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(54) **DOSING DEVICE FOR INTRODUCING AN ADDITIVE INTO A LIQUID FLOW**

(75) Inventors: **Gilbert Barras**, Carignan Pres De Bordeaux (FR); **Matthieu Darbois**, Talence (FR)

Correspondence Address:
CONNOLLY BOVE LODGE & HUTZ LLP
1875 EYE STREET, N.W.
SUITE 1100
WASHINGTON, DC 20036 (US)

(73) Assignee: **Dosatron International**, Bordeaux (FR)

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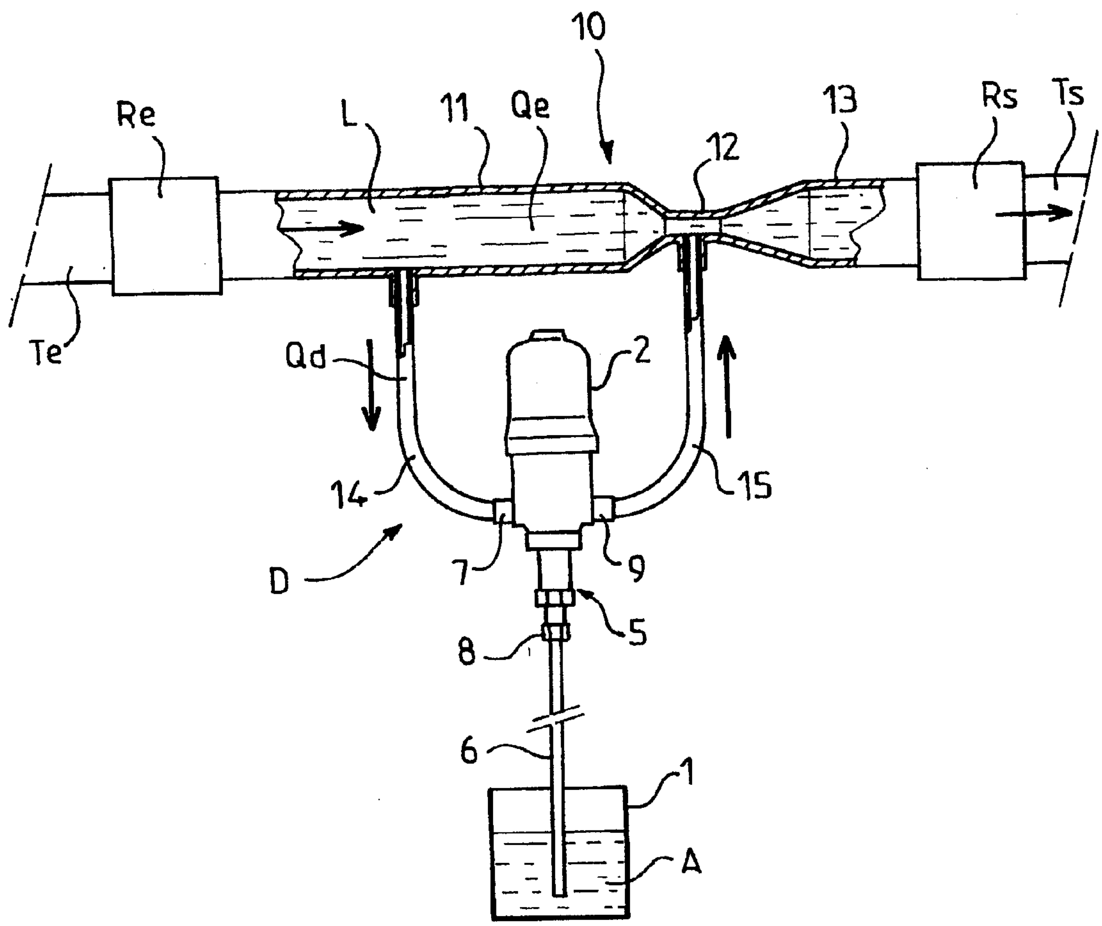
(57) **ABSTRACT**

The invention relates to a dosing device for introducing an additive (A) in to a main liquid flow (L) in a conduit comprising a reciprocating differential piston pump (**2**) which is used for collecting and dosing the additive (A) from a container (**1**) and comprises a first inlet (**7**) for receiving the main liquid flow which ensures the pump actuation, a second inlet (**8**) for collecting the additive and an outlet (**9**) for mixing the additive and the main liquid. The inventive device comprises a Venturi (**10**) disposed in the conduit and the pump (**2**) connected in parallel position with respect thereto, wherein the first inlet (**7**) of the pump is connected to the Venturi input (**11**) and the outlet thereof is connected to the Venturi throat (**12**).



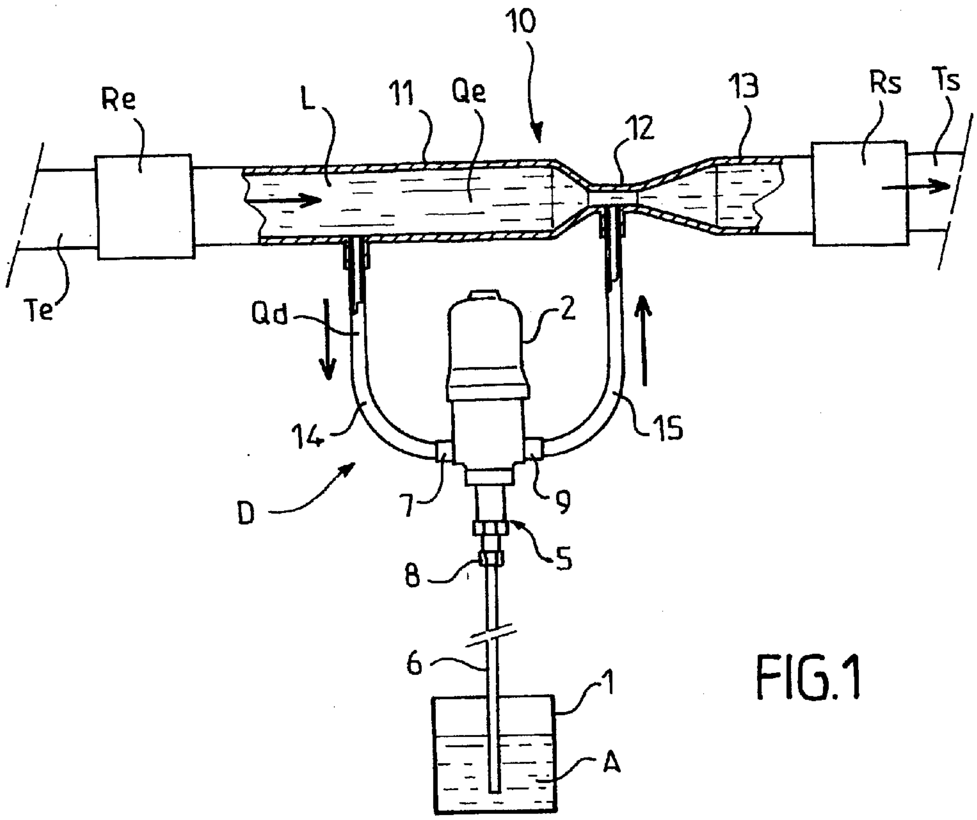


FIG.1

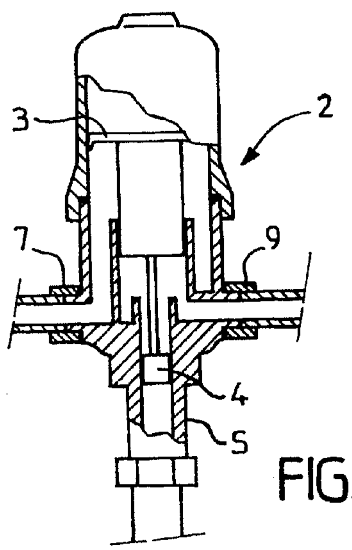


FIG.2

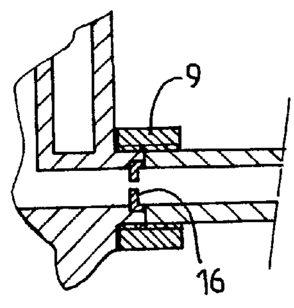


FIG.3

DOSING DEVICE FOR INTRODUCING AN ADDITIVE INTO A LIQUID FLOW

[0001] The invention relates to a dosing device for introducing an additive into a main liquid flow circulating in a conduit, which device comprises a reciprocating differential piston pump for taking up the additive into a container and dosing it, this pump including a first inlet for receiving a main liquid flow that drives the pump, a second inlet for taking up the additive, and an outlet for mixing the additive and the main liquid.

[0002] EP 1 151 196 or U.S. Pat. No. 6,684,753, for example, disclose dosing differential piston pumps that operate using a reciprocating piston motor technology. The drive liquid, which is generally water, passes through the pump and drives the piston. The reciprocating movement of the piston makes it possible to operate an alternative, second pump, incorporated in the first pump, for taking up the additive to be dosed and injecting it into the drive liquid or main liquid. This type of dosing pump offers numerous advantages:

[0003] the dosing volume ratio does not vary with the flow or pressure of the drive liquid;

[0004] the dosing pump offers a wide flow operating range, the upper limit being linked to the maximum permitted frequency;

[0005] dosing remains constant, despite flow variations;

[0006] operation is not over-sensitive to the pressure of the drive liquid; and

[0007] dosing can be regulated.

[0008] However, the upper values of the flows that a pump is able to handle are relatively limited because the cubic capacity of the pump and its dimensions increase with the maximum flow to be handled. Large flows require large pumps whose dimensions are necessarily limited by considerations of maximum overall size and of cost.

[0009] Furthermore, the dosing range is limited, in particular for achieving very small dosing rates, for example of the order of parts per million (ppm). The volumes of additive to be injected at each pump cycle thus become very small and cannot be obtained by a simple mechanical system.

[0010] WO 02/02938 proposes a device that allows small dosing rates. However, this device uses electric periodic control means and solenoid valves, which complicates the installation and increases the cost price.

[0011] A principal object of the invention is to provide a dosing device that allows, simply and inexpensively, handlling of high flows of main liquid with small pumps and makes it possible to increase the permitted dosing range, particularly in favor of small dosing rates.

[0012] According to the invention, a dosing device for introducing an additive into a main liquid flow circulating in a conduit, comprising a reciprocating differential piston pump for taking up the additive into a container and dosing it, this pump including a first inlet for receiving a main liquid flow that drives the pump, a second inlet for taking up the additive, and an outlet for mixing the additive and the main liquid, is characterized in that it comprises a venturi arranged in the conduit, and in that the pump is connected in parallel with the venturi, the first inlet of the pump being connected to the inlet of the venturi while the outlet of the pump is connected to the throat of the venturi.

[0013] Thus, only a fraction of the main liquid flow traverses the pump, and the pump can retain its small dimensions in order to provide dosing on a reduced secondary flow that is then mixed with the main flow.

[0014] Advantageously, the geometry of the venturi is adjusted to the pressure drop in the pump between the first inlet and the outlet in order to make it possible to obtain substantially constant dosing despite flow variations, independently of the inlet pressure.

[0015] The geometry of the venturi may be adjusted in order to establish, in operation, a pressure difference of approximately 1.5 bar and less than 2 bar between the inlet pressure and the pressure at the throat. Moreover, the geometry of the venturi may be adjusted such that the pressure drop created by the venturi is less than 0.5 bar.

[0016] An additional pressure drop may be created in the secondary circuit of the pump, in particular by a jet, especially an adjustable jet, preferably arranged at the outlet of the pump.

[0017] The venturi may be regulated such that the ratio of the flow Qe passing through the venturi to the secondary flow Qd passing through the pump is equal to R so that with a pump enabling a flow Qd to be handled at a dosing rate x% the device makes it possible to handle a flow Qe=Qd.R, at a dosing rate close to x/R%. The venturi may be regulated such that the ratio R is at least equal to ten or close to ten. Significant flows may thus be handled by small pumps.

[0018] In the case of small dosing rates, the ratio R may be above one hundred. The pump may be provided in order to allow a volume ratio between injected additive flow and drive liquid flow passing through the pump that is less than or equal to one one thousandth (1/1000), while the volume dilution of the mixture exiting the pump in the main flow passing through the venturi is less than one percent (1%) such that the volume dosing in the main flow is less than or equal to 10^{-5} or 10 ppm (10 parts per million).

[0019] Advantageously, the venturi and the pump form a single unit, and connecting means are provided at the inlet and at the outlet of the venturi for its insertion and connection to two portions of the conduit.

[0020] Aside from the arrangements set forth above, the invention consists of a number of other arrangements that will be described in greater detail below by way of an illustrative example described with reference to the appended drawing, but which is in no way limiting.

[0021] In this drawing:

[0022] FIG. **1** is a diagram, partly exterior, partly in section, of an installation with a dosing device according to the invention;

[0023] FIG. **2** is a simplified schematic view, with part torn away, of the pump of the device; and

[0024] FIG. **3** shows, in section, on a larger scale, a detail of a variant embodiment.

[0025] With reference to FIG. **1**, it is possible to see a dosing device D for introducing a liquid additive A into a main liquid flow L, this being a flow of water in the example in question. The liquid additive A is contained in a container **1**.

[**0026**] The device D comprises a dosing pump **2** arranged with its axis vertical. The pump **2** is of a known type, in particular one manufactured and marketed by the applicant company, Dosatron International. An example of such pumps is described in EP 1 151 196 and U.S. Pat. No. 6,684,753.

[**0027**] As illustrated schematically in FIG. **2**, generally speaking the pump **2** includes a reciprocating differential piston **3** that drives a piston **4**, of smaller diameter, that provides pumping and injection of the additive A. The piston **4** slides in a cylindrical chamber of an auxiliary pump **5** connected by a take-up tube **6** to the container **1**. The tube **6** is immersed in the additive A to be taken up.

[**0028**] The pump **2** comprises a first inlet **7** for receiving a main liquid flow, generally water, which drives the differential piston **3**. The pump **2** includes a second inlet **8** located in the lower part of the auxiliary pump body **5** for taking up the additive A, and an outlet **9** for mixing the additive A and the main liquid L.

[**0029**] Conventional means with valves or the like are provided for controlling the reciprocating movements of the piston **3**. These known means are neither shown nor described.

[**0030**] The device D comprises a venturi **10** that includes an inlet section **11**, a throat **12** of reduced cross section, and an outlet section **13**.

[**0031**] The pump **2** is connected in parallel to the venturi **10**, the first inlet **7** of the pump being connected by a pipe **14** to the inlet **11** of the venturi, while the outlet **9** of the pump is connected via a pipe **15** to the throat **12** of the venturi.

[**0032**] The transverse sections of the various parts of the venturi are preferably circular, but could have a different shape, for example that of a rectangle.

[**0033**] It is pointed out that a venturi makes it possible to lower the pressure of a stream of fluid in the throat, in particular in order to bring it to below atmospheric pressure. The stream of a liquid in a pipe in the event that no change in altitude is involved is governed by Bernoulli's equation:

$$P+pV^2/2=\text{constant}.$$

[**0034**] Where P=static liquid pressure, V≈liquid speed, and ρ=liquid density.

[**0035**] The pressure difference (Pe−Pc) between the inlet and the throat of the venturi is linked to the geometry (variation in cross section) and to the flow Qe of liquid. By designating the transverse section of the inlet **11** by Se and the transverse section of the throat **12** of the venturi by Sc, the following are obtained:

[**0036**] Inlet speed: Ve=Qe/Se

[**0037**] Speed at the throat: Vc=Qe/Sc, hence Pc−Pe=−1/2p.Qe^2.($1/Sc^2$−**$1/Se^2$**).

[**0038**] A variation in inlet pressure shifts the area of operation of the venturi, the range of which is reduced when the inlet pressure increases.

[**0039**] Advantageously, the pressure difference between the inlet **11** and the throat **12** of the venturi is adjusted to the pressure drop between the inlet **7** and the outlet **9** specific to the pump in normal operation. By way of non-limiting example, this pressure drop may be of the order of 1.5 bar and stays below 2 bar.

[**0040**] The geometry of the venturi is provided in order to create a reduced pressure drop, below 0.5 bar, between the inlet and the outlet of the venturi.

[**0041**] The venturi **10** and the pump **2** may form a single unit, and connecting means Re and Rs are provided at the inlet and at the outlet of the venturi for its insertion and connection to two sections of the conduit Te, Ts.

[**0042**] The operation of the device follows immediately from the above explanations.

[**0043**] The secondary flow that passes via the conduit **14** and into the pump **2** allows operation of the dosing pump between the inlet pressure Pe of the venturi **10** and the pressure Pc at the throat.

[**0044**] The venturi **10** is regulated such that the ratio R of the flow Qe passing through the venturi **10** to the flow Qd passing through the dosing pump **2** is at least equal to 10 (ten). Thus, the main stream does not pass into the dosing pump **2**. This makes it possible to use a pump **2** of small size for dosing an additive product A in a significant stream of main liquid. For example, for achieving a dosing rate of 1% in a flow of 20 m^3/h, with a ratio R equal to ten, it is possible to use a standard pump of maximum flow 2.5 m^3/h, providing a dosing rate of 10%. The invention thus makes it possible to handle large flows of main liquid using relatively small dosing pumps.

[**0045**] Furthermore, the effect of dilution between the stream that traverses the pump **2** and the main stream that passes into the venturi **10** makes it possible to obtain very small dosing rates at a high level of precision. The ratio R for providing the small dosing rates may be at least equal to 100 (one hundred).

[**0046**] A dosing pump **2** allowing a volume ratio between injected additive flow A and flow Qd of drive liquid passing through the pump equal to one one thousandth (1/1000), combined with a dilution of at least one percent (1%), allows a volume dosing of additive A in the main flow Qe of less than 10^{-5}, i.e. 10 ppm (10 parts per million).

[**0047**] For example, a pump **2** allowing a volume ratio of 1/1500 (0.07%) between the flow of additive A taken up and the flow Qd in practice substantially corresponds to the lowest dosing rate obtained with precision, mechanically, with a pump of this type. By regulating the venturi **10** so that it has a Qe/Qd ratio equal to 133 (Qe=20 m^3/h while Qd=150 L/h), the dosing volume ratio of additive A in the main flow becomes equal to:

(0.07*/133), i.e. a ratio of 5×10^{-6}, or 5 ppm.

[**0048**] FIG. **3** illustrates a further possibility for regulating the flow of the pump by creating an additional pressure drop in the secondary circuit of the pump. Preferably, this pressure drop is created by a jet **16** installed at the outlet **9** of the pump. The jet **16** comprises a hole of calibrated passage. For a given pressure difference between the venturi throat and inlet, the frequency of the pump **2** and thus the secondary flow in the pump **2** will be as low as the orifice of the jet **16** is small. In the absence of any jet **16**, the pump **2** generally allows regulation of flow between a maximum value M and a minimum value M/p, where p is close to three, for example. By providing a jet **16**, the regulation range is increased favor lower values, in accordance with the diameter of the calibrated orifice of the jet.

[0049] The jet **16** may be regulated, particularly with the aid of a needle, which makes it possible to vary dosing, in particular in the case of a dosing pump that includes no regulation.

[0050] As a variant embodiment, provision may be made for at least two different jets, mounted in parallel on one or more bypasses, with one or more selection valves, which makes it possible to obtain at least two dosing ranges.

[0051] The combination of the venturi and of the dosing pump allows an operating range independent of pressure. This combination also makes it possible to obtain substantially constant dosing and not only injection that varies as a function of pressure and flow variations.

[0052] Tests carried out using flows of 25 m^3/h to 40 m^3/h at a pressure of 8 bar to 10 bar, particularly for agricultural irrigation purposes, have given satisfactory results with the use of a Dosatron International DI 1500 dosing device operating with 1.1 m^3/h, obtaining an additive dosing rate of 50 ppm in the main flow and then of **4** ppm with a different jet **16**.

[0053] The invention makes it possible to overcome the venturi's pressure limitation.

1. A dosing device for introducing an additive (A) into a main liquid flow (L) circulating in a conduit, comprising a reciprocating differential piston pump for taking up the additive (A) into a container and dosing it, this pump including a first inlet for receiving a main liquid flow that drives the pump, a second inlet for taking up the additive, and an outlet for mixing the additive and the main liquid, characterized in that it comprises a venturi arranged in the conduit, and in that the pump is connected in parallel with the venturi, the first inlet of the pump being connected to the inlet of the venturi while the outlet of the pump is connected to the throat of the venturi.

2. The device as claimed in claim 1, wherein the geometry of the venturi is adjusted to the pressure drop in the pump between the first inlet and the outlet.

3. The device as claimed in claim 1, wherein the geometry of the venturi is adjusted to establish, in operation, a pressure difference of approximately 1.5 bar and less than 2 bar between the inlet pressure and the pressure at the throat.

4. The device as claimed in claim 1, wherein the geometry of the venturi is adjusted such that the pressure drop created by the venturi is less than 0.5 bar.

5. The device as claimed in claim 1, wherein an additional pressure drop is created in the secondary circuit of the pump.

6. The device as claimed in claim 5, wherein the additional pressure drop is created by a jet.

7. The device as claimed in claim 6, wherein the jet is placed at the outlet of the pump.

8. The device as claimed in claim 6, wherein the jet is adjustable.

9. The device as claimed in claim 1, wherein the venturi is regulated such that the ratio of the flow (Qe) passing through the venturi to the secondary flow (Qd) passing through the pump is equal to (R) so that with a pump enabling a flow (Qd) to be handled at a dosing rate x% the device makes it possible to handle a flow Qe=Qd.R, at a dosing rate close to x/R%.

10. The device as claimed in claim 9, wherein the venturi is regulated such that the ratio (R) of the flow (Qe) passing through the venturi to the secondary flow (Qd) passing through the pump is equal to ten or is close to ten.

11. The device as claimed in claim 1, wherein the pump is provided in order to allow a volume ratio between injected additive flow and drive liquid flow passing through the pump that is less than or equal to one one thousandth (**1/1000), while the volume dilution of the mixture exiting the pump in the main flow passing through the venturi is less than one percent (**1%) such that the volume dosing in the main flow is less than or equal to 10^{-5} or 10 ppm (10 parts per million).

12. The device as claimed in claim 1, wherein the venturi and the pump form a single unit, and connecting means (Re, Rs) are provided at the inlet and at the outlet of the venturi for its insertion and connection to two portions (Te, Ts) of the conduit.

* * * * *