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- (81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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**Declarations under Rule 4.17:**

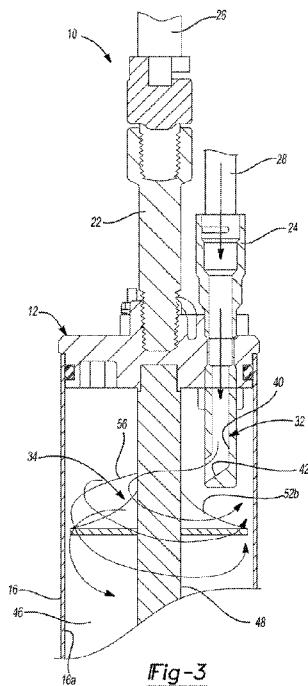
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(54) **Title:** FLUID PUMP HAVING SELF-CLEANING AIR INLET STRUCTURE

(57) **Abstract:** A pneumatically driven fluid pump apparatus is disclosed which makes use of a pump casing, a pump cap secured at a first end of the pump casing, and a liquid discharge tube. The liquid discharge tube communicates with the pump cap extends at least partially within an interior area of the pump casing toward a second end of the pump casing, where fluid is admitted. The pump cap may include a first portion for receiving a pressurized airflow from an external pressurized air source, and a second portion in communication with the first portion and also with the interior area of the pump casing. The second portion directs the pressurized air received through the first portion toward an interior wall portion of the pump casing to create a swirling airflow within the casing. The swirling airflow moves in a swirling manner toward the second end of the pump casing to help clean the interior wall portion of the pump casing.



**Fig-3**



## FLUID PUMP HAVING SELF-CLEANING AIR INLET STRUCTURE

## CROSS-REFERENCE TO RELATED APPLICATIONS

**[0001]** This application claims the benefit of U.S. Provisional Application No. 62/607,732, filed on December 19, 2017. The entire disclosure of the above application is incorporated herein by reference.

## FIELD

**[0002]** The present disclosure relates to pumps, and more particularly to a fluid pump having a self-cleaning air inlet which helps to clean internal surfaces of the pump during each fluid ejection cycle of the pump.

## BACKGROUND

**[0003]** The statements in this section merely provide background information related to the present disclosure and may not constitute prior art.

**[0004]** Pneumatically driven fluid pumps are used in a wide variety of applications to pump out various types of fluids from wellbores. Often the fluids being pumped include contaminants which can cause a build-up of contaminants or sludge-like material on the inside surfaces of the pump. This is highly undesirable from a number of respects, not the least of which is that it can lead to malfunctioning of the pump if the build-up becomes sufficient to interfere with moving parts within the pump. Fluid pumps used in wellbores often make use of a float that must be able to move freely up and down an elongated rod positioned within a pump housing. The float is used to signal when sufficient fluid has accumulated within the pump housing so that valving can be used to implement a fluid ejection cycle. The build-up of contaminants along the interior wall surface of the pump housing may eventually interfere with free movement of the float within the pump housing.

**[0005]** To address the above concerns, it traditionally has been necessary to periodically remove the pump from its associated wellbore, disassemble it, clean it, reassemble it, and then reinstall it in the wellbore. As will be appreciated, this can be time consuming and costly in terms of the man hours required for such a maintenance sequence.

**[0006]** Accordingly, there is presently a strong interest in providing fluid pumps that incorporate a design and construction which is less susceptible to the build-

up of contaminants within the pump, and which will allow the pump to operate over significantly longer time intervals before requiring removal, disassembly and cleaning.

#### SUMMARY

5           **[0007]**     In one aspect the present disclosure relates to a pneumatically driven fluid pump apparatus. The apparatus may comprise a pump casing, a pump cap secured at a first end of the pump casing, and a liquid discharge tube. The liquid discharge tube may be in communication with the pump cap and may extend at least partially within an interior area of the pump casing toward a second end of the pump casing. Liquid is admitted into the pump casing at the second end. A fluid discharge tube may be included which is in communication with the pump cap for receiving liquid collected within the pump casing. The fluid discharge tube enables the fluid to be discharged through the liquid discharge tube from the pump casing. The pump cap may include a first portion for receiving a pressurized airflow from an external  
10           pressurized air source, where the pressurized air is used to help displace liquid collecting within the pump casing upwardly through the liquid discharge tube, and a second portion in communication with the first portion and also with the interior area of the pump casing. The second portion directs the pressurized air received through the first portion toward an interior wall portion of the pump casing to create a swirling airflow  
15           within the casing. The swirling airflow moves in a swirling manner toward the second end of the pump casing and imparts a swirling action to help clean the interior area of the pump casing, while also imparting a swirling action to the liquid having collected within the pump casing, and ejecting the swirling liquid upwardly into and through the fluid discharge tube.

25           **[0008]**     In another aspect the present disclosure relates to a pneumatically driven fluid pump apparatus. The apparatus may comprise a pump casing, a pump cap secured at a first end of the pump casing, and a liquid discharge tube in communication with the pump cap and extending at least partially within an interior area of the pump casing toward a second end of the pump casing. Liquid is admitted into the pump casing at the second end. A fluid discharge tube may also be included which is in  
30           communication with the pump cap for receiving liquid collected within the pump casing and discharged through the liquid discharge tube. The pump cap may include a first portion for receiving a pressurized airflow from an external pressurized air source, and a second portion in communication with the first portion and also with the interior area

of the pump casing. The second portion directs the pressurized air received through the first portion toward an interior wall portion of the pump casing to create a swirling airflow within the pump casing. An air deflector may be disposed in the pump casing in the path of the pressurized air discharged from the second portion of the pump cap.

5 The air deflector further helps to create the swirling airflow within the pump casing, while also imparting a swirling action to the liquid having collected within the pump casing, and ejecting the swirling liquid upwardly into and through the fluid discharge tube.

**[0009]** In still another aspect the present disclosure relates to a method for  
10 cleaning an interior area of a pump casing of a pneumatically driven fluid pump. The method may comprise using a pump cap secured to a first end of an elongated, tubular pump to receive a pressurized airflow from a remote pressurized air generating device, to be admitted into an interior area of the pump casing. The method may further include using a liquid discharge tube in communication with the pump cap and  
15 extending at least partially within an interior area of the pump casing toward a second end of the pump casing, to receive liquid which has been admitted into the pump casing at a second end of the pump casing. The method may further include directing the pressurized airflow received at the pump cap through the pump cap into a nozzle portion operably associated with the pump cap. The method may further include using  
20 the nozzle portion to turn the pressurized a fluid discharge conduit into a swirling airflow that travels along an interior wall portion of the pump casing toward the second end of the pump casing, to thus clean the pump casing, while imparting a swirling action to the liquid and forcing the swirling liquid collecting within the pump casing upwardly into and through the liquid discharge tube.

25

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0010]** The drawings described herein are for illustration purposes only and are not intended to limit the scope of the present disclosure in any way.

**[0011]** Figure 1 is an elevational side view of one example of a pneumatically  
30 driven fluid pump in accordance with one embodiment of the present disclosure;

**[0012]** Figure 2 is an exploded side view of an upper portion of the pump shown in Figure 1 illustrating various component of an air inlet assembly of the pump;

**[0013]** Figure 3 is a side cross sectional view taken in accordance with section line 3-3 in Figure 1 illustrating how pressurized air is admitted to an interior of a

housing of the pump during a fluid discharge cycle and is caused to flow air and then water in a swirling action by the inlet subsystem to effectively scrub an interior wall of the pump casing; and

5       **[0014]**     Figure 4 is a cross section view of a nozzle that forms a portion of an air inlet cleaning subsystem for the pump.

#### DETAILED DESCRIPTION

10       **[0015]**     The following description is merely exemplary in nature and is not intended to limit the present disclosure, application, or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features.

15       **[0016]**     Referring to Figure 1 a pump 10 is shown in accordance with one embodiment of the present disclosure. In this example the pump 10 is of the type that is well suited for use in a wellbore. The pump 10 includes a pump cap 12 secured to a first (i.e., upper) end 14 of a pump casing 16. A screened inlet 18 is disposed at a second (i.e., lower) end 20 of the pump casing 16. The pump cap 12 has a fluid discharge fitting 22 and an air inlet fitting 24 (e.g., a well-known quick release style fitting) which are both coupled to the pump cap 12. A fluid discharge conduit 26, typically a flexible plastic, elastomeric or rubber tubing, is coupled to the fluid discharge fitting 22 (for example, a well-known quick release style fitting) for transmitting fluid collected in and discharged from the pump 10 out from a wellbore. An air inlet conduit 28, which may also be a rigid or flexible conduit made from plastic, elastomer, rubber or any other suitable material, is coupled to the air inlet fitting 24 and supplies pressurized air into an interior chamber of the pump 10 formed within the pump casing 16 during a fluid pumping or ejection cycle. While not shown in Figure 1, the pump 10 often incorporates a float assembly which is used to sense a level of fluid within the wellbore in which the pump 10 is located, and controls valving associated with the fluid discharge fitting 22 and the air inlet fitting 24 to control the admission and interruption of the pressurized airflow into the interior of the pump 10, and thus the cyclic ejection of fluid collected within the pump 10. However, the pump 10 of the present disclosure is not limited to use with pumps that employ a float, but rather may be used with any other type of fluid level sensing system.

25       **[0017]**     In Figure 2, internal components of the pump 10 that form a self-cleaning air inlet subsystem 30 (hereinafter simply "air inlet subsystem 30") are shown.

In this example the air inlet subsystem 30 may include a nozzle 32 and an air deflector 34. In this example the nozzle 32 includes a main body portion 36 and a threaded end portion 38 that may be threadably engaged with a threaded bore 39 in the pump cap 12. With brief reference to Figure 4, the nozzle 32 includes a bore 40 having a hole 42  
5 formed in the main body portion 36, for example by drilling or any other form of machining, which communicates with the bore 40. The hole 42 may be formed parallel to the bore 40 or at some angle which is non-parallel to the bore 40, depending on the placement of the nozzle 32 within the pump casing 16. In one example the hole 42 may be formed at an angle to the bore 40 so that it is angled downwardly toward the  
10 deflector 34 when the nozzle 32 is installed in the pump 10.

**[0018]** With continued reference to Figure 2, the air inlet fitting 24 includes a threaded portion 44 which engages within the threaded bore 39 so that pressurized air may be communicated from air inlet conduit 28, through the threaded bore 39 and into an interior area 46 of the pump casing 16. A rigid fluid discharge tube 48 extends  
15 longitudinally into the interior area 46 of the pump casing 16 for initially receiving fluid ejected from the interior area 46 during a fluid ejection cycle.

**[0019]** With further reference to Figure 2, the air deflector 34 in this example forms a sleeve-like element that may be inserted over a portion of the fluid discharge tube 48 and secured thereto via pin 50 or similar threaded component that extends  
20 through the fluid discharge tube 48. Alternatively the air deflector 34 may be secured by adhesives, by a physical hose-style clamp, or by any other suitable means that maintains it positioned at a desired location along the length of the fluid discharge tube 48 and does not impede fluid flow through the fluid discharge tube. Still further, it is possible for the air deflector 34 to be formed such that it is able to snap into a groove  
25 formed on the fluid discharge tube 48, or could be formed to be positioned over a circumferential groove in the fluid discharge tube and held thereon with a suitable clamp. Still further, it is possible that the fluid discharge tube 48 and the air deflector 34 may be formed as a single integrated component, for example as a single piece component molded from plastic using a suitable molding process (e.g., injection  
30 molding or spun formed).

**[0020]** The air deflector 34 may include an outwardly flaring portion 52 at a lower end thereof which is sized to have a diameter just slightly smaller than an internal diameter of the outer pump housing (e.g., by a few millimeters). This enables pressurized air received from the air inlet conduit 28 to be deflected and formed into a

circumferentially swirling airflow by the air deflector 34 that flows past an outermost edge 54 of the air deflector 34 and downwardly towards a lower end of the pump casing 16, to enable substantially all of the fluid which has accumulated in the interior area 46 to be ejected upwardly through the fluid discharge tube 48.

5           **[0021]** In another embodiment, the swirling airflow may be formed by presenting the pressurized airflow flowing through the nozzle 32 such that the pressurized airflow is presented to an underside 52a of the outwardly flaring portion 52. This will involve orientating the nozzle 32 to direct the pressurized airflow through the hole 42 in an upwardly directed, or upwardly/laterally directed manner, toward the  
10 underside 52a. Still further, a swirling airflow within the pump casing 16 may be achieved by presenting the pressurized airflow leaving the hole 42 directly at an inside wall surface 16a of the pump casing 16 either normal to the inside wall or at some non-perpendicular angle to the inside wall surface 16a. Still further, the swirling airflow may be created by directing the pressurized airflow leaving the hole 42 at the fluid discharge  
15 tube and/or at a groove-like or undulating outer surface of the fluid discharge tube, or even smooth outer surface of the fluid discharge tube. Still further, a helix may be machined on the inside wall surface 16a and/or a baffle positioned within the pump casing 16, to help create the swirling airflow 56. Still further combinations of the above features may be used, for example, a helix groove formed on the inside wall surface  
20 16a of the pump casing 16 along with the air deflector 34, and also a grooved/undulating outer surface on an exposed section of the fluid discharge tube 48. Thus, two, three or more distinct airflow generating/enhancing features may be employed within the pump casing 16 to create the swirling airflow.

**[0022]** It will be appreciated that the nozzle 32 could be formed as a manifold  
25 with two or more holes 42 spaced apart angularly and/or vertically to even further shape the swirling airflow. Still further, if the nozzle 32 is formed as a manifold with two or more holes 42, it could be formed so as to wrap partially around the fluid discharge tube 48.

**[0023]** Referring to Figure 3, example of the circumferential, swirling airflow is  
30 indicated by lines 56. This example assumes that the circumferential, swirling airflow 56 is created as pressurized air exits the hole 42 in the nozzle 32 and is deflected on an upper surface 52b of the air deflector 34. The flared shape of the air deflector 34, and particularly the outwardly flaring portion 52, induce the swirling motion to the airflow and helps to direct the airflow into contact with the inside wall surface 16a of the pump

casing 16. This forms a powerful swirling air column which effects a rotating air and water scrubbing action that removes debris and contaminants which have adhered to the inside wall surface 16a of the pump casing 16 as the fluid level within the pump casing 16 drops during a fluid ejection cycle. The rotating air/water column also serves  
5 to loosen debris at the pump inlet (i.e., hidden beneath screened inlet 18 in Figure 1) at the second (i.e., lower) end of the pump casing 16. Moreover, this scrubbing action occurs during every fluid ejection cycle.

**[0024]** It is a significant advantage that the implementation of the nozzle 32 and the air deflector 34 do not interfere with the collection of fluid inside the pump casing 16, and do not require modification to the valving (not shown) used to control the  
10 fluid ejection cycle, or any modifications to the pump cap 12. Still further, the nozzle 32 and the air deflector 34 do not necessitate enlarging the pump casing 16 or necessitate modifying the internal construction of the pump 10, or significantly add to its cost, complexity or weight. The air inlet subsystem 30 is expected to significantly lengthen  
15 the intervals between required cleanings of the pump 10, or potentially even eliminate entirely the need for periodic cleanings.

**[0025]** While various embodiments have been described, those skilled in the art will recognize modifications or variations which might be made without departing from the present disclosure. The examples illustrate the various embodiments and are  
20 not intended to limit the present disclosure. Therefore, the description and claims should be interpreted liberally with only such limitation as is necessary in view of the pertinent prior art.

## CLAIMS

What is claimed is:

1. A pneumatically driven fluid pump apparatus, comprising:

a pump casing;

5 a pump cap secured at a first end of the pump casing;

a liquid discharge tube in communication with the pump cap and extending at least partially within an interior area of the pump casing toward a second end of the pump casing, and where fluid is admitted into the pump casing at the second end;

10 a fluid discharge tube in communication with the pump cap for receiving liquid collected within the pump casing and discharged through the liquid discharge tube;

the pump cap including:

a first portion for receiving a pressurized airflow from an external pressurized air source, where the pressurized air is used to help displace liquid collecting within the pump casing upwardly through the liquid discharge tube; and

15 a second portion in communication with the first portion and also with the interior area of the pump casing, which directs the pressurized air received through the first portion toward an interior wall portion of the pump casing to create a swirling airflow within the casing, the swirling airflow moving in a swirling manner toward the second end of the pump casing to help clean the interior wall portion of the pump casing, while  
20 also imparting a swirling action to the liquid having collected within the pump casing, and ejecting the swirling liquid upwardly into and through the fluid discharge tube.

2. The apparatus of claim 1, further comprising an air deflector positioned within the pump casing for deflecting the pressurized airflow from the second portion of the  
25 pump cap and helping to create the swirling airflow.

3. The apparatus of claim 2, wherein the air deflector forms an outwardly flaring element having a diameter smaller than an internal diameter of the pump casing.

30 4. The apparatus of claim 2, wherein the air deflector is secured to the liquid discharge tube.

5. The apparatus of claim 4, wherein the air deflector includes a sleeve which fits over a portion of the liquid discharge tube such that the air deflector is positioned concentrically with the liquid discharge tube.

5 6. The apparatus of claim 1, wherein the second portion comprises a nozzle which projects from the pump cap into the interior area of the pump casing.

7. The apparatus of claim 6, wherein the nozzle includes a threaded end portion which is threaded engaged with a threaded bore in the pump casing.

10

8. The apparatus of claim 6, wherein the nozzle includes:

a bore; and

a hole in communication with the bore, where the hole directing the pressurized airflow received through the bore outwardly from the nozzle toward the interior wall portion of the pump casing to help initiate the swirling airflow.

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9. The apparatus of claim 6, further comprising, wherein the nozzle includes a bore and a hole in communication with the bore, with the hole orientated to direct the pressurized air outwardly from the nozzle towards an axial centerline of the pump casing.

20

10. A pneumatically driven fluid pump apparatus, comprising:  
a pump casing;  
a pump cap secured at a first end of the pump casing;  
a liquid discharge tube in communication with the pump cap and extending at  
5 least partially within an interior area of the pump casing toward a second end of the  
pump casing, and where liquid is admitted into the pump casing at the second end;  
a fluid discharge tube in communication with the pump cap for receiving liquid  
collected within the pump casing and discharged through the liquid discharge tube;  
the pump cap including:  
10 a first portion for receiving a pressurized airflow from an external  
pressurized air source; and  
a second portion in communication with the first portion and also with the  
interior area of the pump casing, which directs the pressurized air received through the  
first portion toward an interior wall portion of the pump casing to create a swirling airflow  
15 within the pump casing; and  
an air deflector disposed in the pump casing in the path of the pressurized air  
discharged from the second portion of the pump cap, the air deflector further helping to  
create the swirling airflow within the pump casing, while also imparting a swirling action  
to the liquid having collected within the pump casing, while also forcing the swirling  
20 liquid upwardly into and through the liquid discharge tube.
11. The apparatus of claim 10, wherein the air deflector includes an outwardly  
flaring portion for assisting in creating the swirling airflow.
- 25 12. The apparatus of claim 11, wherein the outwardly flaring portion is cylindrical.
13. The apparatus of claim 11, wherein the outwardly flaring portion has a  
diameter at least about 1mm smaller than an internal diameter of the pump casing.
- 30 14. The apparatus of claim 10, wherein the air deflector is fixedly secured to the  
liquid discharge tube.

15. The apparatus of claim 14, wherein the air deflector is fixedly to the liquid discharge tube at a point along the liquid discharge tube closer to the first end of the pump casing than the second end of the pump casing.

5           16. The apparatus of claim 10, wherein the air deflector forms a sleeve-like device and is attached over the liquid discharge tube to reside concentrically with the liquid discharge tube.

10           17. The apparatus of claim 13, wherein the second portion of the pump cap comprises a nozzle in communication with the first portion.

18. The apparatus of claim 17, wherein nozzle includes a threaded end portion and is threadably engaged with a threaded bore in the pump cap.

15           19. The apparatus of claim 18, wherein the nozzle includes a bore and a hole in communication with the bore, where the hole directs airflow travelling through the bore outwardly from the nozzle at an angle to impinge at least one of:  
            the interior wall portion of the pump; or  
            the air deflector.

20

20. A method for cleaning an interior area of a pump casing of a pneumatically driven fluid pump, the method comprising:

5 using a pump cap secured to a first end of an elongated, tubular pump to receive a pressurized airflow from a remote pressurized air generating device, to be admitted into an interior area of the pump casing;

using a liquid discharge tube in communication with the pump cap and extending at least partially within an interior area of the pump casing toward a second end of the pump casing, to receive liquid which has been admitted into the pump casing at a second end of the pump casing;

10 directing the pressurized airflow received at the pump cap through the pump cap into a nozzle portion operably associated with the pump cap; and

15 using the nozzle portion to turn the pressurized fluid into a swirling airflow within the pump casing that travels in a swirling path along an interior wall portion of the pump casing toward the second end of the pump casing, to thus clean the pump casing, while imparting a swirling action to the liquid collecting within the pump casing as the swirling liquid is forced upwardly into, and through, the liquid discharge tube out from the pump casing.

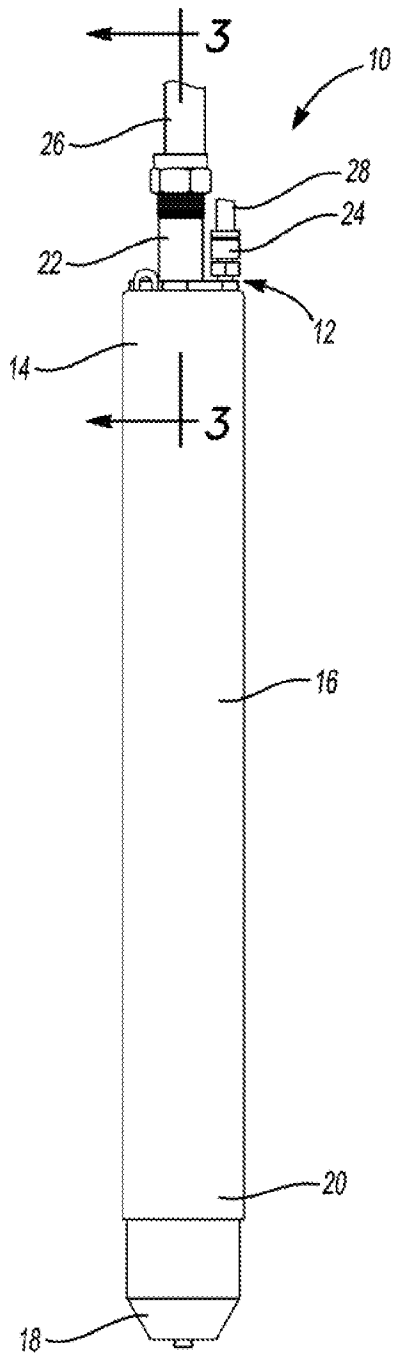


Fig-1

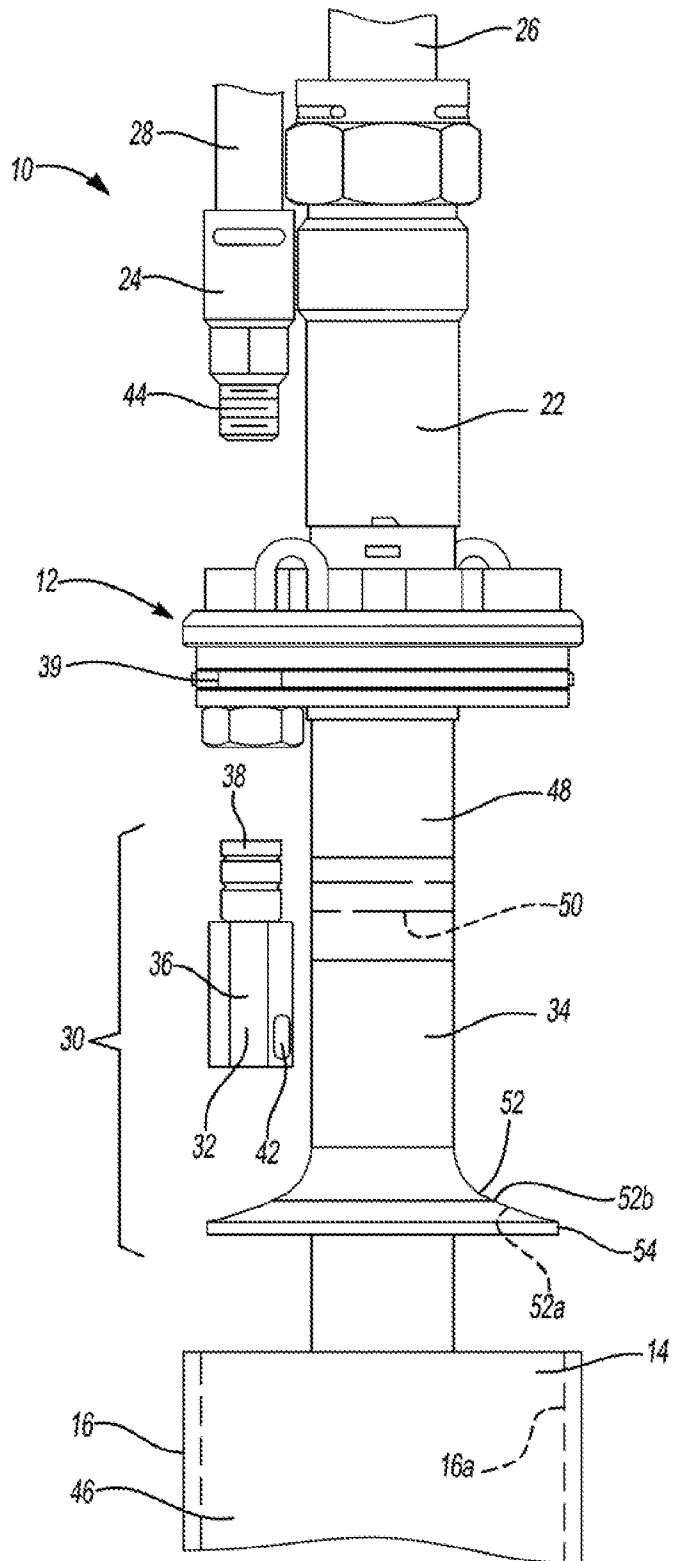
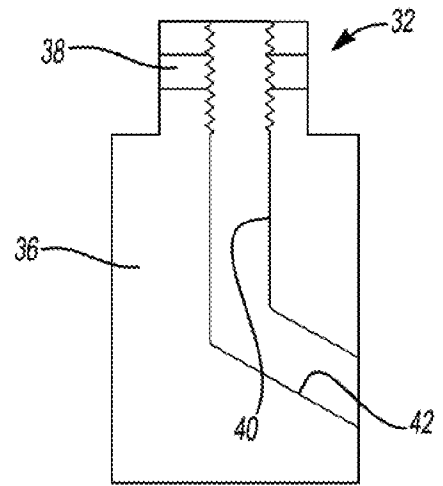
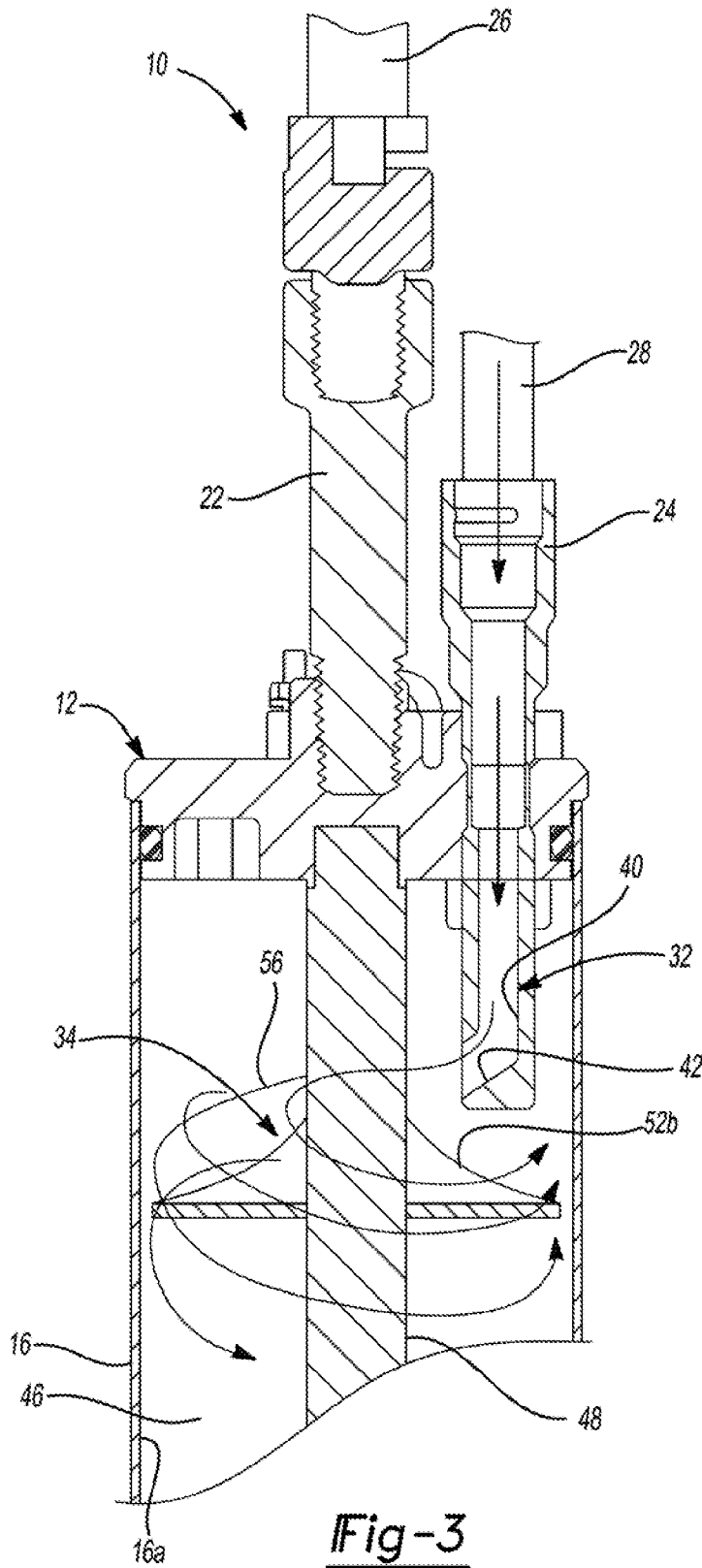


Fig-2



## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/US2018/066144****A. CLASSIFICATION OF SUBJECT MATTER****F04B 9/12(2006.01)i, F04B 53/16(2006.01)j**

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

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

F04B 9/12; B01D 17/038; B01D 33/27; E21B 27/00; F04B 13/02; F04B 47/00; F04B 47/08; F04B 53/10; F04B 53/16

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

Korean utility models and applications for utility models  
Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) &amp; Keywords: pneumatic, fluid, pump, pressurized air, clean and drilling

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5147185 A (NIEHAUS, K. LYNN et al.) 15 September 1992 See column 7, line 1-column 9, line 34 and figures 1-2.	1-20
A	US 2012-0061073 A1 (SONI, MOHAN L. et al.) 15 March 2012 See paragraphs [0023]-[0024] and figure 8.	1-20
A	US 2003-0196952 A1 (KAMPFEN, THEODORE A.) 23 October 2003 See paragraphs [0019]-[0032] and figures 2-6.	1-20
A	CN 105275766 A (QIAN JIANCUN) 27 January 2016 See paragraphs [0025]-[0044] and figures 1-6.	1-20
A	CN 106246518 A (CHINA UNIVERSITY OF PETROLEUM (EAST CHINA)) 21 December 2016 See paragraphs [0024]-[0029] and figures 10-11.	1-20

 Further documents are listed in the continuation of Box C. See patent family annex.

\* Special categories of cited documents:

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

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Date of the actual completion of the international search

08 April 2019 (08.04.2019)

Date of mailing of the international search report

**08 April 2019 (08.04.2019)**

Name and mailing address of the ISA/KR

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## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

**PCT/US2018/066144**

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