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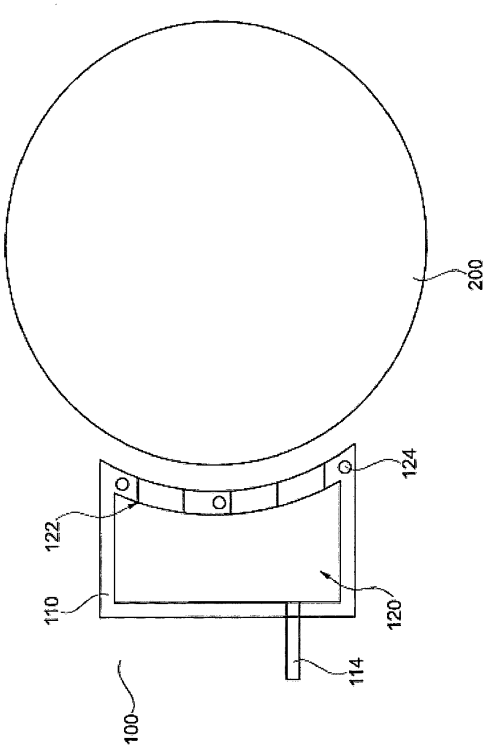
(54) **Cryogenic nozzle and corresponding method**

(57) The invention relates to a cryogenic nozzle comprising a nozzle body (110) defining a nozzle volume (120), a supply channel (114) for supplying cryogenic fluid to the nozzle volume (120), and at least one nozzle orifice (122) for ejecting cryogenic fluid, from the nozzle volume (120), wherein the nozzle body (110) is provided with at least one fluid channel (124).

Figur



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Description

[0001] The present invention relates to a cryogenic nozzle and to a method for ejecting a cryogenic fluid by means of such a cryogenic nozzle.

[0002] For numerous applications, direct cooling using cryogenic fluids (also referred to as cryogenic gases) is advantageous. Herein, cryogenic fluid is ejected from a cryogenic nozzle, wherein an object to be cooled is positioned directly in front of the nozzle opening.

[0003] During phases, in which an object need not be cooled, the flow of cryogenic fluid through the cryogenic nozzle is expediently interrupted. During such an interruption, for example a machining or processing of the object positioned in front of the nozzle opening can be performed.

[0004] If, subsequently, a further cooling of the object is necessary, prior art nozzles can not immediately provide cryogenic fluid in the liquid state, which is necessary for cooling the object. Rather, as the nozzle acquires a higher temperature during said interruption of the flow of cryogenic fluid, an evaporation of cryogenic fluid will initially occur, which will lead to significant delays in the further processing of the object.

[0005] Typical examples of such cryogenic cooling applications are Al-rolling applications.

[0006] The object of the invention is to minimize delays during processing of objects, which, intermittently or continuously, are cooled by means of direct cryogenic cooling.

[0007] This object is solved with a cryogenic valve comprising the features of claim 1. The inventive method for ejecting a cryogenic fluid by means of such a cryogenic nozzle is **characterized in that** a cooling medium is passed through at least one fluid channel of said cryogenic nozzle.

[0008] According to the invention, the at least one fluid channel provided in the nozzle body can be used to transport or circulate a cooling fluid through the nozzle body, thus ensuring that the nozzle can be kept sufficiently cold at all times, even during times at which cooling of an object by means of ejection of cryogenic fluid through the nozzle orifices is interrupted.

[0009] According to the invention, a cryogenic nozzle can at all times be held in a standby state, without an actual cryogenic fluid having to be ejected by the nozzle. By using a cryogenic nozzle according to the invention, it can be ensured that a desired cryogenic cooling can instantly be provided, as soon as cryogenic fluid is ejected from the nozzle.

[0010] Advantageous embodiments of the invention are the subject matter of the dependent claims.

[0011] According to a preferred embodiment, the supply channel can be brought into fluid communication with the at least one cooling channel. Hereby, it is possible to use the same cryogenic fluid for cooling an object (by means of ejection through nozzle orifices) and for cooling the nozzle body.

[0012] Expediently, cryogenic fluid entering the nozzle volume via the supply channel can be directed into the at least one cooling channel, especially during times at which an ejection of cryogenic fluid through nozzle orifices is interrupted. This measure enables a particularly efficient usage of cryogenic fluid.

[0013] Expediently, there are provided control means for directing cryogenic fluid supplied through the supply channel into the nozzle volume and/or the cooling channels. By means of such a control means, an efficient distribution of cryogenic fluid can be provided.

[0014] The inventive cryognic nozzle is in particular suited for spraying or ejecting liquid nitrogen.

[0015] From time to time maintenance actions or repair operations have to be carried out in order to retain or restore the desired function of the cryogenic nozzle. Then it is not only necessary to stop operation of the cryogenic nozzle but also to warm up the cryogenic nozzle. In such cases it is preferred to pass a heating medium through said at least one fluid channel of said cryogenic nozzle. The heating fluid will heat up the cryogenic nozzle such that the maintenance work can be started earlier. The down-time of the cryogenic nozzle can be considerably shortened.

[0016] According to a preferred embodiment a gaseous medium is used as heating fluid. Preferred heating media are in particular inert gases, such as gaseous nitrogen.

[0017] Further advantages and embodiments of the invention will become apparent from the description and the appended figures.

[0018] It should be noted that the previously mentioned features and the features to be further described in the following are usable not only in the respectively indicated combination but also in further combinations or taken alone, without departing from the scope of the present invention.

Brief description of the figures

[0019] Figure 1 shows a first preferred embodiment of a cryogenic nozzle according to the invention, used for direct cryogenic cooling of an object in a schematic side view.

Preferred embodiment of the invention

[0020] In Figure 1, a preferred embodiment of a cryogenic nozzle according to the invention is generally designated 100. It is used for direct cryogenic cooling of an object 200, for example for cooling a roll for rolling aluminium sheets.

[0021] The cryogenic nozzle 100 comprises a nozzle body 110 defining a nozzle volume 120 and at least one nozzle orifice 122. A supply channel for supplying a cryogenic fluid, for example liquid nitrogen (LIN), to the nozzle volume 120 is designated 114.

[0022] Cryogenic fluid entering the nozzle volume 120

through supply channel 114 is ejected through at least one nozzle orifice 122. After exiting the at least one nozzle orifice 122, the cryogenic fluid impinges on object 200, thus providing an effective direct cryogenic cooling.

[0023] Nozzle body 110 is further provided with cooling channels 124, through which a cryogenic fluid can be transported or circulated. The cryogenic fluid flowing through cooling channels 124 can be the same fluid as provided through supply channel 114 for cooling object 200. Also, it can be provided as a different cryogenic fluid. It is possible to provide cryogenic fluid for cooling channels 124 via supply channel 114. Also a separate supply for providing cooling channels 124 with cryogenic fluid is possible.

[0024] By providing a flow of cryogenic fluid through cooling channels 124 in the nozzle body 110, an effective cooling of cryogenic nozzle 100 can be effected during times at which cooling of body 200 (i.e. passage of cryogenic fluid through nozzle orifices 122) is interrupted. By insuring that the nozzle body 110 is thus cooled at all times, delays in cooling of the object 200 after resumption of direct cooling by ejecting cryogenic fluid through orifices 122 can be minimized. As mentioned above, in prior art systems, after resumption of cooling, an initial evaporation of cryogenic fluid due to a warming up of the nozzle body during interruption of actual cooling had to be taken into account.

[0025] Cooling channels 124 can also be used to heat up the cryogenic nozzle 100, for example for maintenance operation. In that case a heating fluid, especially warm nitrogen gas, is passed through the cooling channels 124 after the flow of cryogenic fluid through the nozzle orifices 122 has been stopped. Thereby the downtime for maintenance or repair of the cryogenic nozzle 100 will be reduced.

Claims

1. Cryogenic nozzle comprising a nozzle body (110) defining a nozzle volume (120), a supply channel (114) for supplying cryogenic fluid to the nozzle volume (120), and at least one nozzle orifice (122) for ejecting cryogenic fluid from the nozzle volume (120),
   characterized in that nozzle body (110) is provided with at least one fluid channel (124).

2. Cryogenic nozzle according to claim 1, wherein supply channel (114) can be brought into fluid communication with the at least one fluid channel (124).

3. Cryogenic nozzle according to claim 1, wherein cryogenic fluid entering the nozzle volume (120) via supply channel (114) can be directed into the at least one fluid channel (124), especially during times at which an ejection of cryogenic fluid through nozzle orifices (122) is interrupted.

4. Cryogenic nozzle according to any one of the preceeding claims, comprising control means for directing cryogenic fluid supplied through supply channel (114) into nozzle volume (120) and/or into cooling channels (124).

5. Cryogenic nozzle according to any one of the preceeding claims, wherein said fluid channel is connected to a source of a cooling medium.

6. Cryogenic nozzle according to any one of the preceeding claims, wherein said fluid channel is connected to a source of a heating medium.

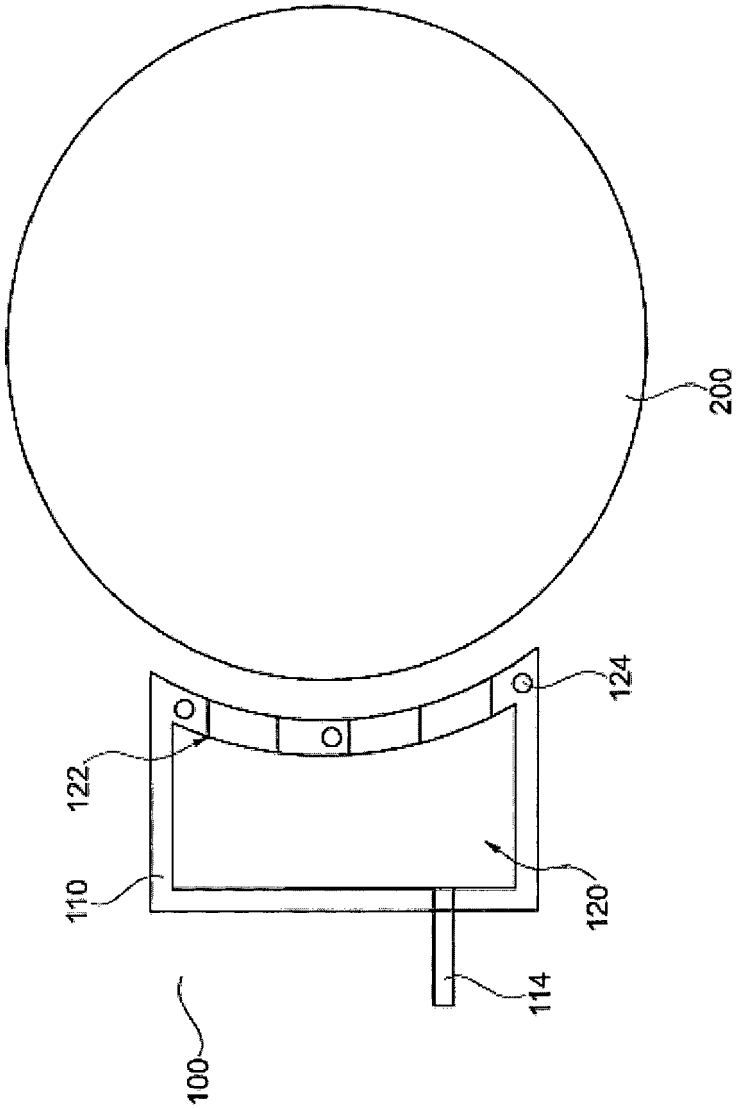
7. Method for ejecting a cryogenic fluid by means of a cryogenic nozzle according to any of claims 1 to 6, **characterized in that** a cooling medium is passed through said at least one fluid channel (124).

8. Method according to claim 7, **characterized in that** liquid nitrogen is passed through said at least one fluid channel (124).

9. Method for ejecting a cryogenic fluid by means of a cryogenic nozzle according to any of claims 1 to 6, **characterized in that** a heating medium is passed through said at least one fluid channel (124).

10. Method according to claim 9, **characterized in that** gaseous nitrogen is passed through said at least one fluid channel (124).

Figur



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EUROPEAN SEARCH REPORT

Application Number
EP 13 00 4835

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2008/196416 A1 (GIRARD JOHN MARTIN [US] ET AL) 21 August 2008 (2008-08-21) * the whole document *	1-10	INV. B05B1/24 B05B9/00 B05B1/00
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TECHNICAL FIELDS SEARCHED (IPC)

B05B
B22D
F27D
F27B
B21B
A23L
F25B
B24C
F25D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	4 November 2013	Rente, Tanja

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 00 4835

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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04-11-2013

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