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(54) **APPARATUS AND METHOD FOR MIXING PRESSURIZED FLUID AND ADDITIVE, WORK MACHINE, FIRE FIGHTING EQUIPMENT, AND RESCUE VEHICLE**

(57) Here, an apparatus for mixing pressurised fluid and an additive is presented. The apparatus (2) includes an inlet (5) for the feed-in of pressurised fluid, an additive container (10a, 10b) and an outlet (6) for the output of the mixture of the pressurised fluid and the additive. The pressurised fluid is divided into a part conveyed to the additive container and a remaining part. The additive container (10a, 10b) is pressurised and additive is conveyed

from the additive container (10a, 10b) into connection with said remaining part to form a mixture of the pressurised fluid and the additive, which mixture is conveyed to said outlet (6). The apparatus includes at least two additive containers (10a, 10b). By a valve arrangement (14), the additive is fed alternately from different additive containers (10a, 10b) into connection with the pressurised fluid.

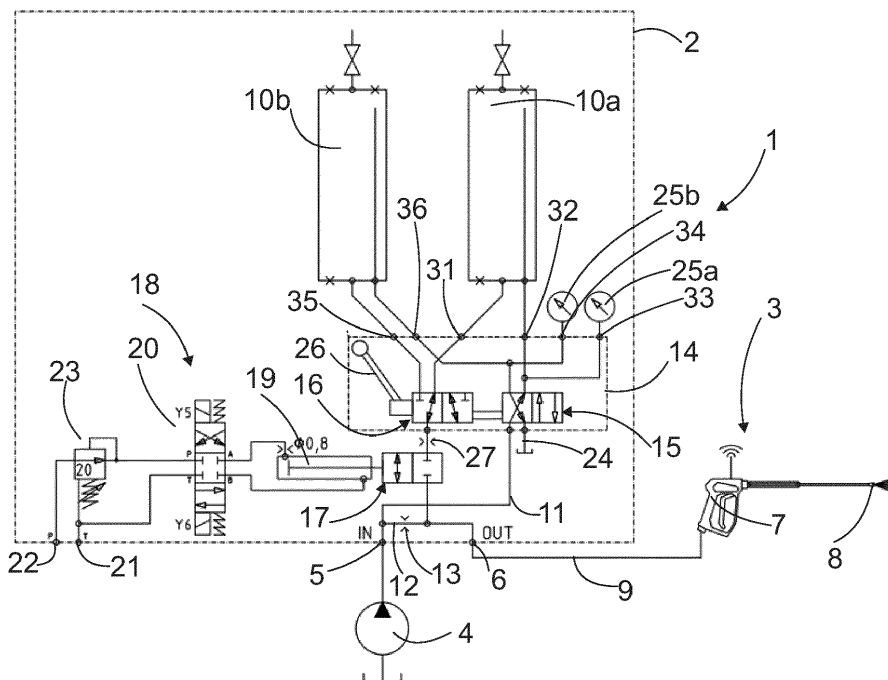


FIG. 1

Description

Background of the invention

[0001] The invention relates to the mixing of pressurised fluid and an additive, and particularly to the mixing of an abrasive to pressurised water.

[0002] The mixture of pressurised fluid and an additive is used, for example, in treating structures and materials, such as when making grooves and holes, in water cutting or in coating removal. A solution for mixing liquid and an additive is described in specification EP2168722A1.

Brief description of the invention

[0003] The object of the invention is to develop a novel type of an apparatus and a method for mixing pressurised fluid and an additive, a work machine, a fire-fighting apparatus and a rescue vehicle. The solution according to the invention is characterised by what is disclosed in the independent claims. Some embodiments of the invention are disclosed in the dependent claims.

[0004] Here, an apparatus for mixing pressurised fluid and an additive is presented. The apparatus includes an inlet for the feed-in of pressurised fluid, an additive container and an outlet for the output of the mixture of the fluid and the additive. The pressurised fluid is divided into a part conveyed to the additive container and a remaining part. The additive container is pressurised and the additive is conveyed from the additive container into connection with said remaining part to form a mixture of the pressurised fluid and the additive together with the remaining part, which mixture is conveyed to said outlet. The apparatus further includes at least two additive containers. By a valve arrangement, the additive is fed alternately from different additive containers into connection with the pressurised fluid. In this manner, the additive can be obtained from the additive container and mixed with the fluid reliably and without interruptions. Furthermore, it is possible to feed the additive in the desired moment, and the emptying of one additive container, for instance, does not cause an interruption in the feed of the additive or the use of the apparatus. The pressurised fluid can be some liquid or gas. Some examples of fluid are water and air. The additive can be an abrasive, for instance. An example of an abrasive is sand, the grain size of which can be e.g. 0.2-2.0 mm. According to an example, the grain size of the abrasive can be 0.001-3 mm. The additive can be e.g. mineral, metal, iron or glass in the form of grains, balls or powder or bentonite or clay or some other additive suitable for the purpose in question.

[0005] According to an embodiment, the valve arrangement comprises at least two valves, the first of which is in a first position arranged to let pressurised fluid into a first additive container and the second valve is in an equivalent first position arranged to let additive from the first additive container into connection with the remaining part of pressurised fluid. Furthermore, the first

valve is in a second position arranged to let pressurised fluid into a second additive container and the second valve is in an equivalent second position arranged to let additive from the second additive container into connection with the remaining part of pressurised fluid. This type of solution is simple and reliable.

[0006] According to an embodiment, the additive container, from which the additive is fed at the time, is pressurised and, at the same time, pressure in the other additive container is depressurised. Then, it is easily possible to e.g. add some additive in the additive container which has been depressurised. According to an embodiment, the depressurisation is done such that the first valve is in said first position arranged to let pressure to depressurise from the second additive container and in said second position arranged to let pressure to depressurise from the first additive container. Thus, the solution can be implemented in a simple manner and e.g. the number of valves can be kept small.

[0007] According to an embodiment, the first and the second valve are mechanically connected to transfer simultaneously between the first and the second position. This type of solution is simple, dependable and reliable.

[0008] According to an embodiment, channels of the valves are formed in a uniform spindle, preferably of cylindrical shape, which spindle is rotatable around its axis from the first position of the valves to the second position of the valves and back. Such a structure is durable and reliable.

[0009] According to an embodiment, the pressurised fluid is water and the additive can be an abrasive, such as sand. Then, the apparatus can be used e.g. for water cutting and/or firefighting.

[0010] The presented apparatus can be used, for example, in treating structures and materials, such as when making grooves and holes, in water cutting or in coating removal. The apparatus can be used for treating e.g. stone, concrete or some other hard material. The apparatus can be used e.g. when repairing bridges to chisel the old gripping surface. Further uses can be e.g. removing a surface, removing road markings and removing rubber from an airfield etc.

[0011] Here is additionally presented a work machine which includes an apparatus described in this connection. The work machine can be e.g. a building machine or an equivalent device which is used on a work site. Furthermore, the work machine can be a moving work machine, such as a maintenance vehicle, a digging machine or a loader.

[0012] Here is further presented a fire-fighting apparatus which includes a source of pressurised water, a fire-fighting device and an apparatus described in this connection. Furthermore, here is presented a rescue vehicle which includes a fire-fighting apparatus in question.

Brief description of the drawings

[0013] The invention is now described in closer detail

in connection with some embodiments and with reference to the accompanying drawings, in which:

Fig. 1 shows a simplified diagram of a water cutting system;

Fig. 2 is a diagonal schematic top view of a structure of a valve arrangement;

Fig. 3 shows a cross section of the valve arrangement of Figure 2 at the point of a 3/2 valve; and

Fig. 4 shows a cross section of the valve arrangement of Figure 2 at the point of a 4/2 valve.

Detailed description of the invention

[0014] Fig. 1 shows a water cutting system which is in the presented embodiment a fire-fighting apparatus 1. The fire-fighting apparatus 1 includes a source of pressurised water, an apparatus 2 arranged for mixing fluid and an additive and a fire-fighting device 3.

[0015] In the presented embodiment, the source of pressurised water is a highpressure pump 4 which is connectable to a water connection and which is connected to feed pressurised water to an inlet 5 of the apparatus 2 arranged for mixing fluid and an additive. A mixture of water and an abrasive operating as the additive is fed from an outlet 6 of the apparatus 2 to the fire-fighting device 3. The fire-fighting device 3 can include a gun part 7 and a nozzle 8. The mixture is sprayed from the nozzle 8 of the fire-fighting device 3 to a target. The fire-fighting device 3 is connected with a hose 9 to the outlet 6. The length of the hose 9 can be e.g. 1-200 m.

[0016] The apparatus 2 has two additive containers 10a and 10b. After the inlet 5, a part of the pressurised fluid is conveyed to a channel 11 to be conveyed to the additive container 10a or 10b. The remainder of the pressurised fluid is conveyed via the channel 12 to the outlet 6. The channel 12 can be arranged with a choke 13 which causes/ensures that there is a pressure difference between the inlet and the outlet of the additive container.

[0017] By the valve arrangement 14, it is selected which one of the additive containers 10a or 10b will be pressurised. Furthermore by means of the valve arrangement 14, additive is conveyed from the pressurised additive container in question into connection with the remaining part of the pressurised fluid. The mixture of the pressurised fluid and the additive is conveyed to the outlet 6. By means of the valve arrangement 14, it is also possible to depressurise the pressure in the unpressurised additive container.

[0018] The valve arrangement 14 has a first valve 15 which is arranged in a first position shown in Fig. 1 to let pressurised fluid into the first additive container 10a. The valve arrangement 14 further has a second valve 16 which is arranged in an equivalent first position to let additive from the first additive container 10a into connection with the remaining part of the pressurised fluid. From the additive container, the additive flows by means of gravity. The additive coming from the additive container can also

contain some fluid.

[0019] Between the second valve 16 and the outlet 6, there can be an on-off valve 17. The on-off valve 17 can be controlled e.g. from the fire-fighting device 7 and it can be used to select if additive is fed among the fluid or not.

[0020] The amount of additive being fed among the fluid can be determined e.g. by means of the sizes of the channel systems. Typically, the share of additive in the mixture is 0.5-10%. In order to be able to adjust the amount of the additive, it is also possible to arrange a choke 27 e.g. between the second valve 16 and the on-off valve 17.

[0021] In the embodiment shown in Fig. 1, the on-off valve 17 is controlled by a hydraulic control arrangement 18. The hydraulic control arrangement 18 includes a control cylinder 19, the position of the spindle of which is controlled by a control valve 20. The control valve 20 can be controlled by a control signal e.g. from the fire-fighting device 7. The control signal can be e.g. an electrical signal and it can be transmitted from the fire-fighting device 7 to the control valve 20 e.g. electrically.

[0022] With regard to the hydraulic control arrangement 18, Fig. 1 additionally shows connectors 21 and 22 by which the apparatus 2 is connected to hydraulic lines and a pressure-balancing valve 23. Instead of the hydraulic control arrangement 18, the on-off valve 17 can be controlled e.g. by a pneumatic control arrangement or some other control arrangement suitable for the purpose.

[0023] When the first valve 15 and the second valve 16 are transferred to a second position, the first valve 15 is arranged to let pressurised fluid into the second additive container 10b. The second valve 16 is arranged in an equivalent second position to let additive from the second additive container 10b into connection with the remaining part of the pressurised fluid.

[0024] The first valve 15 is in said first position arranged to let the pressure depressurise from the second additive container 10b. In said second position, the first valve is arranged to let the pressure depressurise from the first additive container 10a. In the presented embodiment, the first valve 15 is a 4/2 directional valve and the second valve 16 is a 3/2 directional valve.

[0025] The pressure is depressurised into a depressurisation fitting 24. The depressurisation fitting can comprise e.g. a hose by which pressure is conveyed into a surrounding space. It is possible that e.g. air can flow from the depressurisation fitting 24 which air is let inside the additive container when filling the additive container. Furthermore, it is possible that fluid, such as water, can flow from the depressurisation fitting 24 from inside the additive container.

[0026] The valve arrangement 14 is also connected with pressure gauges 25a and 25b. The first pressure gauge 25a shows the magnitude of pressure in the first additive container 10a and the second pressure gauge 25b shows the magnitude of pressure in the second ad-

ditive container 10b.

[0027] The first valve 15 and the second valve 16 are transferred from the first position to the second position and back by turning an operating handle 26. The first valve 15 and the second valve 16 are connected to each other mechanically. Hence, the moving of the operating handle 26 makes the valves 15 and 16 simultaneously transfer between the first and the second position.

[0028] The structure of the valve arrangement 14 is shown in Figs. 2, 3 and 4. The channels of the valves 15 and 16 are formed in a uniform spindle 28. The spindle 28 is of cylindrical shape. At the end of the spindle 28 is fastened the operating handle 26 by which the spindle is turned around its axis. The range of movement of the operating handle 26 is limited by pins 29.

[0029] The spindle 28 is fitted inside a valve body 30. The spindle 28 is sealed into connection with the body 30 by means of seals fitted around the spindle 28. The profile of the seal can be such that it includes a two-part lip.

[0030] Fig. 2 additionally shows fittings 31 ja 32 by which the valve arrangement 14 is connected to the first additive container 10a. Furthermore, Fig. 2 shows fittings 33 and 34 into which are connected pressure gauges 25a and 25b. Fittings 35 and 36, by which the valve arrangement 14 is connected to the second additive container 10b, are shown in Figs. 3 and 4.

[0031] Figure 4 also shows a bore 37. Pressure is depressurised via the bore 37. In connection with the bore 37 at the opposite end in relation to the operating handle 26 of the spindle, there is a depressurisation fitting 24 which can include e.g. a thread into which a depressurisation hose is attachable.

[0032] The apparatus 2 for mixing pressurised fluid and an additive can be arranged into connection with a moving device, such as a work machine or a vehicle. On the other hand, the whole fire-fighting apparatus 1 can be arranged into connection with a moving device, such as a work machine or a vehicle.

[0033] Those skilled in the art will find it obvious that, as technology advances, the basic idea of the invention may be implemented in many different ways. The invention and its embodiments are thus not restricted to the examples described above but may vary within the scope of the claims.

Claims

1. An apparatus for mixing pressurised fluid and an additive, which apparatus (2) includes an inlet (5) for the feed-in of the pressurised fluid, an additive container (10a, 10b), an outlet (6) for the output of the mixture of the fluid and the additive, an arrangement for dividing the pressurised fluid into a part to be conveyed to the additive container (10a, 10b) and a remaining part, whereby from the additive container (10a, 10b) is arranged to convey additive into con-

nection with said remaining part to form a mixture of the pressurised fluid and the additive, which is arranged to be conveyed to said outlet (6), which apparatus (2) includes at least two additive containers (10a, 10b) and a valve arrangement (14) for connecting the different additive containers (10a, 10b) alternately to feed the additive into connection with the pressurised fluid, **characterised in that** the valve arrangement (14) comprises at least two valves (15, 16), the first valve (15) of which is in a first position arranged to let pressurised fluid to the first additive container (10a) and the second valve (16) is in an equivalent first position arranged to let additive from the first additive container (10a) into connection with the remaining part of the pressurised fluid and the first valve (15) in question is in a second position arranged to let pressurised fluid into the second additive container (10b) and the second valve (16) in question is in an equivalent second position arranged to let additive from the second additive container (10b) into connection with the remaining part of the pressurised fluid.

2. An apparatus according to claim 1, wherein the first valve (15) is in said first position arranged to let pressure to depressurise from the second additive container (10b) and in said second position arranged to let pressure to depressurise from the first additive container (10a).
3. An apparatus according to claim 1 or 2, wherein the first valve (15) and the second valve (16) are mechanically connected to transfer simultaneously between the first and the second position.
4. An apparatus according to claim 3, wherein channels of the valves (15, 16) are formed in a uniform spindle (28) which is rotatable around its axis from the first position of the valves (15, 16) to the second position of the valves and back.
5. An apparatus according to claim 4, wherein the spindle (28) is of cylindrical shape.
6. An apparatus according to any one of previous claims, wherein the first valve (15) is a 4/2 directional valve and the second valve (16) is a 3/2 directional valve.
7. An apparatus according to any one of previous claims, wherein the pressurised fluid is water.
8. An apparatus according to any one of previous claims, wherein the additive is an abrasive, such as sand.
9. A method for mixing pressurised fluid and an additive, the method comprising dividing the pressurised

fluid into a part to be conveyed to an additive container (10a, 10b) and a remaining part, pressurising the additive container (10a, 10b), conveying additive from the additive container (10a, 10b) into connection with said remaining part to form a mixture of the pressurised fluid and the additive, providing at least two additive containers (10b, 10a) and feeding the additive alternately from different additive containers (10a, 10b) into connection with the pressurised fluid, **characterised by** providing a valve arrangement (14), which comprises at least two valves (15, 16), letting in a first position of the first valve (15) pressurised fluid to the first additive container (10a) and letting in an equivalent first position of the second valve (16) additive from the first additive container (10a) into connection with the remaining part of the pressurised fluid and letting in a second position of the first valve (15) in question pressurised fluid into the second additive container (10b) and letting in an equivalent second position of the second valve (16) in question additive from the second additive container (10b) into connection with the remaining part of the pressurised fluid.

10. A method according to claim 9, comprising pressurising the additive container (10a, 10b), from which the additive is fed at the time, and, at the same time, depressurising the other additive container (10a, 10b).
11. A work machine which includes an apparatus according to any one of claims 1 to 8.
12. A work machine according to claim 11, which work machine is a moving work machine.
13. A fire-fighting apparatus, which includes a source of pressurised water, a fire-fighting device (3) and an apparatus according to any one of claims 1 to 8.
14. A rescue vehicle which includes a fire-fighting apparatus according to claim 13.

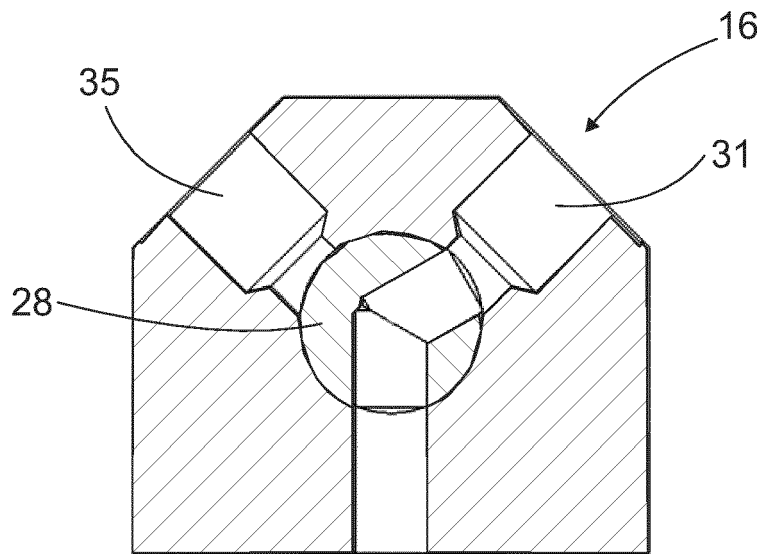


FIG. 3

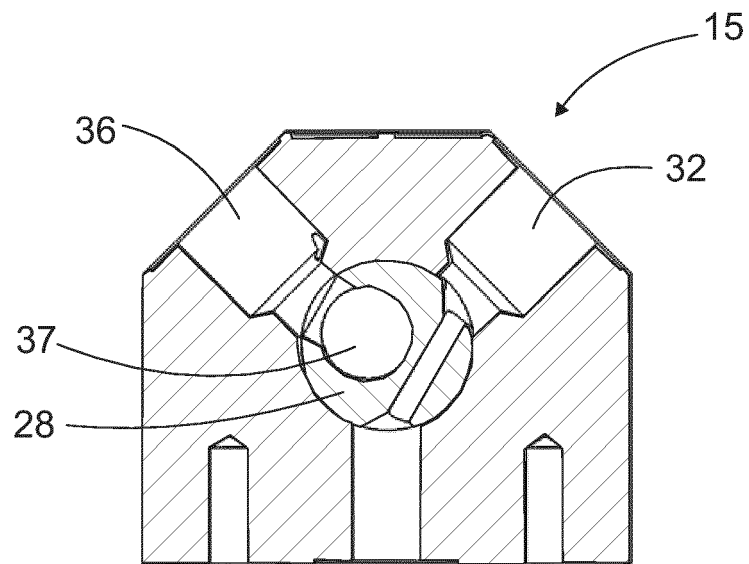


FIG. 4



EUROPEAN SEARCH REPORT

Application Number

EP 22 15 8831

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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