METHOD FOR COOLING METAL PARTS HAVING UNDERGONE A NITRIDING/NITROCARBURISING TREATMENT IN A MOLTEN SALT BATH, UNIT FOR IMPLEMENTING SAID METHOD AND THE TREATED METAL PARTS

Cross Reference to Relate Applications

This application is a national stage filing under section 371 of International Application No. PCT/FR2012/051651 filed on July 12, 2012, and published in French on January 24, 2013 as WO 2013/011228 A1 and claims priority of French application No. 1156459 filed on July 15, 2011, the entire disclosure of these applications being hereby incorporated herein by reference.

Background Art

The invention relates to a method and a facility for cooling metal parts that have been subjected to a molten salt bath nitriding/nitrocarburizing treatment. The invention also relates to the parts so treated.

The use of methods that employ a thermochemical diffusion of nitrogen by nitriding or nitrocarburizing in baths of molten salts to reduce the coefficient of friction and improve the adhesive and abrasive wear resistance of metal parts is fully understood by those skilled in the art. In the main, these salt baths generally comprise cyanate and alkaline carbonate. When the nitriding temperature is reached, the alkaline cyanate releases nitrogen and carbon which diffuse over the surface of the part. The treatment times are generally between 20 and 180 mn at temperatures of between 400 and 700°C. These industrially used processes are known for example under the brand names SURSULF or TENIFER.

It will be remembered that a nitriding/nitrocarburizing treatment process comprises the following main steps:

- degreasing the parts,
- preheating,
- nitrocarburizing treatment,
- cooling,
- rinsing,
- drying,

treatment that has a sufficiently high degree of cleanness and is of good enough appearance, in other words, with no trace of oxidation on any one portion or on any of the parts treated.

It will also be understood that it is not possible, especially where an industrial treatment is concerned, to obtain parts that are sufficiently ductile while at the same time showing no trace of oxidation.

The purpose set by the invention is to overcome these drawbacks in a straightforward, safe, efficient and rational manner.

The problem the invention therefore sets out to resolve is that of ensuring, in respect of an industrial treatment of metal parts that have been subjected to a molten salt bath nitriding/nitrocarburizing treatment, that there are no traces of oxidation-corrosion, so that the ductility thereof can be improved.

Brief Summary of the Invention

To resolve this problem, a method has been devised and perfected for cooling metal parts that have been subjected to a molten salt bath nitriding/nitrocarburizing treatment, according to which:

- before the end of said treatment, a chamber, arranged so that the oxygen contained in said enclosure can be discharged in order to create an inert atmosphere, is filled with refrigerant, in liquid form and with a strong capacity for volume expansion as it evaporates,
- all the treated parts are transferred into the chamber,
- the chamber is closed,
- the parts are left in the chamber for a preset length of time to reach a temperature at which the salt congeals and forms a protective barrier,
- the parts are removed and subjected to a rinsing operation.

To advantage, the refrigerant is liquid nitrogen which will evaporate very quickly due to the heat of the bath and of the parts. Said evaporation will produce a volume of gas about 630 times greater, which will very quickly discharge the oxygen found inside the chamber. The result is a cooling that is slow in the metallurgical sense of the term, but fast enough to be compatible with an industrial process, of the parts in an inert atmosphere, ensuring that they have a degree of ductility with no risk of oxidation spots appearing and consequently no danger of subsequent dust emissions.

According to another feature, the chamber is filled with liquid nitrogen, 2 to 3 ~~mm~~ minutes before the end of the nitriding/nitrocarburizing treatment. At the end of the nitriding/nitrocarburizing treatment the parts are transferred vertically to the chamber filled with liquid nitrogen at a minimum rate of 6 m/mn. After cooling to a temperature of about 350°C, they are rinsed in water at a temperature of between 40 and 50°C, and then in water at a temperature of between 15 and 25°C.

To implement the method, the cooling chamber is placed in direct relation with the nitriding/nitrocarburizing station while being secured to a transfer carriage for a quick transfer of all the parts into said chamber.

To resolve the problem posed of obtaining a slow cooling of the parts and an extremely rapid nitrogen saturation of the inside of the chamber, without having to resort to pre-pumping systems to drive out the air initially present, the chamber consists of a double-walled bell into which the liquid nitrogen is injected, said double wall having arrangements for diffusing the nitrogen inside the bell.

According to other features, the base of the bell engages with means capable of giving free access to the inside of said bell for the transfer of parts, and of closing this access during the cooling phase. The means consist of doors secured to one portion of the treatment station.

The invention also relates to the parts that have been subjected to a molten salt bath nitriding/nitrocarburizing treatment, according to the features of the method claimed. More generally, the invention relates to metal parts in respect of which no oxidation spots can be seen and nitride precipitate is present in the diffusion zone

Brief Description of the Drawing Figures

The invention is disclosed hereinafter in further detail with the help of the appended drawings wherein:

- Figure 1 is a diagrammatic cross-section view of the bell-shaped chamber according to the features of the invention.
- Figures 2, 3 and 4 are diagrammatic views showing main phases of the treatment method according to the features of the invention.
- Figures 5, 6, 7, 8 and 9 show a sample of parts after a 60-minute treatment in a SURSULF nitrocarburizing bath (CN-: 4.15%; CNO- 30.5 %) at 580°C and cooled according to the prior art and in different conditions (figures 5, 6, 7 and 8) and according to the invention, i.e. in liquid nitrogen (figure 9); with each sample is associated the corresponding micro-section.

Detailed Description

The facility for the molten salt bath nitriding/nitrocarburizing of metal parts is not described in detail since it is fully understood by those skilled in the art, even though able to be found in various alternative implementations.

C L A I M S

-1- A ~~M~~method of cooling metal parts that have been subjected to a molten salt bath nitriding/nitrocarburizing treatment in a treatment station, ~~characterized in that~~comprising:

- Arranging a cooling chamber in direct overlying relation with the treatment station,
- before ~~the~~ an end of said treatment, filling ~~a~~ the cooling chamber ~~(1)~~, ~~arranged so that the oxygen contained in said chamber can be discharged in order~~ with refrigerant in liquid form, volume expansion as the refrigerant evaporates discharging oxygen from the cooling chamber to create an inert atmosphere within the cooling chamber, ~~is filled with refrigerant in liquid form and with a strong capacity for volume expansion as it evaporates,~~
- transferring vertically all the treated parts from the treatment station directly into the inert atmosphere within ~~are transferred into~~ the cooling chamber ~~(1)~~,
- ~~the chamber is closed~~ closing the chamber~~(1)~~,
- leaving the parts ~~are left~~ in the chamber for a preset length of time to reach a temperature at which ~~the~~ salt congeals and forms a protective barrier, and
- ~~the~~ removing the parts ~~are removed~~ from the chamber and then subject~~inged~~ the parts to a rinsing operation, whereby the cooling method results in parts exhibiting no trace of surface oxidation.

-2- The ~~M~~method as claimed in claim 1, ~~characterized~~ wherein ~~that~~ the refrigerant ~~is~~ comprises liquid nitrogen.

-3- The ~~M~~method as claimed in claim 2, ~~characterized~~ wherein ~~that~~ the filling the chamber ~~is~~ comprises fill~~ing~~ed with liquid nitrogen, 2 to 3 ~~mm~~ minutes before the end of the nitriding/nitrocarburizing treatment.

-4- The ~~M~~method as claimed in claim 2, ~~characterized~~ wherein ~~that~~ the parts are transferred from the chamber filled with liquid nitrogen at a minimum rate of 6 m/~~mn~~minute.

-5- The ~~M~~method as claimed in ~~any one of claims 1-4~~claim 1, ~~characterized~~ wherein ~~that~~ the rinsing is performed in water at a temperature of between 40 and 50°C, and then in water at a temperature of about 20°C.

-6- A Ffacility for implementing the method as claimed in any one of claims claim 1 5 and, comprising a molten salt bath nitriding/nitrocarburizing treatment station for the treatment of a set of parts characterized in that and a cooling chamber (1) is placed in direct overlying relation with the nitriding/nitrocarburizing station while being secured to a transfer carriage for a quick direct vertical transfer of all the parts into said chamber.

-7- The Ffacility as claimed in claim 6, characterized wherein that the chamber consists of comprises a double-walled bell with a double-wall(1a) into which liquid nitrogen is injected, said double wall (1a) having arrangements for diffusing the nitrogen inside the bell.

-8- The Ffacility as claimed in claim 7, characterized wherein that the a base of the bell engages (1) with means capable of for giving free access to the an inside of said bell for the direct vertical transfer of the set of parts into the cooling chamber, and of for closing this said access during the a cooling phase.

-9- The Ffacility as claimed in claim 8, characterized wherein that the means consist comprises of doors (3) and (4) secured to one portion of the treatment station.

-10- Metal parts treated according to the specified method as claimed in any one of claims 1 5 claim 1.