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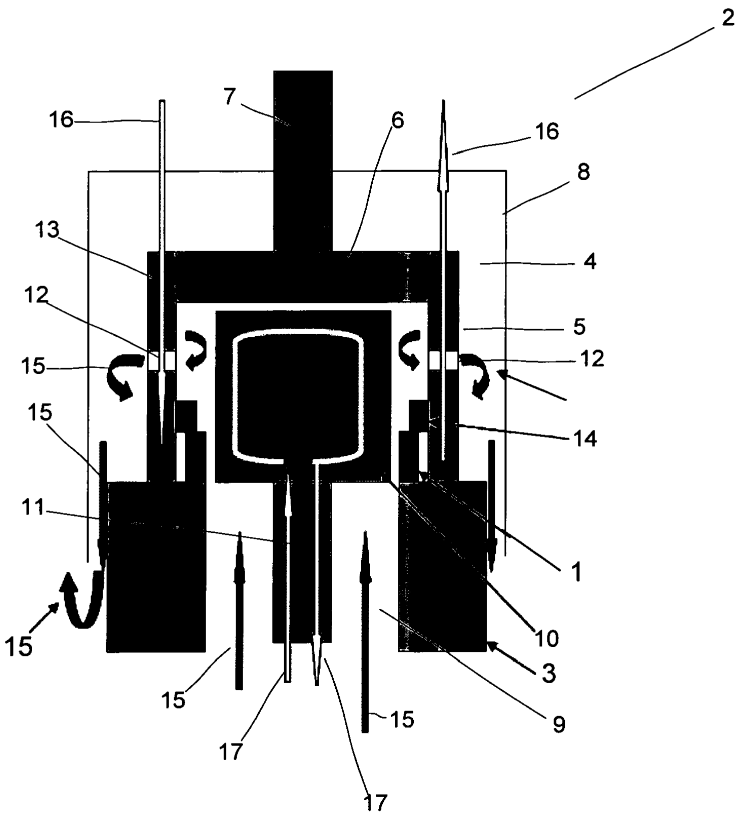
(54) Method for hardening of a metallic workpiece

(57) The invention relates to a method for hardening of a metallic workpiece (1), wherein the workpiece (1) is placed and fixed in a fixture (2) and wherein in the fixture (2) the workpiece (1) is cooled by a gaseous cooling medium (15)

Fig.



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Description

[0001] The invention relates to a method for hardening of a metallic workpiece, wherein the workpiece is placed and fixed in a fixture and wherein in the fixture the workpiece is cooled by a cooling medium.

[0002] During the heat treatment of metal workpieces, such as gear parts, unwanted deformations of the workpiece may occur due to thermal stresses and structural transformations. To eliminate these deformations often costly reworking of the workpiece is needed to meet the required tolerances.

[0003] It is therefore already known to cool down a hot heat-treated metal workpiece inside a fixture. The workpiece is placed in a fixture and inside the fixture it is subjected to a cooling medium. The fixture ensures that the workpiece retains the desired dimensions while it is cooled down. For example, a gear is attached to a fixture serving as a mandrel and cooled in that position. In this case the mandrel ensures that during the cooling process the inner diameter of the gear does not shrink too much.

[0004] In the prior art the cooling of the workpieces is carried out by direct heat exchange with oil. That technology, however, requires the use of quenching oils and the need for cleaning equipment in order to remove the oil from the quenched workpieces. In addition, the oil must be destructed when its material properties deteriorate and from time to time oil must be replenished due to product withdrawal.

[0005] Another disadvantage of oil cooling is the poor controllability of the cooling process. The cooling rate is difficult to adjust and in particular the cooling speed can hardly be varied during the cooling process.

[0006] An object of the present invention is therefore to provide an improved method for hardening of metallic workpieces.

[0007] This object is solved by a method for hardening of a metallic workpiece, wherein the workpiece is placed and fixed in a fixture and wherein in the fixture the workpiece is cooled by a cooling medium, which is characterized in that a gaseous cooling medium is used.

[0008] The invention relates to a method for cooling and hardening of a metallic workpiece, wherein the workpiece is cooled in a fixture which prevents or at least minimizes distortion or deformation of the workpiece such that the desired tolerances are met with regard to the dimensions of the workpiece. In the following such a method shall be called "fixture hardening". The invention especially relates to a method for cooling and fixture hardening of a workpiece made of steel.

[0009] The invention does not relate to methods for cooling and hardening of work pieces wherein the shape or particular dimensions of the workpiece are actively changed during the cooling process, for example by means of a press or another appropriate tool. In contrast, in fixture hardening the workpiece is positioned in and/or fixed to a fixture in order to avoid changes with respect to at least one dimension of the workpiece, preferably to some or even all dimensions, and/or to the shape of the workpiece. In contrast to a press, the fixture does not change the dimensions or shape of the workpiece. In general, during cooling of the workpiece thermal stresses and / or phase transformations shall not induce re-shaping or re-forming of the workpiece.

[0010] The term fixture shall mean a tool, which is used to hold the workpiece during the cooling process. The fixture is not used for active deformation of the workpiece, but only to prevent or minimize deformations of the workpiece, which are caused by temperature changes, thermal stresses and / or structural changes during the cooling process. The fixture could be a clamping fixture or a mandrel or a tool with segments and/or jaws that can be pressed against the workpiece to fix it.

[0011] Preferably, the fixture comprises two or more component parts which can be moved relative to each other in order to fix the workpiece. During the cooling process the component parts are held in fixed positions relative to each other. The fixture is not used to change the dimensions of the workpiece by compressive forces or other mechanical interaction.

[0012] According to the invention, the workpiece is positioned in a fixture and the workpiece is cooled in the fixture by means of a gaseous cooling medium. The use of a gaseous cooling medium allows a better and more specific control of the cooling process. The cooling rate can be varied by variation of one or more of the parameters flow rate, pressure and temperature of the gaseous cooling medium. For example, by increasing the flow rate or the pressure of the gaseous cooling medium the cooling rate can be increased.

[0013] The invention is particularly suitable for fixture hardening of one or more metal workpieces, which prior to being placed into the fixture have been heat treated.

[0014] It is advantageous to use nitrogen, argon, helium and/or hydrogen as cooling medium or any mixtures thereof. Gaseous nitrogen is used with particular advantage due to its viability and low price.

[0015] The cooling medium is preferably brought into direct heat exchange with the workpiece to be cooled. The gaseous cooling medium is supplied to the workpiece so that it comes in direct contact with one or more locations or regions on the workpiece. The heat transfer is primarily achieved by convection and heat flow.

[0016] It is also possible to cool the workpiece by indirect heat exchange with the gaseous cooling medium. In that case, the workpiece and the gaseous cooling medium are spatially separated, for example by a heat-permeable wall. For example, the fixture can be provided with cooling channels through which the gaseous cooling medium flows and thereby cools the fixture and indirectly the workpiece. The indirect heat exchange between the workpiece and the cooling medium is significantly slower than the direct heat exchange, in which the gaseous cooling medium flows against and/or around the workpiece. Therefore, direct heat exchange or a combination of direct heat exchange and indirect heat exchange is normally preferred.

[0017] In case a conventional fixture hardening tool shall be used for the inventive method, the conventional inlets for the cooling oil could be used for the gaseous cooling medium. However, it is preferred to design a new fixture hardening tool optimized for the flow conditions of the gaseous cooling medium.

[0018] It has also proven advantageous to cool the fixture by a second coolant, in addition to the cooling of the workpiece by means of the gaseous cooling medium wherein the gaseous cooling medium is used to cool the workpiece directly and/or indirectly. For this purpose the fixture may be provided with cooling channels or cooling fins. The second coolant may flow through, against and/or around the cooling channels or cooling fins such that there is a heat exchange between the fixture and the second coolant.

[0019] The second coolant may also be a gaseous medium, in particular also the same substance as the gaseous cooling medium, which according to the invention is used for cooling the workpiece. But preferably, the fixture is cooled by means of a liquid coolant, in particular by means of water or oil. In a preferred embodiment, water or oil is passed through cooling channels or spaces located in the fixture to cool the fixture. In addition, the workpiece, which is located in the fixture, is subjected to a flow of the gaseous cooling medium flowing against, around and/or through the workpiece.

[0020] Especially when solid workpieces are cooled relative large differences between the surface temperature of the workpiece and its core temperature inside the workpiece can occur. These temperature differences can cause thermal stress in the workpiece and lead to material fatigue. In a preferred embodiment, therefore, at least one of the parameters of pressure, flow, quantity or temperature of the gaseous cooling medium supplied to the workpiece and/or at least one of the parameters of pressure, flow, quantity or temperature of the second coolant is controlled, i.e. changed in a controlled manner during the cooling process.

[0021] The cooling effect and the cooling rate depend on the type of cooling medium, the flow of the cooling medium, that means the quantity of cooling medium supplied to the workpiece per unit time, its pressure and its temperature. Likewise, the cooling of the fixture is dependent on the type, quantity, pressure, flow and temperature of the second coolant. Preferably, therefore, one or more of these parameters such as pressure and/or flow and/or flow rate of the gaseous cooling medium and/or of the second coolant are controlled to affect the cooling process.

[0022] These parameters are preferably controlled and/or varied depending on the temperature of the workpiece. The temperature can be determined in one or more locations or regions on the workpiece either continuously during the cooling process or at - preferably regular - time intervals. The temperature may be measured by a thermometer or a temperature sensor or by measuring the heat radiation, for example by means of a pyrometer.

[0023] It is also possible to determine in advance the relationship between the cooling time, the workpiece temperature and one or more of the above-mentioned parameters of the gaseous cooling medium or of the second coolant. During fixture hardening this relationship is then used to control the inventive process. For example, after a certain cooling time which corresponds to a certain temperature decrease one or more of the parameters are changed to affect the cooling rate.

[0024] It has been shown that a particularly good and uniform metallic microstructure is achieved by reducing the cooling when the surface temperature of the workpiece deviates by less than a predetermined or preselected value from the martensite start temperature. The reduction of the cooling effect is particularly achieved in that at least one of the parameters of pressure, flow or quantity of the gaseous cooling medium supplied to the workpiece and/or at least one of the parameters of pressure, flow or quantity of the second coolant is reduced or in that the supply of gaseous cooling medium and/or the second coolant is interrupted for a certain period of time.

[0025] The term "martensite start temperature" shall mean the temperature at which the martensitic transformation begins. When a ferrous metal is cooled below the martensite start temperature, the austenite structure begins to transform into a martensitic structure. The martensite start temperature, abbreviated as Ms, depends not only on the basic metal but also on the alloying elements and their content. The martensite start temperature Ms is steel specific and the man skilled in the art can found them in special public available tables.

[0026] In a preferred embodiment, the cooling rate is reduced when the surface temperature of the workpiece deviates by less than a predetermined value from the martensite start temperature. At this time the core temperature is still significantly higher. By reducing the cooling rate the core temperature of the workpiece and its surface temperature are allowed to get equal or close to equal. In this way, thermal stresses inside the workpiece are removed and a more uniform transformation to martensite structure is achieved.

[0027] The cooling rate is preferably reduced when the surface temperature of the workpiece is between Ms and Ms50 (50% completion of martensite), that is in the range between the martensite start temperature and the temperature when the transformation to martensite structure has been completed to 50%. The following slow cooling shall be considerably slower than the original cooling rate. For example, a cooling rate less than 1°C per second has proven advantageous for the fatigue properties. The re-start of faster cooling is determined by other material properties but preferably the material is let to slow cool as long as possible (with respect to that enough martensite is formed, the right hardness is achieved etc). An actual halt at a specific temperature does not improve the fatigue if not followed by a slow cooling. The halt can be from 0 seconds up to 300 seconds depending on size and target.

[0028] The invention is particularly suitable for fixture hardening of ferrous metals, alloyed and unalloyed steels. The work pieces are preferably rotationally symmetrical components, components such as gears, crown wheels, sleeves, or gear parts, shafts, clutch components or bearing rings.

[0029] In one embodiment the workpiece is cooled at a cooling rate of more than 10 °C/s, preferably between 10 and 20 °C/s, when the surface temperature of the workpiece is above the martensite start temperature Ms.

[0030] At a surface temperature between Ms and Ms50 the cooling rate is preferably reduced or even stopped. In that phase the cooling rate is less than 5 °C/s, preferably less than 3 °C/s, more preferred less than 1 °C/s. It is also possible to first stop the cooling for a certain period of time, for example for a time period up to 300 seconds, followed by slow cooling at a cooling rate of less than 5 °C/s, less than 3 °C/s or less than 1 °C/s. Thereafter, when the surface temperature has reached a certain value or when the slow cooling has been carried out for a certain period of time, the cooling rate is preferably increased to 10 °C/s to 20 °C/s.

[0031] A preferred cooling process could comprise the following steps:

- The workpiece which for example has a temperature between 860 °C and 1050 °C is fast cooled at a cooling rate of more than 10 °C/s.
- When a preselected temperature between Ms and Ms50 has been reached the cooling is stopped for 0 to 300 seconds.
- Thereafter, the workpiece is cooled at a slow cooling rate of less than 5°C for a time interval of 60 seconds to 300 seconds.
- Finally, the workpiece is cooled at a cooling rate of more than 10 °C/s to the desired end temperature.

[0032] According to the invention the cooling is achieved by using a gaseous cooling medium. The flow rate of the gaseous cooling medium is preferably between 20 and 400 m^3/h. The pressure of the gaseous cooling medium is preferably close to atmospheric pressure due to the construction of today's fixture hardening equipment. But theoretically the total process time for cooling the workpiece can be shortened by increasing the pressure to a range inbetween 1 bar and 30bar.

[0033] The flow velocity of the gaseous cooling medium is preferably between 1 m/s and 50 m/s, more preferred between 1 and 20 m/s. It is also possible to use an impingement cooling process wherein the gaseous cooling medium is directed to the workpiece at gas velocities of more than 30 m/s up to 60 m/s.

[0034] In the following, the invention as well as preferred details of the invention will be described with respect to the attached drawing wherein

figure 1 shows an apparatus for the inventive fixture hardening process

[0035] A steel workpiece 1, for example a ring-like rotational symmetric gear component, has been carburized. Preferable conditions for carburization are a temperature between 900 °C and 1100 °C. Subsequently, the still hot workpiece 1 shall be fixture hardened, that is it shall be cooled down and thereby hardened while it is fixed in a fixture 2.

[0036] The fixture 2 is a rotational-symmetric tool comprising a component support 3 and an upper part 4. The component support 3 is provided with a central passage 9. The diameter of the central passage 9 is adapted to the inner diameter of the ring-like workpiece 1.

[0037] The upper part 4 comprises vertical cylindrical walls 5 covered by a top plate 6 and a piston 7 which allows to move and position the upper part 4 relative to the component support 3. Upper part 4 and component support 3 can be moved relative to each other along the symmetry axis of the fixture 2. The vertical cylindrical walls 5 are provided with openings 12.

[0038] A hood 8 is fixed to the piston 7 and encloses the upper part 4. The hood 8 has a cylindrical form with vertical side walls and is closed to the top.

[0039] A mandrel 10 can be moved through the central passage 9 into the hollow interior of the upper part 4. The outer diameter of the mandrel 10 matches the inner diameter of the workpiece 1. The mandrel 10 is provided with cooling channels 11. A supply of cooling water (not shown) is connected to the cooling channels 11 and allows to pass cooling water through the cooling channels 11 and to thereby cool the mandrel 10.

[0040] The upper part 4 is also provided with cooling channels 13 connected to a supply of cooling water (not shown). By passing cooling water through the cooling channels 13 it is possible to cool the upper part 4, too.

[0041] For fixture hardening the workpiece 1 is placed on the component support 3. The inner diameter of the workpiece 1 is equal to the diameter of the central passage 9 through the component support 3. The workpiece is fixed by a component holder 14. Mandrel 10 is moved through the central passage 9 and through the inner opening of the workpiece 1 into the hollow interior of the upper part 4. The outer diameter of the mandrel 10 and the inner diameter of the workpiece 1 are the same or at least nearly the same.

[0042] Then, gaseous nitrogen as cooling medium is supplied via the central passage 9 into the hollow interior of the upper part 4. The gaseous nitrogen passes the workpiece 1, leaves the interior of the upper part 4 via the openings 12, enters into the space between the upper part 4 and the hood 8 and finally leaves the hood 8 at its lower end.

[0043] The gaseous nitrogen flows around the workpiece 1 and thereby cools the workpiece 1 by direct heat exchange.

[0044] In addition cooling water is passed through cooling channels 11 in the mandrel 10 and through cooling channels 13 of the upper part 4. The cooling water 16, 17 cools down the mandrel 10 and the upper part 4 which in the case of the mandrel 10 are in direct contact with the workpiece 1 or in case of the upper part 4 are in indirect contact with the workpiece1 via component holders 14. Thus, the cooling water 16, 17 indirectly cools the workpiece 1 and boosts the cooling rate. This is in particular advantageous when thick and heavy workpieces are cooled.

[0045] In the beginning when the workpiece 1 is still hot with a temperature between for example 900 °C and 1100 °C, the gaseous nitrogen 15 is supplied to the fixture 2 and to the workpiece 1 at a pressure between 1 and 3 bar and a flow rate of for example 20 to 400 m^3/h. When the surface temperature of the workpiece 1 has been lowered to a predefined temperature between Ms and Ms50 the flow of gaseous nitrogen is reduced such that the cooling rate is less than 1°C / s. Thus, at or close to the Martensitic start temperature the cooling rate is decreased and the temperature of the inner core of the workpiece 1 and its surface temperature are allowed to approach each other. The time for entering and / or passing the Martensitic range increases which has been shown to increase the fatigue strength of the workpiece material. The cooling water 16, 17 can also be flow controlled.

[0046] It is also possible to first stop the cooling at the predefined temperature between Ms and Ms50 for a certain time, for example 50 seconds to 300 seconds, and then proceed with the slow cooling at a cooling rate of less than 1 °C/s.

[0047] The invention allows a controlled gaseous fixture hardening process by adopting the flow and / or pressure of the gaseous cooling medium with respect to the Martensitic start temperature of the workpiece material.

[0048] For example, a workpiece 1 made of steel is cooled by gaseous nitrogen as cooling medium at a pressure of 1 barg and a flow rate of 250 m^3/h for 25 seconds and by a flow of 1 m^3/h cooling water (as second coolant) for 25 seconds. This cooling step results in a workpiece having a surface temperature of 180°C. Then having reached this surface temperature the cooling is stopped for 30 seconds. Thereafter the cooling process is continued for 180 seconds by using a flow of 2.5 m^3/h for 60 seconds gaseous nitrogen at a pressure of 1 barg (no water cooling in this phase) until finish temperature 120°C is reached.

[0049] The invention has several advantages over the prior art:

- increased fatigue strength of the fixture hardened workpiece,
- reduced distortions
- provides dry clean workpieces
- elimination of the need for cooling oils
- no need to control the quality of the cooling oil
- no need to replenish withdrawn cooling oil
- no need to destruct used oil
- allows the customer to customize the cooling sequence to optimize fatigue properties
- allows the customer to customize the cooling sequence to optimize hardness
- allows the customer to customize the cooling sequence to optimize the surface structure

Claims

1. Method for hardening of a metallic workpiece (1), wherein the workpiece (1) is placed and fixed in a fixture (2) and wherein in the fixture (2) the workpiece (1) is cooled by a cooling medium (15), **characterized in that** a gaseous cooling medium (15) is used.

2. Method according to claim 1, **characterized in that** nitrogen, argon, helium and / or hydrogen are used as cooling medium (15).

3. Method according to claim 1 or 2, **characterized in that** prior to being placed into the fixture (2) the workpiece (1) is subjected to a heat treatment.

4. Method according to any of claims 1 to 3, **characterized in that** the workpiece (1) is cooled by direct heat exchange with the gaseous cooling medium (15).

5. Method according to any of claims 1 to 4, **characterized in that** the fixture (2) is cooled by a second coolant (16, 17).

6. Method of claim 5, **characterized in that** the fixture (2) is cooled with water or oil.

7. Method according to any of claims 1 to 6, **characterized in that** at least one of the parameters of pressure, flow, quantity or temperature of the gaseous cooling medium (15) and / or at least one of the parameters of pressure, flow, quantity or temperature of the second coolant (16, 17) is changed.

8. Method according to claim 8, **characterized in that** at least one of the parameters of pressure, flow, quantity or temperature of the gaseous cooling medium (15) and / or at least one of the parameters of pressure, flow, quantity or temperature of the second coolant (16, 17) is controlled depending on the temperature of the workpiece (1).

9. Method according to claim 8, wherein said at least one of the parameters of pressure, flow or quantity of the gaseous cooling medium (15) and / or at least one of the parameters of pressure, flow or quantity of the second coolant (16, 17) is reduced when the surface temperature of the workpiece (1) differs from

the martensite start temperature by less than a predetermined value.

10. Method according to claim 9 **characterized in that** said at least one of the parameters of pressure, flow or quantity of the gaseous cooling medium (15) and / or at least one of the parameters of pressure, flow or quantity of the second coolant (16, 17) is reduced when the surface temperature of the workpiece (1) is between the martensite start temperature Ms of the workpiece material and the temperature when the transformation of the workpiece material to martensite structure has been completed to 50% (Ms50).

11. Method according to any of claims 9 or 10, wherein said at least one of the parameters of pressure, flow or quantity of the gaseous cooling medium (15) and / or at least one of the parameters of pressure, flow or quantity of the second coolant (16, 17) is reduced for a time period between 60 and 300 seconds.

12. Method according to claim 11 **characterized in that** the cooling rate is reduced to less than 5 °C/s, preferably less than 3 °C/s, more preferred less than 1 °C/s.

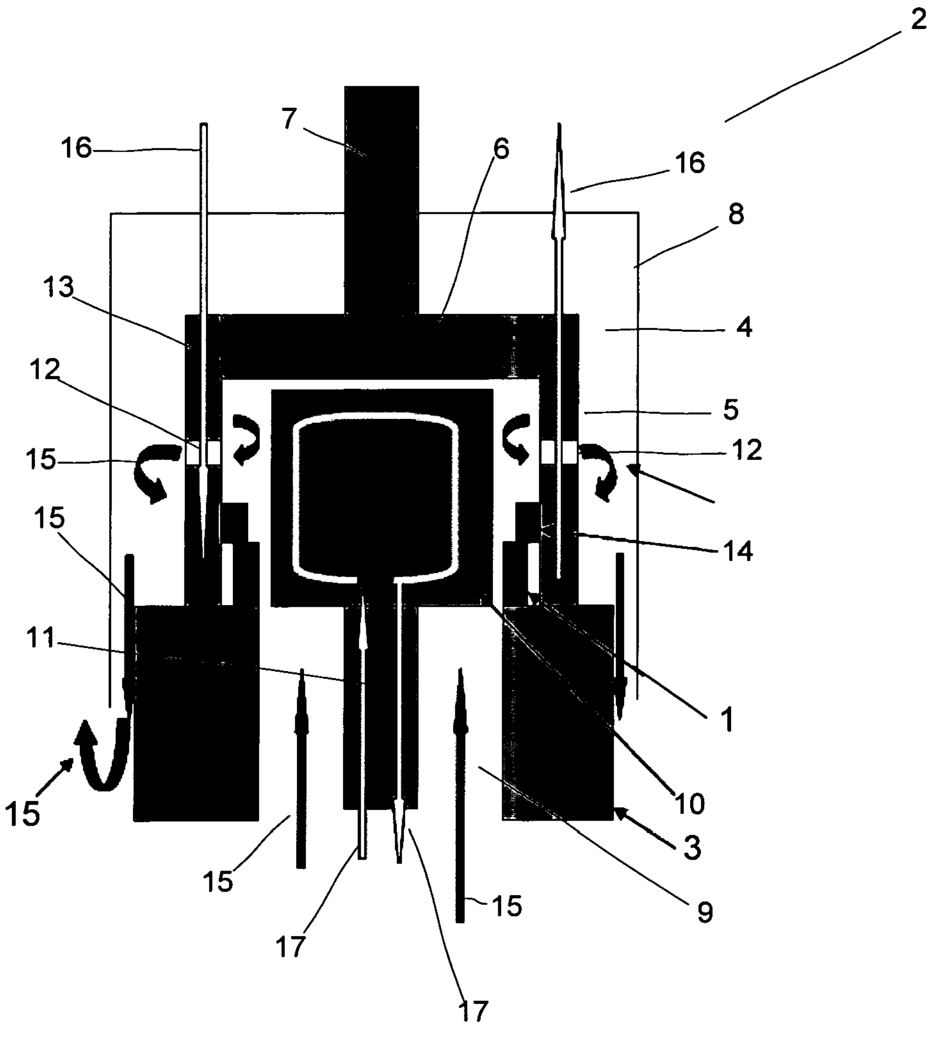
13. Method according to any of claims 1 to 12 **characterized in that** the workpiece (1) is cooled at a cooling rate between 10 and 20 °C / s when the workpiece temperature is above the martensite start temperature Ms.

14. Method according to any of claims 1 to 13, **characterized in that** the cooling of the work piece (1) comprises the following steps:

- fast cooling at a cooling rate of more than 10 °C/s,
- no cooling or slow cooling at a cooling rate less than 5°C for a time interval of 60 seconds to 300 seconds,
- fast cooling at a cooling rate of more than 10 °C/s.

15. Method according to any of claims 1 to 14, **characterized in that** the flow rate of the gaseous cooling medium (15) is between 20 and 400 m^3/h.

Fig.



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EUROPEAN SEARCH REPORT

Application Number
EP 11 00 9827

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 Y	DE 33 07 041 A1 (JENNY PRESSEN AG [CH]) 30 May 1984 (1984-05-30) * page 10, paragraph 3 - page 12, paragraph 5; claims 1-29; figures 1,2,4 * * page 13, paragraph 2 * * page 14, paragraph 4 - page 15, paragraph 2 *	1-9 10-15	INV. C21D1/613 C21D1/673 C21D9/00 C21D9/28 C21D9/32 C21D9/34 C21D1/19
Y	WO 2006/042538 A1 (ALD VACUUM TECHN GMBH [DE]; HEUER VOLKER [DE]; LOESER KLAUS [DE]) 27 April 2006 (2006-04-27) * page 7, paragraph 2 - page 8, paragraph 2; figure 3 *	10-15	
X	US 5 452 882 A (WUNNING JOACHIM [DE]) 26 September 1995 (1995-09-26) * column 11, line 38 - column 13, line 38 *	1-4, 13-15	
X A	WO 99/02744 A1 (SKF IND TRADING & DEV [NL]; KAPAAN HENDRIKUS JAN [NL]; NOORLANDER CORN) 21 January 1999 (1999-01-21) * claims 1,2; figures 1-4 *	1 2-4	TECHNICAL FIELDS SEARCHED (IPC) C21D
A	EP 0 869 189 A1 (LINDE AG [DE]) 7 October 1998 (1998-10-07) * claims 1-5 *	1,2,15	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	8 June 2012	Lilimpakis, Emmanuel

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CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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08-06-2012

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 3307041	A1	30-05-1984	NONE	
WO 2006042538	A1	27-04-2006	DE 102004051546 A1	04-05-2006
			DE 112005002656 A5	09-08-2007
			WO 2006042538 A1	27-04-2006
US 5452882	A	26-09-1995	NONE	
WO 9902744	A1	21-01-1999	AU 8465098 A	08-02-1999
			CN 1262709 A	09-08-2000
			DE 69808916 D1	28-11-2002
			DE 69808916 T2	11-09-2003
			EP 0996751 A1	03-05-2000
			JP 2001509547 A	24-07-2001
			NL 1006539 C2	12-01-1999
			US 6585834 B1	01-07-2003
			WO 9902744 A1	21-01-1999
EP 0869189	A1	07-10-1998	DE 19709957 A1	17-09-1998
			EP 0869189 A1	07-10-1998

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