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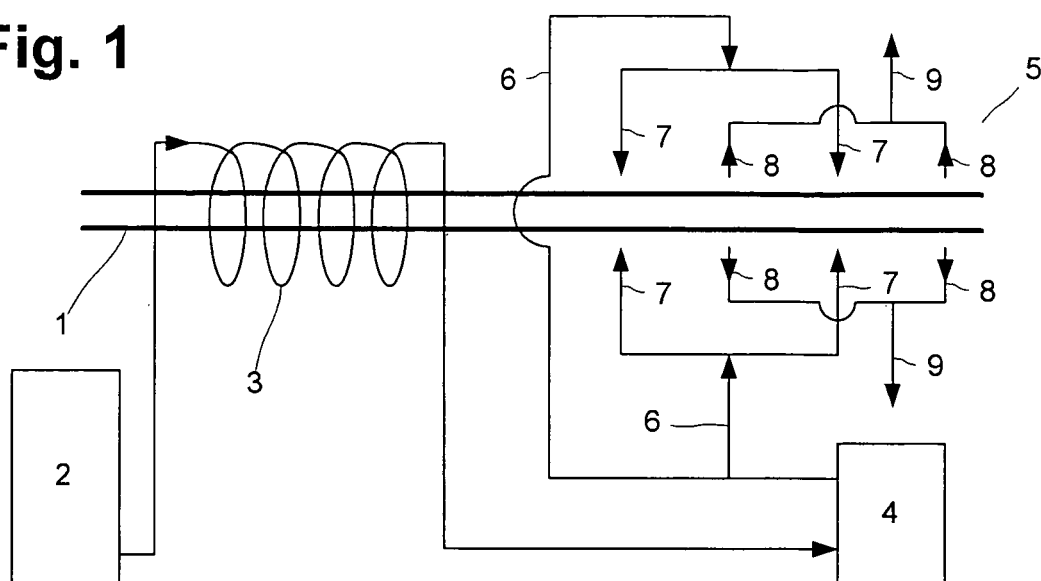
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(54) **Method for cooling tubes**

(57) The invention relates to a method for cooling an object (1), in particular a metal wire or a metal tube. First, said object (1) is cooled in indirect heat exchange (3) with

a liquefied gas (2), then said liquefied gas is evaporated (4) to produce a cold gas and said cold gas is blown (6, 7) onto said object (1).

Fig. 1



Description

[0001] The invention relates to a method for cooling an object, in particular a metal wire or a metal tube, wherein a jet of a cold gas is blown onto said object. Further the invention is related to a device for cooling an object comprising a passage way for said object and a gas blowing device with gas outlets for directing a cold gas to said passage way.

[0002] Pending German Patent Application Number DE 10 2004 054 627 (not yet published) discloses a device for cooling long objects, for example tubes, by blowing cold gas onto the object. The device comprises a first chamber with a plurality of nozzles for blowing out cold gas jets. Further, an enveloping tube is provided which envelopes the object. The cold gas blown out of the first chamber flows between the object and the enveloping tube and thereby additionally cools down the object.

[0003] The device disclosed in the above-mentioned German Patent Application shows a good heat contact between the cold gas and the object. However, to enhance the heat transfer coefficient the warmed gas should be removed as fast as possible from the object to be cooled. Otherwise it will form an insulating gas buffer.

[0004] Therefore, it is an object of the present invention, to provide an improved method and an improved device for cooling an object by blowing gas jets onto it.

[0005] This object is achieved by method for cooling an object, in particular a metal wire or a metal tube, wherein a jet of a cold gas is blown onto said object, which is characterized in that said object is cooled in indirect heat exchange with a liquefied gas, said liquefied gas is then evaporated to produce said cold gas and said cold gas is blown onto said object.

[0006] The inventive device for cooling an object comprises a passage way for said object and a gas blowing device with gas outlets for directing a cold gas to said passage way wherein a heat exchange passage for a liquefied gas and means for evaporating said liquefied gas in order to produce a cold gas are provided, wherein said heat exchange passage for said liquefied gas is in heat exchange contact with said passage way for said object.

[0007] According to the invention the cold of a liquefied gas is utilized to cool the object in two steps:

[0008] First, the liquefied gas is brought into indirect heat exchange with the object. The liquefied gas flows through heat exchange passages which are arranged close to the passageway where the object is placed into or passed through. By convection of the atmosphere surrounding the object heat is transferred to the liquefied gas. In addition, especially when cooling hot objects with a temperature above 500 °C there is a substantial temperature difference between the hot object and the liquefied gas. Thus, part of the heat is transferred to the liquefied gas by radiation.

[0009] Then the liquefied gas is evaporated to produce

a cold gas. Part of the liquefied gas might already have been evaporated during the indirect heat exchange of a liquefied gas with the object.

[0010] Finally, the cold gas is blown onto the object to directly exchange heat with the object. By the inventive method the cold of a liquefied gas is highly efficiently utilized.

[0011] Preferably, liquid nitrogen is used as liquefied gas.

[0012] According to a preferred embodiment of the invention said heat exchange passages for the liquefied gas are arranged around said gas blowing device. By that arrangement the indirect cooling by the liquefied gas and the direct cooling by means of jets of cold gas is carried out at the same place. The space for cooling the object, for example the metal tube, is thus minimized.

[0013] The liquefied gas is passed through heat exchange passages to indirectly cool the object. Preferably these heat exchange passages are designed as a spiral wound around the passageway where the object to be cooled is passed through. More preferably the spiral pipeline for the liquefied gas is wound around the gas blowing device.

[0014] After having indirectly cooled the object the liquefied gas is transferred to an evaporator where the liquefied gas is evaporated, for example in indirect heat exchange with air or water. The resulting cold gas is fed to the gas blowing device, blown out through gas outlets and directed to the object. Preferably the gas blowing device also comprises gas inlets arranged close to the passageway for the object. Gas which has been warmed up in heat exchange with the hot object can be withdrawn very quickly by means of these gas inlets. Thus, the heat transfer coefficient is essentially improved. It is preferred to utilize a fan or a similar device to suck in warm gas from the passageway into the gas inlets.

[0015] The invention is preferably suitable for cooling metal objects, such as tubes, wires or sheets, after a heat treatment. The inventive device can be placed in-line with the heat treatment process.

[0016] The invention as well as further details of the invention shall now be described with reference to the accompanying drawings.

Figure 1 shows an inventive device for cooling hot metal tubes.

Figure 2 shows an alternative arrangement of the inventive gas cooling device.

Figure 3 shows another embodiment of the gas blowing device.

[0017] Figure 1 illustrates the principle of the invention. The inventive method is preferably be used for cooling hot metal tubes 1 after a heat treatment process when they have a temperature of approximately 1000 °C.

[0018] From a storage tank 2 liquid nitrogen is trans-

ferred to a spiral pipeline 3. In the center of the spiral pipeline 3 there is a passage way where the hot tube 1 is transported through. Tube 1 is thus in indirect heat exchange with the liquid nitrogen.

[0019] There are two heat transfer mechanisms active: First, heat is transferred from the tube 1 to the spiral pipeline 3 by convection of the surrounding atmosphere. Second, due to the large temperature difference the spiral pipeline 3 and tube 1 there is a significant heat transfer by radiation.

[0020] After leaving spiral pipeline 3 the nitrogen partly evaporated, partly still in liquid phase, flows to an evaporator 4. In evaporator 4 the nitrogen is completely transferred into the gaseous phase. The resulting nitrogen gas is fed to a gas blowing device 5 via pipeline 6. There, the gas is distributed to several gas outlets 7 which are arranged around the passage way for tube 1. The nitrogen gas is blown out of the gas outlets 7 and directed to tube 1.

[0021] Gas outlets 7 are alternately disposed with gas inlets 8. The nitrogen which has been warmed up by tube 1 is sucked into the gas inlets 8 and withdrawn through line 9.

[0022] Figure 2 shows another arrangement of the gas blowing device 5 and the spiral pipeline 3. The gas blowing device 5 as well as the spiral pipeline 3 are in principle of the same design as shown in figure 1. However, the gas blowing device 5 is disposed within in the center part of the spiral pipeline 3.

[0023] The advantage of the arrangement according to figure 2 is that cooling is achieved within a shorter length and that the nitrogen gas blown out of gas outlets 7 is also cooled by the liquid nitrogen flowing in spiral pipeline 3. Further, the forced flow of the nitrogen gas out of gas outlets 7 and into gas inlets 8 also enhances the convective heat transfer to spiral pipeline 3. On the other hand, the radiative heat transfer is reduced since part of the spiral pipeline 3 is in the shape of the gas blowing device 5.

[0024] Figure 3 illustrates another embodiment of the inventive gas blowing device especially designed for cooling of wires. For sake of simplicity, the spiral pipeline 3 is not shown in this figure. The spiral pipeline 3 may be arranged as shown in figure 1 or in figure 2. Gas feed pipeline 6 for feeding the evaporated nitrogen gas to the gas outlets 12, 14 and pipeline 9 for withdrawing the warm nitrogen gas are also not shown in figure 3.

[0025] The gas blowing device comprises two wind boxes 10, 11 positioned opposite to each other on both sides of the passage way for wire 1. Both wind boxes 10, 11 comprise gas outlets 12, 14 and gas inlets 13, 15. The gas outlets 12 and the gas inlets 13 of wind box 10 are arranged alternately. The same applies for wind box 11. In addition, gas outlets 12 and gas outlets 14 of wind boxes 10 and 11 are positioned crosswise. That means, opposite gas outlet 12 of wind box 10 there is gas inlet 15 of wind box 11. Thus, the cold gas is blown out of gas outlet 12, flows around wire 1 is sucked into gas inlet 15. And gas which is directed to wire 1 via a gas outlet 14 of

wind box 11 is withdrawn through that gas inlet 13 of wind box 10 which is positioned directly opposite to gas outlet 14.

Claims

1. Method for cooling an object (1), in particular a metal wire or a metal tube, wherein a jet of a cold gas is blown onto said object (1), **characterized in that** said object (1) is cooled in indirect heat exchange (3) with a liquefied gas (2), said liquefied gas is then evaporated (4) to produce said cold gas and said cold gas is blown (5) onto said object (1).
2. Method according to claim 1 **characterized in that** liquid nitrogen is used as liquefied gas (2).
3. Device for cooling an object (1) comprising a passage way for said object (1) and a gas blowing device (5) with gas outlets (7) for directing a cold gas to said passage way, **characterized in that** a heat exchange passage (3) for a liquefied gas and means (4) for evaporating said liquefied gas in order to produce a cold gas are provided, wherein said heat exchange passage (3) for said liquefied gas is in heat exchange contact with said passage way for said object (1).
4. Device according to claim 3 **characterized in that** said heat exchange passage (3) for said liquefied gas is arranged around said gas blowing device (5).
5. Device according to any of claims 3 or 4 **characterized in that** said heat exchange passage (3) for said liquefied gas is designed as a spiral winded around said gas blowing device (5).
6. Device according to any of claims 3 to 4 **characterized in that** said gas blowing device (5) comprises gas inlets (8) directed to said passage way.
7. Device according to claim 6 **characterized in that** said gas inlets (8) and said gas outlets (7) are disposed on two opposite sides of said passage way and that each of said gas inlets (8) is positioned opposite one of said gas outlets (7).

Fig. 1

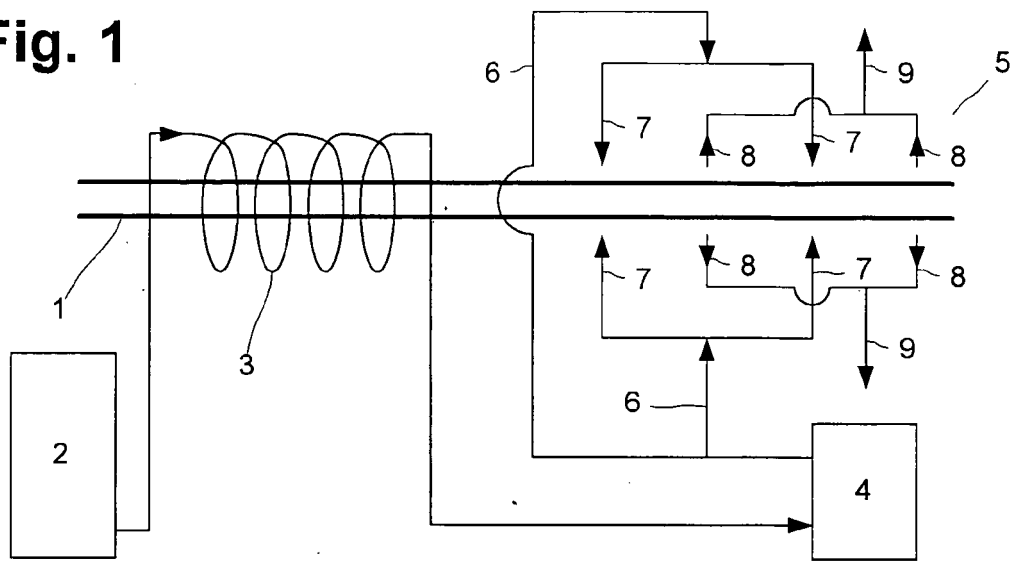


Fig. 2

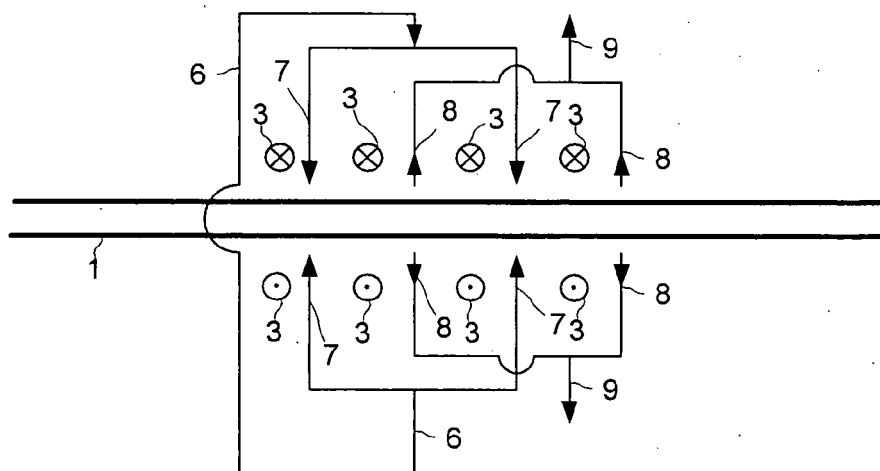
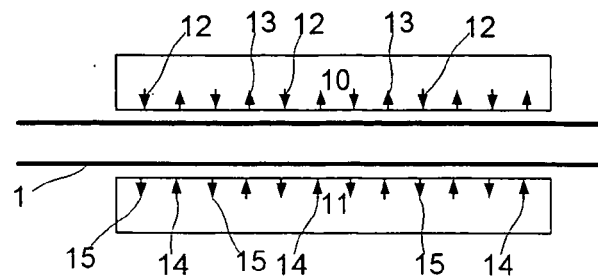


Fig. 3





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EUROPEAN SEARCH REPORT

Application Number
EP 06 00 7311

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	EP 1 621 829 A (LINDE AKTIENGESELLSCHAFT) 1 February 2006 (2006-02-01)	1-3,6,7	INV. C21D9/00
Y	* columns 2-7, paragraph 19; claims 1-12 *	4,5	F25D3/10
Y	PATENT ABSTRACTS OF JAPAN vol. 1997, no. 11, 28 November 1997 (1997-11-28) & JP 09 196528 A (HORIBA LTD), 31 July 1997 (1997-07-31) * abstract *	4,5	F25D29/00
Y	----- DATABASE WPI Section PQ, Week 199531 Derwent Publications Ltd., London, GB; Class Q41, AN 1995-239105 XP002386742 & RU 2 025 558 C1 (METEOR RES TECH ENTERP) 30 December 1994 (1994-12-30) * abstract *	4,5	
Y	----- DATABASE WPI Section Ch, Week 198344 Derwent Publications Ltd., London, GB; Class J08, AN 1983-806463 XP002386743 & SU 985 688 A (ODESSA REFRIG IND RES) 30 December 1982 (1982-12-30) * abstract *	4,5	TECHNICAL FIELDS SEARCHED (IPC)
A	----- FR 1 393 378 A (MINIKAY A.-G) 7 July 1965 (1965-07-07) * page 3, column 2 - page 4, column 2 *	1-7	C21D F25D
A	----- EP 0 576 134 A (THE BOC GROUP, INC) 29 December 1993 (1993-12-29) * column 4 - column 11 *	1-7	
	----- -/--		
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 22 June 2006	Examiner Chebeleu, A
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EUROPEAN SEARCH REPORT

Application Number
EP 06 00 7311

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 3 385 073 A (SNELLING CHARLES D) 28 May 1968 (1968-05-28) * column 6 - column 7 *	1-7	
A	WO 03/029720 A (THERMO KING CORPORATION; VIEGAS, HERMAN, H; SESHADRI, JAYARAM; NILSSON) 10 April 2003 (2003-04-10) * claims 1-16 *	1-7	
			TECHNICAL FIELDS SEARCHED (IPC)
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 22 June 2006	Examiner Chebeleu, A
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 06 00 7311

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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22-06-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1621829	A	01-02-2006	NONE
JP 09196528	A	31-07-1997	NONE
RU 2025558	C1	30-12-1994	NONE
SU 985688	A	30-12-1982	NONE
FR 1393378	A	07-07-1965	NONE
EP 0576134	A	29-12-1993	AT 155230 T 15-07-1997 AU 656679 B2 09-02-1995 AU 4002893 A 16-12-1993 CA 2095494 A1 11-12-1993 CN 1080389 A 05-01-1994 DE 69311978 D1 14-08-1997 DE 69311978 T2 06-11-1997 ES 2104058 T3 01-10-1997 JP 6174348 A 24-06-1994 PL 299245 A1 21-02-1994
US 3385073	A	28-05-1968	NONE
WO 03029720	A	10-04-2003	NONE

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- DE 102004054627 [0002]