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

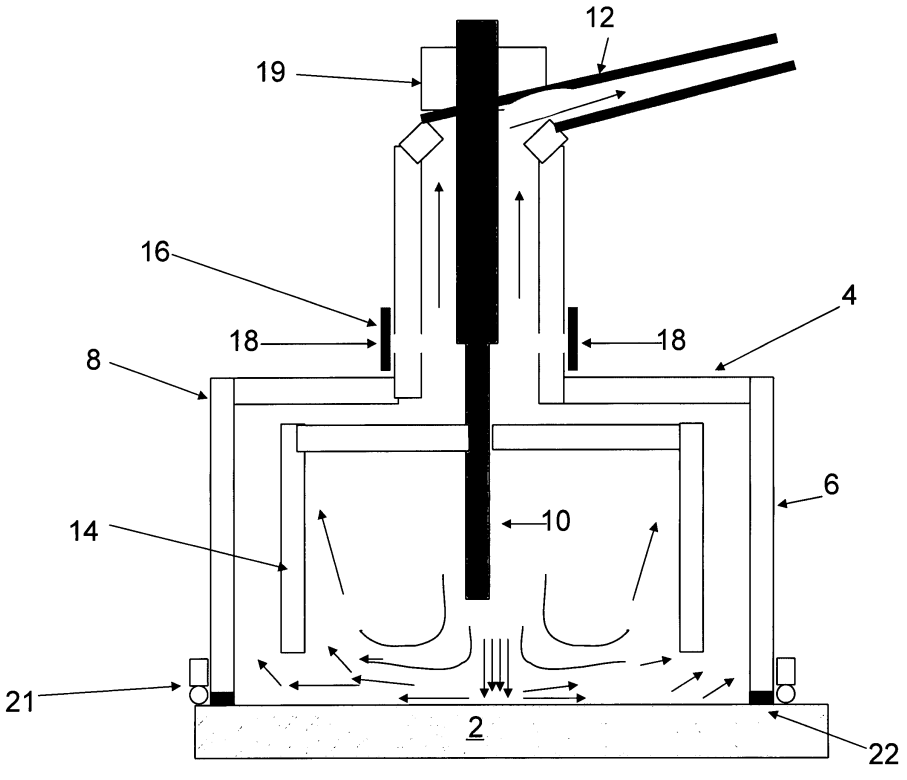
(72) Inventor: **Wigfall, Tim**
Old Tupton
S42 6LQ Chesterfield
Derbyshire (GB)

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

(54) Device for capturing material during dry ice blasting

(57) The invention relates to a device for capturing of material during a dry ice blasting decontamination process and is characterized by
- a blasting gun (10)
- an outer shroud (4), open to the cleaning surface (2), closed to the sides and having an opening at the top for the blasting gun (10) and one or more suction adapters (12)
- an inner baffle (14) rigidly fixed to the outer shroud 4 and mounted onto the stem of the spray gun (10), opened to the cleaning surface (2), closed to the sides and closed to the top creating a gap near the surface (2) allowing the ablated material to be sucked into the hollow between outer shroud (4) and inner baffle (14)

Figure 1



EP 2 305 425 A1

Description

[0001] The invention relates to a device and a method for capturing material during a dry ice blasting 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 cleanness, 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, and a freezing layer is formed on a surface of the contaminated subject because the temperature of the blasted CO_2 gas is very low, thus reducing decontamination efficiency of the contaminated subject.

[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 static solutions is that only relative small objects can be cleaned. The drawbacks of the movable solutions are the impeded sight to the region of impact of the blasting jet and the handicap of having to carry the additional weight of the capture device and acssociated hoses, this is particularly detrimental when the operator already has to wear heavy protective clothing as in radioactive contaminated surroundings in nuclear plants or nuclear industry.

[0009] US 7,097,717 discloses a device with a shroud mounted directly onto the gun. This device uses an air curtain flowing parallel to the blasting jet to prevent contaminated gas from diffusing into the atmosphere. Collection takes place in a collecting space nearby the gun and by special outside suction channels. The sucking gas stream near the jet leads to a widening of the jet and a decrease of the blasting performance of the jet. The active air curtain needs an air supply with at least one additional hose, which is not very easy to handle in nuclear industry environments.

[0010] It is an object of the present invention to provide a device and a method for capturing material during dry ice blasting which has higher efficiency, operational reliability and improved ease of use.

[0011] It is also an object of the invention to enable the temperature of the exhaust gas to be modified to protect components of the system from damage due to cold embrittlement and fatigue.

[0012] It is a third object of the present invention to provide a method and a device for capturing material during dry ice blasting which eases the handling for the operator - especially in nuclear industry when the operator is impeded by wearing heavy and bulky protective clothing.

[0013] Based on the present invention the object can be accomplished by a device of one of the claims 1 - 6 or by a method of claim 7.

[0014] The core idea of the invention is to use a sort of double shroud with an outer shroud, similar to the state of the art, and an inner shroud or baffle which protects the cleaning jet from being influenced by the exhaust extract stream. So the effect of the cleaning can be enhanced as more and faster ice particles impact and break or loosen the adhering contaminants from the cleaning surface.

[0015] The equipment is designed to be used when cleaning flat surfaces - in horizontal or vertical planes. The equipment is designed to make use of the general air movements/turbulence and deflection that are generated by the cleaning process.

[0016] The extract system is portable and will be mounted onto the "stem" of the dry ice blasting gun. This arrangement gives the advantage of most efficient particulate capture due to maintained distance between the nozzle and the exhaust capture "duct", this has the effect of equalizing and maintaining exhaust entrainment velocities within the shroud.

[0017] One objective is to capture as much of the surface contamination material as possible which is liberated by the dry ice blasting process. The exhaust gas and entrained particulates will be scrubbed using appropriate methods including cyclone and bag filter technologies as they are commonly known or used. The system can be linked to a particulate filtration system (cyclone/hepafilter) to achieve the required particle size, capture or filtration profile.

[0018] There can be a "fail safe" pressure monitored

link between the gun and the extract system - to protect against the creation of positive pressure within the extract shroud (which would lead to a potential for the release of contaminated material into the surrounding areas). The equipment can be designed to ensure that a negative pressure is maintained within the shroud or shroud at all times. Extract volumes will be determined by a combination of three factors: i) the volume of air that has to be removed to compensate for the air/carbon dioxide introduced by the cleaning process (so as to maintain a negative pressure within the shroud), ii) the amount of extract air required to form an effective "air curtain" seal between the shroud and the surface being cleaned iii) the amount of air to be introduced to create a suitable temperature in the exhaust gas to prevent cold temperatures arising that would cause damage to the extract/filtration equipment. The equipment can feature safety interlocks between exhaust system and dry ice blasting equipment - to ensure the gun can only be used when the extract system is active.

[0019] The equipment includes the feature of a "sight" to enable the operator to judge the "sweep" of the blast and, therefore, enable effective cleaning of the entire surface. The equipment comes with a variety of interchangeable "sights" that reflect a variety of nozzle cleaning patterns, hence allowing the operator to gauge where he or she is cleaning for optimum accuracy and efficiency in operation.

[0020] The equipment will feature other safety interlocks including the operation of the filtration system - for example if the collection device is full, or filter is blocking/ "blinding". In the event that there is a problem with the function of the filtration system then the interlock system will prevent the dry ice blasting gun from being operated.

[0021] The inventive shroud includes an internal baffle arrangement - this has several benefits including:

- making use of the natural air flow from the blast to facilitate vacuum capture.
- evenly spreading the vacuum/extract momentum within the shroud or shroud (Delete)and ..... (delete spaces) hence avoiding preferential flows or dead spots
- preventing distortion of the blast jet by the vacuum, which would mean: loss of dry ice pellets (delete) and loss of cleaning efficiency due to direct entrainment into the exhaust stream.

[0022] As the dry ice particles are very cold and sublime when they impact upon the surface, the resultant exhaust gas is also very cold and there is a danger that it will cause cold damage to components in the exhaust system (the exhaust hose is particularly susceptible to embrittlement and fracture), it is also possible that humidity in the air may condense and freeze in the exhaust system and clog up the filters . To avoid this situation, an electric or supplementary heating can be installed or supplemental air can be mixed to warm the total flow. The invention illustration Figure 1 shows how exhaust gas temperature can be very easily modified by the use of a supplemental air inlet which is regulated using a rotating collar in the suction adapter. By turning the collar the area of the supplemental inlet air orifice is varied, hence allowing more or less air of room temperature into the exhaust stream via this bypass flow allowing the desired exhaust temperature to be achieved.

[0023] This independent exhaust gas temperature control via variable orifice collar in the exhaust gas line is advantageous because it allows temperature control without disturbance to optimized extract/capture volumes/velocities within the shroud. When necessary the variable orifice collar will be adjusted to allow the inlet of additional air into the exhaust gas stream with the benefit of warming it and preventing cold damage to the exhaust pipework/fan etc. Exhaust pipework is particularly susceptible to cold damage because the nature of the blast cleaning process means that it is constantly being moved and flexed. When cold, materials that are subject to constant physical stress are very prone to fracture and failure (and hence the potential for release of the contaminant material into the general environment).

[0024] In one embodiment the equipment has brushes and multidirectional rollers to allow free movement of the shroud across the work surface whilst maintaining a constant but small gap to reduce the likelihood of escape of air or dust between the wall and the shroud surface. Brushes, especially on the outer shroud wall, enable the best possible seal between the exhaust shroud and work piece during movement of the cleaning equipment.

[0025] The air, the CO_2 and the released contaminants can be sucked out by one or more suction adapters. The suction adapter or adapters can be arranged wherever it seems appropriate. Preferred is a central suction adapter in the middle of the top wall of the outer shroud, preferably pivotable. So the maneuverability is enhanced and the device can easy be moved in any direction. The central position also homogenizes the exhaust gas flow inside the shroud and avoids "dead spaces".

[0026] The device can be of any shape, preferred are a round, oval or square shape of the outer shroud and/or of the inner baffle corresponding. Round or oval shapes have the advantages of very easy handling.

[0027] Although the inner baffle and outer shroud are rigidly fixed against each other, the equipment is constructed to allow the dry ice blasting gun to be adjusted forwards/backwards to enable the optimum distance between the nozzle and clean surface to be set.

[0028] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which

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.

[0029] Figure 1 shows an embodiment of an inventive device on a surface 2 to be cleaned. The device is built up by a outer shroud 4 with side walls 6 and a top wall 8. An inner baffle/shroud 14 is rigidly fixed to the outer shroud 4 with a predetermined gap between the two (to allow the passage of the exhaust gas to the extract 12). The "stem" of the spray or blasting gun 10 passes through a cental orifice in the top of the outer 4 and inner shroud 14. The shroud assembly 4,14 is held in position on the stem of the gun by an adjustable clamp 19 which is designed to allow the gun stem/nozzle assembly to slide in/out - to enable the distance between the nozzle and the surface to be optimized and then fixed in place. The outer shroud 4 has on its top a central adapter 12 to exhaust where the gases (air and CO_2) and particles released are transported to the exhaust. In this embodiment a supplemental air inlet 18 is foreseen, which can be opened or closed by a rotating collar 16 for letting additional byepass air into the exhaust stream. The inner baffle 14 shields the jet which is directed to the surface 2 in a very effective manner (and hence prevents it from being distorted and dry ice from being sucked directly by the vacuum into the exhaust stream). Brushes 22 seal the shroud 4 against the surface 2 and prevent the escape of released contaminants to the atmosphere. Multidirectional rollers 21 keep the desired distance.

[0030] Figure 2 shows schematically the same embodiment from a top view. The side walls 6 of the outer shroud 4 confine the device. The inner baffle 14 has the same shape as the outer shroud 4 and is rigidly fixed to it. The exit face of the jet gun 10 is rectangular. A pair of sights 20 are fixed to allow the operator to align the blasting equipment to ensure that the "sweep" of clean is aligned with the area that has already been cleaned - hence improving the effectiveness and speed of cleaning. The dotted lines show lines of sight.

[0031] The gun mounted shroud/shroud and inner baffle that form part of the invention may be rectangular in cross section - as per the illustration, or if advantageous, may be of other shapes/form (bell-like etc) for advantageous flow of the exhaust gases.

Reference List:

[0032]

2 surface to be cleaned
4 outer shroud
6 side wall outer shroud
8 top wall outer shroud
10 blasting or spray gun & nozzle
12 connection adapter to exhaust
14 inner baffle/shroud
16 rotating collar
18 supplemental air inlet
19 gun stem collar clamp
20 interchangeable sights
21 multidirectional rollers
22 brushes

Claims

1. Device for capturing of material during a dry ice blasting decontamination process, **characterized by**

   - a blasting gun (10)
   - an outer shroud (4), open to the cleaning surface (2), closed to the sides and having an opening at the top for the blasting gun (10) and one or more suction adapters (12)
   - an inner baffle (14) rigidly fixed to the outer shroud 4 and mounted onto the stem of the spray gun (10), opened to the cleaning surface (2), closed to the sides and closed to the top creating a gap near the surface (2) allowing the ablated material to be sucked into the hollow between outer shroud (4) and inner baffle (14).

2. Device according to claim 1, **characterized by** brushes (22) and or multidirectional rollers (23) for tracking across the surface at a set clearance, and sealing the bottom for the outer shroud (4) to the surface (2).

3. Device according to claim 1 or to claim 2, **characterized by** a central suction adapter (12) in the middle of the top wall (8) of the outer shroud (4), preferably pivotable.

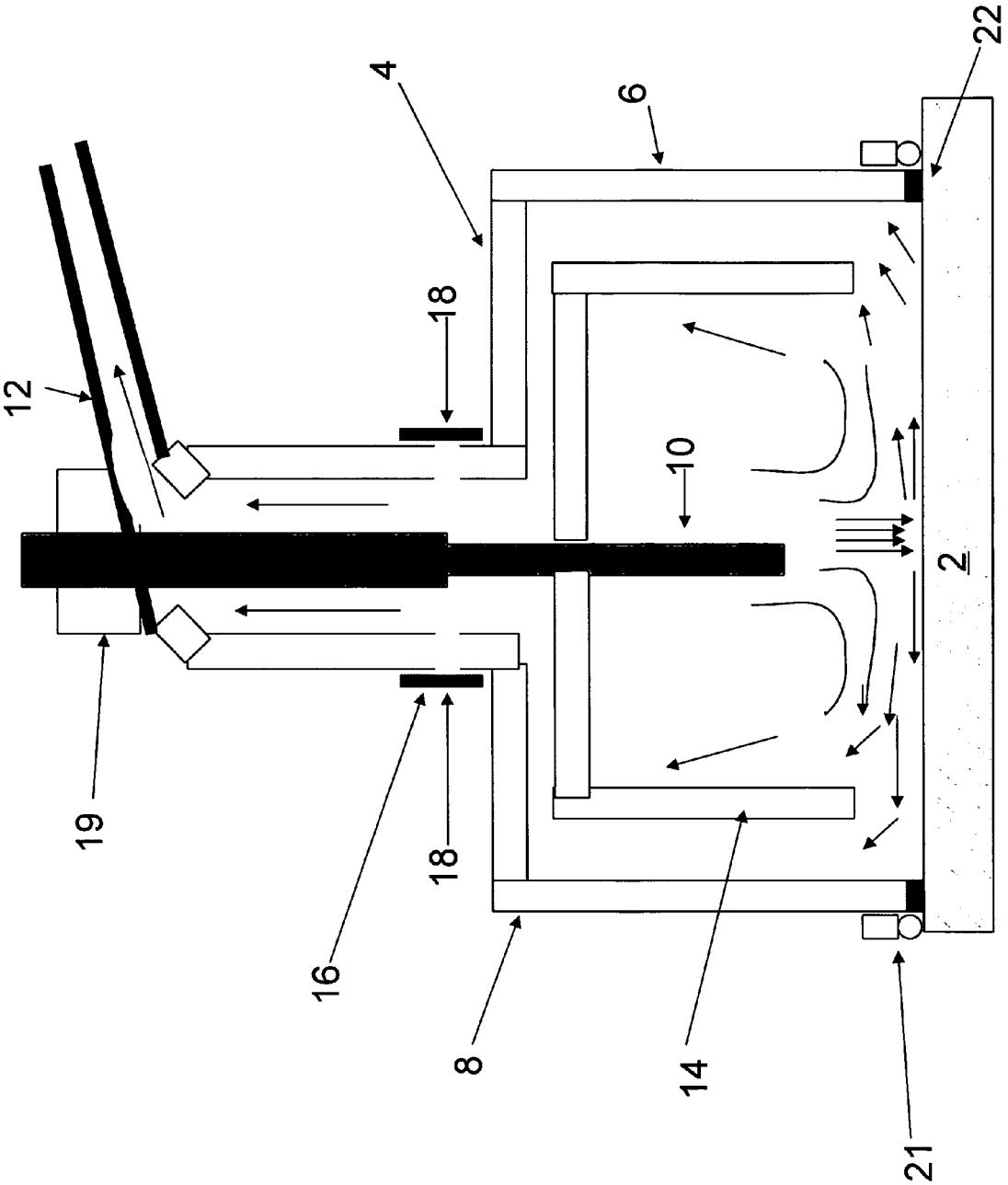
4. Device according to one of the preceding claims, **characterized by** a round, oval or square form of the outer shroud (4) and/or the inner baffle (14).

5. Device according to one of the preceding claims, **characterized by** a supplemental air inlet (18) with variable orifice rotating collar (16) in the suction adapter (12).

6. Device according to one of the preceding claims, **characterized by** a retractable gun (10) to set the correct distance between the nozzle and the work surface (2) for optimum cleaning effect.

7. Method of capturing material during a dry ice blasting decontamination process using a shroud (4) with one or more suction adapters (12) **characterized by** using a baffle (14) shielding the dry ice spray from being distorted and encouraging entrainment and capture of the blasting gases and liberated particulate material.

Figure 1



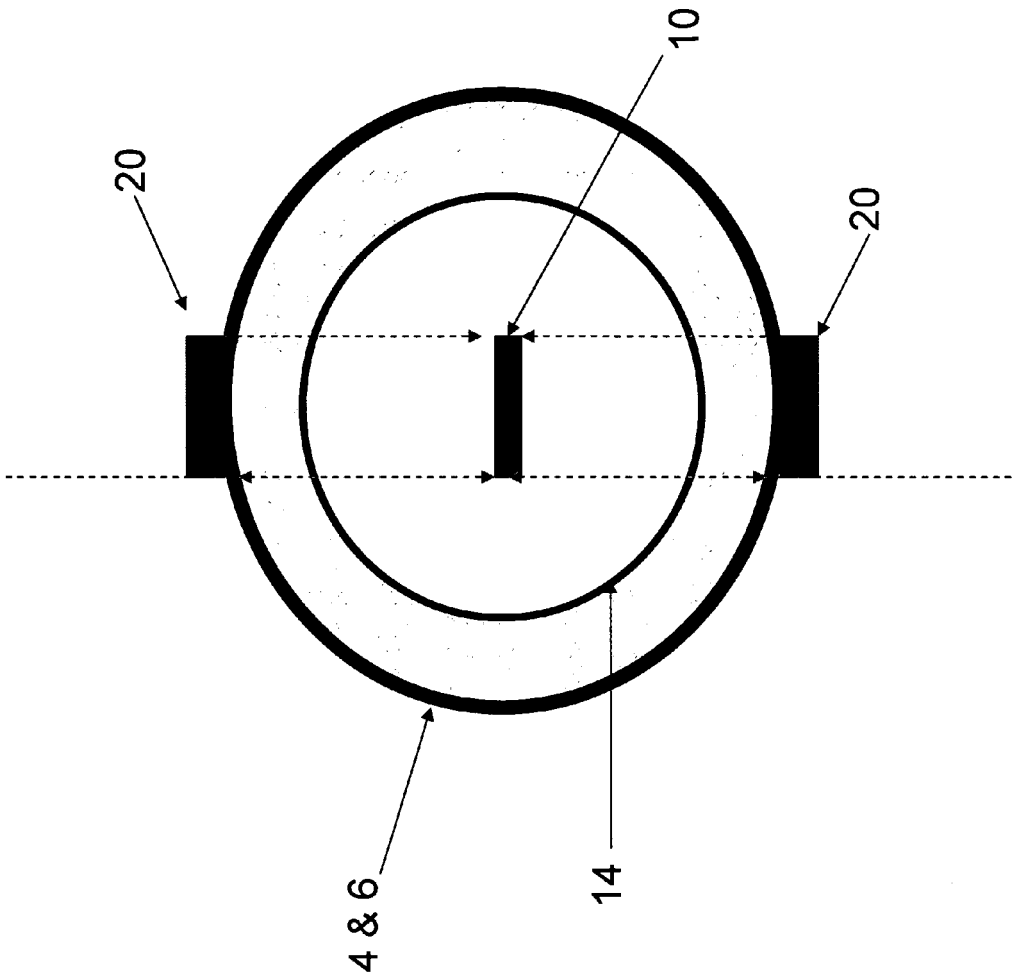


Figure 2

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EUROPEAN SEARCH REPORT

Application Number
EP 09 01 2616

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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	26 February 2010	Eder, Raimund

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 09 01 2616

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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