(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 081 884 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
19.10.2016 Bulletin 2016/42

(51) Int Cl.:
***F25C 3/04** (2006.01)* ***B05B 7/00** (2006.01)*

(21) Application number: **16164968.6**

(22) Date of filing: **12.04.2016**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **14.04.2015 IT MI20150534**

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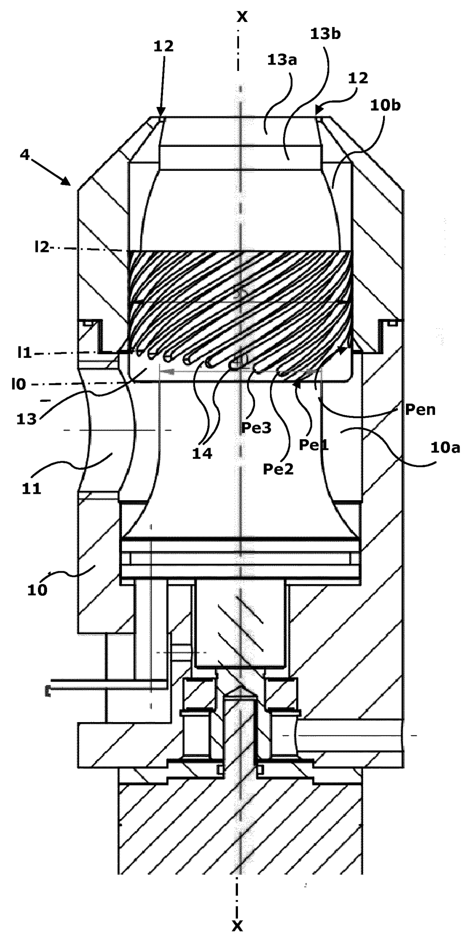
(54) **WATER SPRAY NOZZLE FOR A SNOW GUN**

(57) Water spray nozzle for a snow gun, of the type comprising a distributor (13), housed between a water-supply lower chamber (10a) and a water-distribution upper chamber (10b) ending in an annular exit (12), said distributor (13) having a cylindrical surface, at least part of which (band l_1-l_2) seals against a corresponding cylindrical area of the wall of the upper chamber (10b), on said cylindrical surface of the distributor a plurality of helical grooves (14) being formed, which grooves receive the water coming from the lower chamber (10a) and lead it into the upper chamber (10b) and towards the annular exit (12) of the nozzle, simultaneously imparting to the same a rotary motion. The ends of said helical grooves (14) in connection with the lower chamber (10a) are formed at axially different heights on the circumference of the distributor (13) and said distributor (13) is axially movable for connecting a different number of said helical grooves (14) with the lower chamber (10a).

Fig.4



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Printed by Jouve, 75001 PARIS (FR)

Description

FIELD OF THE INVENTION

[0001] The present invention relates to an apparatus for the artificial snow production, the so-called "snow gun" and, in particular, an improved nozzle for this apparatus. As used herein, the term "snow gun" is meant to refer to all those devices that are used to turn water into snow while projecting it on the ski slopes, to obtain an artificial snowfall in case of scarcity of natural atmospheric precipitation.

PRIOR STATE OF THE ART

[0002] It is known that the snow guns comprise a gun body, i.e., an essentially tubular, cylindrical shaped structure, open at both its ends, inside which on one end a motorized fan is arranged and, and on the other end a main nozzle or more main nozzles are arranged annularly for atomising water.

[0003] In snow guns of more recent construction "nucleating devices" are also provided, i.e. secondary nozzles, arranged near or around the main nozzles, able to spray a mixture of water and compressed air, so as to give rise to the rapid formation of very small ice particles, which have the function of nuclei to trigger the formation of snowflakes using the water atomised into droplets of larger size coming from the main nozzles.

[0004] Thanks to this structure, the current snow guns are able to obtain a good artificial snowfall. However, this is very dependent on both the physical features of the slope to be covered with snow and, above all, the local environmental conditions, namely humidity and temperature. Under low temperature and humidity conditions, in fact, the formation of snowflakes takes place easily even with high water flow rates in the main nozzles, while in higher humidity and temperature conditions, i.e. temperatures near 0°C, the flow rate to the nozzles must be maintained at the minimum levels so that there is a sufficient contact time between water droplets, ice nuclei and ambient air to cause a proper formation of the snowflakes.

[0005] For these reasons, the main nozzles of the snow guns are currently built in different shapes and dimensions, which depend on the snow-making power to be obtained. Since the replacement of the nozzles is an operation that requires a certain amount of time and the environmental conditions at the snow gun plants vary even with considerable speed, the snow guns are currently equipped with nozzles suitable to the average environmental conditions of a certain seasonal period, thus accepting a sub-optimal operation of the snow gun when the actual conditions significantly depart from those expected, and, therefore, the nozzle must be operated with water flow rates which are different from that for which the nozzle has been optimized. Alternatively, it is known to equip a snow gun with a plurality of nozzles, possibly having different nominal flow rate, and then equip the snow gun with a control system allowing the activation of one or more of the present nozzles, to obtain a flow rate suitable to the current environmental conditions. Of course, this latter solution entails higher costs of construction and installation of the snow gun.

[0006] To overcome, at least in part, the problem of an insufficient or sub-optimal atomisation when the main nozzles are operated at flow rates which are different from the planned one, it is also known to equip the snow guns with fan groups, able to form an air flow at high speed inside the snow gun, said air flow helping the further fragmentation of the water jet coming out from the main nozzles, thus allowing the snow formation even with flow rate and environmental conditions which are not compatible with each other. However, the use of air fans for this purpose entails a high energy consumption and, therefore, makes the use of snow guns uneconomical.

SUMMARY OF THE INVENTION

[0007] Object of the present invention is, therefore, to provide an improved nozzle for snow guns which overcomes the mentioned drawback and which allows, in particular, to change the flow rate features of the atomised water jet while maintaining an optimal atomisation in every flow rate condition, in a simple way and without requiring laborious replacement operations of the main nozzles or the progressive activation of more nozzles, depending on the ski plant requirements and/or the actual environmental conditions, so as to allow an efficiency improvement of the snow gun and a consequent reduced need for resorting to more expensive functionality with forced ventilation of the gun.

[0008] This object is achieved by a nozzle for snow guns having the features defined in claim 1. Other preferred features of the invention are defined in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Further features and advantages of the invention will anyhow be more evident from the following detailed description of some preferred embodiments, given by mere way of non-limiting example and illustrated in the accompanying drawings, wherein:

Fig. 1 is a very schematic longitudinal sectional view of the general structure of a snow gun incorporating an improved nozzle according to the invention;
Fig. 2 is a schematic perspective view of the gun of Fig. 1;
Fig. 3 is a partial longitudinal sectional view of the main nozzle of the snow gun according to the invention, in operating conditions;
Fig. 4 is a view identical to the upper portion of Fig. 3, but at a larger scale;
Fig. 5 is a view similar to that of Fig. 3, but in a com-

plete shutdown condition of the main nozzle operation;

Fig. 6 is a longitudinal sectional view of an alternative embodiment of the main nozzle of the snow gun according to the invention; of which

Fig. 7 represents a schematic front view.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0010] As illustrated in the drawings, the snow gun according to the invention comprises a main body 1, having the shape of a cylindrical or preferably slightly conical tube open at both ends, respectively the entry 1E and the exit 1U ends.

[0011] Inside the body 1, near its entry mouth 1E, a motor 2 which rotates the blades 3 of a fan is arranged: this is apt to create an important ventilation air flow within the body 1, directed from the entry mouth 1E towards the exit mouth 1U.

[0012] Also inside the body 1, near the exit mouth 1U, a main nozzle 4 is also arranged which is centred on the longitudinal axis X-X of the body 1 and apt to form a water jet, shown schematically by the cone profile G1 in Fig. 1. The shape of the nozzle 4 and the supplied water pressure are apt to form, in a manner known per se, a jet of atomised water.

[0013] In correspondence of the edge of the exit mouth 1U of the body 1, nucleating devices 5 are evenly provided. When supplied with compressed air and water, these nucleating devices are apt to release smaller jets G2, having a conical shape, of minute water particles, called nuclei, which freeze immediately in contact with air and are suitable to form, in a way also known per se, initiator elements of the atomised water transformation of the main jet G1 into snowflakes.

[0014] According to the fundamental feature of the present invention, said main nozzle 4 has the structure represented schematically in Fig. 3 and, in greater detail, in Fig. 4. Here, it can be seen that this structure comprises a fixed case 10, provided with an entry opening 11 of the water under pressure and an exit opening 12 of the atomised water jet G1. The water entering through the opening 11 distributes in a lower chamber 10a and in an upper chamber 10b, between which a distributor 13 is interposed.

[0015] This distributor 13 is in the form of a cylindrical body, arranged axially movable within the case 10. The size and shape of the distributor 13 is such that at least part of its cylindrical surface is substantially abutted against a corresponding cylindrical zone of the inner circular wall of the case 10, which delimits the bottom of the upper distribution chamber 10b.

[0016] More precisely, said cylindrical surface of the distributor 13 comprises an upper area, where a real waterproofing is carried out, this area being comprised between the level l_1 and the level l_2 (Fig. 4) and a lower area, comprised between the level l_0 and the level l_1 which forms a water intake zone, as better explained below.

[0017] In fact, on said outer cylindrical surface of the distributor 13 a plurality of helical grooves 14 is formed, which lead the water from said lower chamber 10a towards the upper chamber 10b and then towards the exit 12 of the nozzle, while simultaneously imparting to the water a strong rotary motion able to cause the formation of a conical jet G1 having suitable shape and speed for an efficient water atomisation.

[0018] More precisely, the lower ends of the helical grooves are arranged in the lower area of the cylindrical surface of the distributor 13, i.e. the aforementioned intake zone, and, thus, they form the water entry point; in fact, said water intake zone freely faces the chamber 10a and the water, as a result of its pressure, is forced to go up along the helical grooves 14.

[0019] According to an important feature of the invention, the grooves 14 formed on the cylindrical wall of the distributor 13 have helical profiles which are parallel and identical, except with regard to the lower starting point (with respect to the drawing of Fig. 4) of each groove. As can be clearly seen from the drawing, while all the exits of the grooves 14 at their upper end are aligned on a single circumferential plane P_u, the entries of said grooves, at their lower end, are sequentially staggered in height, starting from a point P_{el}, which is located at the previously mentioned level l_0, then the point P_{e2}, and so on up to the point P_{en}, this latter being at level l_1, as it appears from Fig. 4.

[0020] In other words, said lower ends of the grooves, forming the entrance way of the water coming from the lower chamber 10a and going into the upper chamber 10b, are staggered at progressively increasing height with respect to the axial height of said cylindrical intake zone of the distributor 13.

[0021] According to a further important feature of the invention, said distributor is movable along its axis X-X, to progressively hide said intake zone, or vice versa, inside said cylindrical zone that delimits, at the bottom, the wall of the upper chamber 10b.

[0022] Thanks to this construction, it is therefore possible to obtain, in an extremely simple manner, through a displacement of the distributor 13 along the axis direction X-X, a reduction of the number of grooves 14 actually operating. The axial movement of the distributor 13 is preferably obtained by means of an electric motor M of small size of the stepper type, axially mounted behind the nozzle and connected to the distributor 13 through a screw/nut system. Thanks to this, the longitudinal position of the distributor 13 inside the nozzle can be easily adjusted, even remotely, by imposing the desired number of rotations to the stepper motor M. Any other control system, either manual or motorized, which allows obtaining a controlled axial movement of the distributor 13 is equally usable and, therefore, comprised within the scope of protection of the present invention.

[0023] In the example shown in Fig. 4 it can be seen that all the grooves 14 are operational, since also the groove end indicated with reference P_{en}, i.e. the most spaced from the level l_0, is open towards the chamber 10a; therefore, all the grooves carry water. Starting from this position of the distributor 13, a reduction of the water flow rate is obtained by making the distributor 13 go up in the direction of the arrow F, so as to bring one or more of the lower ends of the grooves 14 in correspondence of the cylindrical zone of the upper chamber 10a of the distributor, where the sealing effect with the cylindrical surface of the lower part of the distributor 13 free from grooves 14, prevents the water to reach the lower ends of said grooves.

[0024] According to a further important feature of the present invention, the annular exit 12 of the water from the upper mouth of the main nozzle 4 is formed between the inner edge of this mouth and the upper end surface of the distributor 13, which surface includes a terminal conical zone 13a, arranged downstream of a cylindrical zone 13b, which, therefore, makes up a connection with the body of the distributor 13, to perform the nozzle function better described hereinafter.

[0025] Thanks to this arrangement it is in fact possible - through the movement of the distributor 13 in the direction of the arrow F - to cause, at first, a gradual reduction of the exit 12 width, as a result of the approach of the conical-surface zone 13a towards the edge of the mouth, and subsequently the complete closure of the exit 12 when the cylindrical-surface zone 13b is in contact with the edge of the mouth.

[0026] This closed position is highlighted in Fig. 5, where it can be seen that the surface of the cylindrical-surface zone 13b is in contact with the edge of the mouth and, at the same time, the grooved portion of the distributor 13 is almost entirely above the level l_0, i.e., with the lower ends of all the grooves 14, except the first P_{e1}, which are in a sealing area, and that is no longer in communication with the lower chamber 10a of the water entry. Thus, in this closed position, a minimum flow rate passes in the only active groove 14 and leaks through the thin annular clearance 12 which is formed between the cylindrical zone 13b and the inner edge of the nozzle mouth, where, in fact, no sealing is provided to this purpose. Said minimum flow rate is necessary to maintain the nozzle in active condition, when the operation of the same - due to any reason - must be done in a discontinuous manner.

[0027] Thanks to this construction it is possible to simultaneously achieve two effects, namely, on the one hand, it is possible to optimally and gradually adjust the flow rate of the water coming from the nozzle and, on the other hand, to maintain a full flow within the grooves 14 also at low flow rates, since the reduction of the flow rate caused by the width reduction of the exit 12 corresponds to a progressive reduction of the number of grooves 14 in which water can enter. In this way, the rotation effect impressed by the distributor 13 maintains its effectiveness unaltered even at low flow rates; thus the formation of the cone jet G1 and its proper atomisation are optimal in any condition of use. In summary, it is just the intrinsic structure of the nozzle of the present invention - wherein at a higher flow rate corresponds a higher number of operating grooves 14 to properly supply the upper chamber 10b - which allows an always optimal atomisation effect of the water jet G1.

[0028] In Figures 6 and 7 it is illustrated a second embodiment of the nozzle of the present invention, in which, around the main nozzle 4, laterally to the annular exit 12, it is further arranged a crown of minimum flow-rate small nozzles 15. These nozzles are connected, through a thin duct 16, to the lower chamber 10a of the water supply. The nozzles 15 have the function of maintaining a well-defined minimal flow rate of water, thus a minimum spraying effect, when the main nozzle 4 is closed.

[0029] As already said above, in fact, it may be appropriate to maintain a minimum activity of the gun, on the one hand, to allow the continuous formation of a finishing layer of snow on the skiing surface and, on the other hand, to maintain a water flow in the nozzle, suitable to avoid the local ice formation, and, therefore, to maintain the nozzle in the active condition for a possible successive period of full flow rate operability.

[0030] Fig. 7 illustrates an arrangement in which a plurality of nozzles 15 is evenly provided around the main nozzle 4; however, the number of these nozzles can be, obviously, modified according to the user's needs.

[0031] In this embodiment, the minimum flow rate is precisely controlled by the number and the opening section of the nozzles 15 and, therefore, it is no longer necessary to maintain a minimum flow rate through the exit 12 of the main nozzle, as described above; to this purpose in the cylindrical zone 13b a groove 17 for housing an O-ring sealing is provided, which O-ring sealing allows to obtain a sealingly closure of the main nozzle when said O-ring sealing comes into contact with the exit edge of the upper chamber 10a of the nozzle.

[0032] In a third embodiment of the nozzle of the present invention (not shown), the conical-surface zone (13a) has a higher conicity, i.e., a higher inclination of the conical wall, in correspondence of the semicircumference of the nozzle which faces upwards in operating conditions. This arrangement causes an exit 12 having a greater width in the upper area of the jet G1 with respect to the lower one. Moreover the width of the exit 12 is the greater, the more the distributor 13 is positioned backwards and, therefore, the greater the water flow rate. This modified conicity, therefore, causes a differentiated distribution of the flow rate of the water jet G1, whose upper portion is more rich of water with respect to the lower one. In certain operating conditions this arrangement may be advantageous to increase the contact time of the water particles with the nuclei and, thus, to facilitate a better formation of snowflakes.

[0033] It is easily understood that, thanks to the above disclosed nozzle structure an improved nozzle for a snow gun has been provided, the water flow rate of which can easily be adapted to environmental conditions which can be also very different one from the other, so that it is no longer necessary to provide different embodiments of the snow gun, suitable to meet the different needs of the user, as well as it is no longer necessary to provide a snow gun with a plurality of nozzles to be progressively activated, thus fully achieving the first object of the invention.

[0034] In practice, it has been found that, through this structure of the spray nozzle, it is possible to obtain a much more precise and accurate control of the spray cone G1. As a result, it becomes also possible to use a single main nozzle mounted in axial position, while the nucleating devices remain positioned on the exit edge of the tubular body of the snow gun, as shown in Fig. 2. Mixing between the two flows G1 and G2 is, therefore, more efficient and the structure of the snow gun is considerably simplified and, therefore, a lower cost thereof can be achieved.

[0035] The possibility to adjust the nozzle flow rate in a precise manner, while maintaining a high quality of the cone jet G1, allows to quickly make the snow gun flexible to changed environmental conditions, reducing - also automatically - the snow gun flow rate when the environmental conditions are less favourable to snow formation and increasing it in the opposite case. This allows a drastic reduction of the time periods in which it is necessary to operate the motor 2 and the fan 3, thus reaching also the second object of the present invention.

[0036] It is understood, however, that the invention is not to be considered as limited by the particular arrangement illustrated above, which represents only an exemplary embodiment of the same, but different variants are possible, all within the reach of a person skilled in the art, without departing from the scope of the invention itself, as defined by the following claims.

Claims

1. Water spray nozzle for a snow gun, of the type comprising a distributor (13), housed between a water-supply lower chamber (10a) and a water-distribution upper chamber (10b) ending in an annular exit (12), said distributor (13) having a cylindrical surface, at least part of which (band l_1-l_2) seals against a corresponding cylindrical area of the wall of the upper chamber (10b), on said cylindrical surface of the distributor a plurality of helical grooves (14) being formed, which grooves receive the water coming from the lower chamber (10a) and lead it into the upper chamber (10b) and towards the annular exit (12) of the nozzle, simultaneously imparting to the same a rotary motion, **characterised in that** the ends of said helical grooves (14) in connection with the lower chamber (10a) are formed at axially different heights on the circumference of the distributor (13) and **in that** said distributor (13) is axially movable for connecting a different number of said helical grooves (14) with the lower chamber (10a).

2. Water spray nozzle as in claim 1, **characterised in that** said distributor (13) is provided, at the end thereof facing the annular exit (12) of the nozzle, with a conical-surface zone (13a) apt to cooperate with the exit edge of the upper chamber (10b), for causing a width change of said annular exit (12) upon changing the axial position of said distributor (13).

3. Water spray nozzle as in claim 2, **characterised in that** said distributor (13) is furthermore provided, at the end thereof facing the annular exit (12) of the nozzle, with a cylindrical-surface zone (13b) upstream of said conical-surface zone (13a), apt to cooperate with the exit edge of the upper chamber (10b), for causing a closed position of the nozzle.

4. Water spray nozzle as in claim 3, wherein in said closed position of the nozzle a thin annular clearance remains between said cylindrical-surface zone (13b) and the exit edge of the upper chamber (10b) for allowing the passage of a minimum water flow rate.

5. Water spray nozzle as in any one of the preceding claims, wherein the axial movement of the distributor (13), between the positions of minimum flow rate and of maximum flow rate is controlled by an electric step motor (M) coaxial with the distributor and connected thereto through a screw/nut system.

6. Water spray nozzle as in any one of the preceding claims, **characterised in that** it furthermore comprises, arranged crown-like around said annular exit mouth (12), one or more minimum flow-rate nozzles (15) connected to said lower chamber (10a) through thin water supply ducts (16).

7. Water spray nozzle as in claim 4 and 6, furthermore comprising a sealing housed in a groove (17) of said cylindrical-surface zone (13b), for sealingly closing the thin annular clearance between said cylindrical-surface zone (13b) and the exit edge of the upper chamber (10b).

8. Water spray nozzle as in any one of the preceding claims, wherein said conical-surface zone (13a) has a higher conicity in the nozzle semicircumference which faces upwards in operating conditions.

9. Snow gun, of the type consisting of a cylindrical or slightly conical tubular body (1), within which there are arranged: a fan (3) operating at an entry end (1E) for generating a ventilation air flow, at least a water spray nozzle (4) at the opposite exit end (1U), and a plurality of nucleating devices (5) which surround said water spray nozzle (4), **characterised in that** said water spray nozzle (4) is according any one of

the preceding claims.

10. Snow gun as in claim 9, wherein said nucleating devices (5) are located on the exit edge of the gun tubular body (1) and said water spray nozzle is in an axial position.

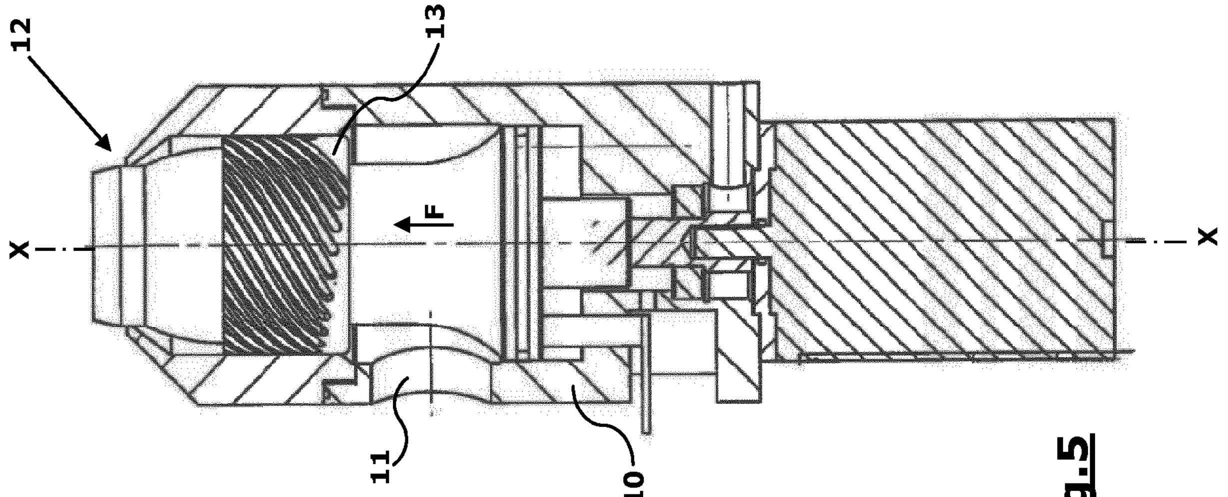

Fig.5

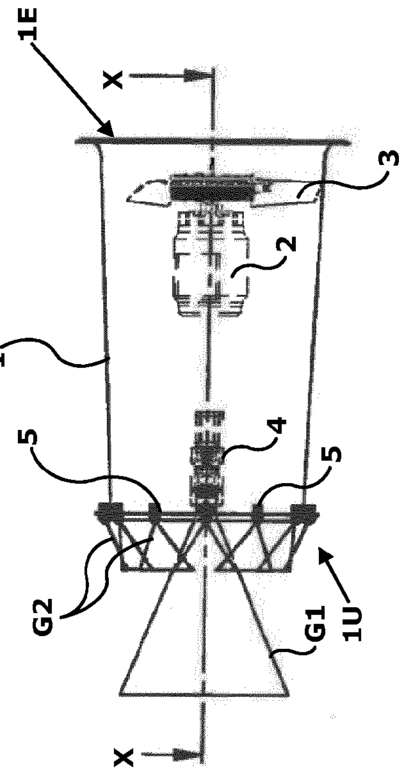

Fig.1

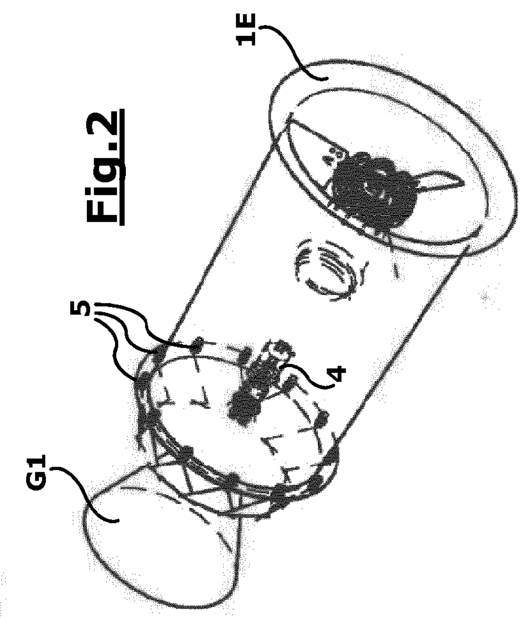

Fig.2

Fig.4

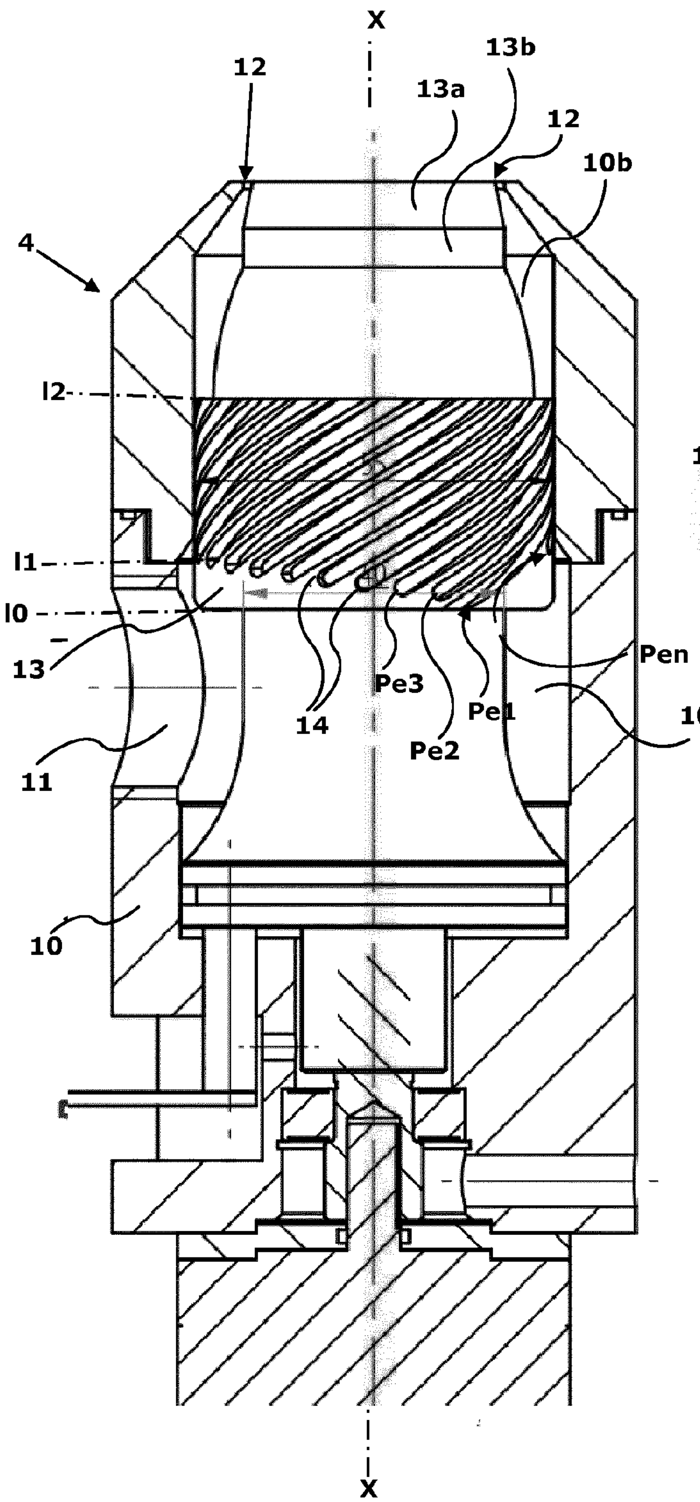
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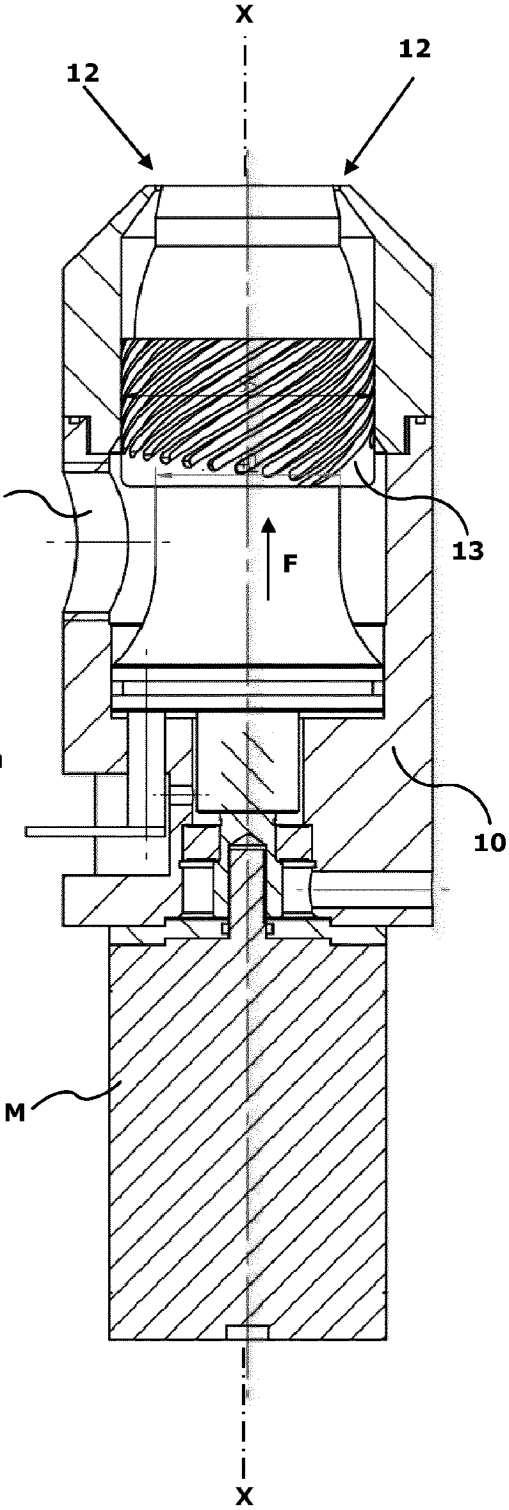
Fig.3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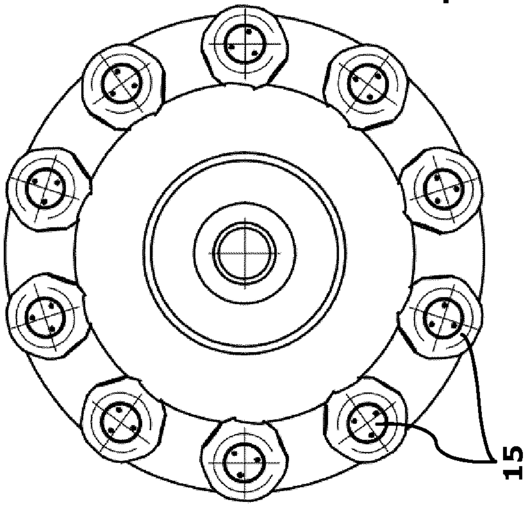

Fig.7

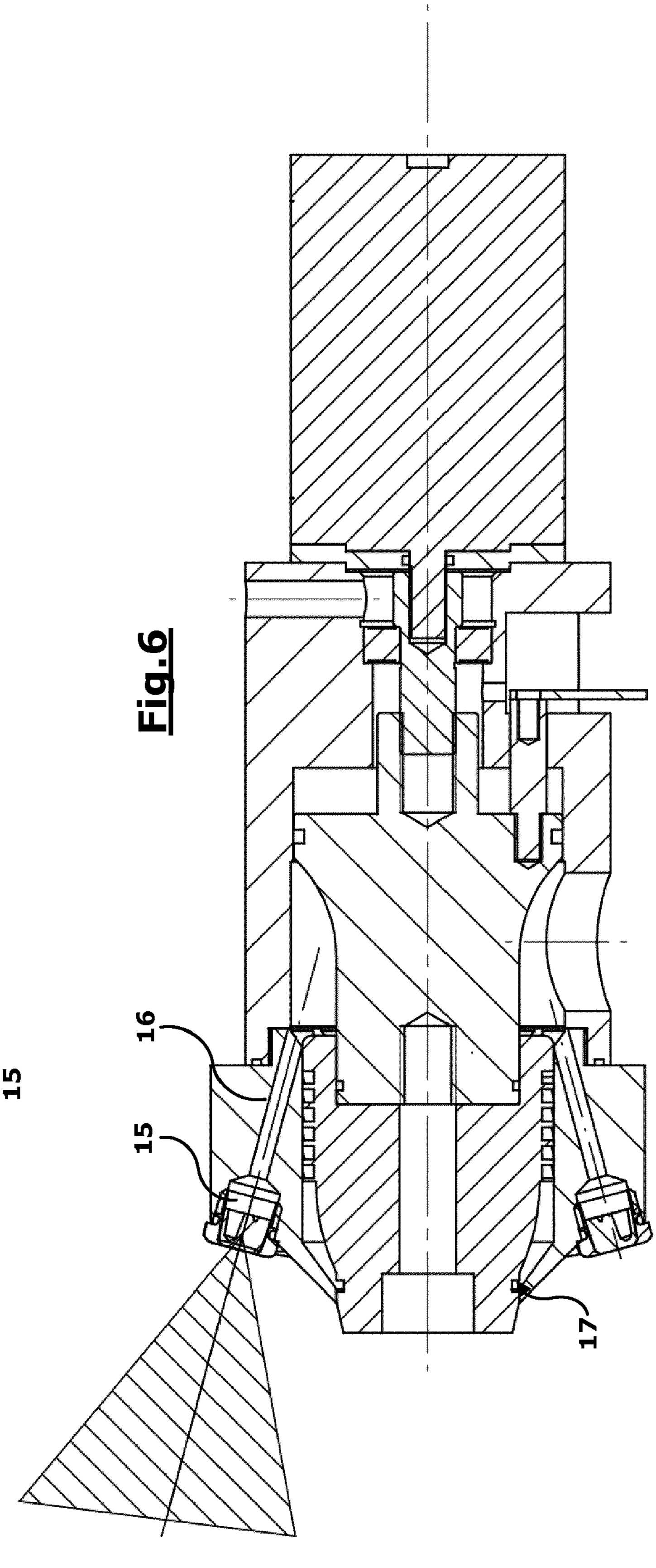

Fig.6

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EUROPEAN SEARCH REPORT

Application Number
EP 16 16 4968

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	EP 1 114 287 B1 (DICC REALISATION S A [CH]) 3 July 2002 (2002-07-03) * the whole document * -----	1	INV. F25C3/04 B05B7/00
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			TECHNICAL FIELDS SEARCHED (IPC)
			F25C B05B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	14 July 2016	Kolev, Ivelin

CATEGORY OF CITED DOCUMENTS

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14-07-2016

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