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## (54) Snow production cannon

(57) To provide a cannon (1) of optimum efficiency, which is able to produce an artificial snow of various characteristics and also as close as possible to those of natural snow, and is quieter than current cannons for equal nozzles installed, use is made of water atomization nozzles (8) provided with a sized capillary hole (11) having lobes (12) positioned on opposite sides of the central axis of symmetry (9) of the nozzle (8), (Figure 5).

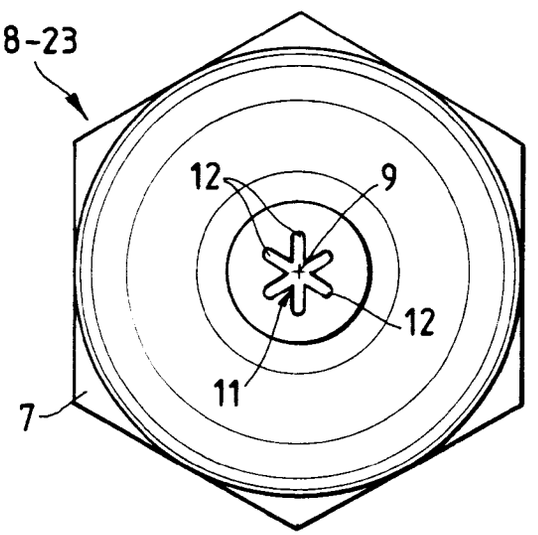


Fig.5

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## Description

This invention relates to a snow production cannon.

WO 94/03764 describes a snow production cannon in accordance with the classifying part of claim 1. These types of cannon are also commonly known as low pressure cannons.

In this type of cannon the sole function of the nozzles is to atomize the water as finely as possible within the air flow produced by the cannon. The air flow (having a temperature of less than zero °C) performs the double function of freezing the minuscule water droplets and conveying them onto the ground on which the snow is required. From the aforegoing it is therefore apparent that each nozzle is therefore one of the basic components of the cannon in that the cannon efficiency also depends on it.

In this respect, the nozzle provides the thermodynamic transformations which are fundamental both to the formation of the artificial snow and to its quality.

In brief, the cannon efficiency, its quietness and the snow quality all depend mainly on the nozzle.

Current nozzles and hence the cannons using them are all susceptible to improvement in relation to the aforestated characteristics.

The object of the present invention is therefore to provide a cannon able to offer better performance than current cannons, ie a cannon which has greater efficiency than known cannons (increase in snow produced for equal energy expended), is able to produce an artificial snow with characteristics as close as possible to those of natural snow, and is quieter than current cannons for equal nozzles installed.

This object is attained by a snow cannon in accordance with claim 1.

The provision of lobes oppositely positioned about the central axis of symmetry enables the water to be atomized in a form which is closer to snow crystals than the crystals produced by the traditional sized capillary holes of circular plan shape.

There is an increase in snow produced for equal energy expended and hence a greater cannon efficiency, leading also to a reduction in the energy wasted as noise production. Snow of different type can be obtained by varying the number of lobes. Various types of snow can be produced by using simultaneously on the same cannon various nozzles of different sized capillary holes. These types of snow can be chosen on the basis of its use and the meteorological conditions. The cannon of the invention therefore has considerable flexibility of use not attainable by known cannons using nozzles only with circular shaped nozzles.

A possible embodiment of the invention is described hereinafter by way of non-limiting example. Said embodiment is described with the aid of the accompanying figures.

Figure 1 is a schematic illustration of a cannon according to the invention.

Figure 2 is a perspective front view of the cannon of Figure 1.

Figure 3 is a partly full and partly sectional view of a first nozzle of the cannon according to the invention for atomizing only water.

Figure 4 is a partly full and partly sectional view of a second nozzle of the cannon according to the invention for simultaneously atomizing water and air.

Figure 5 is a front view of the nozzles of Figures 3 and 4.

Figures 6-17 are cross-sections, or plan views of some types of outlet ports of the nozzles fitted to the cannon of the invention. With reference to said figures and in particular to Figure 1, the snow production cannon according to the invention, indicated overall by 1, is of the type comprising essentially a tubular body 2 operationally associated with means 3 for generating an air flow, means 4 for producing pressurized water and means 22 for producing compressed air. It should be noted that the means 4 and 22 usually form part of a system simultaneously feeding several cannons 1. The air flow generating means 3 generate an air flow F entering through a first mouth 5 located at the rear end of the tubular body 2 and leaving from the second mouth 6 located at the front end of the tubular body 2 parallel to the axis 7 of said tubular body 2.

The pressurized water production means 4 feed at least one nozzle 8 of the first type positioned in correspondence with the front mouth 6 of the tubular body 2 and arranged to atomize only the pressurized water by directing it into the air flow F leaving the tubular body 2. The nozzles 8 of the first type are therefore fed only with pressurized water. In the illustrated embodiment a plurality of nozzles 8 of the first type are provided arranged along one or more concentric circles in correspondence with the front mouth 6. The compressed air production means 22 and the pressurized water production means 4 simultaneously feed at least one nozzle 23 of the second type positioned in correspondence with the front mouth 6 of the tubular body 2. The nozzles 23 of the second type are therefore arranged to atomize water with the aid of the compressed air and direct the atomized water towards the interior of the air flow F leaving the tubular body 2.

In the illustrated embodiment there are provided a plurality of nozzles 8 of the first type arranged along concentric circles in correspondence with the front mouth 6 but more internal than the circle along which the nozzles 23 of the second type are arranged.

According to an important characteristic of the invention, said nozzles of the first type 8 and second type 23 comprise a sized capillary hole 11 in which the port of said sized capillary hole 11 has a geometrical shape in plan view formed from at least two lobes 12 oppositely positioned about its central axis of symmetry 9. The nozzles 8 of the first type and the nozzles 23 of the second type are provided with means for their fixing to the front mouth 6 of the cannon 1 comprising a first external

thread 16 and an operating hexagon 17, these being provided on the outer surface of the hollow body 24 of the nozzles 8 and 23. The difference between a nozzle 8 of the first type and a nozzle 23 of the second type is mainly in their internal structure, ie the shape of the respective first core 13 and second core 14, their hollow bodies 24 being identical. This results in a substantial reduction in the production and storage costs of said nozzles. In particular, the production of the sized capillary holes 11 is facilitated in that these are always produced in one and the same element (ie the hollow body 24) irrespective of whether said element 24 is intended for nozzles 8 of the first type or nozzles 23 of the second type. The cores 13 and 14 perform the important function of helping the capillary hole 11 to atomize the fluid.

The first core 13 is formed from an elongate element 25 positioned within the concavity of the body 24 of the nozzle 8, coaxial to the central axis of symmetry 9 of the nozzle and hence of the sized capillary hole 11. The element 25 has:

- a first end connected to the body 24 of the nozzle 8 by a second thread 26 interrupted by at least one first groove 27 parallel to the central axis of symmetry 9 for water passage,
- a second end spaced from the inner surface of the body 24 of the nozzle 8,
- its outer surface provided with at least one second groove 28 arranged to also transmit a rotary component to the fluid passing through the nozzle 8.

The second core 14 is formed from a tubular element 29 positioned within the concavity of the body 24 of the nozzle 23, coaxial to the central axis of symmetry 9 of the nozzle 23 and hence of the sized capillary hole 11. The element 29 has:

- a first end connected to the body 24 of the nozzle 23 by a third thread 30 interrupted by at least one second groove 31 for water passage,
- a second end tapered and spaced from the icer surface of the body 24 of the nozzle 23,
- smooth inner and outer surfaces.

In the nozzles 23 of the second type, the water passes between the inner surface of the nozzle hollow body 24 and the outer surface of the tubular element 29, the air passing within the tubular element 29.

Air and water mix within the nozzle body 24 upstream of the sized capillary hole 11 before leaving through said sized capillary hole 11.

In the particular embodiment illustrated in Figure 1 the electrical and electronic remote operating and control equipment for the cannon 1, indicated overall by 20, is housed on the carriage 18 provided with wheels 19 or alternatively with skis, not shown. The cannon 1 also comprises hydraulic means 21 for varying the range. These means can also be remotely controlled.

Figures 6-17 show some of the further geometrical forms which the sized capillary hole 11 can have when viewed in plan. According to said figures:

- the port of the sized capillary hole 11 has the following geometrical plan shape: three lobes 12 positioned 120° apart about the central axis of symmetry;
- the port of the sized capillary hole 11 has the following geometrical plan shape: two lobes 12 oppositely positioned about the central axis of symmetry 9;
- the port of the sized capillary hole 11 has the following geometrical plan shape: two lobes 12 oppositely positioned about the central axis of symmetry 9 and having rounded ends;
- the port of the sized capillary hole 11 has the following geometrical plan shape: three lobes 12 positioned 120° apart about the central axis of symmetry and having rounded ends, with the width of the lobes 12 decreasing from the central axis of symmetry towards the outside;
- the port of the sized capillary hole 11 has the following geometrical plan shape: three lobes 12 positioned 120° apart about the central axis of symmetry and having right-angled ends, in which two lobes 12 are of equal length, which is less than the length of the remaining lobe 12;
- the port of the sized capillary hole 11 has the following geometrical plan shape: three lobes 12 positioned 120° apart about the central axis of symmetry and having right-angled ends, in which two lobes 12 are of equal length, which is greater than the length of the remaining lobe 12;
- the port of the sized capillary hole 11 has the following geometrical plan shape: four lobes 12 oppositely positioned about the central axis of symmetry 9 and having right-angled ends;
- the port of the sized capillary hole 11 has the following geometrical plan shape: four lobes 12 oppositely positioned about the central axis of symmetry 9 of the nozzle and having rounded ends;
- the port of the sized capillary hole 11 has the following geometrical plan shape: five lobes 12 radially or oppositely positioned about the central axis of symmetry 9 of the nozzle and having rounded ends;
- the port of the sized capillary hole 11 has the following geometrical plan shape: five lobes 12 radially or oppositely positioned about the central axis of symmetry 9 of the nozzle and having right-angled ends;
- the port of the sized capillary hole 11 has the following geometrical plan shape: six lobes 12 oppositely positioned about the central axis of symmetry 9 of the nozzle and having right-angled ends;
- the port of the sized capillary hole 11 has the following geometrical plan shape: six lobes 12 oppositely positioned about the central axis of symmetry 9 of the nozzle and having rounded ends;
- the port of the sized capillary hole 11 has the follow-

ing geometrical plan shape: eight lobes 12 oppositely positioned about the central axis of symmetry 9 of the nozzle and having right-angled ends;

- the port of the sized capillary hole 11 has the following geometrical plan shape: eight lobes 12 oppositely positioned about the central axis of symmetry 9 of the nozzle and having rounded ends;
- the port of the sized capillary hole 11 has the following geometrical plan shape: three lobes oppositely positioned about the central axis of symmetry 9 of the nozzle, their dimensions increasing from the vertices towards said central axis of symmetry 9 so as to assume the form of a triangle;
- the port of the sized capillary hole 11 has the following geometrical plan shape: three lobes oppositely positioned about the central axis of symmetry 9 of the nozzle, their dimensions increasing from the vertices towards said central axis of symmetry 9 so as to assume the form of a triangle with rounded vertices.

To obtain a snow of the desired quality, ie that which is most suitable for the meteorological requirements of the moment and/or for the use to be made of it, the same cannon 1 can be provided with nozzles 8 having the ports of the sized capillary hole 11 of different geometrical plan shapes. Hence it is not excluded that traditional nozzles with circular ports can operate together with nozzles the sized capillary holes of which have ports represented by the lobes 12. By means of the cannon according to the invention the energy necessary to produce the same quantity of snow can be reduced up to 1/4.

It has also been noted that the artificial snow produced by said cannon has greater persistence than natural snow or than that obtained by cannons using nozzles with circular ports.

In a further embodiment (not shown) the cannon according to the invention can be operationally associated with a high pressure cannon provided with a nozzle housed in correspondence with the second mouth 6 and directing its flow parallel to the axis 7, arrow F.

## Claims

1. A snow production cannon (1) of the type comprising a tubular body (2) operationally associated with means (3) for generating an air flow, means (4) for producing pressurized water and means (22) for producing compressed air, in which:

   - the air flow generating means (3) generate an air flow (F) entering through a first mouth (5) located at the rear end of the tubular body (2) and leaving from the second mouth (6) located at the front end of the tubular body (2) parallel to the axis (7) of said tubular body (2),
   - the pressurized water production means (4) feed at least one first nozzle (8) and at least one second nozzle (23), these being positioned in correspondence with the front mouth (6) of the tubular body (2) and arranged to atomize the pressurized water by directing it into the air flow (F) leaving the tubular body (2),
   - the compressed air production means (22) feed at least the second nozzle (23) positioned in correspondence with the front mouth (6) of the tubular body (2) and arranged to atomize the pressurized water by directing it into the air flow (F) leaving the tubular body (2),

   characterised in that said first nozzle (8) and said second nozzle (23) comprise a sized capillary hole (11) in which the port of said sized capillary hole (11) has a geometrical plan shape formed from at least two lobes (12) oppositely positioned about the central axis of symmetry (9).

2. A cannon as claimed in claim 1, characterised by comprising a first type of nozzle (8) arranged to atomize only water and a second type of nozzle (23) arranged to atomize water and air simultaneously, said nozzles (8, 23) comprising respectively a first core (13) and a second core (14) for pre-channelling the flow of fluid or fluids traversing them.

3. A cannon as claimed in claim 2, characterised in that the first core (13) is formed from an elongate element (25) positioned within the concavity of the body (24) of the nozzle (8) of first type, coaxial to the central axis of symmetry (9) of the nozzle (8) and hence of the sized capillary hole (11), and having:

   - a first end connected to the body (24) of the nozzle (8) of the first type by a second thread (26) interrupted by at least one first groove (27) for water passage,
   - a second end spaced from the inner surface of the body (24) of the nozzle (8),
   - its outer surface provided with at least one second helical groove (28) arranged to also transmit a rotary component to the fluid passing through the nozzle (8).

4. A cannon as claimed in claim 1, characterised by comprising a plurality of nozzles (8) of the first type arranged along one or more concentric circles in correspondence with the front mouth (6).

5. A cannon as claimed in claim 2, characterised in that the second core (14) is formed from a tubular element (29) arranged within the concavity of the body (24) of the nozzle (23), coaxial to the central axis of symmetry (9) of the nozzle and hence of the

sized capillary hole (11), and having:

- a first end connected to the body (24) of the nozzle (23) by a second thread (30) interrupted by at least one second groove (31) for water passage,
- a second end tapered and spaced from the inner surface of the body (24) of the nozzle (23),
- a smooth inner surface.

**6.** A cannon as claimed in claim 5, characterised in that in the nozzles (23) of the second type, the water passes between the inner surface of the nozzle hollow body (24) and the outer surface of the tubular element (29), the air passing within the tubular element (29), the air and water mixing within the nozzle body (24) upstream of the sized capillary hole (11) before leaving through said sized capillary hole (11).

**7.** A cannon as claimed in claim 1, characterised by comprising a plurality of nozzles (23) of the second type arranged in correspondence with the front mouth (6) along a circle concentric to but more external than the circles along which the nozzles (8) of the first type are arranged.

**8.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: three lobes (12) positioned 120° apart about the central axis of symmetry (9).

**9.** A cannon as claimed in claim 2, characterised in that the nozzles (8) of the first type and the nozzles (23) of the second type are provided with means for their fixing to the front mouth (6) of the cannon (1), which comprise a first thread (16) and an operating hexagon (17), these being provided on the outer surface of the hollow body (24) of the nozzles (8, 23).

**10.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: two lobes (12) oppositely positioned about the central axis of symmetry (9).

**11.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: two lobes (12) oppositely positioned about the central axis of symmetry (9) and having rounded ends.

**12.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: three lobes positioned 120° apart about the central axis of symmetry (9) and having rounded ends, with the width of the lobes (12) decreasing from the central axis of symmetry (9) towards the outside.

**13.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: three lobes (12) positioned 120° apart about the central axis of symmetry (9) and having right-angled ends, in which two lobes (12) are of equal length, which is less than the length of the remaining lobe (12).

**14.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: three lobes (12) positioned 120° apart about the central axis of symmetry (9) and having right-angled ends, in which two lobes (12) are of equal length, which is greater than the length of the remaining lobe (12).

**15.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: four lobes (12) oppositely positioned about the central axis of symmetry (9) and having right-angled ends.

**16.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: four lobes (12) oppositely positioned about the central axis of symmetry (9) of the nozzle and having rounded ends.

**17.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: five lobes (12) radially or oppositely positioned about the central axis of symmetry (9) of the nozzle and having rounded ends.

**18.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: five lobes (12) radially or oppositely positioned about the central axis of symmetry (9) of the nozzle and having right-angled ends.

**19.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: six lobes (12) oppositely positioned about the central axis of symmetry (9) of the nozzle and having right-angled ends.

**20.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: six lobes (12) oppositely positioned about the central axis of symmetry (9) of the nozzle and having rounded ends.

**21.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: eight lobes (12) oppositely positioned about the central axis of symmetry (9) of the nozzle and having right-angled ends.

**22.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: eight lobes (12) oppositely positioned about the central axis of symmetry (9) of the nozzle and having rounded ends.

**23.** A cannon as claimed in claim 1, characterised in that the port of the sized capillary hole (11) has the following geometrical plan shape: three lobes (12) oppositely positioned about the central axis of symmetry (9) of the nozzle, their dimensions increasing from the vertices towards said central axis of symmetry (9) so as to assume the form of a triangle.

**24.** A cannon as claimed in claim 23, characterised in that said triangle has rounded vertices.

**25.** A cannon as claimed in claim 1, characterised in that said at least one nozzle (8) externally comprises means (16, 17) for its fixing to the tubular body (2).

**26.** A cannon as claimed in claim 25, characterised in that said fixing means comprise a thread (16) and a manoeuvring hexagon (17).

**27.** A cannon as claimed in claim 25, characterised in that on it there are mounted a plurality of nozzles (8) having the ports of their sized capillary holes (11) of different geometrical shape.

**28.** A cannon as claimed in claim 25, characterised in that the nozzles (8) are arranged in correspondence with the second mouth (6) along concentric circles, the nozzles (8) of the first type being positioned along more inner circles whereas the nozzles (23) of the second type are positioned along more outer circles.

**29.** A cannon as claimed in claim 1, characterised by being operationally associated with a high pressure cannon, the nozzle of which is housed in correspondence with the second mouth (6) and directs its flow parallel to the axis (7), arrow (F).

**30.** A cannon as claimed in claim 1, characterised by comprising electrical and electronic remote operating and control equipment (20) for the cannon (1), housed on the carriage (18).

**31.** A cannon as claimed in claim 30, characterised in that the carriage (18) is provided with wheels (19) or alternatively with skis.

**32.** A cannon as claimed in claim 30, characterised by comprising hydraulic means (21) for varying the range.

**33.** A cannon as claimed in claim 32, characterised in that the hydraulic range variation means (21) can be remotely controlled.

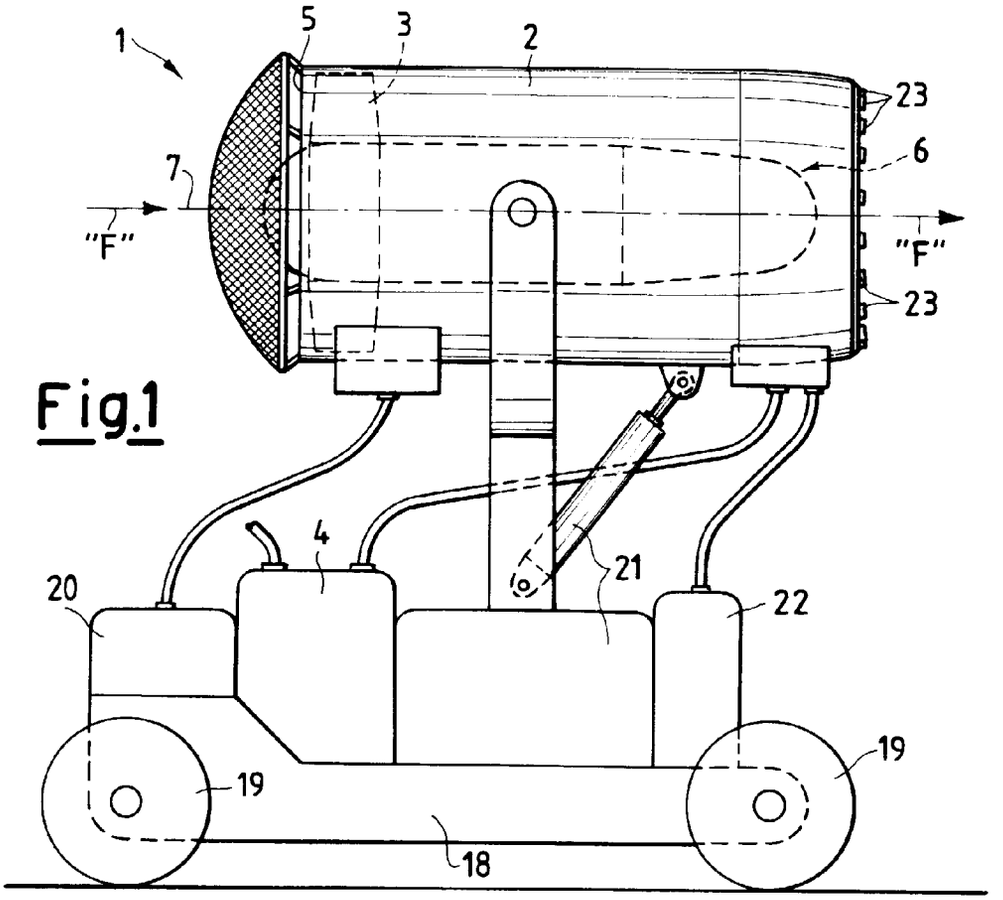



Fig.1

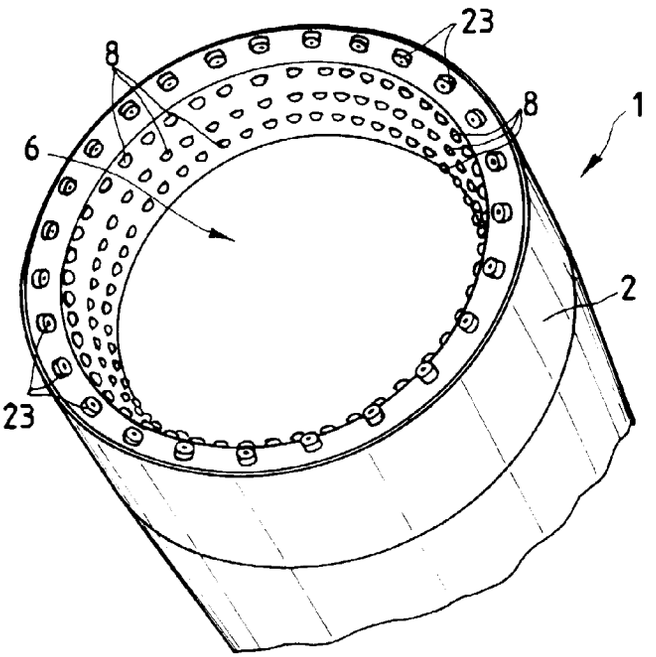



Fig.2

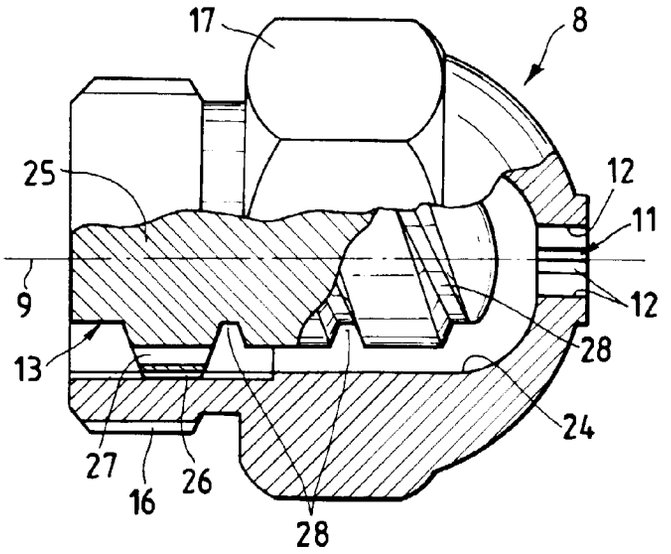



Fig.3

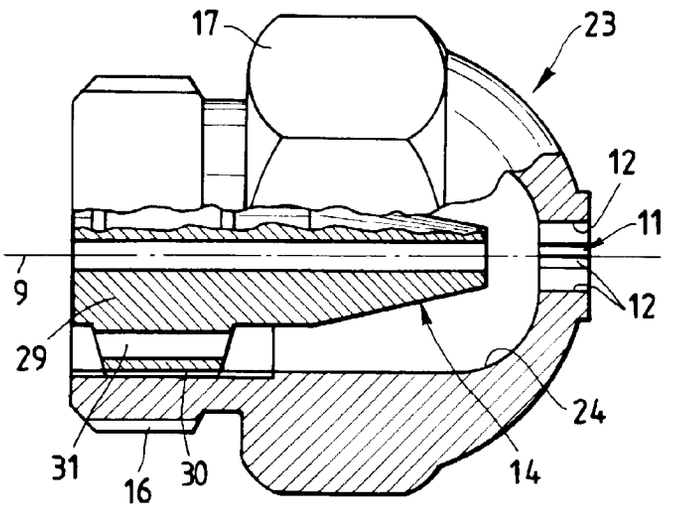



Fig.4

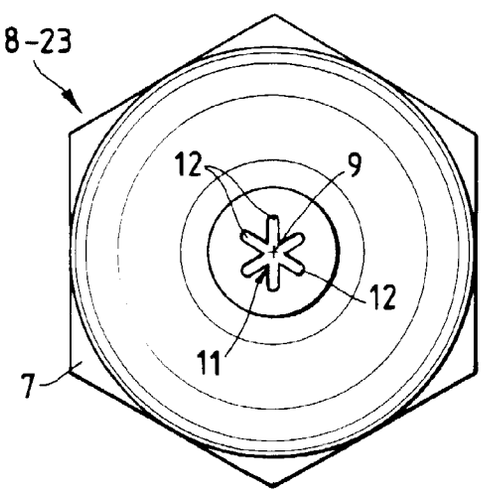



Fig.5

Fig.6

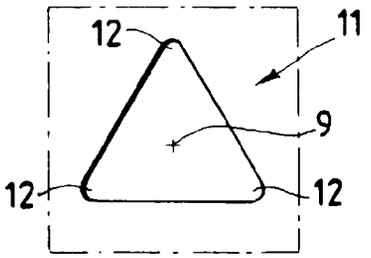



Fig.7

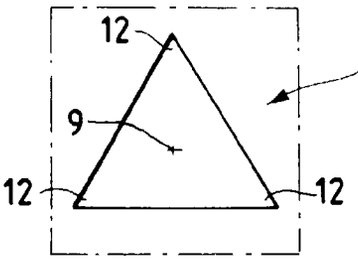



Fig.8

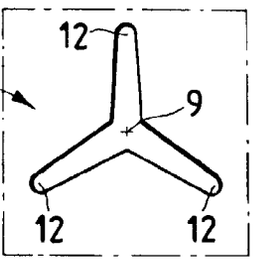



Fig.9

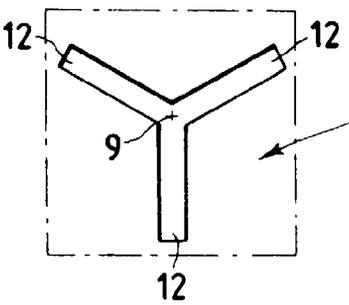



Fig.10

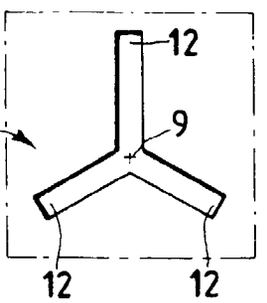



Fig.11

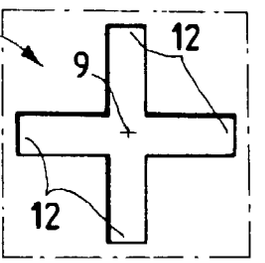



Fig.12

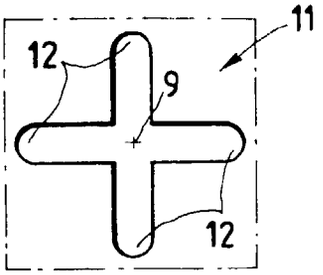



Fig.13

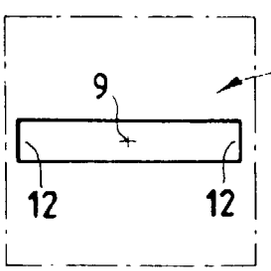



Fig.14

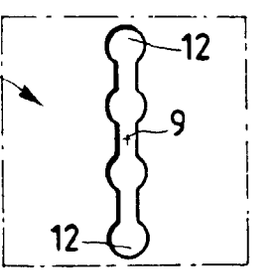



Fig.15

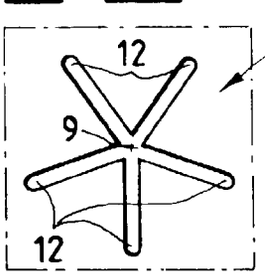



Fig.16

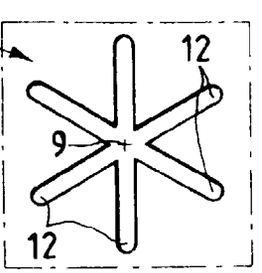
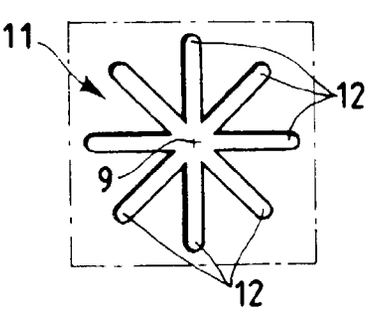



Fig.17



European Patent Office

# EUROPEAN SEARCH REPORT

Application Number
EP 98 20 0151

## 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) |
|---|---|---|---|
| A | US 3 979 061 A (KIRCHER)<br>* column 3, line 3 - column 9, line 7; figures 1-10 * | 1,2,4,7, 28 | F25C3/04<br>B05B1/02 |
| A | US 4 004 732 A (HANSON)<br>* column 7, line 60 - column 10, line 53; figures 1-7 * | 1,2,4,7, 28,30-33 | |
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