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(54) INTERNAL MIX AIR ATOMIZING SPRAY NOZZLE

LUFTZERSTÄUBENDE SPRITZDÜSE

BUSE DE PULVÉRISATION À MÉLANGE INTERNE D'AIR

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Description

[0001] The present invention relates to an atomizer for liquids. Such an atomizer is used to produce jets of nebulized liquid used, for example, for the evaporative cooling of hot gas jets. In particular, an atomizer of this type can be used in a wide range of industrial processes, such as, for example, for humidifying environmental air or air flows in ducts, i.e. for cooling high-temperature streams of gas or fumes in evaporative cooling stacks installed downstream of industrial furnaces.

[0002] Several tons of water may be to be injected into the flow to be cooled every hour in processes which produce large amounts of gaseous effluents. Such an operation requires the use of large-sized sprayers.

[0003] In this case, one or more atomizers, which work with relatively low pressure values and produce their jets by spraying a cooling liquid, are used. Such a liquid may be, for example, distilled water or particular chemical substance solutions. The injection is performed with the aid of compressed air.

[0004] Various types of atomizing nozzles are known, e.g. those illustrated in documents US4699587, US4708293, US4828181, US4890793, US4982716 and US 7108203.

[0005] A further example of an atomizer according to the prior art is known from WO 03/095097. With reference to the atomizer described in Patent US 7108203, taken as example of the prior art, an atomizer for liquids of known type is described as consisting of a first duct for conveying a flow of liquid to be nebulized and a second duct configured to convey a flow of gas.

[0006] Indeed, the mixing chamber has an impingement surface, arranged precisely in front of the inlet orifice of the liquid into the mixing chamber, so that the liquid strikes upon it, is reduced to a lamina and is radially diverted to be invested by the incoming high-speed gas jet.

[0007] In this manner, a powerful breakdown of the liquid into smaller size drops, which are thus drawn towards the outlet orifices, is thus achieved.

[0008] Disadvantageously, the method used for the first breakdown of the liquid, i.e. the forced impingement against a fixed surface which produces a liquid lamina which expands radially and is struck by a gas flow, does not appear to be able to ensure a satisfactory breakdown at the independent variations of fluid and gas feeding pressure values, as required in the many cases of application.

[0009] Furthermore, the described device consists of a high number of parts, which negatively affects the production cost thereof.

[0010] Furthermore, disadvantageously, an atomizer of known type cannot obtain an optimal nebulization at low pressures if the atomizer is small in size, because the turbulent recirculation of gas and liquid in the mixing chamber is not sufficient for the purpose. Consequently, excessively large drops of fluid exit from the atomizer and this is potentially damaging for the machine which houses the atomizer. Furthermore, disadvantageously, there are lower limits to the size of the known atomizer under which efficiency decreases further. Indeed, it is not possible to reduce the volume of the mixing chamber to less than a given limit because this would compromise the gas and liquid recirculation inside.

[0011] In this context, the technical task underlying the present invention is to suggest an atomizer for liquids which overcomes the drawbacks of the prior art mentioned above.

[0012] In particular, it is an object of the present invention to provide an atomizer capable of ensuring fluid atomization with sufficiently constant results for each feeding pressure value.

[0013] It is a further object of the present invention to suggest a more compact atomizer for liquids.

[0014] The technical task and the specified objects are substantially reached by an atomizer for liquids comprising the technical features illustrated in one or more of the appended claims.

[0015] In particular, an atomizer for liquids comprises at least one first duct configured to convey a flow of liquid to be nebulized, and at least one second duct configured to convey a flow of gas.

[0016] The atomizer further comprises a mixing chamber in fluid communication with the second duct and having a plurality of orifices for expelling the nebulized liquid.

[0017] At least one nozzle is placed in the first duct in fluid communication with the second duct to let the flow of liquid into the second duct. The second duct has a first abutting surface placed in the second duct and facing the nozzle. Such an abutting surface is configured to receive the flow of liquid and atomize it in the second duct. In particular, such a first abutting surface is placed outside the mixing chamber.

[0018] According to the present invention, the flow of liquid which enters into the mixing chamber is subject to various, subsequent steps of breaking down in which the joint action allows to obtain a satisfactory drop size range in easy manner.

[0019] A first step of breaking down of the flow of liquid is obtained by inserting a spraying nozzle at the outlet of the liquid feeding duct into the mixing chamber; in other words, the liquid is fed into the mixing chamber already broken down into drops. This first step of breaking down considerably improves the knowledge of the process in addition to efficiency because the size range of these drops may be easily measured in a laboratory with the atomizer disassembled, and is thus considered known for each liquid feeding pressure value.

[0020] A second step of breaking down is performed by making the gas flow which enters the mixing chamber at high speed strike the aforesaid drops.

[0021] A third step of breaking down is performed by the impingement of the drops of liquid against the inner wall of the mixing chamber, which consists of a conical surface, the cross section of which tapers towards the outlet orifices, on which the drops drawn by the gas cur-

rent are forced to impinge.

[0022] A fourth step of breaking down is obtained by means of impingement and respective turbulence of the two-phase air-liquid mixture on the bottom of the mixing chamber before finding a way out through the atomization orifices of the nozzle.

[0023] Further features and advantages of the present invention will be more apparent in the following indicative and consequently non-limitative description of a preferred, but not exclusive embodiment example, as shown in the accompanying drawings, in which:

- figure 1 is a top view of a first embodiment of an atomizer according to the present invention;
- figure 2 is a front view taken along the A-A plane of the atomizer in figure 1;
- figure 3 is a top view of a second embodiment of an atomizer according to the present invention;
- figure 4 is a front view taken along the A-A plane of the atomizer in figure 3; and
- figure 5 is a front section view of a detail of a third embodiment of the atomizer according to the present invention.

[0024] With reference to the accompanying figures, numeral 1 indicates an atomizer for liquids according to the present invention.

[0025] In particular, the atomizer 1 comprises at least one first duct 2, which is configured to convey a flow of liquid to be nebulized. The atomizer 1 further comprises at least one second duct 3 configured to convey a flow of gas, typically air. Preferably, the atomizer 1 comprises a plurality of first 2 and second ducts 3. More in detail, the first duct 2 leads into the second duct 3, so as to let the flow of liquid into the second duct 3 and mix it with the gas. The second duct 3 has a converging zone 3a, the function of which is to accelerate the gas flow. Preferably, the first duct 2 leads into the second duct 3 at the converging zone 3a. The first duct 2 is connected to the second duct 3 at a nozzle 10. In particular, such a nozzle 10 is placed in the converging zone 3a of the second duct 3.

[0026] Preferably, the first duct 2 is ring-shaped. Furthermore, as shown in figure 2, the atomizer 1 may comprise a flow guide 19 about which the first duct 2 is defined. More than one nozzle 10 are usually present in the preferred embodiments. In particular, there may be two, four or even more nozzles 10. Such nozzles 10 are preferably made by milling but they may also be perforations or orifices made in any manner known to the person skilled in the art.

[0027] Furthermore, the atomizer 1 has a first abutting surface 15 placed in the second duct 3 and facing the first duct 2. Such a first abutting surface 15 is configured to receive the flow of liquid and atomize it within the second duct 3. In particular, the first abutting surface 15 is placed at the converging zone 3a of the second duct 3. Advantageously, in this manner, the breakdown of the flow of liquid starts already inside the second duct 3.

[0028] Further details on the first 2 and second duct 3 will be provided in a subsequent part of the present description.

[0029] More in detail, the atomizer 1 comprises a main body 5 in which the second duct 3 is obtained at least in part. With reference to both embodiments, the second duct 3 is ring-shaped. In the preferred embodiments, the duct 3 has a plurality of external openings through which the gas is let in. There may two, four or even more of such openings. Such openings are preferably made by drilling. Furthermore, the openings may have a circular section, but may also have a non-circular section and be made in any manner known to a person skilled in art, e. g. by milling or micro-casting.

[0030] More in particular, the main body 5 has a central axis "C". Preferably, the main body 5 is symmetric with respect to the central axis "C". In other words, the main body 5 develops about the central axis "C".

[0031] In further detail, the main body has an outer side surface 5a. Furthermore, the main body 5 has an inner side surface 5b opposite to the outer side surface 5a. Both side surfaces 5a, 5b are developed at least in part along directions parallel to the central axis "C". With reference to the embodiments shown in figures 2 and 4 in particular, the outer side surface 5a is substantially cylinder-shaped. In alternative embodiments (not shown), the outer side surface 5a may have any shape, according to the specific applications.

[0032] The mentioned second duct 3 is defined in part by the inner surface 5b of the main body 5. Such an inner surface 5b is preferably truncated-cone-shaped. With reference to figure 2 in particular, the inclination of the inner side surface 5b with respect to the central axis "C" is constant. Alternatively, as shown in figure 4, such an inclination may vary along a direction parallel to the central axis "C". In other words, in the embodiment shown in figure 4, the inner side surface 5b of the main body 5 is substantially funnel-shaped. It is worth noting that the first abutting surface 15, mentioned above, is defined by a portion of the inner side surface 5b of the main body 5.

[0033] In an alternative embodiment of the invention, shown in figure 5, the main body 5 comprises an outer casing 17 and an insert 18. In this case, the inner side surface 5b of the main body 5 will be made on the insert 18, while the outer side surface 5a is defined by the outer casing 17. Advantageously, the insert 18 may be made of material more resistant to wear, such as ceramic, for example.

[0034] The atomizer 1 further comprises a connecting body 6, associated to the main body 5. Such a connecting body 6 is configured to be connected to a source of fluid to be nebulized and to a source of gas, neither shown in the accompanying figures. The connecting body has an outer surface 6a and at least a first 6b and a second inner surface 6c. The outer 6a and inner 6b, 6c surfaces of the connecting body 6 are developed at least in part along a direction identified by the central axis "C".

[0035] In the embodiment shown in figure 2, the connecting body 6 is placed in contact with the main body 5, in particular at respective interface surfaces 6d, 5d. After having assembled the main body 5 and the connecting body 6, such interface surfaces 6d, 5d define a plane which is crosswise and, in particular, perpendicular to the central axis "C".

[0036] It is worth noting that the inner side surface 5b of the main body 5 and the first inner surface 6b of the connecting body 6 are reciprocally continuous so as to define the second duct 3 in part.

[0037] In the embodiment shown in figure 4, the atomizer 1 comprises a joining body 7 placed between the main body 5 and the connecting body 6. As the connecting body 6, the joining body 7 also has an outer surface 7a and at least a first 7b and a second inner surface 7c. More in particular, the first inner surface 7b joins the first surface 6b of the connecting body 6 to the inner side surface 5b of the main body 5. The second inner surface 7c of the joining body 7 is continuous with the second inner surface 6c of the connecting body 6.

[0038] The connecting body 6 further has a seat 8 for the first duct 2. In particular, the seat 8 is defined near the central axis "C". With reference to the embodiment in figure 4, the central seat itself defines the first duct 2. Alternatively, as shown in figure 2, the central seat 8 houses a separate pipe 9 for a flow of liquid to be nebulized. In this case, an outer wall 9a of the pipe 9 also defines the second duct 3 in part.

[0039] The atomizer 1 further comprises diverting means 4 which are associated to the first duct 3. The diverting means 4 are further configured to divert the flow of liquid coming from the first duct 2 and let it into the second duct 3. In particular, the diverting means 4 are associated to the aforesaid nozzle 10. Such diverting means 4 comprise, in particular, a crosswise element 11 which, by intercepting the flow of liquid within the first duct 2, diverts it abruptly towards the nozzle 10 and thus into the second duct 3.

[0040] It is worth noting that, as shown in figure 2, the diverting means 4 may define a side wall of the second duct 3 in part.

[0041] With reference to figure 2, the diverting means 4 comprise a crosswise, preferably disc-shaped baffle 12, which closes an end of the pipe 9 defining the nozzles 10 in part. In this embodiment, the crosswise element 11 is the baffle 12. The fluid is thus forced towards the nozzles 10, which, by being little more than slots, perform a first nebulization of the fluid as the fluid itself is let into in the second duct 3. With reference to figure 4, the seat 8 has a bottom wall 8a, which works as the crosswise element 11. In this case, the nozzles 10 are defined in the connecting body 6, in particular between a side wall 8b of the seat 8 and the second inner surface 6c of the connecting body 6 itself.

[0042] Thus, in this embodiment, the diverting means 4 comprise the bottom wall 8a of the seat 8, which define a bottom wall of the first duct 2.

[0043] Furthermore, the atomizer 1 has a mixing chamber 13. In particular, such a chamber 13 is configured to receive a mixture of gas and nebulized liquid from the second duct 3. In particular, it is worth noting that the first duct 2 does not lead directly into the mixing chamber 13 in the described and illustrated embodiments of the atomizer 1. In other words, the liquid enters into the mixing chamber 13 through the second duct 3, in particular at the end of the converging zone 3a. Consequently, the liquid enters into the mixing chamber 13 already mixed with the gas in part. The turbulent recirculation which is established in the mixing chamber 13 thus performs a further atomization of the fluid.

[0044] Advantageously, the atomizer 1 has a second abutting surface 16 placed within the mixing chamber 13. In particular, the second abutting surface 16 faces the second duct 3. In this manner, the jet of partially nebulized liquid directly on the second abutting surface 16, thus completing the breakdown of the jet of liquid. More in detail, the mixing chamber 13 is defined within the main body 5. More in particular, the inner side surface 5c defines the mixing chamber 13 at least in part. With reference in particular to the embodiment shown in figure 2, it is worth noting that the diverting means 4, in particular the baffle 12, define the mixing chamber 13 at least in part.

[0045] Furthermore, the chamber 13 has a plurality of orifices 14 to expel the mixture of liquid and gas. The atomization of the liquid is completed during the expulsion through the orifices 14, which in particular are placed at a bottom surface 5c of the main body 5.

Claims

1. An atomizer (1) for liquids, comprising at least one first duct (2) configured to convey a flow of liquid to be nebulized; at least one second duct (3) configured to convey a flow of gas; a mixing chamber (13) in fluid communication with said second duct (3) and having a plurality of orifices (14) for expelling the nebulized liquid; wherein said atomizer (1) further comprises at least one nozzle (10) placed in said first duct (2) and in fluid communication with said second duct (3) to let said flow of liquid into said second duct (3), said second duct (3) having a first truncated-cone-shaped abutting surface (15) facing said nozzle (10) and configured to receive said flow of liquid and to atomize it in said second duct (3), said first abutting surface (15) being arranged outside said mixing chamber (13), **characterized in that** said mixing chamber (13) has a truncated-cone-shaped inner surface (5b), the cross section of which is tapered towards said orifices (14), and **in that** said first abutting surface (15) and said inner surface (5b) of said mixing chamber (13) are continuous to each other.

2. An atomizer (1) according to the preceding claim, **characterized in that** said first abutting surface (15) is inclined with respect to an efflux direction of said nozzle (10).

3. An atomizer (1) according to any one of the preceding claims, **characterized in that** in said second duct (3) has a converging zone (3a) to accelerate said flow of gas.

4. An atomizer (1) according to the preceding claim, **characterized in that** said first abutting surface (15) is placed at said converging zone (3a) of said second duct (3a).

5. An atomizer (1) according to the preceding claim, **characterized in that** said first duct (2) leads into said second duct (3) at said converging zone (3a).

6. An atomizer (1) according to any one of the preceding claims, **characterized in that** said nozzle (10) is placed at said converting zone (3a) of said second duct (3).

7. An atomizer (1) according to the preceding claim, **characterized in that** it comprises a second abutting surface (16) placed inside said mixing chamber (13) and facing said second duct (3).

8. An atomizer (1) according to any one of the preceding claims, **characterized in that** it comprises diverting means (4) associated to said second duct (3) and configured to divert said liquid flow towards the first duct (2), said diverting means (4) defining said mixing chamber (13) at least in part.

9. An atomizer (1) according to the preceding claim, **characterized in that** said diverting means (4) comprise a preferably disc-shaped baffle (12) placed between said first duct (2) and said mixing chamber (13).

10. An atomizer (1) according to claim 8 or 9, **characterized in that** said diverting means (4) comprise a bottom wall (8a) of the first duct (2).

11. An atomizer (1) according to any one of claims from 8 to 10, **characterized in that** said diverting means (4) define partially a side wall of the second duct (3).

Patentansprüche

1. Zerstäuber (1) für Flüssigkeiten, mit zumindest einem ersten Kanal (2), der derart konfiguriert ist, eine zu zerstäubende Flüssigkeitsströmung zu fördern; zumindest einem zweiten Kanal (3), der derart konfiguriert ist, eine Gasströmung zu fördern; eine Mischkammer (13) in Fluidkommunikation mit dem zweiten Kanal (3) und mit einer Mehrzahl von Durchbrechungen (14) zum Ausstoß der zerstäubten Flüssigkeit; wobei der Zerstäuber (1) ferner zumindest eine Düse (10) umfasst, die in dem ersten Kanal (2) angeordnet ist und in Fluidkommunikation mit dem zweiten Kanal (3) steht, um die Flüssigkeitsströmung in den zweiten Kanal (3) zu lassen, wobei der zweite Kanal (3) eine erste kegelstumpfförmige Anlagefläche (15) aufweist, die zu der Düse (10) weist und derart konfiguriert ist, die Flüssigkeitsströmung aufzunehmen und diese in dem zweiten Kanal (3) zu zerstäuben, wobei die erste Anlagefläche (15) außerhalb der Mischkammer (13) angeordnet ist, **dadurch gekennzeichnet, dass** die Mischkammer (13) eine kegelstumpfförmige Innenfläche (5b) aufweist, deren Querschnitt sich zu den Öffnungen (14) verjüngt, und dass die erste Anlagefläche (15) und die Innenfläche (5b) der Mischkammer (13) zueinander kontinuierlich sind.

2. Zerstäuber (1) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die erste Anlagefläche (15) in Bezug auf eine Ablaufrichtung der Düse (10) schräggestellt ist.

3. Zerstäuber (1) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der zweite Kanal (3) eine konvergierende Zone (3a) zur Beschleunigung der Gasströmung aufweist.

4. Zerstäuber (1) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die erste Anlagefläche (15) an der konvergierenden Zone (3a) des zweiten Kanals (3a) angeordnet ist.

5. Zerstäuber (1) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der erste Kanal (2) in den zweiten Kanal (3) an der konvergierenden Zone (3a) führt.

6. Zerstäuber (1) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Düse (10) an der konvergierenden Zone (3a) des zweiten Kanals (3) angeordnet ist.

7. Zerstäuber (1) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** er eine zweite Anlagefläche (16) umfasst, die in der Mischkammer (13) angeordnet ist und zu dem zweiten Kanal (3) weist.

8. Zerstäuber (1) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** er ein Umlenkmittel (4) umfasst, das dem zweiten Kanal (3) zugeordnet und derart konfiguriert ist, die Flüssigkeitsströmung zu dem ersten Kanal (2) zu lenken, wobei das Umlenkmittel (4) zumindest teilweise die

Mischkammer (13) definiert.

9. Zerstäuber (1) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Umlenkmittel (4) eine bevorzugt scheibenförmige Ablenkeinrichtung (12) umfasst, die zwischen dem ersten Kanal (2) und der Mischkammer (13) angeordnet ist.

10. Zerstäuber (1) nach einem der Ansprüche 8 oder 9, **dadurch gekennzeichnet, dass** das Umlenkmittel (4) eine Bodenwand (8a) des ersten Kanals (2) umfasst.

11. Zerstäuber (1) nach einem der Ansprüche 8 bis 10, **dadurch gekennzeichnet, dass** das Umlenkmittel (4) teilweise eine Seitenwand des zweiten Kanals (3) definiert.

Revendications

1. Pulvérisateur (1) pour liquides, comprenant au moins un premier conduit (2) configuré pour transporter un écoulement de liquide à nébuliser ; au moins un second conduit (3) configuré pour transporter un écoulement de gaz ; une chambre de mélange (13) en communication de fluide avec ledit second conduit (3) et ayant une pluralité d'orifices (14) pour expulser le liquide nébulisé ; dans lequel ledit pulvérisateur (1) comprend en outre au moins une buse (10) placée dans ledit premier conduit (2) et en communication de fluide avec ledit second conduit (3) pour laisser ledit écoulement de fluide dans ledit second conduit (3), ledit second conduit (3) ayant une première surface de butée de forme tronconique (15) faisant face à ladite buse (10) et configurée pour recevoir ledit écoulement de liquide et pour le pulvériser dans ledit second conduit (3), ladite première surface de butée (15) étant agencée à l'extérieur de ladite chambre de mélange (13), **caractérisé en ce que** ladite chambre de mélange (13) a une surface interne de forme tronconique (5b), dont la section transversale est progressivement rétrécie vers lesdits orifices (14), et **en ce que** ladite première surface de butée (15) et ladite surface interne (5b) de ladite chambre de mélange (13) sont continues l'une par rapport à l'autre.

2. Pulvérisateur (1) selon la revendication précédente, **caractérisé en ce que** ladite première surface de butée (15) est inclinée par rapport à une direction d'écoulement de ladite buse (10).

3. Pulvérisateur (1) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit second conduit (3) a une zone de convergence (3a) pour accélérer ledit écoulement de gaz.

4. Pulvérisateur (1) selon la revendication précédente, **caractérisé en ce que** ladite première surface de butée (15) est placée au niveau de ladite zone de convergence (3a) dudit second conduit (3a).

5. Pulvérisateur (1) selon la revendication précédente, **caractérisé en ce que** ledit premier conduit (2) mène dans ledit second conduit (3) au niveau de ladite zone de convergence (3a).

6. Pulvérisateur (1) selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ladite buse (10) est placée au niveau de ladite zone de convergence (3a) dudit second conduit (3).

7. Pulvérisateur (1) selon la revendication précédente, **caractérisé en ce qu'**il comprend une seconde surface de butée (16) placée à l'intérieur de ladite chambre de mélange (13) et faisant face audit second conduit (3).

8. Pulvérisateur (1) selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**il comprend des moyens de déviation (4) associés audit second conduit (3) et configurés pour dévier ledit écoulement de liquide vers le premier conduit (2), lesdits moyens de déviation (4) définissant ladite chambre de mélange (13) au moins en partie.

9. Pulvérisateur (1) selon la revendication précédente, **caractérisé en ce que** lesdits moyens de déviation (4) comprennent un déflecteur (12) de préférence en forme de disque, placé entre ledit premier conduit (2) et ladite chambre de mélange (13).

10. Pulvérisateur (1) selon la revendication 8 ou 9, **caractérisé en ce que** lesdits moyens de déviation (4) comprennent une paroi inférieure (8a) du premier conduit (2).

11. Pulvérisateur (1) selon l'une quelconque des revendications 8 à 10, **caractérisé en ce que** lesdits moyens de déviation (4) définissent partiellement une paroi latérale du second conduit (3).

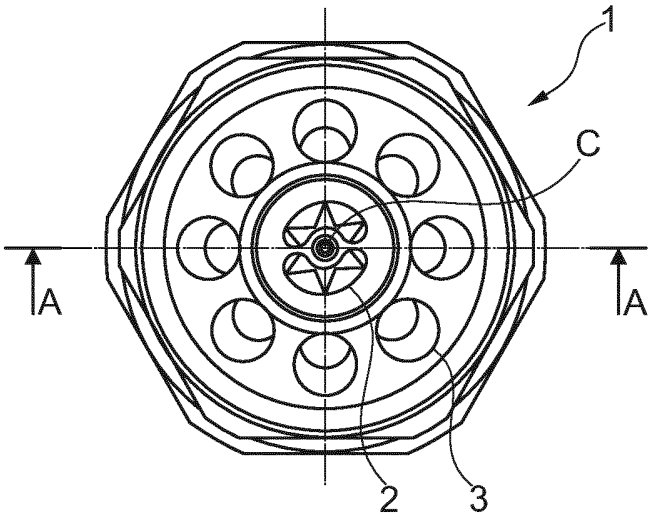
1
C
A
A
2
3

Fig. 1

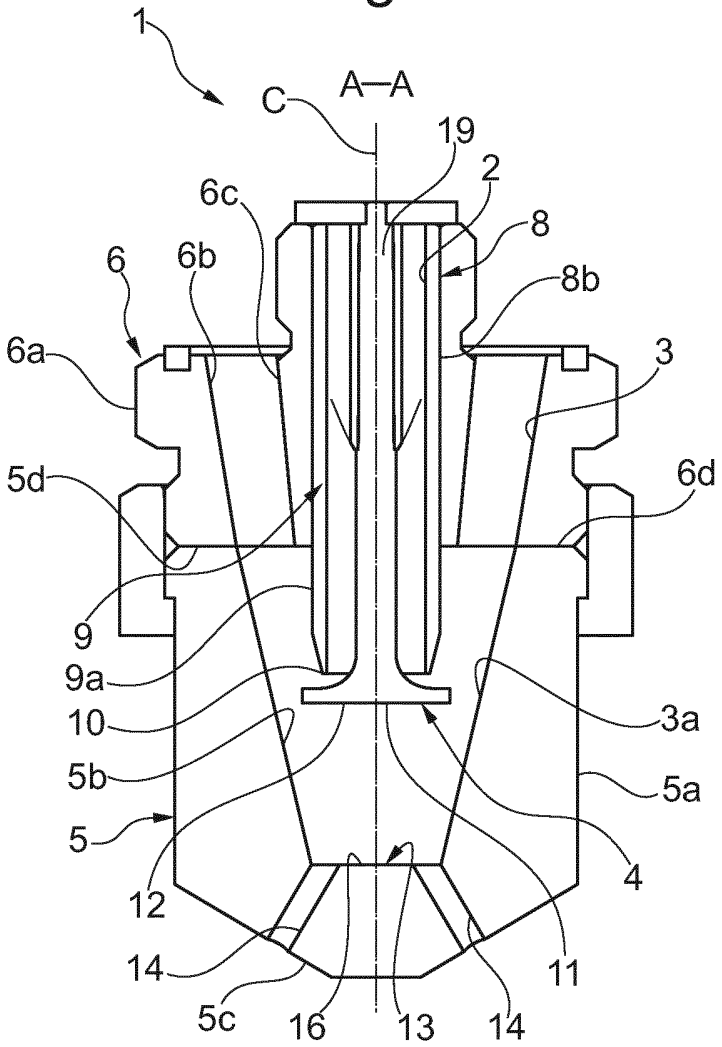
1
C
A—A
19
2
6c
8
6
6b
8b
6a
3
5d
6d
9
9a
10
3a
5b
5a
5
4
12
14
11
5c
16
13
14

Fig. 2

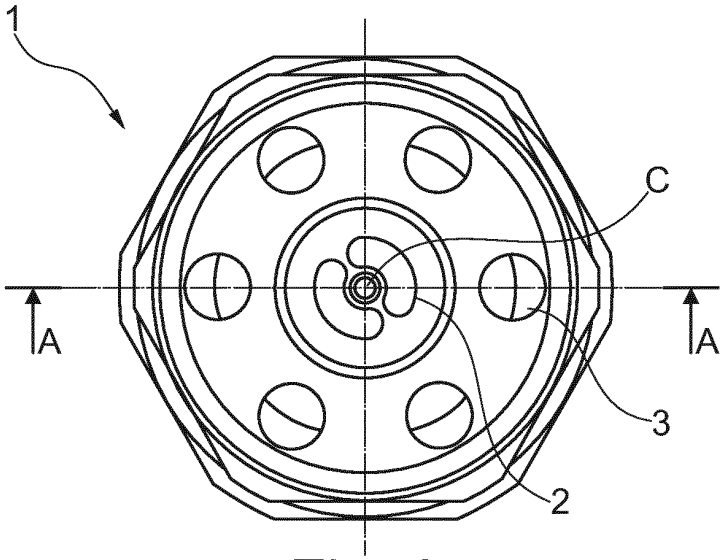
1
C
A
A
3
2

Fig. 3

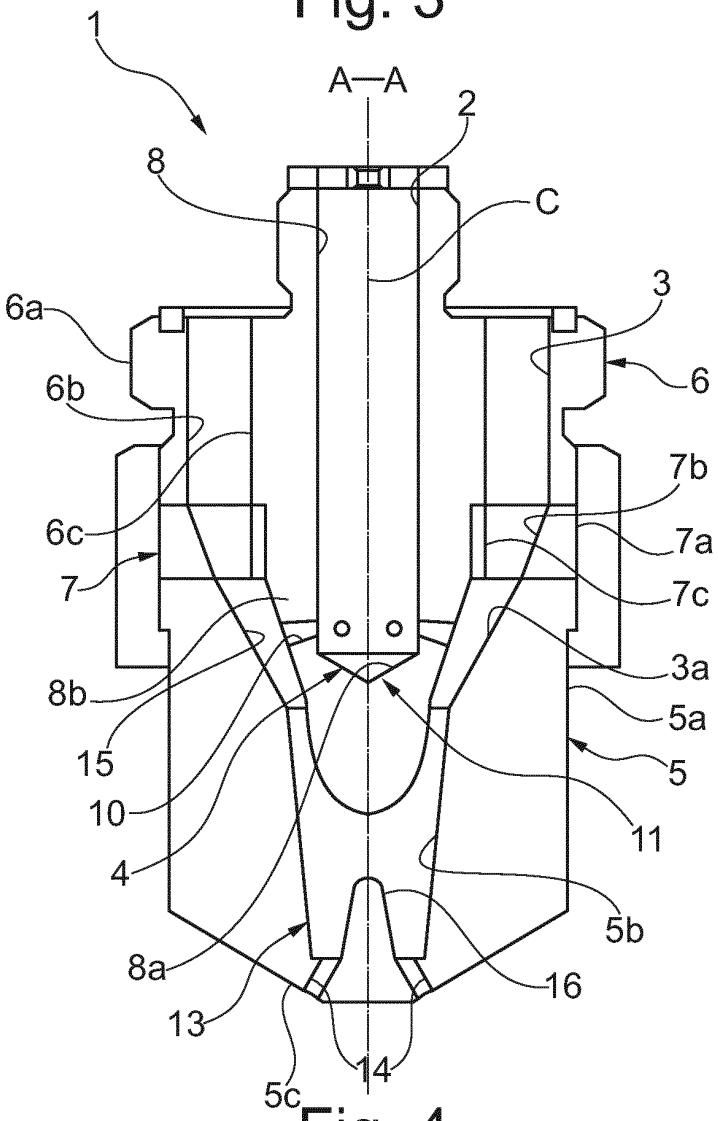
1
A—A
2
8
C
3
6a
6
6b
7b
6c
7a
7
7c
3a
8b
5a
15
5
10
11
4
5b
8a
16
13
14
5c

Fig. 4

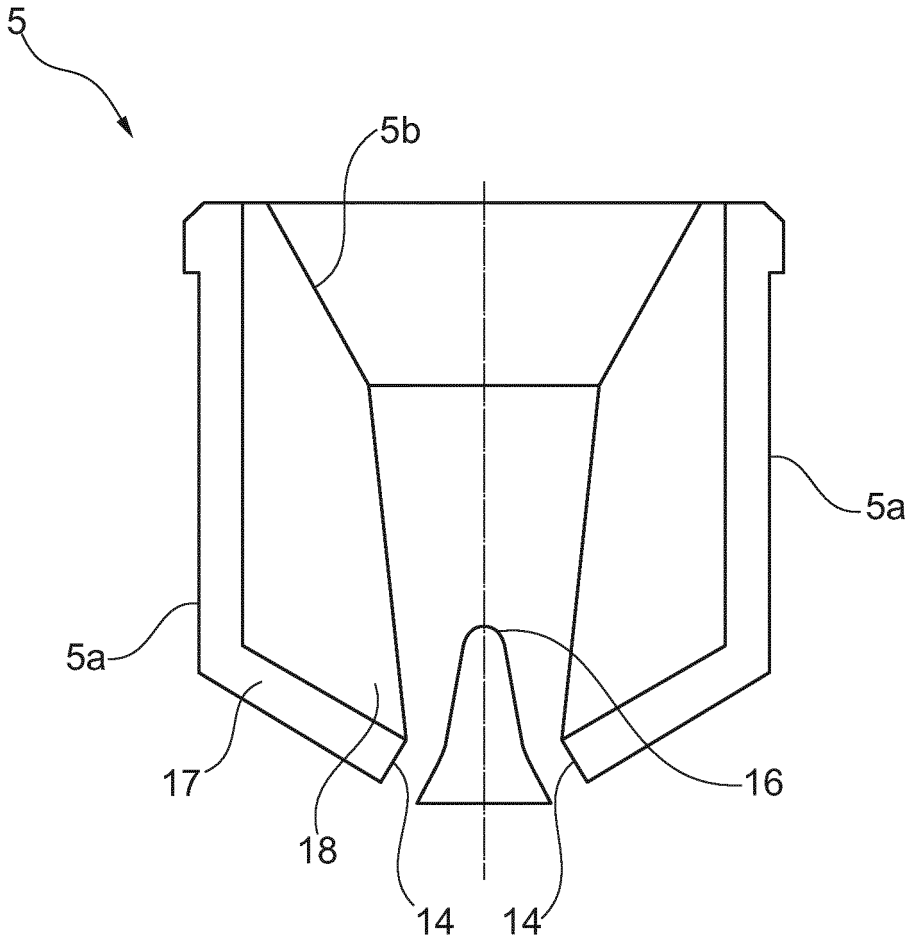

Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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