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(54) Micro-droplet generator

(57) A micro-droplet generator comprises a main body, having a chamber (11) accommodating liquid to be sprayed and a lateral opening (12), a spraying plate (20), placed in the opening and having a plurality of spraying holes (21) as well as an inner side, a vibrating element (30), glued on the spraying plate and driving vibrations thereof, and a top surface carrier (4), placed inside the chamber and having a top surface (41) that with the inner side of the spraying plate forms an inner part of the chamber, wherein a narrow space is left between the inner side of the spraying plate and the top surface of the projection, which upon the vibrations of the spraying plate has a varying width, upon becoming wider sucking in liquid from the chamber, and upon becoming narrower pressing out liquid through the spraying holes.

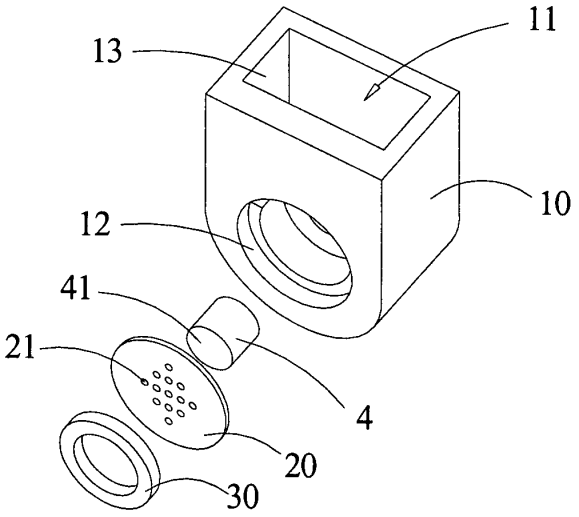

FIG 1

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Description

Field of the Invention

[0001] The present invention relates to a micro-droplet generator, particularly to a micro-droplet generator which works by the piezoelectric effect, producing a well-defined flow of tiny droplets.

Description of Related Art

[0002] Currently available sprayers have two kinds, which work by direct pressure and by vibrations, generating pressure that disperses micro-particles. A common disadvantage of conventional sprayers is the need of large pressure when relatively large particles are generated, resulting in a large noise. For medical applications, spraying of relatively large particles is not required, but precise particle sizes are important. Therefore, sprayers working by vibration have recently been preferred for medical applications. Sprayers of this kind use ultrasound, generated by piezoelectric material, to produce micro-droplets. Shortcomings of these sprayers, however, are high power consumption, the need of a fan to drive micro-droplets into a given direction, a large volume, and non-uniform distribution of micro-particle sizes. Other sprayers which use piezoelectric material have spraying plates with holes of defined diameters to disperse micro-droplets, resulting in considerably reduced power consumption and well-defined micro-droplet sizes. Sprayers of this kind, disclosed in patent or sold on the market, are of two sub-kinds: Sprayers of the first sub-kind by direct vibrational pressure force micro-droplets through spraying plates, sprayers of the second sub-kind have vibrating spraying plates, causing micro-droplets to pass through. Sprayers of the first sub-kind have a higher power consumption than sprayers of the second sub-kind. The latter in some versions use planes that are tapped on, e.g., planes attached to capillary tubes transmitting liquid at ends thereof. These designs, however, have the following shortcomings:

1. Energy is easily dissipated.
2. Volume is large.
3. Manufacturing cost is high.
4. Tapped planes attached to capillaries allow only for small spraying angles.
5. Spraying is performed with limited effectiveness.

SUMMARY OF THE INVENTION

[0003] It is an object of the present invention to provide a micro-droplet generator allowing precise control of flow of micro-droplets.

[0004] Another object of the present invention is to provide a micro-droplet generator having a small volume and low manufacturing cost.

[0005] A further object of the present invention is to provide a micro-droplet generator having a flat shape.

[0006] The present invention can be more fully understood by reference to the following description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Fig. 1 is a perspective view of the micro-droplet generator of the present invention when disassembled.

[0008] Fig. 2 is a sectional side view of the micro-droplet generator of the present invention.

[0009] Figs. 3 and 4 are schematic illustrations of the operation of the present invention.

[0010] Figs. 5 - 7 are perspective views of the projection of the present invention in other embodiments.

[0011] Figs. 8-9 are sectional views of the present invention in further embodiments of the top surface carrier.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] As shown in Fig. 1, the micro-droplet generator of the present invention mainly comprises: a main body 10; a spraying plate 20; a vibrating element 30; and a top surface 41, which is placed on a projection or a plan plate. The main body 10 has an inner chamber 11, accommodating liquid to be sprayed. A lateral opening 12 in the main body 10 connects the chamber 11 with the outside and houses the spraying plate 20. Liquid to be sprayed passes through the opening 12.

[0013] The main body 10 further has an upper side with an inlet 13, through which liquid to be sprayed is poured into the chamber 11. For mobile applications, e.g., ambulant medicine, the chamber 11 is preferably sized large enough for repeated spraying. For stationary applications, e.g., indoor spraying of liquid from a fixed installed supply, the inlet 13 preferably has a fixed connection thereto.

[0014] As shown in Fig. 2, the spraying plate 20 is laid into the opening 12, having a plurality of spraying holes 21 in a dense arrangement. The spraying holes 21 define sizes and spraying directions of sprayed micro-droplets, allowing for precise control thereof.

[0015] As further shown in Fig. 2, the spraying plate 20 has an inner side 22 facing the chamber 11 and contacting liquid to be sprayed therein.

[0016] Referring again to Figs. 1 and 2, the vibrating element 30 is made of piezoelectric material and placed on the spraying plate 20. Applying electric voltage to the vibrating element 30 causes vibrations thereof, driving vibrations of the spraying plate 20.

[0017] The vibrating element 30 and the spraying plate 20 are glued to each other. The spraying plate 20 and the opening 12 have round shapes, while the vibrating element 30 is shaped like a ring. As shown in Figs. 3 and 4, when electric voltage is applied to the vibrating element 30, vibrations thereof are performed in a direction thereto.

[0018] The main characteristic of the present invention

lies in a projection 40 being placed in the chamber 11. The projection 40 has an inner end attached to an inner wall of the main body 10 and an opposite outer end carrying the top surface 41 which is parallel to the inner side 22 of the spraying plate 20, leaving a small space 50 in between.

[0019] When the vibrating element 30 is driving vibrations of the spraying plate 20, the space 50 has a varying width. As shown in Fig. 3, whenever the spraying plate 20 moves outward, away from the top surface 41 of the projection 40, the space 50 becomes wider, so that liquid flows into the space 50. On the other hand, when the spraying plate 20 moves inward, towards the top surface 41 of the projection 40, the space 50 becomes narrower, so that liquid is pressed through the spraying plate 20 and micro-droplets 51 are generated.

[0020] Liquid flow is controlled by grooves cut into the projection 40. As shown in Fig. 5, a face groove 42 that is shaped like a closed loop is cut into the top surface 41 of a projection 40a. Thereby, as shown in Fig. 3, a minimum space between the top surface 41 of the projection 40 and the inner side 22 of the spraying plate 20 is maintained, in which liquid stays due to capillary forces. As shown in Fig. 6, a projection 41b is employed having a chamfered top edge 44, so that a minimum space for liquid is provided into which liquid is drawn due to capillary forces. As shown in Fig. 7, at least one guiding groove 43 is cut into a periphery of a projection 40c, due to capillary forces facilitating flow of liquid to the top surface 41 of the projection 40c. By capillary forces, liquid to be sprayed readily flows into the space 50, even against gravitational forces.

[0021] For accommodating various liquids and casings, the top surface carrier may be the following devices. As shown is Fig. 8, a projection 40d shaped like the letter T is horizontally mounted on the main body 10, or as shown in Fig. 9, a plan plate 40e shaped like the letter q is vertically mounted on the main body 10.

[0022] The main characteristic of the present invention lies in installing of the projection 40 in the chamber 11. As shown in Figs. 3 and 4, placing the top surface 41 of the projection 40 close to the inner side 22 of the spraying plate 20 creates the narrow space 50, confining vibrational energy to a small volume, so that energy is saved and power consumption is low, allowing for battery use and prolonged use. Furthermore, effective transmission of vibrations of the spraying plate 20 to liquid inside the space 50 reduces required power for driving liquid through the spraying holes 21, allowing to reduce diameters thereof for a better spraying effect. The top surface is also implementable on a plan plate, or the top surface is integrated with the spraying plate 20 forming a chamber, to a similar effect.

[0023] What is more, as compared to conventional art, the present invention has a simplified driving system without any need for auxiliary devices, so that manufacturing cost is kept low and volume is reduced. Thereby, mobile applications are readily supported and flat shapes are realizable, making the present invention suitable for applications in ambulant medical devices or air conditioners.

Claims

1. A micro-droplet generator, comprising:

a main body (10), having an inside with a chamber (11) accommodating liquid to be sprayed and a lateral opening (12) allowing liquid in said chamber to flow out;
a spraying plate (20), placed on said main body at said opening (12) thereof and having a plurality of spraying holes (21) in a dense arrangement as well as an inner side (22) facing said chamber (11) which contacts liquid in said chamber (11) ;
a vibrating element (30), glued on said spraying plate (20) and driving vibrations thereof; and
a top surface carrier (4), placed inside said chamber and having a top surface (41) that with said inner side of said spraying plate (21) forms an inner part of said chamber (11);

wherein upon said vibrations of said spraying plate (20) a narrow space between said inner side of said spraying plate (20) and said top surface (41) with varying width is generated, upon becoming wider sucking in liquid from said chamber (11), and upon becoming narrower pressing out liquid through said spraying holes (21), so that effective spraying of liquid is performed.

2. The micro-droplet generator according to claim 1, wherein said top surface carrier (4) is a plan plate (40e) or a projection (40).

3. The micro-droplet generator according to claim 1, wherein said top surface carrier (4) has a groove (42).

4. The micro-droplet generator according to claim 1, wherein said main body (10) has an upper side with an inlet (13) through which liquid is poured into said chamber (11).

5. The micro-droplet generator according to claim 4, wherein said inlet (13) is connected with a stationary supply of liquid, allowing liquid from there to enter said chamber (11).

6. The micro-droplet generator according to claim 1, wherein said vibrating element (30) is made of piezoelectric material, thereby vibrating upon application of electric voltage.

7. The micro-droplet generator according to claim 6, wherein said vibrating element (30) is shaped like a ring, being attached to a circumference of said spraying plate (20).

8. The micro-droplet generator according to claim 2, wherein at least one guiding groove (43)is cut into said projection (40), allowing liquid to flow in between said inner side of said spraying plate (20)and said top surface (41) of said projection (40) .

9. The micro-droplet generator according to claim 3, wherein said groove (42) is shaped like a closed loop.

10. The micro-droplet generator according to claim 2, wherein said projection (40) has a chamfered top edge (44), allowing liquid to reach flow in between said inner side (22) of said spraying plate (20) and said top surface (41) of said projection (40).

11. The micro-droplet generator according to claim 8, wherein said guiding groove (43) is placed on a periphery of said projection (40).

12. The micro-droplet generator according to claim 2, wherein said projection (40) has an inner side fixed to said main body (10).

13. The micro-droplet generator according to claim 2, wherein said projection (40d) is shaped like the letter T and horizontally mounted inside said main body (10).

14. The micro-droplet generator according to claim 2, wherein said plan plate (40e) is shaped like the letter q and vertically mounted inside said main body (10).

15. The micro-droplet generator according to claim 2, wherein said plan plate (40e) has an inner side fixed to said main body (10).

16. The micro-droplet generator according to claim 2, wherein said projection (40) is integrated with said main body (10) .

17. The micro-droplet generator according to claim 2, wherein said plan plate (40e) is integrated with said main body (10).

18. The micro-droplet generator according to claim 1, wherein said spraying plate (20) is laid into said opening (12) of said main body (10).

19. The micro-droplet generator according to claim 1, wherein said vibrating element (30) drives vibrations of said spraying plate (20) by common electric power.

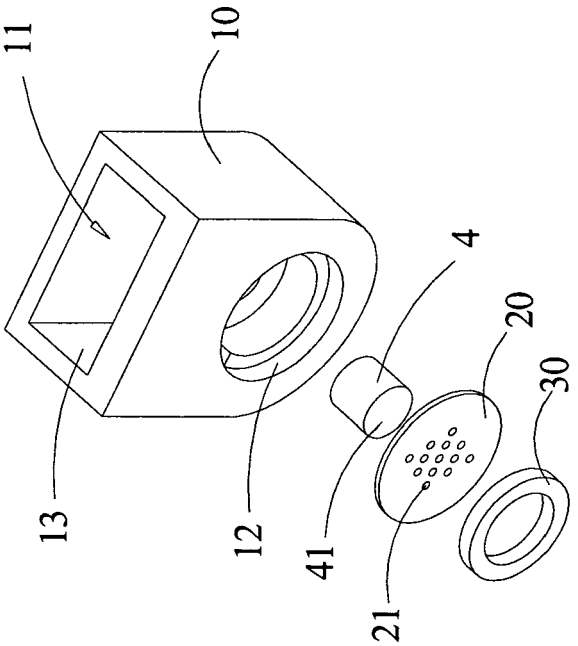

FIG 1

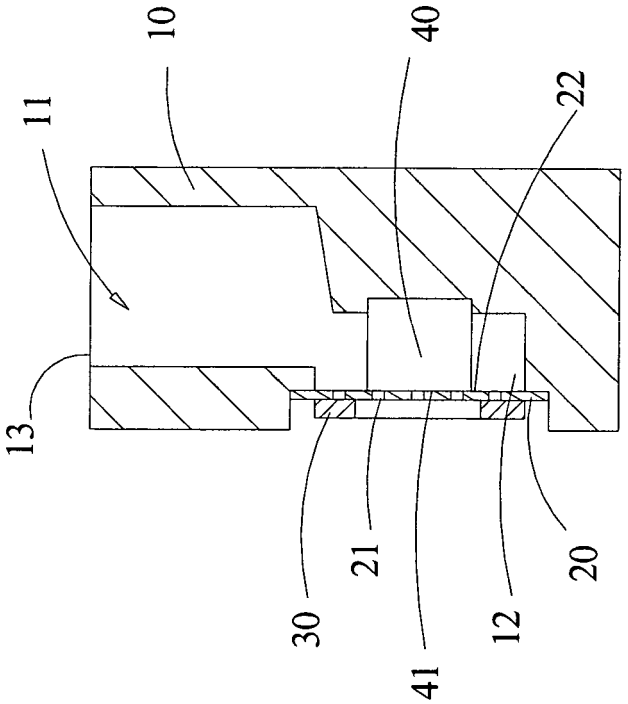

FIG 2

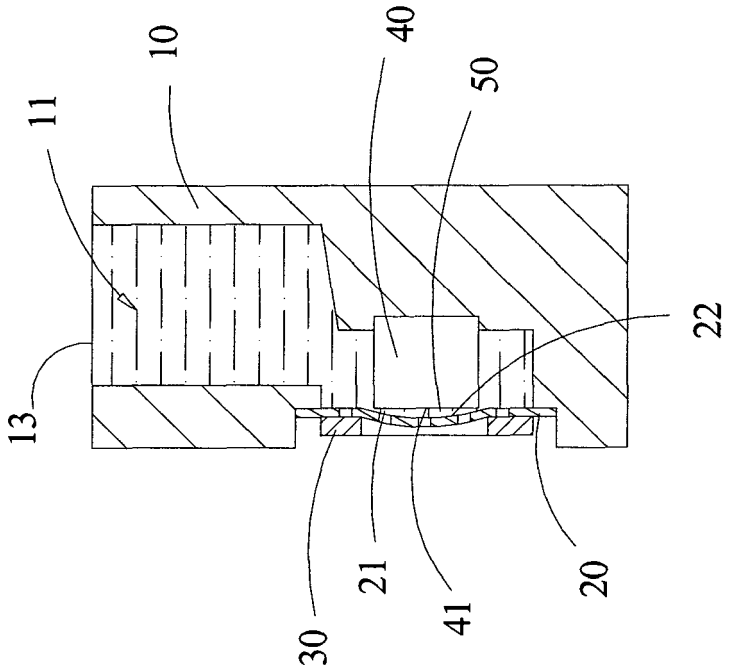

FIG 3

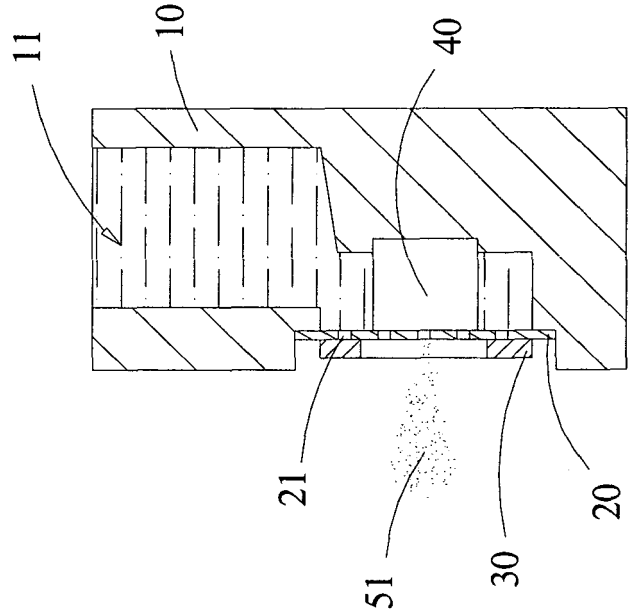

FIG 4

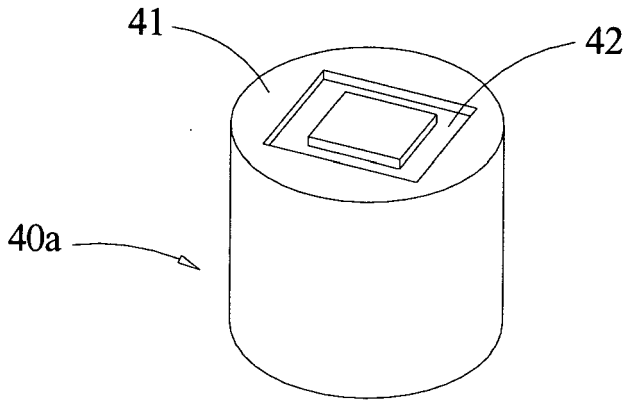

FIG 5

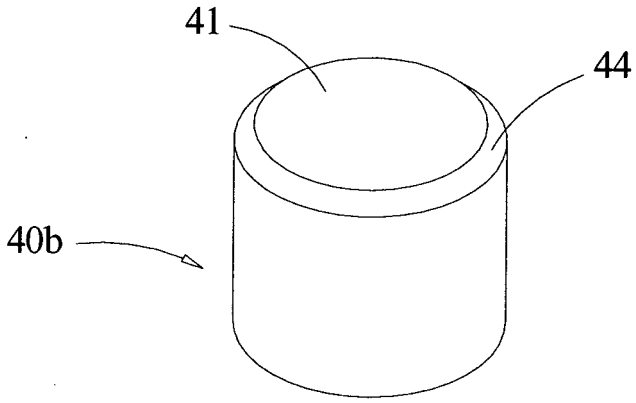

FIG 6

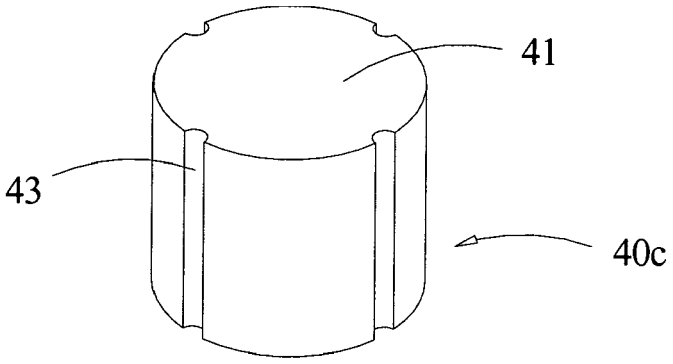

FIG 7

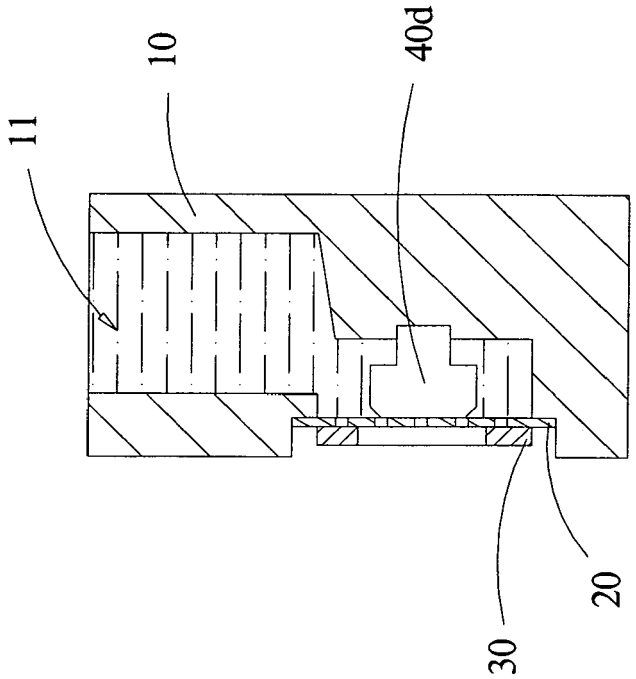

FIG 8

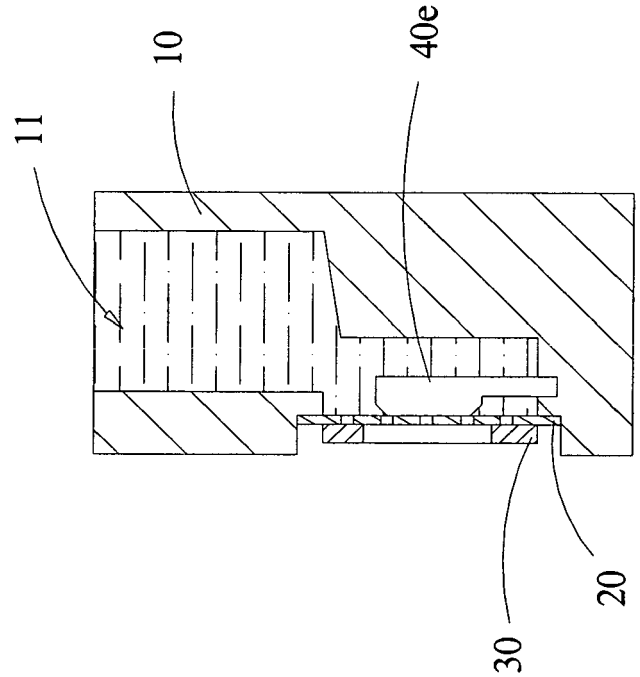

FIG 9

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 05 44 7232

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 February 2006	Brévier, F

CATEGORY OF CITED DOCUMENTS

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