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

(11) EP 2 306 467 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.04.2011 Bulletin 2011/14

(21) Application number: **09012566.7**

(22) Date of filing: **05.10.2009**

(51) Int Cl.:
G21F 9/00 *(2006.01)* ***B08B 3/12*** *(2006.01)*
B08B 7/04 *(2006.01)* ***B23K 26/00*** *(2006.01)*
B24C 11/00 *(2006.01)*

(84) Designated Contracting States:
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 SE SI SK SM TR
Designated Extension States:
AL BA RS

(71) Applicant: **Linde Aktiengesellschaft**
80331 München (DE)

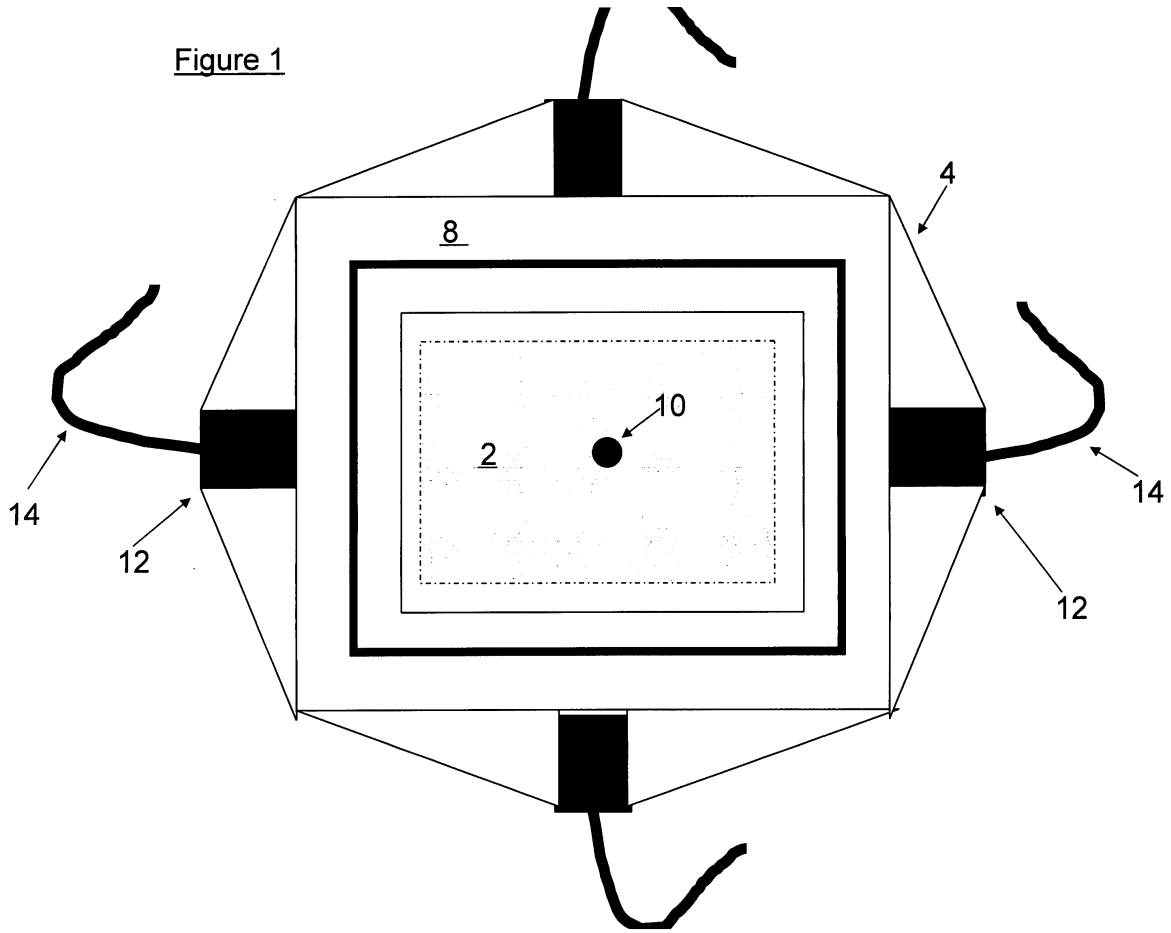
(72) Inventor: **Wigfall, Tim**
Chesterfield S42 6LQ
Derbyshire (GB)

(74) Representative: **Kasseckert, Rainer**
Linde AG
Legal Services Intellectual Property
Dr.-Carl-von-Linde-Strasse 6-14
82049 Pullach (DE)

(54) Method of capturing material during dry ice blasting

(57) The invention relates to a method of capturing material during a dry ice blasting decontamination process using a moveable hood (4) with one or more suction adapters (12), the hood (4) being open to the cleaning surface (2), closed to the sides and having an opening at the top to insert a dry ice blasting gun (10) which can be moved independently within the confines of the hood (4)

Figure 1



EP 2 306 467 A1

Description

[0001] The invention relates to a method and a device for capturing material that has been liberated during a dry ice cleaning decontamination process.

[0002] As well known to those skilled in the art, recently, CO_2 decontamination processes have attracted considerable attention. In comparison with conventional chemical and physical decontamination processes, the CO_2 decontamination process has advantages of cleanliness, rapid decontamination speed, and not producing secondary wastes, thus it is frequently applied to various fields such as atomic piles, semiconductor fabrication, and optical and medical equipment.

[0003] If CO_2 gas at a very low temperature passes through an orifice of a nozzle under conditions in which liquid phase and vapor phase coexist (pressure of 800 psi) to be dropped to 80 psi in pressure, a portion of high-pressure CO_2 gas (about 45 %) is converted into solid granules like snow. These granules consist of crystal particles of sub-micron units, and are blasted onto a subject which is to be decontaminated. This is a CO_2 snow-blasting decontamination process.

[0004] Additionally, there is a conventional CO_2 pellet-blasting decontamination process, in which solid previously-prepared granules are compressed to form predetermined lump-like shapes, and these lumps, or so-called pellets, are blasted onto a contaminated subject to decontaminate the subject.

[0005] According to these conventional decontamination processes, a CO_2 decontamination medium (CO_2 snow or CO_2 pellets), when blasting through a nozzle to a surface of a contaminated subject, transfers its collision energy into particulate contaminants to remove them. In our description or claims the term "dry ice" shall include powder, snow, particles, pellets of all sizes and shapes.

[0006] Disadvantages of the above processes are that particulate contaminants removed by the CO_2 decontamination medium are instantaneously diffused into the atmosphere by the blasting gas.

[0007] For collecting or capturing the ablated material or contaminants there are known static solutions with confined areas like disclosed in the DE 199 26 084 A1 or the US 5,123,207, or movable solutions like disclosed in the DE 203 08 788 U1 or the US 7,097,717.

[0008] The drawback of the existing static solutions is that only relative small objects can be cleaned. The drawbacks of the movable solutions are the impeded sight of the region of impact of the blasting jet and the handicap of bearing and moving the weight of the gun mounted collection device and associated extract hoses - this is particularly detrimental when the operator already has to wear heavy protective clothing for example in radioactive contaminated surroundings in nuclear plants or the nuclear industry.

[0009] It is an objective of the present invention to provide a method and a device for capturing material during dry ice blasting which enables: i) effective cleaning (by improved vision of the work piece), ii) local capture of liberated material to prevent escape into the general environment, iii) the handling of the equipment for the operator. The invention has particular relevance to decontamination procedures to be carried out in the nuclear industry but is also relevant to any application where the material that is liberated by cleaning is required to be captured.

[0010] Based on the present invention the object can be accomplished by a method of one of the claims 1 - 3 or by a device of one of the claims 4 - 12.

[0011] The core idea of the invention is a moveable hood with suction adapters to the exhaust, which can be positioned on a part of the surface which has to be cleaned. The hood is open on its top and allows independent movement of the blasting gun. The operator has only to hold and move the blasting gun and no further equipment and is able to see the area being cleaned during the operation. After a first area of the surface is cleaned, the hood is then moved to the next area and the cleaning is resumed.

[0012] The capture process makes use of the general air movements/turbulence/deflections generated by the cleaning process.

[0013] The extract system can be independently mounted and therefore exerts no additional physical load or strain on the blast gun operator. An area can be cleaned and then the extract manifod/hood moved to clean the next areas in a chessboard type fashion - adjoining square by square.

[0014] Software and possibly interactive flow and exhaust controls ensure that optimum extract capture velocities are maintained (and hence optimize contaminant material recovery). The invention also incorporates adjustable internal baffles which enable the control and distribution of air movement/velocities at the top and bottom of the device.

[0015] The system (adapters, hoses) can be linked to a particulate filtration system (such as a cyclone or hepa-filter) to achieve the required particle size/capture/filtration profile. Once entrained, the gas can be scrubbed using appropriate methods including cyclone and bag filter technologies.

[0016] The equipment is designed to be used when cleaning flat surfaces - in horizontal or vertical planes. The equipment has been designed to be used as part of the general area nuclear decontamination process for buildings. It is designed to be portable and suitable for use by operators wearing nuclear environment PPE. The static extract system offers the advantage of adding no additional weight to the dry ice blasting gun and, therefore, much less physical exertion for the operator.

[0017] The equipment can be configured to ensure that a negative pressure is maintained in the general working environment - and hence avoid the escape of contaminant material into the surrounding environment. The system can include a "fail safe" pressure monitored link between the gun and the extract system - to protect against

the creation of positive pressure within the general working environment, which could be a potential for contamination of surrounding areas. The system will be configured such that the dry ice blasting equipment cannot be operated unless safety interlock signals are first satisfied - to confirm the function of the local extract and capture system. The face velocities of the air curtain and the local capture source can be adjusted by means of both the extracted air volume and the internal baffle clearances within the capture hood. The equipment will feature safety interlocks between exhaust systems and dry ice blasting equipment to ensure the gun can only be used when the extract system is active.

[0018] The design of the extract hood allows the operator of the blasting equipment to see the area whilst it is being cleaned - enabling him to judge the effectiveness and coverage of the blast cleaning operation. The equipment will feature other interlocks including the performance of the filtration system (e.g. collection device full, filter "blinding" etc).

[0019] In a preferred embodiment, as much of the surface contamination material as possible which is liberated by the dry ice blasting process can be captured. This is achieved by the use of a two part capture technique:

a) local capture at the point of liberation
b) enclosure/containment of the cleaning area by an air curtain

to contain the gas and dust that is liberated within the enclosure or hood.

[0020] The air curtain can be created actively by an air supply blowing in air in designated directions or passively by a baffle within the hood that induces an air curtain by directing the flow of the sucked air in a desired way. The air curtain is produced by air directed essentially perpendicular to the direction of the jet. The internal baffle creates air movement which radiates from the outside to the center of the hood and is created nearby the top of the hood. This air movement creates a "curtain" which allows external air into the hood but confines the gases and particles within the hood so that they are entrained and removed by the exhaust system, hence avoiding the release of potentially contaminating materials.

[0021] In an preferred embodiment the device is made out of an outer hood of an inner baffle which are arranged in such a way that a gap is created near the surface allowing the ablated material to be sucked into the hollow between the outer hood and the inner baffle. In this way a passive air curtain is made with the advantage that the operator needs no inlet or supply for pressurized air to produce the curtain.

[0022] In one embodiment the inner baffle is adjustable at will against the outer hood. This enables the gap between the inner baffle and the top of the outer hood to be varied, with the result of control of face/extraction velocities at the air curtain and local capture point.

[0023] In a further embodiment there are brushes and/or multidirectional rollers foreseen to seal the bottom of the outer hood to the surface. The rollers will maintain a small but constant gap between the hood and the wall surface whilst the brushes will form a seal of this gap to reduce the likelihood of escape of air or dust between the device and the wall or surface which has to be cleaned.

[0024] The device can be of any shape, preferred are a round, oval or square shape of the outer hood and/or of the corresponding inner baffle. Round or oval shapes have the advantages of ease of handling. The square form has the advantage that a rectangular confined region is cleaned and in a second step the next (adjacent) region which will be cleaned has also an square form. Therefore an entire area can be cleaned - in a chess board type pattern, field by field.

[0025] The suction adapter or adapters can be arranged wherever it seems appropriate. Advantageously they are arranged in the sides of the outer hood at a designed height, this optimizes the extract distribution within the hood and ensures that the baffle provides shielding to the cleaning jet - so as to minimize any distortion effects on it by the extracted air.

[0026] Using the inventive device, the surface can be cleaned step by step by positioning the device in a first location, cleaning the space which can be reached through the opening in the top of the hood and then transferring the device to an adjacent position where upon cleaning is then resumed. This simple relocation is easy if a floor or another horizontal plain has to be cleaned. In a preferred embodiment a stand is used which allows the device to be positioned in new places step by step by relocating it to the neighboring site, and the next, and so on. Another simple adaptation is by the use of rails and slides, so one that areas in one direction can be cleaned very efficiently. For relocating in the other direction - preferably perpendicular to - wheels and brakes or another stand system with rail can be used. The relocation of the cleaning hood can be made step by step or continuously. It can be made by hand (manually) or be automated using a motor. The solution with a stand is especially designed for the use on vertical surfaces like walls.

[0027] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taking conjunction with the accompanying drawings which are;

Fig. 1 is a plan view of a device for capturing material during dry ice blasting
Fig. 2 is a sectional view of the same embodiment
Fig. 3 is a sketch of another embodiment and
Fig. 4 is an example for cleaning a wall surface.

[0028] Figure 1 shows a plan view of a device according to the invention for cleaning the surface 2. The device consists of an hood 4 which is in this embodiment is of rectangular shape. The hood has four suction adaptors 12 with suction hoses 14 leading to an exhaust manifold.

The hood 4 shows a rectangular opening on its top, through which we can look to the area of the surface 2 which can now be cleaned - confined by the chain dotted line. The opening is of such an amplitude or dimension, that a blasting gun 10 for cleaning can be put in and moved in all directions, i.e. from left to the right and - in the image plain - from top to bottom. Eight inclined lateral suction channels or funnels improve the flow of the waste gas to the adaptors 12.

[0029] Figure 2 shows the same embodiment in a sectional view. The hood 4 is made out of side walls 6, which contain the suction adapters 12 which lead to suction hoses 14 and to the exhaust. On the top of the hood there is a top wall 8 with the rectangular opening shown in Figure 1. Into this opening the gun or nozzle 10 can be put and moved from the left to the right and from forward to backward to clean the surface 2. According the invention there is foreseen a baffle 5 inside the hood 4. Here it has the same shape as the hood 4, in this embodiment a rectangular shape. The baffle 5 is arranged in such a height or distance from the surface 2, that air can be sucked out in two ways. The first pathway is along the surface 2 and the second pathway is between the top wall 8 and the top of the baffle 5, whereby this stream of air generates a passive air curtain preventing the emission of gas and particles or released contaminants. Brushes 22 seal the gap between the hood 6 and the surface 2. Multidirectional rollers 23 maintain a small but constant gap between the hood 6 and the surface 2 .

[0030] Figure 3 shows a sketch of a second embodiment with an active air curtain. The active air curtain is produced by outlet nozzles in the top region of the hood 4 which are supplied by the hose the pressurized air hoses 16 with pressurized air. The air curtain on the top of the hood is preventing all material, which is released from the surface 2 to come in contact with the outer atmosphere.

[0031] Figure 4 shows a wall 20 which has to be cleaned. A stand 18 is provided which allows the operator to position the hood at different (indexed) heights to define adjacent extracted areas where cleaning is to be performed. In this embodiment the area that is about to be cleaned is located on the left side at the top. After the cleaning is carried out on the top left hand side of the wall the hood can be moved downward one field in a chess board type pattern to move the device to the next local extract area below. In this way, one vertical column of areas can be cleaned. The mobile stand has indexed settings and can be placed static. It is also possible to use wheels for moving it horizontally along the wall/surface to the next column of areas to be cleaned. Relocation of the hood, either horizontally or vertically, can be done manually or by motor and step by step or continuously (with a speed appropriate for the operator to clean the whole surface). The second embodiment with automated movement of the extract hood across the surface to be cleaned offers significant advantage, both in terms of operational efficiency/rate of clean, and also reduced manual handling/physical stress on the operator.

Reference List

[0032]

2.	surface
4	hood
5	baffle
6	side wall
8	top wall
10	gun
12	suction adapter
14	suction hose
16	pressurized air hose
18	stand
20	wall
22	brushes
23	roller

Claims

1. Method of capturing material during a dry ice blasting decontamination process using a moveable hood (4) with one or more suction adapters (12), the hood (4) being open to the cleaning surface (2), closed to the sides and having an opening at the top to insert a dry ice blasting gun (10) which can be moved independently within the confines of the hood (4).

2. Method of claim 1, **characterized by** a supply (16) for air creating an air curtain.

3. Method of claim 1, **characterized by** a baffle (5) shielding the dry ice spray from being distorted and enhancing the capture of process gases and liberated particulate material by making use of both exhaust suction and natural gas movements within the enclosed area.

4. Device for capturing material during a dry ice blasting decontamination process **characterized by** a hood (4) with one or more suction adapters (12), the hood (4) being open to the cleaning surface (2), closed to the sides and having an opening at the top to insert

and displace independently a dry ice blasting gun (10).

5. Device according to claim 4, **characterized by** an air supply creating an air curtain.

6. Device according to one of the claims 1 to 4, **characterized by**

- an outer hood (4), open to the cleaning surface (2), closed to the sides and having and opening at the top for inserting and displacing a blasting gun (10) and having one or more suction adapters (12).
- an inner baffle (5), open to the cleaning surface (2), closed to the sides and open to the top creating a gap near the surface (2) allowing the ablated material to be sucked into the hollow between outer hood (4) and inner baffle (5).

7. Device according to claim 6, **characterized by** a second gap between the top of the outer hood (4) and the inner baffle (5) to allow air to be sucked in/ across the face of the hood to form an air curtain.

8. Device to any of the claims 4 to 7, **characterized by** brushes (22) for sealing the bottom of the outer hood (4) to the surface (2).

9. Device according to one of the claims 4 to 8, **characterized by** around, oval or square shape of the outer hood (4) and/or the inner baffle (5).

10. Device according to one of the claims 4 to 9, whereby the suction adapters (12) are arranged in the sides of the outer hood (4) in a designed height which optimizes extraction distribution and allows shielding of the blast jet by the sides of the inner baffle (5).

11. Device according to claim 10, whereby the inner baffle (5) is movable against the outer hood (4).

12. Device according to any of the claims 4 to 11, **characterized by** a stand (18) for adjusting the advice manually or by motor to different positions, step by step or continuous.

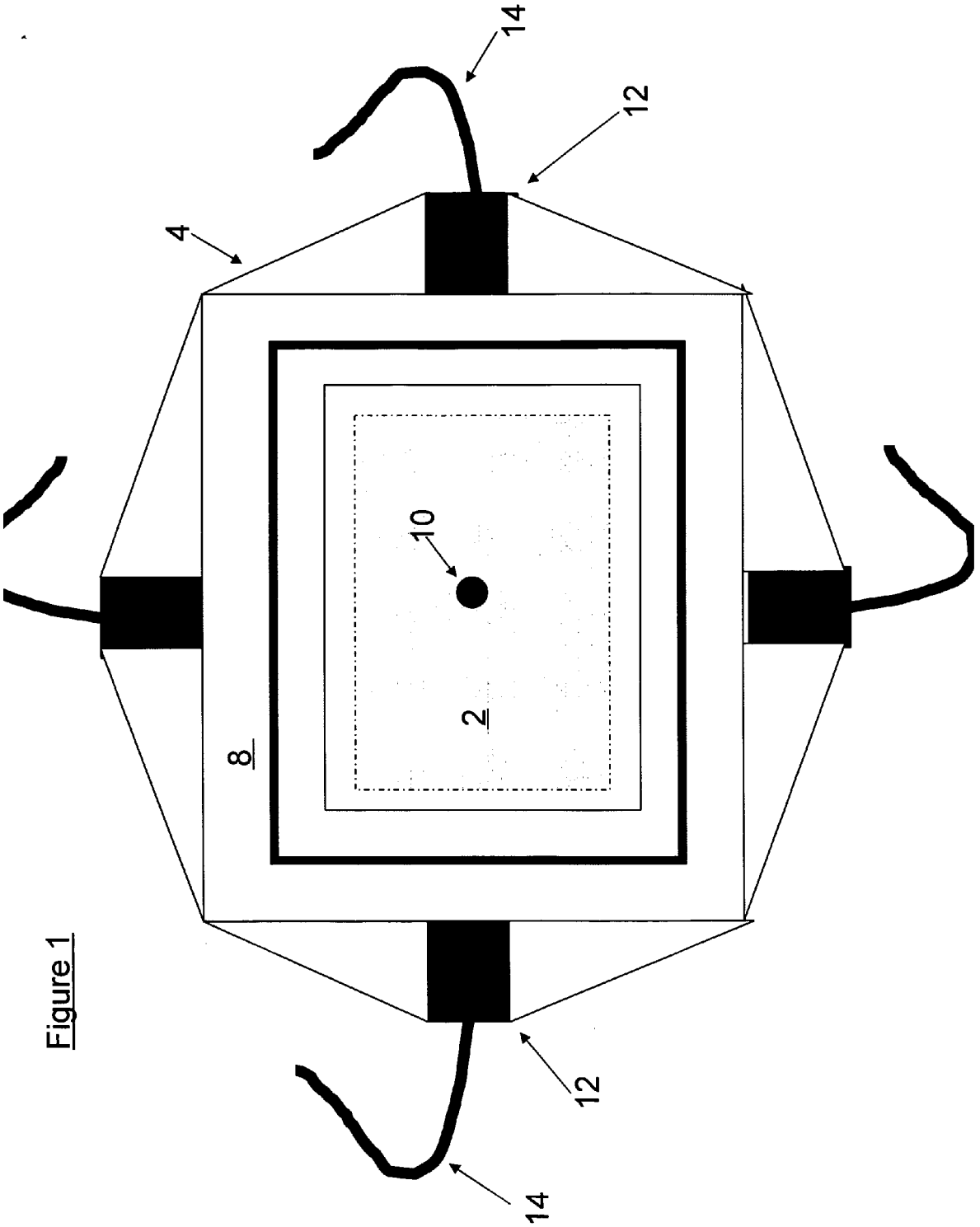


Figure 1

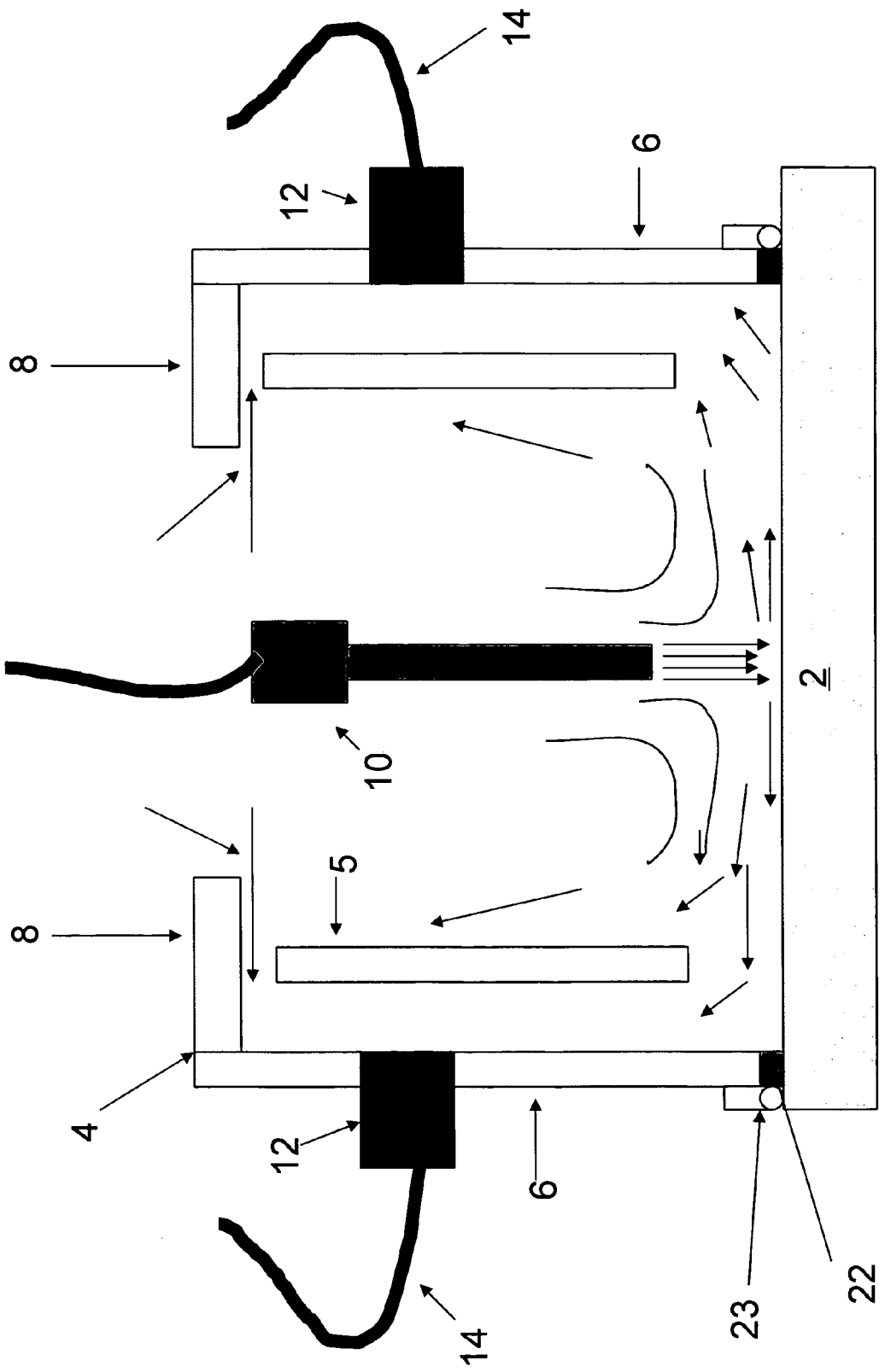


Figure 2

Figure 3

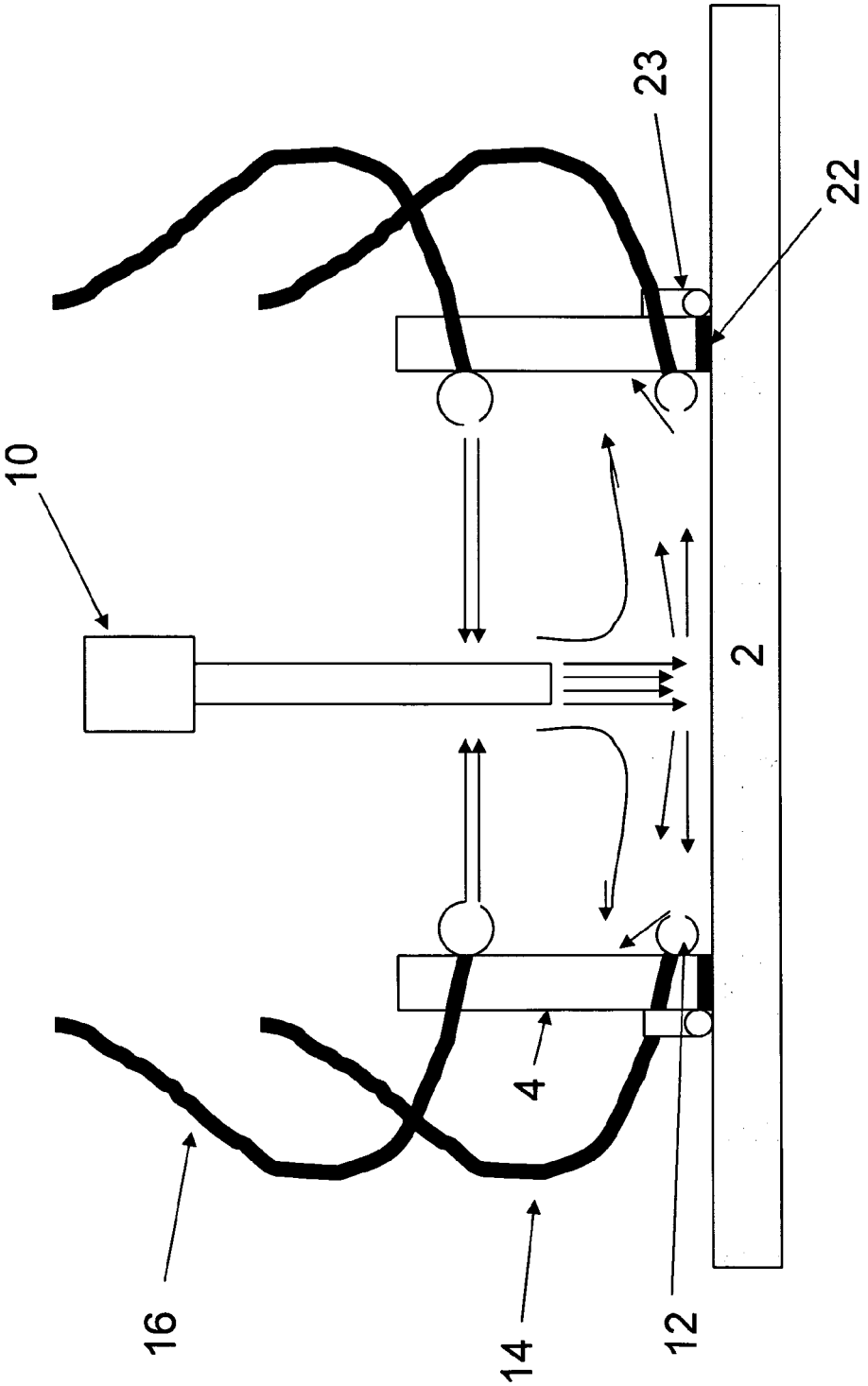
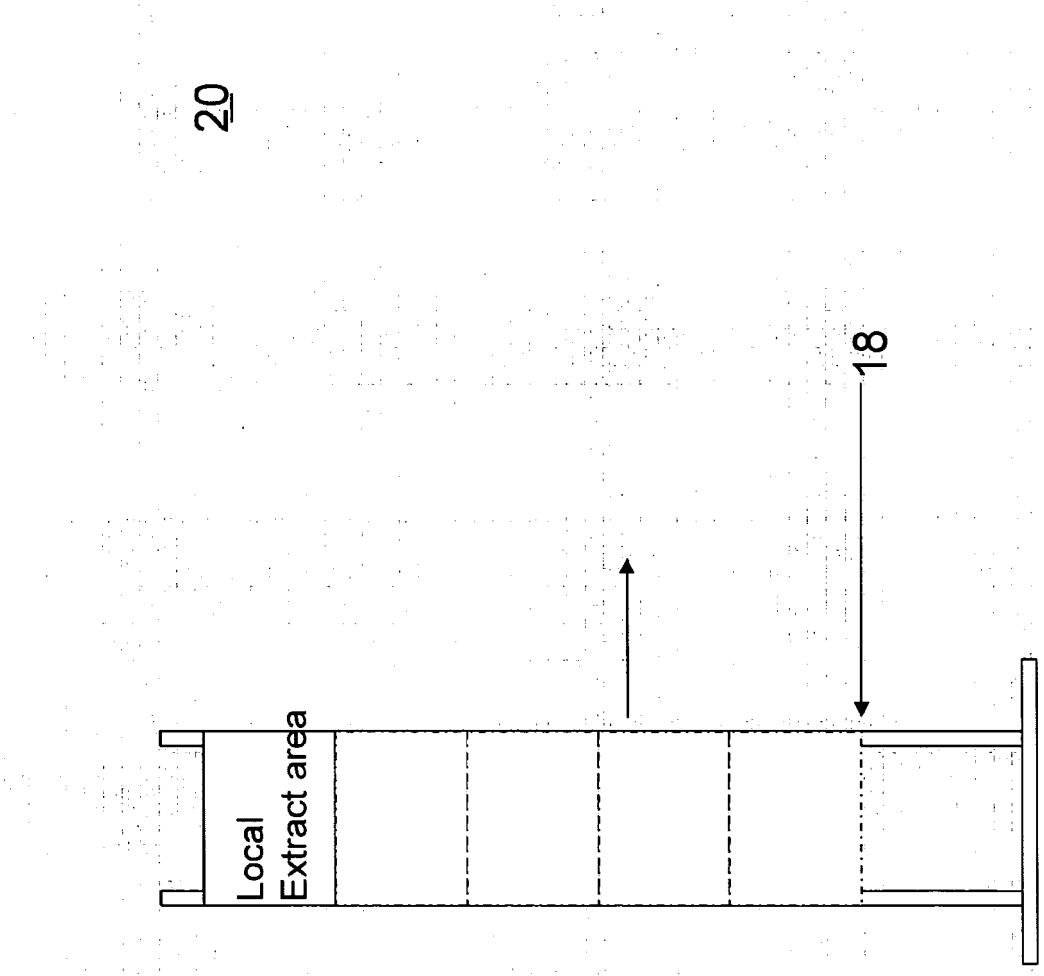


Figure 4



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EUROPEAN SEARCH REPORT

Application Number
EP 09 01 2566

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	23 April 2010	Lohberger, Severin

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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