United States Patent

[11] 3,583,423

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[21] Appl. No. 858,444
[22] Filed Sept. 16, 1969
[45] Patented June 8, 1971
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New York, N.Y.
[32] Priority Sept. 18, 1968
[33] Netherlands
[31] 6813306

[54] **DOSING DEVICE FOR GASEOUS OR LIQUID SUBSTANCES**
2 Claims, 1 Drawing Fig.

[52] U.S. Cl. 137/117
[51] Int. Cl. G05d 7/03
[50] Field of Search 137/117

[56] **References Cited**

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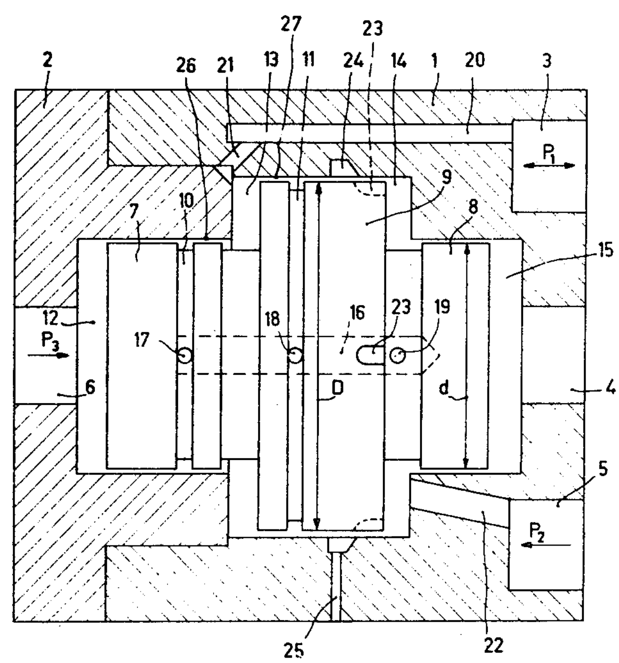
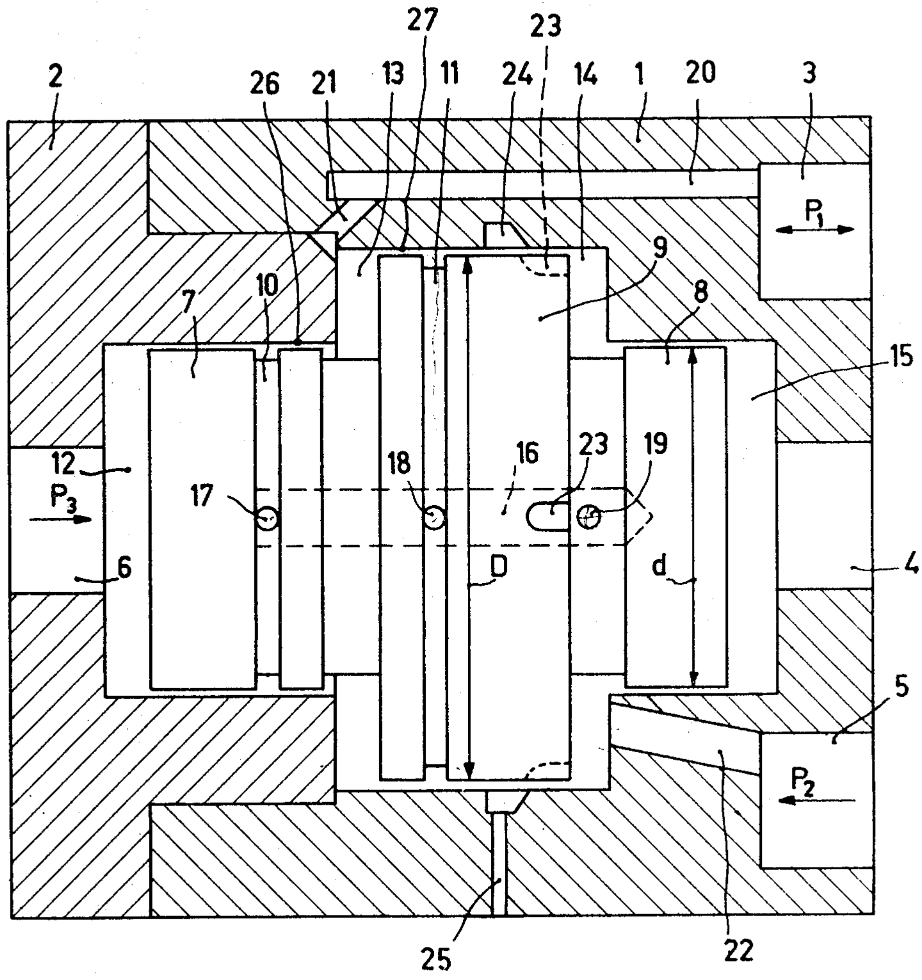
ABSTRACT: The invention relates to a dosing device for supplying or removing quantities of gaseous or liquid substances to or from a space. The dosing device is meant for dosing any desirable, not too large, quantity, for example, from a few cm.^{3} per second to a quantity zero, in which the pressure of the dosed quantity may be from less than 1 atm. to some tens of atmospheres.





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DOSING DEVICE FOR GASEOUS OR LIQUID SUBSTANCES

It has this far been difficult to produce such a dosing device, because the component parts must meet very high standards, and the adjustability, presents great difficulties. The device according to the invention however, is simple to manufacture and the adjustability of the supplied quantity is also simple since no spindles, valves or the like are required. Moreover, both the supply and the removal of the dosed quantity to and from a space can be produced with the same device.

According to the invention, a dosing device as described above is characterized in that a cylinder comprises a piston assembly consisting of two pistons of the same diameters, between which a piston of a larger diameter is situated and chambers are situated between the pistons. One of the two pistons, having equal diameters, and the piston having the larger diameter, have a circumferential groove on their circumference. A communication duct for the substance to be dosed opens into the two chambers, a communication duct debouching near each of the free end faces of the pistons having the same diameters, in one of which an adjustable control pressure prevails, the other duct communicating with the ambient pressure. The largest piston situated in the center of the piston assembly has on its circumference at least one axial slit which forms a communication, depending upon the axial position of the piston assembly, of an adjustable size between the chamber which is situated near the piston, which does not comprise a circumferential groove, and an annular space present in the cylinder wall. This space communicates with a duct for removing the substance to be dosed. Open communications are provided between the two annular grooves present on the said pistons, and the chamber in which the slit opens. The pressure in the chamber with which the slit communicates is regulated by the position of the piston assembly in the cylinder. This pressure also prevails in the two annular grooves, whereas in the other chamber the pressure prevails of the desirable volume flow, said other chamber communicating, through a narrow gap formed between the piston parts and the cylinder wall parts of both the larger and the smaller diameters, with the two circumferential grooves in which the regulated pressure prevails.

When temperature variations occur in the volume flow to be dosed or when the device is to be used in a space in which varying temperatures occur, according to a further embodiment of the invention, the various elements of piston assembly and the cylinder are made of materials having different coefficients of expansion, so that upon temperature variations, the variation of the gap height compensates for the change of the viscosity of the liquid or the gas.

In order that the invention may be readily carried into effect, one example of the invention will now be described in greater detail, by way of example, with reference to the accompanying drawing, the sole FIGURE of which shows a cross-sectional view of a cylinder with piston assembly which is arranged therein so as to be axially movable.

Reference numeral **1** in the drawing denotes a cylinder to which a cylinder cover **2** is secured. On the right-hand side, three communication possibilities **3**, **4** and **5** are shown; on the left-hand side a fourth communication possibility **6** is shown in the cover **2**. The cylinder **1** comprises a piston assembly consisting of two equal pistons **7** and **8**, having diameters *d*, and a larger piston **9**, having a diameter D, between the pistons **7** and **8**. The piston **7** has an annular groove **10**; the piston **9** has a similar groove **11**. Between the end face of the piston **7** and the cover **2**, a chamber **12** is situated; furthermore, a chamber **13** is situated between the cover **2** and the other side of the piston **9**. Similar chambers which are denoted by **14** and **15** are situated between a side face of the piston **9** and the cylinder **1** and between the end face of the piston **8** and the end of the cylinder.

Centrally located in the piston assembly a duct **16** is provided which is in open communication, through apertures **17**, **18** and **19**, with the annular grooves **10** and **11** and with the chamber **14**. These consequently communicate with each other the same pressure prevailing in each. A duct **20** which is in open communication with the chamber **13**, through a duct **21**, opens into the connection possibility **3**. The connection possibility **5** communicates with the chamber **14**, through a duct **22**. In the circumference of the piston **9** four slits **23** are provided; these slits open on the one hand into the chamber **14** and produce a communication with an annular space **24** in the cylinder wall having a size which is dependent upon the position of the piston assembly. The annular space **24** communicates through a duct **25** with the ambient pressure. The gap between the circumferences of the pistons and the respective cylinder walls lies in the order of magnitude of 20μ.

The operation of the dosing device will now be described for a volume flow emerging from the duct **20**, for example, a flow of oil, in which a desirable supply can be realized between a few cm³ per second and zero. An oil duct communicates with the connection **6**, at a pressure p_3 which will be termed control pressure. It should be possible to adjust said pressure in accordance with the desirable supply, for example, at high-pressure level with a pressure regulating valve and at low-pressure level, for example, with a liquid column. An oil duct communicates with the connection possibility **5** at a pressure, the value p_2 of which is regulated in chamber **14**, by the overlap of the slits **23** and the annular space **24**. For a volume flow emanating from the duct **20** the regulating pressure p_2 is larger than the pressure p_1. The pressure p_2 prevails in the chamber **12**, since there is an open communication through duct **22**, duct **16**, and apertures **17**, **18** and **19**. However, the emanating pressure p_1 prevails in the chamber **13**, since said chamber is in open communication with the emanating aperture **3**. Owing to the pressure difference p_2-p_1 between the annular grooves **10** and **11** on the one hand, and the chamber **13** on the other, a laminar flow occurs in the two annular gaps **26** and **27**. The differential pressure p_2-p_1 follows from the equilibrium of forces of the piston assembly, namely:

$$p3\frac{\pi}{4}d^2+p1\frac{\pi}{4}(D^2-d^2)=p2\frac{\pi}{4}(D^2-d^2)$$

From this it follows that

$$p2-p1=p3\frac{d^2}{D^2-d^2}$$

It is found that with given *D* and *d*, the differential pressure between p_2 and p_1 is only dependent upon the pressure p_3. As is known, the supply through a laminar resistor of the type as is formed by the gaps **26** and **27** is linearly dependent upon the differential pressure across said resistance according to the equation known from fluid dynamics:

$$\phi=\frac{\pi DH^3}{12/\mu}\cdot\frac{p2-p1}{L}$$

wherein Φ is the supply, *D* the diameter, *H* the gap height, μ the viscosity and *L* the gap width. For a dosing device of the type described having given dimensions and for a given liquid it holds at substantially constant temperature that $\phi=C(p_2-p_1)$, wherein *C* is a constant. The supply to be dosed is hence only determined by the value of p_3 (for this is, proportional to p_2-p_1). Since p_3 can be adjusted at any desirable value, any desirable small supply can be adjusted. The above consideration is correct at a constant temperature of the oil and of the ambient pressure. When temperature variations occur this results in a variation of the viscosity of the oil, so that hence the supply varies. This supply deviation as a result of the deviation in viscosity can be compensated for by making the gap height *H* in gaps **26** and **27** likewise a function of the temperature, so that H^3/μ from the supply formula for laminar flow likewise remains constant. This can be realized with a suitable choice of the material of the cylinder and the piston assembly. A suitable choice of the dimensions of the piston diameter and the gap height can also contribute to suppressing supply variations as a result of temperature influences.

When a comparatively high-pressure p_2 and hence also p_1, is used, it may be desirable to arrange a second cylinder around the cylinder 1, which second cylinder encloses the cylinder on both sides, and to supply therein the same pressure p_2, so that likewise said pressure p_2 is exerted on the circumference of the cylinder 1.

In the embodiment described the dosed quantity is supplied to a space; when this quantity has to be removed from a space, the duct in which the pressure p_3 prevails is connected to the communication 4 and communication 6 remains open.

I claim:

1. A dosing device for supplying or removing quantities of liquid or gaseous substances to or from a space, characterized in that a piston assembly is present in a cylinder and consists of two pistons of equal diameters, between which a piston of a larger diameter is situated and chambers are situated between the pistons, one of the two equal pistons and the piston having the larger diameter comprising on their circumference a circumferential groove, a communication duct for the substance to be dosed opening into the two chambers, a communication duct opening near each of the free end faces of the pistons having equal diameters in one of which an adjustable control pressure prevails, the other duct communicating with the ambient pressure, the largest piston situated in the center of the piston assembly comprising on its circumference at least one axial slit which forms a communication of an adjustable size, which is dependent upon the axial position of the piston assembly, between the chamber which is situated near the piston which does not comprise a circumferential groove and an annular space present in the cylinder wall, which space communicates with a duct for removing the substance to be dosed, open communications being present between the two annular grooves present on the said pistons, and the chamber into different coefficients slit opens, the pressure in the chamber with which the slit communicates being regulated by the position of the piston assembly in the cylinder, said pressure also prevailing in the two annular grooves, the pressure of the desired volume flow prevailing in the other chamber, said other chamber communicating by means of a narrow gap formed between the piston parts and the cylinder wall parts of both the larger and the smaller diameters, with the two circumferential grooves, in which the regulated pressure prevails.

2. A dosing device as claimed in claim 1, characterized in that the materials of which the piston assembly and the cylinder consists, have different coefficients of expansion, so that upon temperature variations, the variation of the gap height compensates for the variation of the viscosity of the liquid or the gas.

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,583,423 Dated June 8, 1971

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It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

IN THE CLAIMS

Claim 1, line 22, delete "dif-";

line 23, delete "ferent coefficients" and insert --which the--.

Signed and sealed this 2nd day of January 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents