United States Patent [19]
Gierek et al.
[11] 3,922,211
[45] Nov. 25, 1975

[54] METHOD FOR IMPROVING ABRASION RESISTANCE AND FOR REDUCING FRICTION OF SURFACES RUBBING ONE AGAINST ANOTHER IN MACHINERY

[75] Inventors: **Adam Gierek**, Katowice; **Franciszek Binczyk**, Siemianowice Slaskie; **Andrzej Kowalski**, Katowice, all of Poland

[73] Assignee: **Politechnika Slaska im. Wincentego Pstrowskiego**, Gliwice, Poland

[22] Filed: **Oct. 16, 1974**

[21] Appl. No.: **515,683**

[52] **U.S. Cl.** .... **204/140;** 204/145 F
[51] **Int. Cl.**[2] **C23B 1/00**
[58] **Field of Search** .... 204/140, 144.5, 145 F

[56] **References Cited**

UNITED STATES PATENTS

3,293,159	12/1966	Mekjean et al.	204/145 F
3,591,472	7/1971	Amsallem	204/140
3,666,667	5/1972	Wieczorek	204/145 R
3,796,645	3/1974	Fujita et al.	204/145 R

Primary Examiner—T. M. Tufariello
Attorney, Agent, or Firm—Haseltine, Lake & Waters

[57] **ABSTRACT**

A process for improving abrasion resistance and reducing friction of a ferrous metal surface rubbing against another such surface in machinery, comprising submerging the surface in a bath of molten salt containing a sulfur compound and subjecting the surface to an electrolytic treatment with electric current of periodically reversing polarity, said surface forming an electrode which is positively polarized for a period of 2 to 20 times longer than the period of its negative polarization, the other electrode being a steel crucible or a steel electrode similar in shape to the shape of the surface to be treated, the process in the latter case taking place in a ceramic crucible. The process is conducted in a molten salt bath containing: 68 to 90 percent by weight of potassium rhodanate, 5 to 28 percent by weight of sodium rhodanate, 2 to 5 percent by weight of sodium thiosulphate or 2 to 5 percent by weight of sodium sulphide.

9 Claims, No Drawings

METHOD FOR IMPROVING ABRASION RESISTANCE AND FOR REDUCING FRICTION OF SURFACES RUBBING ONE AGAINST ANOTHER IN MACHINERY

The invention relates to a method for improving abrasion resistance and for reducing friction between steel and iron surfaces rubbing against one another in machinery.

Known treatments for improving abrasion resistance of alloy steel products include surface hardening by nitriding, carbonizing, nitriding and carbonizing, chrome hardening, boronizing, etc., while for reducing friction, nitriding and sulphur treatment, or sulphur treatment alone is used. The presently known and used methods of treatment are applied at high temperatures of 550° to 1,000°C for 2 to 10 hours, and thus they require that furnaces in which the treatment is applied be constructed of suitable materials, these materials being, on the one hand, resistant to high temperatures (e.g. in the case of carbonizing, chrome hardening, nitriding and carbonizing), and having, on the other hand, a high resistance to the effect of molten salts at high temperatures (e.g. in the case of boronizing, cyanide treatment, nitriding and sulphur treatment). The materials used for the components of furnaces in which the above mentioned methods of treatment are applied are usually high-alloy cast steels and irons. Furthermore, the above mentioned processes require that an accessory system for controlled atmosphere, or a system for generating of vacuum (e.g. for chrome hardening) has to be used.

A thermochemical treatment for improvement of abrasion resistance and for the reduction, at the same time, of the coefficient of friction is the nitriding and sulphur treatment applied from a liquid, solid or gas phase. Most commonly used is a nitriding and sulphur treatment applied from a liquid or from a gas phase.

One liquid phase nitriding method consisting in soaking ferrous alloy products in a bath consisting of 50 to 95 percent of NaCN cyaniding salts, 5 to 10 percent of a sulphur treatment salt usually in the form of sodium or potassium sulphide, and 5 to 10 percent of diluting salts usually in the form of chlorides and carbonates. This treatment is applied at the temperature of 550° to 600° for 0.5 to 4 hours depending on the size of the treated elements. The cyanide salts used in this process are highly toxic and great precautions are therefore required in the process. Another known method consists in sulphur treatment of ferrous alloy products by electrolysis in molten salts containing sulphur compounds in the form of approximately 95 percent of a mixture of sodium and potassium rhodanates and 1.0 to 5 percent of added cyanide salts. Cyanide salts are added in order to retain a constant composition of the bath during the process.

The process takes place at a current density of approximately 3.2 A/sq. decimeter at a temperature of 200°C, and its duration is about 10 minutes. The objects treated are connected to the positive pole, the cathode being the metal crucible. This method is also very hazardous because of the presence of cyanide salts.

The aim of the present invention is to improve abrasion resistance of ferrous alloy products, particularly of cast iron, steel and cast steel products, and to prevent their scuffing in dry and technical friction.

This aim has been attained by forming a layer of sulphides (mainly in the form of FeS) on the surface of the threated object, said layer being obtained by electrolysis of molten salts containing a sulphur compound, said electrolysis using a periodically reversing current, namely a current periodically changing its polarity due to the use of a time switch which reverses the polarity of the current at predetermined intervals.

For surface sulphur treatment the objects are submerged in the salt bath and are connected to a pole of alternating polarity whose period of positive polarity is two to 20 times longer in time than the period of negative polarity. The time of positive polarity is 10 to 40 seconds, and that of negative polarity is 2 to 5 seconds. The other pole is a steel crucible or a steel electrode, the shape of the electrode being complementary to the shape of the surface treated (e.g. if treated object is cylindrical, the electrode is also cylindrical). When a shaped electrode is used the process may take place in a ceramic crucible. The distance between the electrodes should be 3 to 15 centimeters. By application of reversing current the layer of sulphides is uniformly applied because the concentration of respective ions at the individual electrodes is compensated. In this process the reversing current plays a similar role to that of the cyanide salts used in the previously described method of sulphur treatment by electrolysis, thus eliminating the risk due to the highly toxic cyanide salts used in the prior art process.

The process in accordance with the invention is conducted in salt baths containing 68 to 90 percent by weight of potassium rhodanate, 5 to 28 percent by weight of sodium rhodanate and 2 to 5 percent by weight of sodium thiosulphate, or 2 to 5 percent by weight of sodium sulphide.

The electrolysis is carried out in a furnace equipped with a ventilation system providing a uniform temperature around the crucible. The process is conducted for 5 to 10 minutes at a temperature of 200° to 250°C and at a current density of 0.5 to 5.0 A/sq. decimeter; for ferrous alloy products of ferritic structure a current having a 0.5 to 1.5 A/sq. decimeter density is used, and for those of pearlitic structure the density of current is 1.5 to 5 A/sq. decimeter. If currents of higher densities are used, then the reduction in the mass of the treated products caused by dissolving in sodium proceeds much faster than the gain in the mass from the growing layer of sulphides. Due to the fact that this novel thermochemical treatment takes place at a relatively low temperature, quenched or toughened surfaces may be also subjected to it without the risk of affecting their structure or strength. This is an important advantage of the method. Another advantage of this novel process is that the highly toxic cyanide salts are eliminated. A considerably reduced time is required for the treatment, namely from the approximately 1 to 2 hours required for sulphur treatment by immersion to approximately 8 minutes required for treatment in accordance with the process of this invention. This results in considerable saving in electric power.

The following examples illustrate the practice of this invention without limiting its scope.

Example I.

Composition of salt bath:	
potassium rhodanate (KSCN)	80 percent
sodium rhodanate (NaSCN)	15 percent
sodium thiosulphate ($Na_2S_2O_3$)	5 percent

-continued

Salt bath temperature	220°C
Process duration time	10 minutes
Current density	0.5 A/sq. decimeter
Negative polarizing time	2 sec.
Positive polarizing time	30 sec.
Example II.	
Composition of salt bath:	
potassium rhodanate	90 percent
sodium sulphide	5 percent
sodium rhodanate	5 percent
Salt bath temperature	200°C
Process duration time	7 minutes
Current density	2.0 A/sq. decimeter
Negative polarizing time	4 sec.
Positive polarizing time	25 sec.
Example III.	
Composition of salt bath:	
potassium rhodanate	68 percent
sodium rhodanate	28 percent
sodium sulphide	2 percent
sodium thiosulphate	2 percent
Salt bath temperature	250°C
Current density	5 A/sq. decimeter
Process duration time	5 minutes
Negative polarizing time	5 sec.
Positive polarizing time	40 sec.

We claim:

1. A process for improving abrasion resistance and reducing friction of a ferrous metal surface against another such surface comprising submerging said surface in a bath of molten salts containing a sulfur compound and subjecting said surface to an electrolytic treatment with electric current of periodically reversing polarity said surface comprising one of two electrodes and

being positively polarized for a period from two to 20 times as long as it is negatively polarized.

2. A process according to claim 1 wherein the other of said two electrodes is of complementary shape to the surface to be treated.

3. A process according to claim 1 wherein the period of positive polarity of the surface to be treated is from 10 to 40 seconds and the period of negative polarity is 2 to 5 seconds.

4. A process according to claim 1 wherein said bath of molten salts comprises 68 to 98 percent by weight of potassium rhodonate, 5 to 28 percent by weight of sodium rhodonate, and 2 to 5 percent by weight of a sulfur-containing salt selected from the group consisting of sodium thiosulfate and sodium sulphide.

5. A process according to claim 1 wherein the current density is 0.5 to 5.0A/sq. decimeter.

6. A process according to claim 1 wherein said ferrous metal surface has a ferritic structure and the current density of said electrolytic treatment is 0.5 to 1.5 A/sq. decimeter.

7. A process according to claim 1 wherein said ferrous metal surface has a pearlitic structure and the current density of said electrolytic treatment is 1.5 to 5.0 A/sq. decimeter.

8. A process according to claim 1 wherein the temperature of said bath of molten salts is 200°C to 250°C.

9. A process according to claim 1 wherein the duration of said electrolytic treatment is from 5 to 10 minutes.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,922,211 Dated November 25, 1975

Inventor(s) Adam Gierek et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In column 1, between lines 9 and 10 insert:

"Claims priority, application Poland, October 20, 1973, P 166,016"

Signed and Sealed this

sixth **Day of** *April 1976*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks