

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) Publication number:

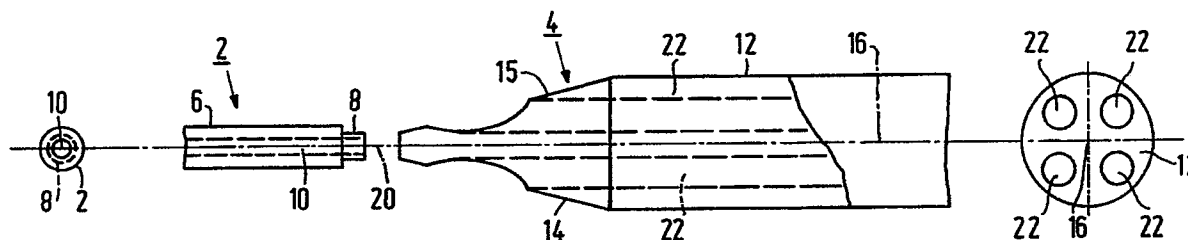
0 430 359 A1

(12)

EUROPEAN PATENT APPLICATION(21) Application number: **90203093.1**(51) Int. Cl.⁵: **B05B 7/02, B05B 1/26**(22) Date of filing: **23.11.90**(30) Priority: **27.11.89 NL 8902921**(43) Date of publication of application:
05.06.91 Bulletin 91/23(84) Designated Contracting States:
DE FR GB Bulletin 00/1(71) Applicant: **N.V. Philips' Gloeilampenfabrieken
Groenewoudseweg 1
NL-5621 BA Eindhoven(NL)**(72) Inventor: **Monten, Laurentius Franciscus Jean
Marie
c/o INT. OCTROOIBUREAU B.V. Prof.
Holstlaan 6
NL-5656 AA Eindhoven(NL)**(74) Representative: **Scheele, Edial François et al
INTERNATIONAAL OCTROOIBUREAU B.V.
Prof. Holstlaan 6
NL-5656 AA Eindhoven(NL)**(54) **Capillary nebulizer.**

(57) A nebulizer for forming an aerosol for material analysis is composed of a gas supply capillary (10) and a gas supply capillary system (2) arranged relative to each other. The liquid supply capillary system (4) comprises one or more single or composite capillaries (22), which merge into surfaces (15) of a truncated supporting cone of the capillary tube. At a side facing the gas supply capillary, the

cone is truncated in a guide surface which either is directed substantially transversely to the capillary axes or extends substantially parallel thereto and has a diameter of, for example, 0.25 to 0.5 mm. Preferably, the relative positioning of the outlet opening of the gas supply capillary and the guide surface is readjustable.

**FIG. 1****EP 0 430 359 A1**

CAPILLARY NEBULIZER.

The invention relates to a nebulizer comprising a capillary supply system for material to be analysed and a capillary carrier gas supply system for forming an aerosol in an interaction space around flow outlets of both supplies.

Such nebulizers are known from an article of B.L. Sharp, published in "Journal of Analytical Atomic Spectrometry", August 1988, Vol. 3, pp. 613-652, especially the survey "Nebulizers", p. 614. Nebulizers for analytical purposes are classified therein in Concentric-flow, Cross-flow and Babington nebulizers. It has been found in practice that all three types of nebulizers have disadvantages which result in an aerosol having too low a particle density and excessively large particles. Furthermore, the nebulizers are not adjustable or can be adjusted only with difficulty and supply ducts thereof are liable to be clogged.

In such nebulizers, a change-over without problems between, for example, material solutions in water and solutions in, for example, an organic liquid having a deviating viscosity and the like is desired. In known concentric flow nebulizers, in fact a readjustment is substantially not possible. The material to be examined is supplied in the form of a liquid via a central capillary and the carrier gas is supplied through an opening surrounding it concentrically. The central capillary and the carrier gas duct are accommodated in a common supply holder. The capillary for material supply may be mounted so as to be displaceable in the holder in axial direction. As a result, the outlet opening and the gas supply opening are also displaceable in axial direction with respect to each other, which may slightly influence the formation of aerosol.

In the Cross-flow nebulizer, outlet openings for the flow of material and the flow of carrier gas are directed transversely to each other. The distance of each of the openings from the prolonged axis of the other opening as a rule is fixedly adjusted and cannot be varied. When this distance is made readjustable, the formation of aerosol can certainly be strongly influenced, but this would result in that such a nebulizer becomes unstable.

In the Babington nebulizer, the material is supplied in the form of a film flow over a wall surface and the flow of carrier gas is supplied through an opening in the wall. If as the wall a part of a comparatively large sphere or gutter is chosen and the flow of material is arranged at a comparatively great distance from the gas supply opening, a nebulizer can be obtained which operates in a stable manner. However, this construction does not permit any adjustment possibilities for this type of nebulizer.

The invention has for its object to obviate the said disadvantages and for this purpose the nebulizer of the kind mentioned in the opening paragraph is characterized according to the invention in that an end of the capillary material supply system located in the interaction space has a flat guide surface for deflecting the flow of carrier gas and one or more openings for supplying the flow of material to the guide surface.

Due to the fact that in a nebulizer according to the invention the flow of carrier gas is abruptly stopped at the area of the material supply and is deflected, a strong interaction and turbulence is obtained, which results in many small particles in a flow of aerosol which can be influenced by mechanical adjustment and spreads into a wide fan.

In a preferred embodiment, the capillary material supply system comprises a single capillary or a system of several single capillaries, for example two to four capillaries orientated symmetrically around a longitudinal axis, or an annular capillary likewise arranged symmetrically around the longitudinal axis. Due to the annular liquid capillary, the effectiveness of the nebulizer increases without the adjustment possibilities being limited. The increase of effectiveness is obtained in that now a single uninterrupted umbrella-shaped plume of mist is obtained.

In a further preferred embodiment, the capillary material supply system is accommodated in a rod-shaped holder, which merges into a preferably truncated cone surface, the capillaries merging into a surface of the cone. By the choice of the conical angle and, as the case may be, the extent of truncation, the flow of material can be directed optimally. By adjustment of the distance between the cone end and the end of the gas supply, the flow of aerosol can be optimized. In a preferred embodiment, the full conical angle is, for example, about 25° and the truncation may be, for example, about $300\text{ }\mu\text{m}$ with a capillary cross-section of, for example, $400\text{ }\mu\text{m}$. The capillary holder with the capillaries consists, for example, of solid ceramic material, such as Al_2O_3 , of glassy carbon or a similar comparatively inert material.

In a further preferred embodiment, a gas supply capillary is accommodated in a holder which serves at the same time as a support for the material supply capillary system and is provided with means for a radial displacement of the gas supply capillary with respect to the material supply. A gas supply capillary is mounted for this purpose, for example, in an adjustable three-point support. More particularly, the holder is provided with a length adjustment mechanism for the gas capillary.

More particularly, a guide surface of the capillary liquid supply system is independently adjustable in an axial direction with respect to the axis of the remaining capillary liquid supply system. As a result, a comparatively small construction, which consequently can be robust and inexpensive, can also be adapted to the differences in viscosity of a flow of liquid to be examined.

A few preferred embodiments according to the invention will be described more fully hereinafter. In the drawing:

Fig. 1 shows a configuration of outlet openings in the proximity of an interaction space of a nebulizer according to the invention, and

Fig. 2 shows an outline of a construction of such a nebulizer.

Of a nebulizer, Fig. 1 shows a gas supply 2 and a liquid supply 4 in their relative positioning. The gas supply 2 has a simple tube 6 with, as the case may be, a part of reduced width 8 enclosing a capillary gas supply duct 10. The gas supply capillary has preferably, but not necessarily, a circular cross-section, for example, about 100 to 300 μm in diameter. The liquid supply device 4 with a tube 12 terminating at an end facing the gas supply in a conical shape is arranged axially opposite to the gas supply capillary at a preferably adjustable distance of, for example, about 0.5 mm from a gas outlet opening 11. A surface 15 of the cone encloses an angle of, for example, 10° - 30° with a tube axis 16 and is truncated at a free end with a guide surface 20 substantially at right angles to the axis 16 having a diameter of, for example, about 300 μm . The truncated cone thus formed may be circular, like the tube 12, but may also be rectangular, polygonal or elliptical. The tube 12 is provided with liquid supply capillaries 22, four in number in the embodiment shown, which in this case are arranged symmetrically around the axis 16, have a diameter of, for example, about 400 μm and are located at a distance of, for example, 0.5 mm from the axis 16, calculated to the axis of the capillaries. These capillaries are not necessarily circular either, although this is a preferred embodiment. The capillaries merge into the surface 15 of the truncated cone, which for four capillaries may also have, for example, a square cross-section. Liquid with a solution or suspension of material to be examined is supplied through the capillaries 22, flows in the direction of the guide surface 20 and a gas flow from the capillary 10 directed thereto and constitutes at this area a mist or an aerosol, which is transported to an examination space for analysis. The capillaries are arranged, for example, in a tube 12 consisting of a comparatively inert material.

Fig. 2 shows the example of a mechanical construction of a nebulizer with a gas supply tube 2 and a liquid supply tube 12. The gas supply tube

is clamped in a holder 30, which in this case is connected via a bracket 32 with two axes of rotation 34 and 36 to a housing 40 for the liquid supply tube 12. A support 38 for the bracket 32 is accommodated for this purpose with clamping fit in an opening 42 of the housing 40. For readjustment of the gas supply with respect to the liquid supply, the bracket is provided, for example via a screw connection 44, with a connection 46 adjustable from an opposite side of the housing 40. The tube 12 is mounted by means of a conical body 48 and a preferably conical spring 50 in the housing 40. The tube 12 is axially displaceable by means of an adjustment screw 52 and is tiltable by means of a transverse adjustment mechanism shown further in Fig. 2a about the ball 48, as a result of which the discharge direction can be readjusted. The tube 12 is clamped between these abutment surfaces of a tensile spring 54, an X adjustment screw 56 and a Y adjustment screw 58, respectively. It is also possible to utilize an abutment and two compression springs. Otherwise, all suitable forms of mounting and readjustment for the gas and liquid supply of a nebulizer according to the invention may be used. The preferred embodiment described is based on reverse flow of the gas supply and the material supply. In an otherwise corresponding manner, use may also be made of a transverse flow, that is to say that the direction of the flow of gas and the direction of supply of the liquid enclose with each other an angle of, for example, about 90° . The relative adjustment can then be carried out roughly in a corresponding manner. All the desired intermediate forms between reverse flow and transverse flow may be chosen, while also angles larger than 90° may be favourable for given cases.

Claims

1. A nebulizer comprising a capillary supply system for material to be analysed and a capillary carrier gas supply system for forming an aerosol in an interaction space around ends of both supplies, characterized in that an end of the capillary material supply system located in the interaction space has a flat guide surface for deflecting a flow of carrier gas and one or more openings for supplying the flow of material to the guide surface.
2. A nebulizer as claimed in Claim 1, characterized in that the material supply system comprises in an outlet end surface a system of several single capillary openings.
3. A nebulizer as claimed in Claim 1, character-

ized in that the capillary material supply system comprises an annular opening in an outlet end surface.

4. A nebulizer as claimed in any one of the preceding Claims, characterized in that a rod-shaped holder for the material supply system has an end in the form of a truncated cone, into a conical surface of which merge the capillary openings. 5
10
5. A nebulizer as claimed in Claim 4, characterized in that a conical surface of the conical end encloses an angle of about 15° with a longitudinal axis of the holder. 15
6. A nebulizer as claimed in any one of the preceding Claims, characterized in that the capillary material supply system comprises four equal capillaries arranged symmetrically with respect to a longitudinal axis of a capillary holder. 20
7. A nebulizer as claimed in any one of the preceding Claims, characterized in that a holder for the capillary material supply system consists of polycrystalline or monocrystalline Al_2O_3 . 25
8. A nebulizer as claimed in any one of the preceding Claims, characterized in that a gas supply capillary holder acts as a support for the material supply system. 30
9. A nebulizer as claimed in any one of the preceding Claims, characterized in that the gas supply system and material supply system are arranged at least substantially at an angle of 180° with respect to each other. 35
40
10. A nebulizer as claimed in any one of Claims 1 to 8, characterized in that the gas supply system and the material supply system are arranged at least substantially at an angle of 90° with respect to each other. 45
11. A nebulizer as claimed in Claim 8, 9 or 10, characterized in that the holder for a gas supply capillary is provided with a radial displacement mechanism for the capillary. 50
12. A nebulizer as claimed in Claim 8, 9, 10 or 11, characterized in that the holder for a gas supply capillary is provided with an axial capillary adjustment mechanism. 55
13. A nebulizer as claimed in any one of the preceding Claims, characterized in that the

guide surface of the capillary liquid supply system is separately displaceable in an axial direction with respect to the axis of the remaining capillary liquid supply system.

14. An optical spectrometer, characterized in that it is provided with a nebulizer as claimed in any one of the preceding Claims.

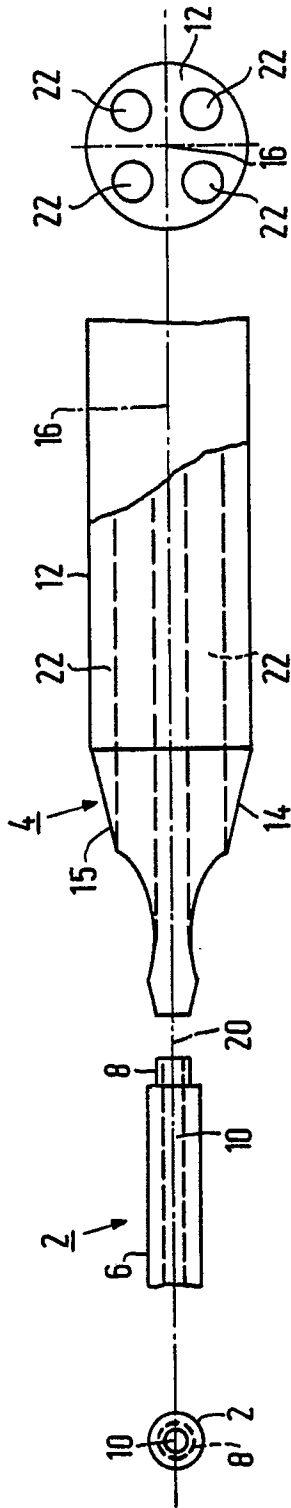


FIG. 1

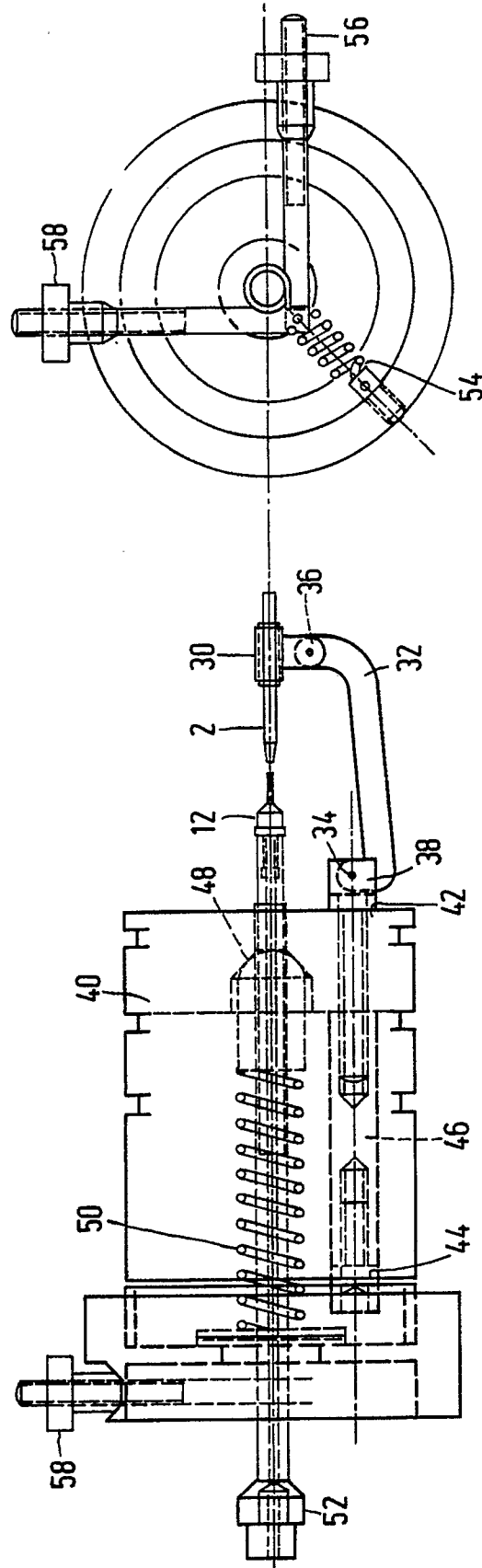


FIG. 2



European
Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 20 3093

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-A-1 475 166 (VEB_MEDIZINTECHNIK) * the whole document * - - -	1,3,8,12, 13	B 05 B 7/02 B 05 B 1/26
A	EP-A-0 146 517 (ARBORELIUS) * the whole document * - - - - -	1,2,6,8	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B 05 B A 61 M
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of search 25 February 91	Examiner JUGUET J.M.
CATEGORY OF CITED DOCUMENTS X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons ----- &: member of the same patent family, corresponding document			