing the downhole mixing apparatus. Accordingly, the apparatus A adds flexibility in performing workover operations, such as installing inflatable packers for permanent zonal isolation, or using such chemicals downhole as part of a remedial and stimulation program, or for maintenance or other tasks downhole. The apparatus A can be used with one or more pumps connected to one or more inlets **12**. Each constituent can be separately defined in a tube or an annular space and actuated by a pump or pumps (not shown). Electronic sensors can be employed with the apparatus A to communicate the position of piston **38** and transmit information to the surface in a manner well known in the art.

FIGS. **4***a–c* and **5** illustrate an alternative embodiment of the apparatus and method of the present invention particularly suited for wireline applications. Those skilled in the art will appreciate that typical wireline applications involve a lubricator of a fixed length, usually approximately 40 feet, through which the tools must be lowered. The apparatus of the present invention, as illustrated in FIGS. **4***a–c*, accommodates a way of inserting through a lubricator a tool that may actually have to exceed the overall length of the lubricator.

As shown in FIG. **4***a*, the wireline **80** supports a downhole pump **82**, the output of which is controlled through a control module **84**. The control module includes one or more solenoid valves **86** which can direct the output of pump **82** selectively into flow channels **88** or **90**, as shown in FIG. **5**. In the assembly shown in FIGS. **4***a–c*, a plurality of ingredient modules are illustrated. A series of modules **92–98** are illustrated to house the more plentiful ingredient. Accordingly, more of those modules exist than for the second ingredient represented by module **100**. In FIGS. **4***a–c*, module **100** is connected to flow channel **90** while modules **92–98** are all aligned to flow channel **88**. The pump **82**, in combination with the solenoid valves **86** and control module **84**, which includes logic circuits, microprocessors and timers, can direct flow into flow channel **88** or **90** on a time basis. By directing the output of pump **82** into flow channel **88**, the volumetric displacement of pump **82** is applied to pistons **102**, **104**, **106**, and **108**, causing all these pistons for the initial component to move in tandem. Below each piston **102–108** is a storage location to house the initial ingredient. The storage locations are indicated as **110–116**. Each of these storage locations **110–116** has, respectively, an outlet **118–124** which is initially sealed from the outlet path **126** which extends through all the components. In a similar manner, module **100** contains the other ingredient to be mixed and has in it a piston **128** over a storage compartment **130**, which ultimately opens into the mixing path **127** upon movement of the piston **128**. The pump **82** can selectively drive piston **128** through flow channel **90** for a particular predetermined time and then alternate to driving the other pistons **102–108** through flow channel **88** for a different time. Since the pump used is preferably of a fixed volumetric delivery per unit time, accurate mixing can be accomplished by judicious control of the solenoid(s) **86** so that what is delivered to mixer **132** is the precise mix desired, whereupon the mixture exits the mixer **132** and goes directly into the downhole tool **134**.

Optionally, deployment bars such as **136** and **138** can be used to facilitate the introduction of the apparatus illustrated in FIG. **4** through a lubricator which may be shorter than the combined length of the apparatus. The deployment bars allow isolation of the well when wellhead rams seal around the bars to facilitate their introduction through a lubricator which does not exceed the overall length of the apparatus in

a manner that is commonly known in the art. The development bars **136** and **138** merely carry through them the passages from the solenoid(s) **86** to provide flow continuity internally between the assembled modules. Those skilled in the art will appreciate that different numbers of modules can be deployed without departing from the spirit of the invention. One, two, or more ingredients can be mixed as desired with the proper sequencing and control of the solenoid(s). The apparatus is ideally suited for wireline applications, which allows the materials to be mixed to be positioned adjacent the downhole tool **134** in a rapid manner.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made without departing from the spirit of the invention.

What is claimed is:

1. A method of mixing at least a first and second material downhole, comprising the steps of:

loading said first material in a first compartment in a tool body;

loading said second material in a second compartment in a tool body initially isolated from said first compartment;

lowering the tool into a wellbore; and

initiating mixing of said first and second materials within said tool body prior to application of said mixed fluids downhole.

2. The method of claim **1**, further comprising the steps of:

applying pressure to said first and second compartments; and

displacing said first and second chemicals from said first and second compartments in a predetermined volume relation to each other.

3. The method of claim **2**, further comprising the step of:

using a common piston to apply pressure to said first and second comparments.

4. The method of claim **1**, further comprising the steps of:

mounting the tool on a wireline; and

using a downhole pump to initiate said mixing.

5. The method of claim **4**, further comprising the steps of:

using sequencing valves to direct output of said pump;

using a constant volume delivery pump; and

controlling by volume the mixture between said first and second materials by time control of said sequence valves.

6. The method of claim **4**, further comprising the steps of:

using a static mixer to mix the first and second materials after they are displaced from said first and second compartments; and

directing the mixed materials from the static mixer into a downhole tool.

7. The method of claim **6**, further comprising the steps of:

using a gas-generating material as one of the materials to be mixed;

adding the mixed materials from said static mixer to a packer; and

using the gas-generating material to hold packer inflation as the mixed materials in the packer harden.

8. A injection apparatus for delivering at least one material to a desired position downhole, comprising:

a body defining at least two compartment therein;

at least one piston in said body movably mounted therein to reduce the volume of said compartments and drive out of said compartments materials initially stored therein; and

means for selectively actuating said piston when said body is positioned downhole to mix the materials in said body prior to driving the mixed materials from said body.

9. The apparatus of claim **8**, further comprising:

said piston, upon actuation, driving said materials from each compartment in a predetermined volume ratio.

10. The apparatus of claim **9**, wherein:

said piston reduces the stored volume of said compartments in tandem.

11. A method of mixing at least a first and second material downhole, comprising the steps of:

loading said first material in a first compartment in a tool body;

loading said second material in a second compartment in a tool body initially isolated from said first compartment;

nesting one of said first and second compartments within the other;

lowering the tool into a wellbore; and

initiating mixing of said first and second materials downhole.

12. A method of mixing at least a first and second material downhole, comprising the steps of:

loading said first material in a first compartment in a tool body;

loading said second material in a second compartment in a tool body initially isolated from said first compartment;

nesting one of said first and second compartments within the other, and

lowering the tool into a wellbore;

using a common piston to apply pressure to said first and second compartments;

applying pressure to said first and second compartments;

displacing said first and second chemicals from said first and second compartments in a predetermined volume relation to each other; and

initiating mixing of said first and second materials downhole.

13. The method of claim **12**, further comprising the step of:

providing at least one tube as said first compartment with an annulus around said tube as said second compartment.

14. The method of claim **13**, further comprising the steps of:

extending said tube longitudinally through said piston; and

continuing said tube in longitudinal segments beyond said piston.

15. The method of claim **14**, further comprising the steps of:

providing at least one cutter on said piston; and

longitudinally cutting said tube with said cutter to facilitate piston advancement.

16. The method of claim **15**, further comprising the step of:

maintaining said tube in tension while said piston is advancing.

17. The method of claim **15**, further comprising the step of:

supporting said cutter on a support plate connected to and spaced apart from said piston.

18. The method of claim **16**, further comprising the step of:

creating flow communication within the body of the tool between said tube and said annulus as a result of piston movement.

19. The method of claim **18**, further comprising the step of:

providing a mixing plate in said tool body to allow said chemicals to mix as a result of passing therethrough.

20. The method of claim **19**, further comprising the step of:

providing an in-line mixer at the outlet of said tool body.

21. The method of claim **20**, further comprising the step of:

moving said piston with fluid pressure.

22. A injection apparatus for delivering at least one material to a desired position downhole, comprising:

a body defining at least two compartments selectively isolated from each other;

said compartments are nested one within the other, with said first compartment comprising a tube and said second compartment comprising the surrounding annulus;

a piston in said body movably mounted therein to reduce the volume of said compartments and drive out of said compartments a materials initially stored therein;

said tube extends through said piston and is retained in tension in said body;

said piston reduces the stored volume of said compartments in tandem;

means for selectively actuating said piston when said body is positioned downhole;

whereupon actuation of said piston, material is delivered from each compartment in a predetermined volume ratio.

23. The apparatus of claim **22**, wherein:

said tube extends in longitudinal segments beyond said piston;

said piston further comprising at least one cutter; and

said cutter cutting said tube longitudinally in response to piston progress.

24. A injection apparatus for delivering at least one material to a desired position downhole, comprising:

a body defining at least two compartments selectively isolated from each other;

a piston in said body movably mounted therein to reduce the volume of said compartments and drive out of said compartments a materials initially stored therein;

said piston reduces the stored volume of said compartments in tandem;

means for selectively actuating said piston when said body is positioned downhole;

said body further comprises a mixing plate therein to facilitate mixing;

said compartments initially isolated from each other by a breakable member on each compartment which breaks as a result of piston movement reducing the volume of said compartments;

said mixing plate further promoting mixing in said body as the material from each compartment passes therethrough; and

whereupon actuation of said piston, material is delivered from each compartment in a predetermined volume ratio.

* * * * *