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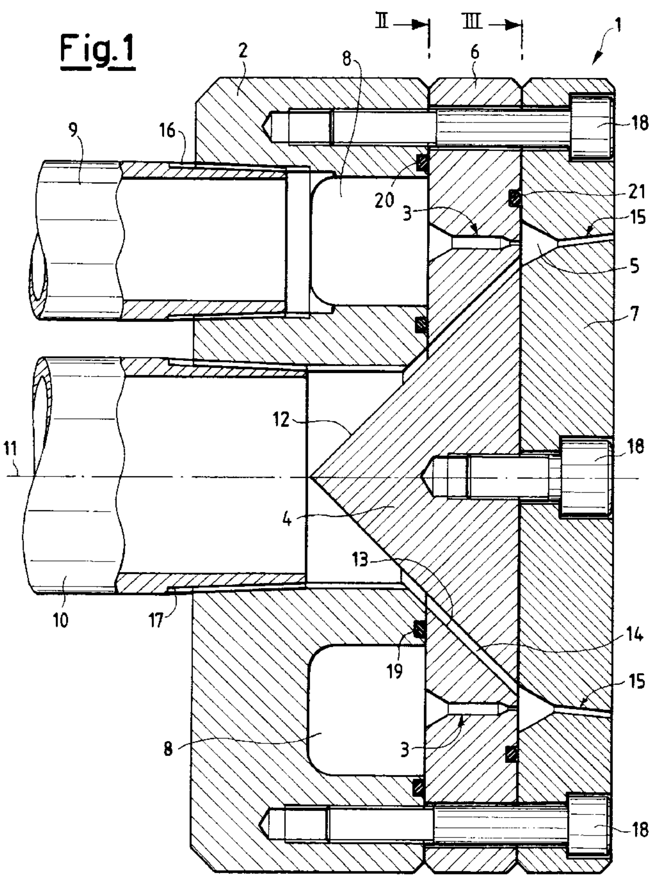
(54) **Snow production cannon**

(57) To increase the efficiency of the cannon (1) (ie to increase the artificial snow quantity produced for the same energy expended), upstream of each atomization nozzle (15) there is provided a chamber (5) in which the liquid is pre-mixed with the gas. The gas is injected into the chamber (5) by at least one injection nozzle (3), (Figure 1).



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Description

This invention relates to a snow production cannon.

EP-A-0 250 425, EP-A-0 084 186 and EP-A-0 084 187 describe snow production cannons in accordance with the introduction to claim 1. In this sector, technical progress is continually aimed at increasing the efficiency of said devices, ie increasing the snow quantity produced for equal energy used.

The main object of the present invention is therefore to provide a snow production cannon of optimum efficiency. In other words the main object of the invention is to indicate a method for snow production which increases the efficiency of the atomization stage.

This object is attained by a snow production cannon in accordance with the first claim, and by a method for snow production in accordance with claim 32, to which reference should be made for brevity.

Briefly, air is injected by at least one injection nozzle into the pre-mixing chamber (or into the pre-hole of the further nozzle), from which it can leave only through the respective further nozzle (this being the atomization nozzle) to atomize the liquid therein in an optimum manner.

A further object of the invention is to obtain artificial snow of good quality.

A further object of the invention is to provide a cannon of simple and economical structure, ie a structure composed of a relatively small number of elements which are joined together in a manner which enables them to be easily assembled and disassembled.

The further objects of the invention are attained by a snow production cannon in accordance with the dependent claims, to which reference should be made for brevity.

A possible embodiment of the invention is described hereinafter by way of non-limiting example. This embodiment is illustrated in the accompanying figures.

Figure 1 is a longitudinal section through a snow production cannon according to the invention.

Figure 2 is a cross-section on the line II-II of Figure 1.

Figure 3 is a cross-section on the line III-III of Figure 1.

Figure 4 is a longitudinal section through an injection nozzle.

Figure 5 is a longitudinal section through an atomization nozzle.

Figures 6-17 are cross-sections showing the exit ports of injection and/or atomization nozzles constructed in accordance with further embodiments.

It should be noted that the longitudinal direction is that parallel to the direction of fluid flow through the cannon during operation, whereas the transverse direction is that perpendicular to the direction of fluid flow through the cannon during operation.

With reference to said figures, and in particular to Figures 1-5, the cannon of the particular embodiment used to describe the invention, indicated overall by 1, is of the type comprising a plurality of nozzles positioned along concentric circles. The cannon 1 comprises essentially the following elements, listed in the order of fluid flow through the elements: a first element 2 distributing gas to injection nozzles 3, a second element 4 distributing liquid to a pre-mixing chamber 5, a third element 6 for injecting gas and a fourth element 7 in which the fluid and gas are mixed to form aerosol, with propelling of said aerosol out of the cannon 1.

The first element 2 ccmprises an annular chamber 8 which can be hydraulically connected to a pressurized gas feed pipe and is hydraulically connected to the inlet of the injection nozzles 3.

The first element 2 can also be connected to the pressurized liquid feed pipe 10. The second element 4 is of cone shape, the vertex of which is positioned on the axis 11 of the pressurized liquid feed pipe 10, its base perimeter being tangential to the mouth of the pre-mixing chambers 5. The axis 11 coincides with the axis of the cannon 1. The third element 6 houses the injection nozzles 3 and comprises a conical hole (not clearly visible) loosely housing the second element 4 such that between the outer surface 12 of the second element 4 and the inner surface 13 of the conical hole there is a passageway 14 for liquid feed to the pre-mixing chambers 5. The fourth element 7 comprises the pre-mixing chambers 5 and a plurality of atomization nozzles 15, for which each pre-mixing chamber represents the pre-hole. The pipes 9 and 10 are connected to the first element 2 by respective threads 16 and 17. The first element 2, the second 4, the third 6 and the fourth 7 are joined together by screws 18 all of which can be manoeuvred from the front of the cannon so as to facilitate assembly and disassembly. Annular gaskets 19-21 provide the necessary hydraulic seal between the elements mechanically connected together.

With particular reference to Figure 4, each injection nozzle 3 comprises, aligned along the axis of symmetry 22 and listed in the order in which the gas flows through them, a pre-hole 23 and a sized capillary hole 24. The pre-hole 23 comprises three portions 25-27. The first portion 25 is in the form of a cone frustrum converging into the second portion 26. The second portion 26 is cylindrical and has a diameter equal to the minor base of the first portion 25. The third portion 27 is in the form of a cone frustrum converging into the sized capillary hole 24 in which the minor base has a diameter greater than the dimensions of said sized capillary hole 24. Each atomization nozzle 15 comprises, aligned along the axis of symmetry 28 and listed in the order in which the fluid flows through them, a pre-hole 5 and a sized capillary hole 29. The pre-hole of the atomization nozzle is the pre-mixing chamber 5, in the shape of a cone frustum converging into the sized capillary hole 29.

To facilitate distribution of the snow produced, the axes of symmetry 28 of each atomization nozzle 15 cut the axis 11 of the cannon 1. In the illustrated example, the angle of incidence a is about 7°.

in the example, the ports of the sized capillary holes 29 and 24 of the atomization nozzles 15 and injection nozzles 3 have ports of equal shape, however said ports could be of different shape, and/or of variously assorted forms.

In the particular case shown in Figures 1-5, the ports of the sized capillary holes 29 and 24 of the atomization nozzles 15 and injection nozzles 3 are of circular shape.

Some of the possible geometrical forms of the ports of the sized capillary holes 24 and 29 of the nozzles 3 and 15 are shown in Figures 6-17.

In a first example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: at least two lobes oppositely positioned about the central projection axis of the nozzle. In a second example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: two lobes oppositely positioned about the central projection axis of the nozzle and having right-angled ends. In a third example the ports of the sized capillary holes of the nozzles have the following geometrical plan shape: two lobes oppositely positioned about the central projection axis of the nozzle and having rounded ends. In a fourth example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: three lobes positioned 120° apart about the central projection axis of the nozzle and having right-angled ends. In a fifth example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: three lobes positioned 120° apart about the central projection axis of the nozzle and having rounded ends. In a sixth example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: three lobes positioned 120° apart about the central projection axis of the nozzle and having rounded ends, with the width of the lobes decreasing from the central axis towards the outside. In a seventh example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: three lobes positioned 120° apart about the central projection axis of the nozzle and having right-angled ends in which two lobes have equal length, which is less than the remaining lobe. In an eighth example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: four lobes oppositely positioned about the central projection axis of the nozzle, ie cross-shaped and having right-angled ends. In a ninth example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: four lobes oppositely positioned about the central projection axis of the nozzle, and having rounded ends. In a tenth example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: five lobes oppositely positioned about tne central projection axis of the nozzle, and having right-angled ends. In an eleventh example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: five lobes oppositely positioned about the central projection axis of the nozzle, and having rounded ends.

In a twelfth example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: six lobes oppositely positioned about the central projection axis of the nozzle, and having right-angled ends.

In a thirteenth example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: six lobes oppositely positioned about the central projection axis of the nozzle, and having rounded ends. In a fourteenth example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: eight lobes oppositely positioned about the central projection axis of the nozzle, and having right-angled ends. In a fifteenth example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: eight lobes oppositely positioned about the central projection axis of the nozzle, and having rounded ends. In a sixteenth example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: triangular. In a seventeenth example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: triangular with rounded vertices.

In an eighteenth example the ports of the sized capillary holes 24, 29 of the nozzles have the following geometrical plan shape: at least two lobes oppositely positioned about the central projection axis of the nozzle, and along which pairs of circular holes are provided in symmetrical positions.

The use of capillaries with the aforestated geometrical forms enables artificial snow crystals of different shapes to be formed.

The opportune choice of the ports and/or combinations of different ports even on the same cannon element enables artificial snow to be produced with different characteristics, so as to be the most suitable possible for the skiing use for which it is usually produced.

During operation, the cannon 1 essentially implements a method for artificial snow production comprising a first stage of gas injection into the liquid while this is upstream of the atomization nozzle 15. The injection stage is accomplished by passing the liquid through the injection nozzle 3 which opens into a pre-injection chamber 5 positioned upstream of the atomization nozzle 15. There is then a second stage in which the liquid is atomized into the atmosphere by the previously injected pressurized gas, to obtain said artificial snow when the aerosol produced by the atomization nozzle 15 emerges into the atmosphere.

For reasons of economy and ready availability and in order not to result in ecological harm, the gas is air and the liquid is water.

The use of other fluid mixtures thereof is however not excluded.

Claims

1. A snow production cannon (1) having a propelling axis (11) and comprising at least one atomization nozzle (15) provided with at least one capillary hole (29), and means (9, 10) for conveying into said atomization nozzle (15) at least one liquid and at least one pressurized gas which by means of said atomization nozzle (15) are atomized and propelled out of the cannon (1), characterised in that upstream of said atomization nozzle (15) there is provided, for pre-mixing the liquid with the gas, at least one chamber (5) into which the gas is injected by at least one injection nozzle (3) provided with a least one capillary hole (24), said pre-mixing chamber (5) being a closed chamber in that the fluid can traverse it only by passing through the sized capillary holes (24, 29) of said nozzles (3, 15).

2. A cannon as claimed in claim 1, characterised in that the injection nozzle (3) comprises, aligned along the axis of symmetry (22) and listed in the order in which the fluid flows through them, a pre-hole (23) and a sized capillary hole (24), said pre-hole (23) comprising three portions (25-27), in which:

   - the first portion (25) is in the form of a cone frustum converging into the second portion (26),
   - the second portion (26) is cylindrical and has a diameter equal to the minor base of the first portion (25),
   - the third portion (27) is in the form of a cone frustrum converging into the sized capillary hole (24) in which the minor base has a diameter greater than the dimensions of said sized capillary hole (24).

3. A cannon as claimed in claim 1, characterised in that the atomization nozzle (15) comprises, aligned along the axis of symmetry (28) and listed in the order in which the fluid flows through them, a pre-hole (5) and a sized capillary hole (29), in which said pre-hole is the pre-mixing chamber (5), said pre-mixing chamber (5) being in the shape of a cone frustum converging into the sized capillary hole (29).

4. A cannon as claimed in claim 1, characterised by comprising a plurality of atomizaticn nozzles (15) and a plurality of injection nozzles (3) the respective sized capillary holes (29,24) of which have ports of equal form.

5. A cannon as claimed in claim 1, characterised by comprising a plurality of atomization nozzles (15) and a plurality of injection nozzles (3) the respective sized capillary holes (29, 24) of which have ports of different form.

6. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) are of circular plan shape.

7. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: at least two lobes oppositely positioned about the central projection axes (22, 28) of the nozzles (3, 15).

8. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: two lobes oppositely positioned about the central projection axes (22, 28) of the nozzles (3, 15) and having right-angled ends.

9. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: two lobes oppositely positioned about the central projection axes (22, 28) of the nozzles (3, 15) and having rounded ends.

10. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: three lobes positioned 120° apart about the central projection axes (22, 28) of the nozzles (3, 15) and having right-angled ends.

11. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: three lobes positioned 120° apart about the central projection axes (22, 28) of the nozzles (3, 15) and having rounded ends.

12. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: three lobes positioned 120° apart about the central projection axes (22, 28) of the nozzles (3, 15) and having rounded ends, with the width of the lobes decreasing from the central axes (22, 28) towards the outside.

13. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: three lobes positioned 120° apart about the central projection axes (22, 28) of the nozzles (3, 15) and having right-angled ends

in which two lobes have equal length, which is less than the remaining lobe.

14. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: four lobes oppositely positioned about the central projection axes (22, 28) of the nozzles (3, 15), ie cross-shaped and having right-angled ends.

15. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: four lobes oppositely positioned about the central projection axes (22, 28) of the nozzles (3, 15), and having rounded ends.

16. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: five lobes oppositely positioned about the central projection axes (22, 28) of the nozzles (3, 15), and having right-angled ends.

17. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: five lobes oppositely positioned about the central projection axes (22, 28) of the nozzles (3, 15), and having rounded ends.

18. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: six lobes oppositely positioned about the central projection axes (22, 28) of the nozzles (3, 15), and having right-angled ends.

19. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: six lobes oppositely positioned about the central projection axes (22, 28) of the nozzles (3, 15), and having rounded ends.

20. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: eight lobes oppositely positioned about the central projection axes (22, 28) of the nozzles (3, 15), and having right-angled ends.

21. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: eight lobes oppositely positioned about the central projection axes (22, 28) of the nozzles (3, 15), and having rounded ends.

22. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: triangular.

23. A cannon as claimed in claim 1, characterised in that the ports of the respective sized capillary holes (24, 29) of the nozzles (3, 15) have the following geometrical plan shape: triangular with rounded vertices.

24. A cannon as claimed in claim 1, characterised by comprising the following elements listed in the order in which the fluids pass through them: a first element (2) distributing gas to the injection nozzles (3), a second element (4) distributing liquid to the premixing chambers (5), a third element (6) for injecting gas and a fourth element (7) in which the fluid and gas are mixed to form aerosol, with propelling thereof out of the cannon (1).

25. A cannon as claimed in claim 24, characterised in that the first element (2) distributing gas to the injection nozzles (3) comprises an annular chamber (8) which can be hydraulically connected to a pressurized gas feed pipe (9) and is hydraulically connected to the inlet end of the injection nozzles (3), said first element (2) alsc being connectable to the pressurized fluid feed pipe (10).

26. A cannon as claimed in claim 24, characterised in that the second element (4) is in the shape of a cone the vertex of which is positioned on the axis (11) of the pressurized liquid feed pipe (10), its base perimeter being tangential to the mouth of the pre-mixing chambers (5).

27. A cannon as claimed in claim 24, characterised in that the third element (6) houses the injection nozzles (3) and comprises a conical hole loosely housing the second element (4) such that between the outer surface (12) of the second element (4) and the inner surface (13) of the conical hole there is created a passageway (14) for liquid feed to the premixing chamber (5).

28. A cannon as claimed in claim 24, characterised in that the fourth element (7) comprises the pre-mixing chamber (5) and a plurality of atomization nozzles (15).

29. A cannon as claimed in claim 24, characterised in that the first element (2), the second (4), the third (6) and the fourth (7) are joined together by screws (18) all of which can be manoeuvred from the front of the cannon (1).

30. A cannon as claimed in claim 3, characterised in that the axis of symmetry (28) of each atomization nozzle (15) cuts the axis (11) of the cannon (1).

31. A cannon as claimed in claim 30, characterised in that the angle a of incidence between the axis of symmetry (28) of each atomization nozzle (15) and the axis (11) of the cannon (1) is about 7°.

32. A method for producing artificial snow in which said snow is obtained by a stage involving atomization of a liquid into the atmosphere by a pressurized gas, characterised in that said atomization stage is preceded by a stage in which the gas is injected into the liquid while this is upstream of the atomization nozzle (15).

33. A method as claimed in claim 32, characterised in that the injection stage is implemented by passing the liquid through an injection nozzle (3) which opens into a pre-mixing chamber (5) positioned upstream of the atomization nozzle (15).

34. A method as claimed in claim 32, characterised in that the gas is air and the liquid is water.

Fig.1

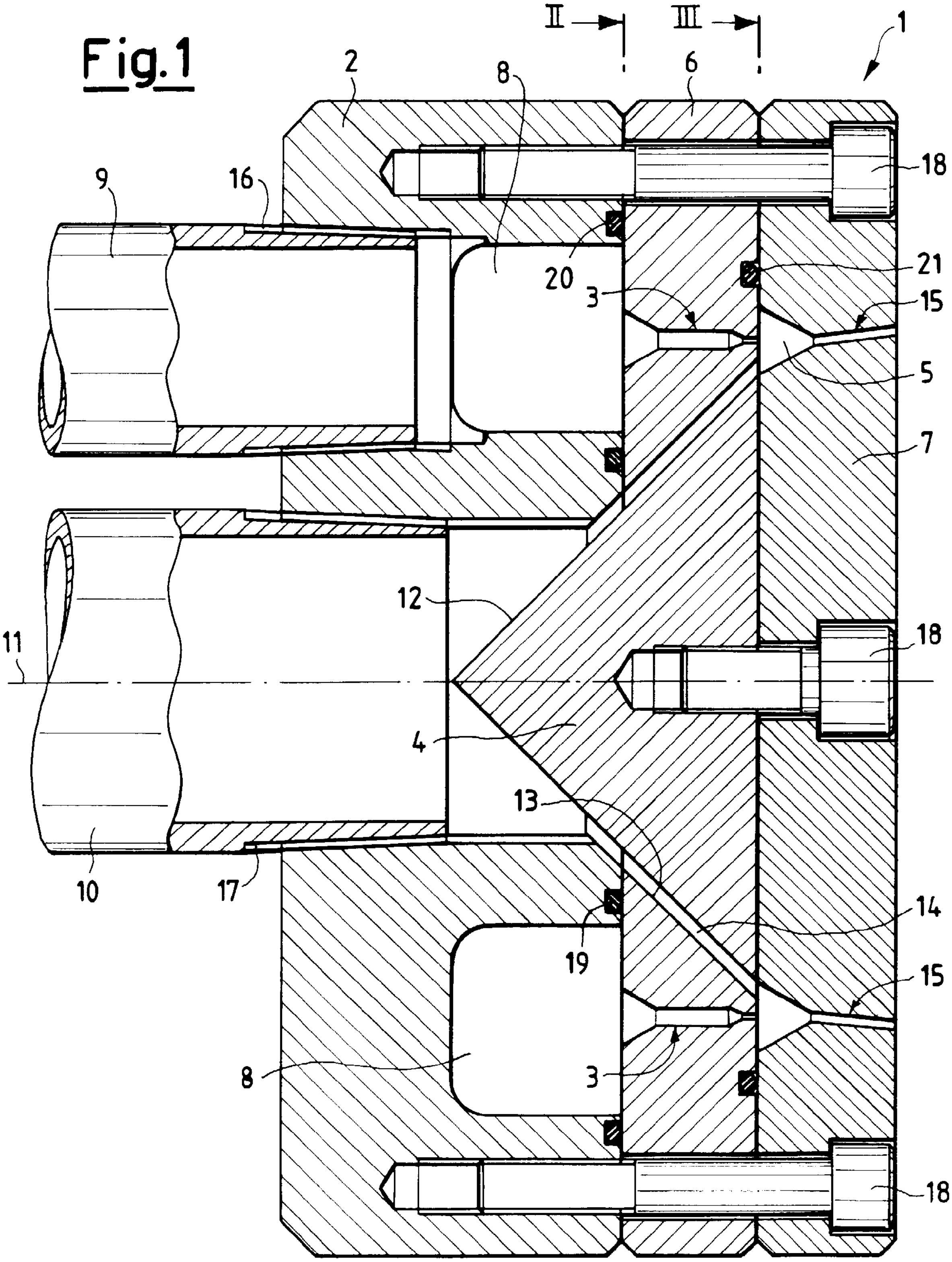


Fig.2

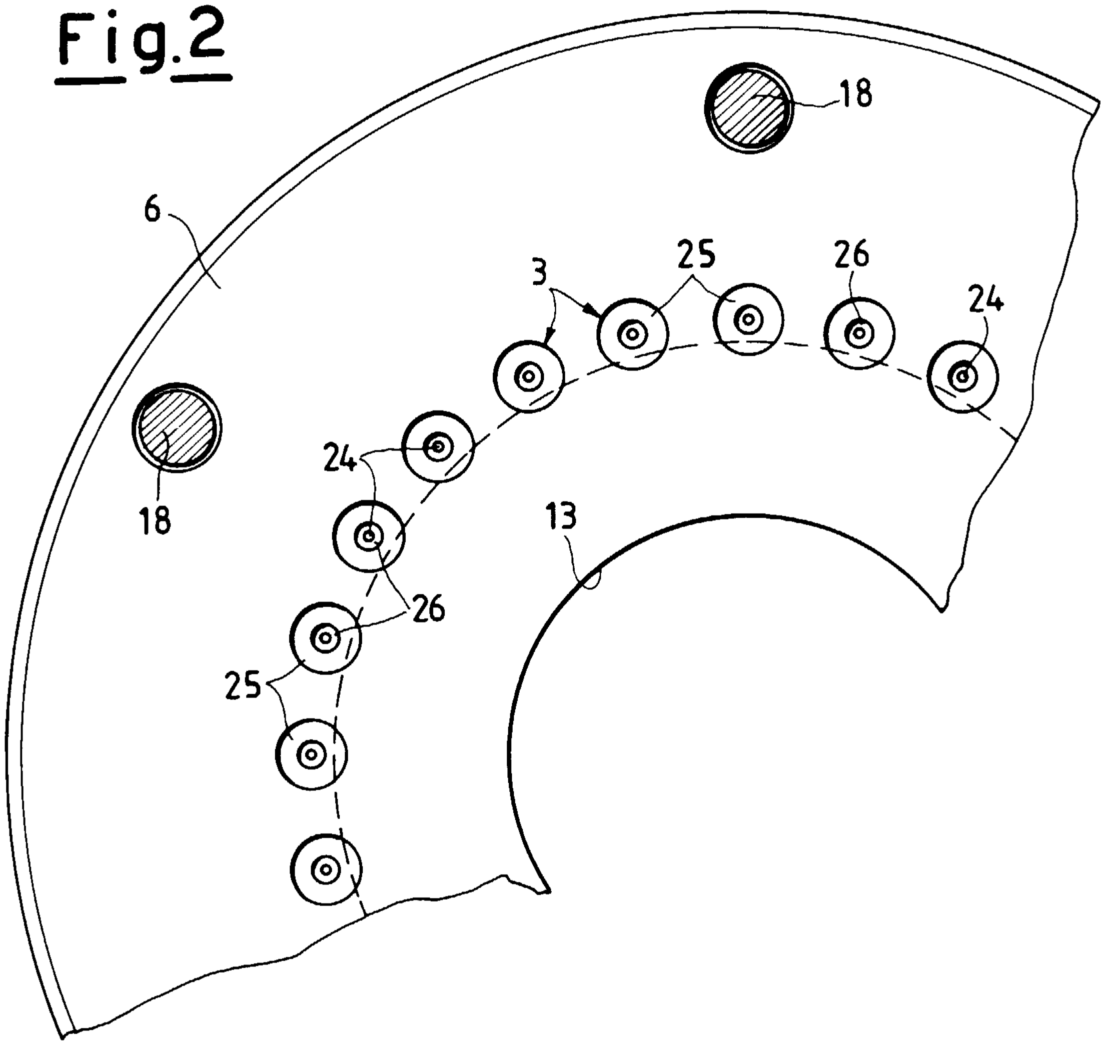


Fig.4

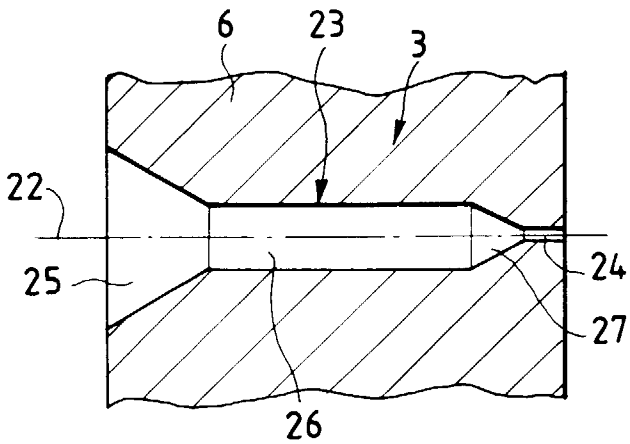


Fig.3

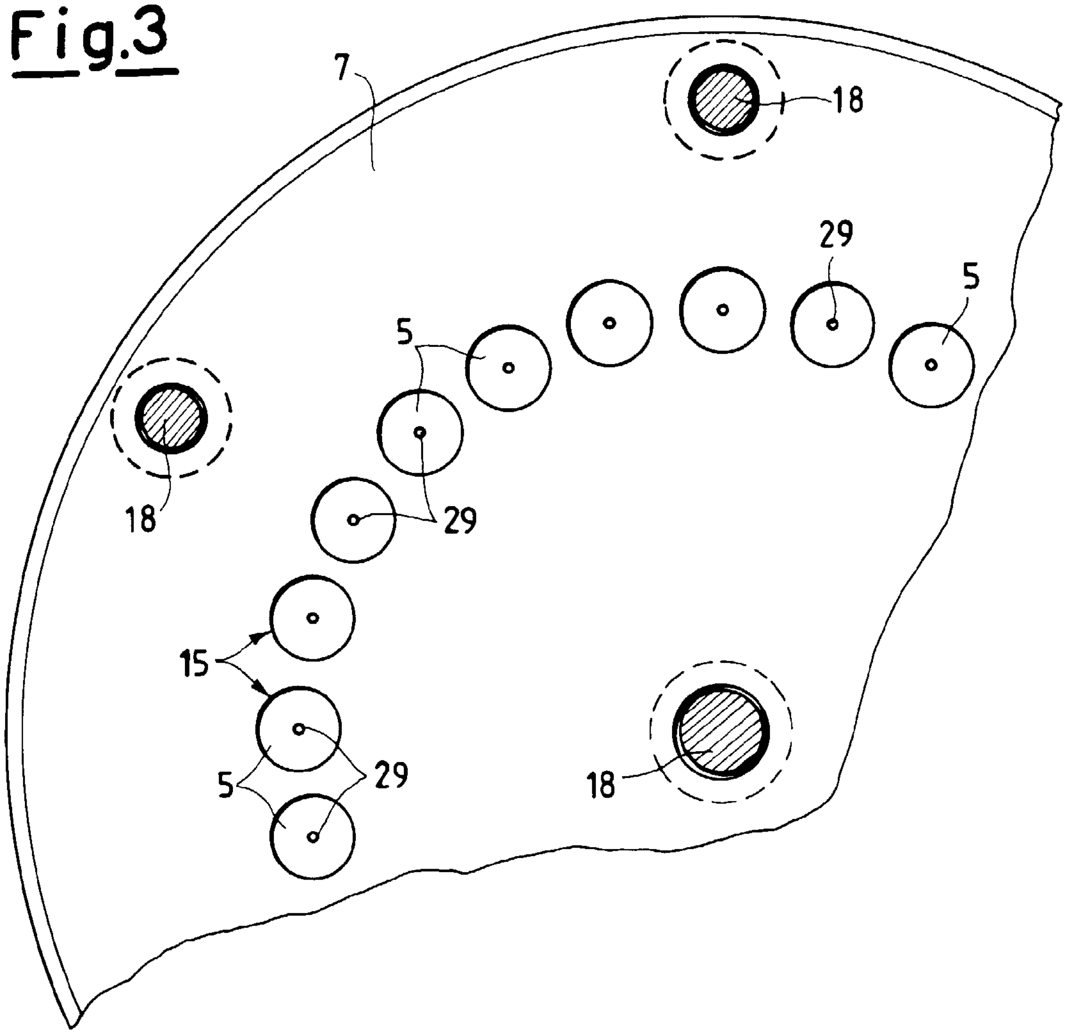


Fig.5

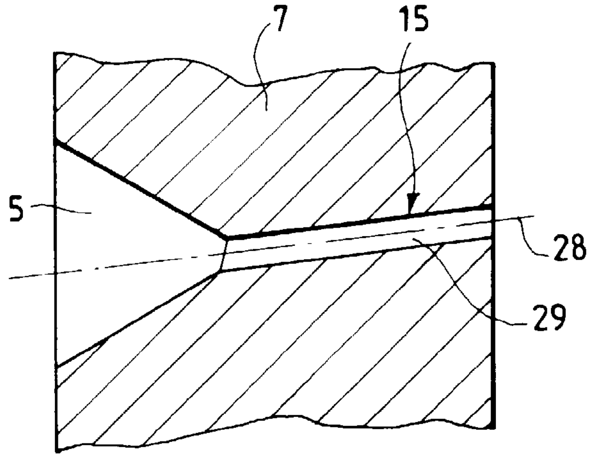


Fig.6

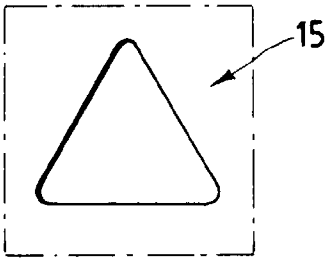


Fig.7

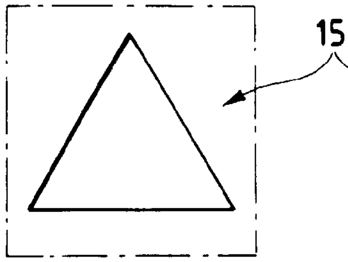


Fig.8

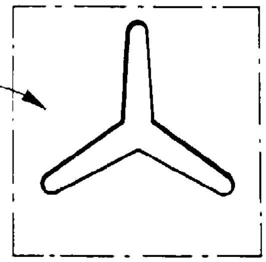


Fig.9

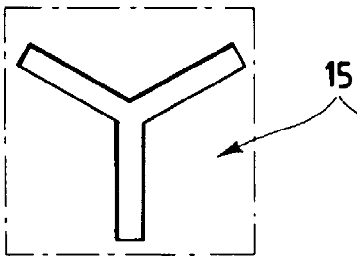


Fig.10

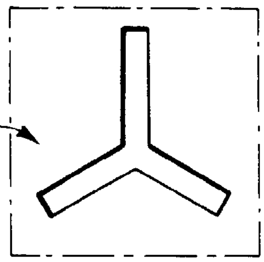


Fig.11

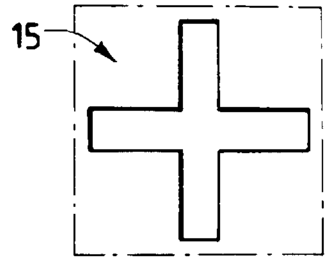


Fig.12

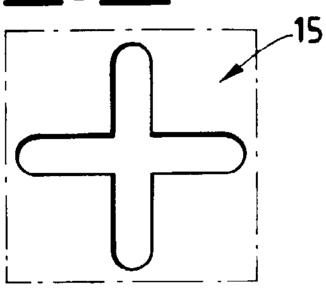


Fig.13

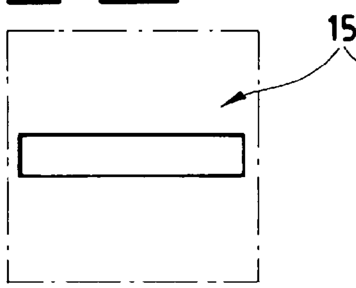


Fig.14

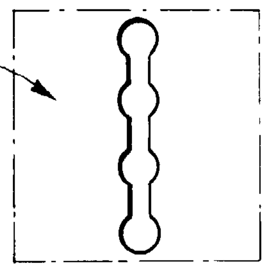


Fig.15

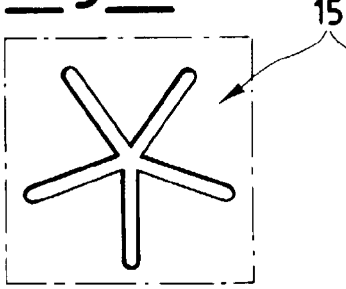


Fig.16

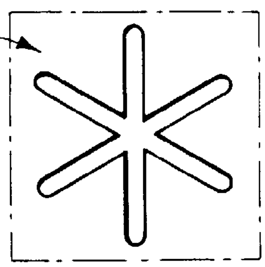
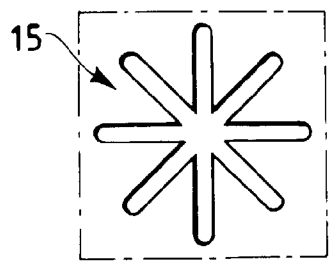


Fig.17



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 20 0150

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.6)
Y	US 2 676 471 A (PIERCE) * column 4, line 14 - column 6, line 13; figures 4-6 *	1	F25C3/04 B05B7/04
Y	GB 628 083 A (CRIBB) * page 2, line 61 - line 122; figures 1-5 *	1	
A	US 3 945 567 A (RAMBACH) * column 4, line 9 - column 6, line 3; figures 2-5 *	1	
A	US 3 908 903 A (BURNS) * column 3, line 40 - column 7, line 34; figures 2-4 *	1	
A	US 3 421 693 A (FRASER) * column 2, line 12 - column 5, line 46; figures 1-13 *	1,4	
A	DE 69 932 C (GILLET VON MONTMORE) * the whole document *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	EP 0 101 109 A (SHELL) * page 3, line 21 - page 8, line 5; figures 1-3 *	1	F25C B05B
A	US 4 655 395 A (CIOFFI) * column 3, line 10 - column 4, line 12; figures 1-4 *	1	
A	US 4 730 774 A (SHIPPEE)		
A	US 5 083 707 A (HOLDEN)		
A	US 2 678 236 A (TINKER)		
A	US 2 960 064 A (NORTON)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27 April 1998	Boets, A

CATEGORY OF CITED DOCUMENTS

X particularly relevant if taken alone
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A technological background
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T theory or principle underlying the invention
E earlier patent document, but published on, or after the filing date
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