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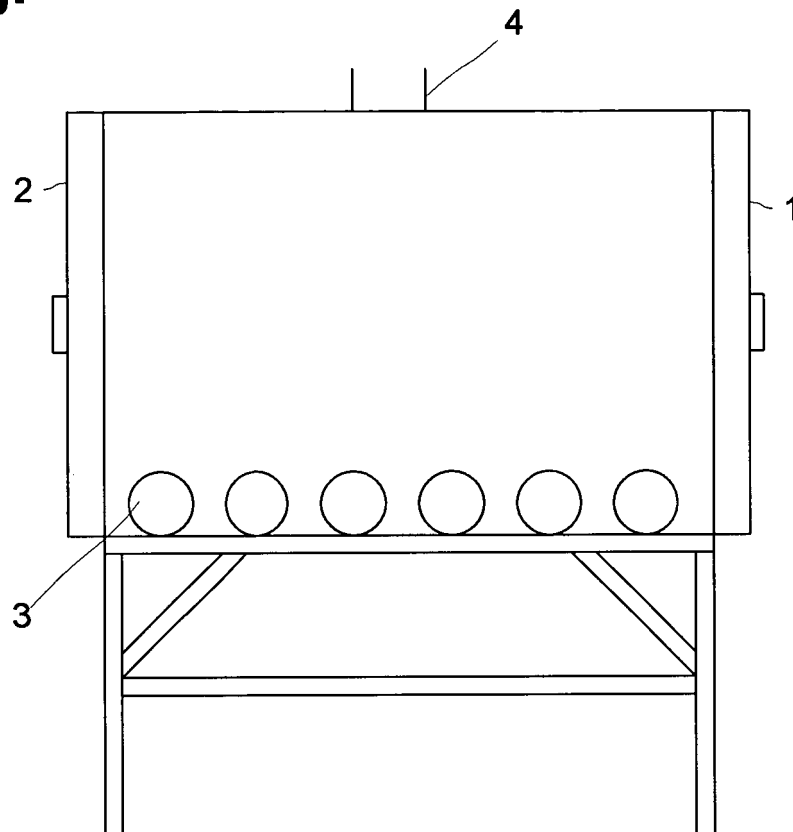
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(54) **Sub-zero cabinet for in-line treatment of metals**

(57) The invention relates to a cooling chamber for treatment of parts, especially metal parts, at low temperatures comprising an inlet for a cooling medium, an outlet

(4) for vent gas, an entrance door (1), and a separate exit door (2) and transportation means (3) for transporting said parts from said entrance door to said exit door.

Fig.



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Description

[0001] The invention relates to a cooling chamber for treatment of parts, especially metal parts, at low temperatures comprising an inlet for a cooling medium and an outlet for vent gas and an entrance door. Further the invention relates to a method for cooling parts wherein said parts are introduced into a cooling chamber through an entrance door and wherein said parts are cooled down in said cooling chamber by heat exchange with a cooling medium.

[0002] Processing of steels at sub-zero temperatures can improve various mechanical properties such as hardness and strength, wear resistance and dimensional stability. There are different methods to bring steel parts down to the desired temperature:

[0003] For example, the parts can be cooled in a top-loaded cryogenic box freezer. The cryogenic box is loaded and de-loaded manually or by a crane from the top. The inner volume of the box is cooled by liquid nitrogen or cold gaseous nitrogen. The cryogenic box freezer is an economic solution for cooling small production volumes. Since loading and de-loading require both man power and consume time this method is not suitable for higher production volumes.

[0004] A sub-zero cabinet, standing on the floor or on legs, which can be loaded from the front partly solves this problem since it is easier to load and de-load. Further it can be integrated in a heat treatment processing line. However, it is run in batch mode and the productivity is still limited by the loading and de-loading through the entrance door.

[0005] A cryogenic tunnel freezer can easily be integrated in-line a production process. In such a sub-zero tunnel large volumes of parts can be cooled down in a continuous process. But a tunnel solution has a high nitrogen consumption and extremely low temperatures of below -130°C can hardly be reached. Further, long processing times are impractical to carry out in a tunnel.

[0006] Thus it is an object of the present invention to provide a cooling device and a method for treatment of parts at low temperatures.

[0007] This object is achieved by a cooling chamber for treatment of parts, especially metal parts, at low temperatures comprising an inlet for a cooling medium and an outlet for vent gas, an entrance door, and a separate exit door and transportation means for transporting said parts from said entrance door to said exit door.

[0008] The inventive method for cooling parts wherein said parts are introduced into a cooling chamber through an entrance door and wherein said parts are cooled down in said cooling chamber by heat exchange with a cooling medium, is characterized in that said parts are transported from said entrance door to an exit door of said cooling chamber and that said parts are removed from said cooling chamber through said exit door.

[0009] The invention provides a cooling chamber which combines the advantages of a classical front-load-

ed cooling cabinet with the advantages of a classical cryogenic tunnel freezer. The inventive cooling chamber can easily be integrated into a processing line.

[0010] The parts which shall be cooled or treated at low temperatures are introduced into the cooling chamber through the entrance door and then passed through the cooling chamber by the transportation means. During the passage through the cooling chamber the parts are subjected to a cooling medium and cooled down to the desired temperature. The cooling time can preferably be varied by changing the speed of the transportation means which is transporting the parts. When the parts have reached the end of the cooling chamber and the end of the process cycle the exit door is opened and the parts are removed.

[0011] According to a preferred embodiment reels are used as transportation means. The reels are preferably driven by a motor wherein the rotational speed of the reels is preferably adjustable.

[0012] Preferably a liquid nitrogen source is connected to said inlet of the cooling chamber. Liquid nitrogen has the advantage that it is a relative cheap cooling medium and it allows to reach extremely low temperatures. It is preferred to feed the liquid nitrogen into the cooling chamber with a pressure between 1 and 10 bara, preferably between 1 and 4 bara.

[0013] Preferably the liquid nitrogen is sprayed into the cooling chamber. The evaporation cold which is generated thereby and the cold gaseous nitrogen lower the temperature of the cooling chamber and of the parts that are to be treated.

[0014] The volume of the cooling chamber is adjusted to the size of the treated batch, preferably between 0,1 and 5 m^3 , more preferably between 0,3 and 4 m^3 . Preferred dimensions of the inventive cooling chamber are as follows: height between 0,2 m and 1,5 m, width between 0,5 m and 2,0 m and length between 0,5 m and 10 m, wherein the length is defined as the extension along the transportation direction, that is from the entrance door to the exit door. The cooling chamber may also be larger if larger parts shall be treated.

[0015] It is further preferred to provide the cooling chamber with one or several circulating fans. The cooling medium introduced into the cooling chamber is distributed evenly throughout the cooling chamber by the circulating fans. This achieves a homogenous distribution of temperature in the chamber.

[0016] The invention is preferably used to cool down parts to a temperature between $+60^{\circ}\text{C}$ and -196°C , more preferred to sub-zero temperatures and most preferred to a temperature between -50°C and -180°C . For example, for shrink fitting of metals according to the invention it is often sufficient to reach a temperature between -40°C and -80°C . Nearly the same temperature range, for example -70°C to -120°C , is utilized for cold treatment of steel, that is to complete the metallurgic phase transformation of austenite into martensite during the hardening of steels via quench and temper heat treatment. The in-

ventive method may also be used to subject metal parts, especially steel parts, to a cryotreatment at extremely low temperatures down to -180°C for an extended period of time, sometimes as long as 48 hours.

[0017] The inventive method can improve various properties of metal parts, especially of steel parts, namely hardness and strength, wear resistance and dimensional stability. Preferably the invention is included into a line for heat treatment of metals.

[0018] The invention has several advantages compared to the prior art: The cooling chamber can easily be integrated in-line a production process. The transport of the parts through the cooling chamber can be automated by transport reels at the bottom of the cooling chamber and one entrance and one exit door. Compared to a tunnel solution the cooling medium consumption is lowered but it is still benefiting from in-line production. Low temperatures and long treatment times can be reached for an in-line production process without complicated handling as associated with a box freezer or a single door cabinet freezer. The invention is in particular advantageous for cooling metals but it can also be used for cold treatment for polymers, medicals or food.

[0019] The inventive system is relative cheap and requires less energy than a tunnel freezer. It reaches lower temperatures and can generate higher cooling rates. The system is in principle maintenance free. The invention is easy to include in heat treatment lines and to combine with annealing.

[0020] Preferred applications of the invention are the following:

- shrink fitting of metal parts, in particular steel parts, by causing a contraction on cooling in order to facilitate the assembly of parts which have very close tolerances
- cold treatment of steel, in particular of higher-alloy (e.g. tool steels) and carburized steel, in order to complete the transformation of the metal microstructure from austenite to the stronger and harder martensitic structure.
- cryotreatment of metals at liquid nitrogen temperatures

[0021] The invention as well as further details of the invention are described in the following with reference to the accompanying drawing wherein a cooling chamber according to the invention is shown.

[0022] The inventive cooling chamber shown in the figure is designed as a leg standing unit. It is also possible to place the cooling chamber directly on the floor.

[0023] The cooling chamber comprises an entrance door 1 and an exit door 2 which is positioned opposite the entrance door 1. At the bottom of the cooling chamber several reels 3 are arranged in order to transport parts which enter the cooling chamber through the entrance door 1. The cooling chamber is provided with an inlet for liquid nitrogen. The liquid nitrogen is sprayed into the

cooling chamber. The evaporation cold that is generated and the still cold gaseous nitrogen lower the temperature of the parts to be treated. The gaseous nitrogen at extremely low temperature is distributed evenly throughout the cooling chamber by one or several circulating fans, not shown in the figure. The expanding gaseous nitrogen escapes from the cooling chamber via a gas outlet 4.

[0024] The cooling chamber as shown in the figure is integrated into a process line for heat treatment of steel parts.

Claims

1. Cooling chamber for treatment of parts, especially metal parts, at low temperatures comprising an inlet for a cooling medium and an outlet (4) for vent gas and an entrance door (1), **characterized in that** a separate exit door (2) is provided and that there are transportation means (3) for transporting said parts from said entrance door (1) to said exit door (2).
2. Cooling chamber according to claim 1, **characterized in that** said transportation means are reels (3).
3. Cooling chamber according to any of claims 1 or 2, **characterized in that** a liquid nitrogen source is connected to said inlet.
4. Cooling chamber according to any of claims 1 to 3, **characterized in that** said entrance door (1) and said exit door (2) are arranged opposite each other.
5. Cooling chamber according to any of claims 1 to 4, **characterized in that** the inner volume of said cooling chamber is between 0,1 and 5 m³, preferably between 0,3 and 4 m³.
6. Cooling chamber according to any of claims 1 to 5, **characterized in that** said cooling chamber is provided with one or several circulating fans.
7. Method for cooling parts wherein said parts are introduced into a cooling chamber through an entrance door (1) and wherein said parts are cooled down in said cooling chamber by heat exchange with a cooling medium, **characterized in that** said parts are transported from said entrance door (1) to an exit door (2) of said cooling chamber and that said parts are removed from said cooling chamber through said exit door (2).
8. Method according to claim 7, **characterized in that** liquid nitrogen is used as cooling medium.
9. Method according to claim 8, **characterized in that** said liquid nitrogen is introduced into said cooling chamber with a pressure between 1 and 10 bara,

preferably between 1 and 4 bara.

10. Method according to any of claims 7 to 9, **characterized in that** said parts are cooled down to a temperature between +60 °C and -180 °C. 5
11. Method according to any of claims 7 to 10, **characterized in that** metal parts, especially steel parts, are cooled down. 10
12. Method according to claim 11, **characterized in that** said metal parts are treated at low temperatures in order to shrink fit said parts, harden said parts, transform the metal microstructure of said parts and/or to improve the wear resistance, toughness and/or dimensional stability. 15

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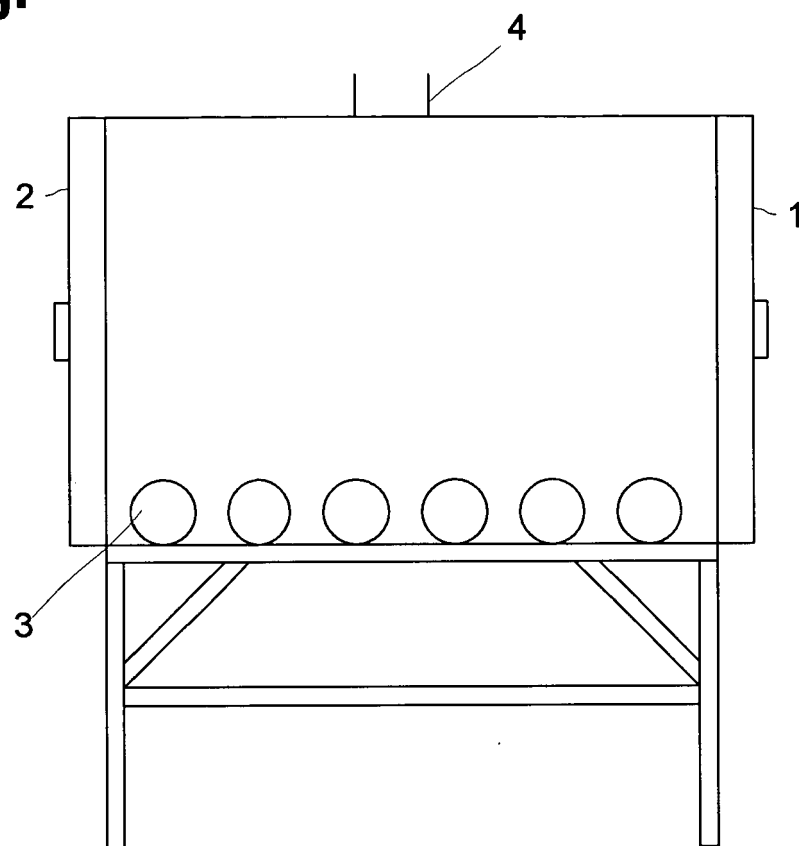
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Fig.





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Application Number
EP 06 00 7312

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 19 September 2006	Examiner Chebeleu, Alice
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 06 00 7312

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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