United States Patent Office 2,793,147 Patented May 21, 1957



2,793,147

# SALT BATH FOR HEAT TREATING CARBON ALLOYED STEEL

Albert Erdmann, Berlin-Neukolln, and Elli Boelke, Berlin-Tempelhof, Germany, assignors to Albert Erdmann & Co., Berlin-Neukolln, Germany

No Drawing. Application October 7, 1954, Serial No. 461,042

6 Claims. (Cl. 148—15)

This invention relates to a salt bath for heat treatment of alloyed high-carbon steel, such as, high-speed and tool steels, the composition of such salt bath comprising an inert base salt and small quantities of a metal oxide, an oxide dissolving substance and a sulfite, the said salts being commercially pure.

The inert base salt consists of barium chloride or of barium chloride combined with one or more of the following: sodium chloride, potassium chloride, sodium carbonate or potassium carbonate. The above mentioned metal oxides are e. g. aluminum oxide, calcium oxide, magnesium oxide. The solubilization of the latter is favored by oxide-dissolving agents, such as, borax, fluorine compounds or pyrophosphates.

It is advantageous to employ a combination of one part of metal oxide with two to three parts of oxide-dissolving substances, the exact quantities depending on the molar weight of these inorganic compounds.

It has now been found that a salt bath with a relatively low content of metal oxides, e. g. below one percent and corresponding quantities of oxide-dissolving agents provide essential advantages over salt baths ordinarily used.

The small quantities of the above additives dissolve completely in the base salt and slags will not separate out of the melts, which may react unfavorably on the wall covering of the bath and, if existing, on the electrodes too. Furthermore, the fusion of the ingredients of the salt bath is accelerated.

Moreover, it has been discovered that the action of such salt baths may be substantially improved by adding small quantities of inorganic sulfites, such as, sodium sulfite or barium sulfite to the salt mixture. The harmful oxygen seems to be neutralized in this manner, so that it does not cause decarbonization of the surface to be hardened.

The sulfites are superior to the ordinarily used nitrites. The nitrites are suitable in quenching baths, to prevent a reaction between a cyanide containing heating bath and a niter quenching bath. The nitrites, however, do not prevent a decarbonization at the temperatures used according to the invention.

Niter baths are only suitable at temperatures between 150 and 500° C. However, salt baths according to the invention may be used at temperatures of about 930 to 1350° C., and the nitrites become ineffective at such temperatures.

It is surprising that sulfites when combined with metal oxides and oxide-dissolving materials are effective as oxygen inhibitors even at those temperatures at which sulfites alone decompose. This may be proved by the fact that at the used temperatures no sulfur dioxide is developed in the bath, as would be expected in case of decomposition of the sulfite.

The added quantity of sulfite is small, usually only up to a few percent of the salt bath mixture. It corresponds to the content of metal oxides and oxide-dissolving agents in the bath. The quantity of added sulfite increases in relation to the other additives, but does not rise in the same rate as those do. 0.01 to 10%, preferably 0.05 to 0.5% sulfites are usually sufficient, depending on the different molecular weights of these compounds.



The sulfites maintain their full activity during the normal period of use of the bath and it is, therefore, not necessary to add fresh salts or sulfites.

The salt baths according to the invention render it possible to impart great hardness even to articles made from poor steel. To prevent contamination by harmful other salts and to keep the composition of the bath constant, it is advisable to use a preheating bath of the following composition:

| | Percent |
|---|---|
| Barium chloride | 60.0 |
| Sodium chloride | 33.6 |
| Borax | 6.0 |
| Magnesium oxide | 0.4 |

The preheating bath may be employed at temperatures from 680 to 1100° C. It is useful likewise for decarbonization-free heating of tool steel.

Naturally other preheating baths may be used in connection with the salt bath according to this invention.

The following examples will illustrate the practice of the invention.

*Example 1*

A salt mixture prepared of:

| | Percent |
|---|---|
| Barium chloride | 98.6 |
| Magnesium oxide | 0.45 |
| Borax | 0.8 |
| Sodium sulfite | 0.15 |

*Example 2*

A salt mixture prepared of:

| | Percent |
|---|---|
| Barium chloride | 96.0 |
| Aluminium oxide | 1.2 |
| Sodium fluoride | 2.5 |
| Barium sulfite | 0.3 |

*Example 3*

A salt mixture prepared of:

| | Percent |
|---|---|
| Barium chloride | 92.0 |
| Sodium carbonate | 2.5 |
| Potassium carbonate | 1.5 |
| Magnesium oxide | 1.2 |
| Borax | 2.5 |
| Sodium sulfite | 0.3 |

*Example 4*

A salt mixture prepared of:

| | Percent |
|---|---|
| Barium chloride | 93.6 |
| Sodium chloride | 3.5 |
| Potassium chloride | 1.5 |
| Aluminium oxide | 0.45 |
| Sodium pyrophosphate | 0.8 |
| Barium sulfite | 0.15 |

*Example 5*

A salt mixture prepared of:

| | Percent |
|---|---|
| Barium chloride | 86.7 |
| Sodium chloride | 3.5 |
| Potassium chloride | 1.5 |
| Magnesium oxide | 2.5 |
| Borax | 5.0 |
| Sodium sulfite | 0.8 |

*Example 6*

A heat treatment process may be carried out as follows: A workpiece of high-speed steel is as usual, preheated

in a muffle furnace in several steps or favorably in a preheating salt bath of the described composition to a temperature of 700 to 800° C. After removing the workpiece from the bath it is put in a heat treatment salt bath, of a composition according to the invention, while avoiding any considerable cooling. In the main bath it is heated to 1180–1320° C. as the respective quality of steel requires, the attained temperature being recognizable, as usual, by the color of the workpiece. An electric furnace or other suitable device may be employed for the process.

*Example 7*

A highly alloyed chromium steel may be treated in the same manner as described in Example 6, but in this case the preheating is carried out in one step to temperatures of 700 to 800° C. and in the main bath, the workpiece is heated to temperatures of 920–980° C.

Although the invention has been described in relation to preferred embodiments and certain variations, numerous other modifications will be apparent to those skilled in the art. Hence it is not intended that the invention be limited except by the spirit and scope of the appended claims.

What we claim is:

1. A salt bath for the heat treatment of alloyed carbon steels essentially consisting of an inert salt base selected from the group consisting of barium chloride and barium chloride in admixture with a minor proportion of at least one alkali metal compound selected from the group consisting of alkali metal chlorides and alkali metal carbonates, up to 3% of a light metal oxide selected from the group consisting of aluminum oxide, magnesium oxide and calcium oxide, a substance capable of dissolving said light metal oxide selected from the group consisting of borax, light metal fluorides and pyrophosphates, the quantity of said oxide dissolving substance being about 2 to 3 parts per 1 part of said metal oxide, and 0.01 to 0.5% of a light metal sulfite.

2. A salt bath according to claim 1 in which said light metal oxide dissolving substance is borax.

3. A salt bath according to claim 1 in which said light metal oxide dissolving substance is a light metal fluoride.



4. A salt bath according to claim 1 in which said light metal oxide dissolving substance is a pyrophosphate.

5. A salt bath according to claim 1 in which the quantity of said light metal oxide is less than 1%.

6. In the heat treatment of alloyed carbon steels, the steps which comprise preheating such steels in a preheating bath at a temperature between 600–1100° C. consisting of

| | Percent |
|---|---|
| Barium chloride | 60.0 |
| Sodium chloride | 33.6 |
| Borax | 6.0 |
| Magnesium oxide | 0.4 |

and then heat treating such steels in a fused salt bath at a temperature between 930–1350° C. essentially consisting of an inert salt base selected from the group consisting of barium chloride and barium chloride in admixture with a minor proportion of at least one alkali metal compound selected from the group consisting of alkali metal chlorides and alkali metal carbonates, up to 3% of a light metal oxide selected from the group consisting of aluminum oxide, magnesium oxide and calcium oxide, a substance capable of dissolving said light metal oxide selected from the group consisting of borax, light metal fluorides and pyrophosphates, the quantity of said oxide dissolving substance being about 2 to 3 parts per 1 part of said metal oxide, and 0.01 to 0.5% of a light metal sulfite.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 1,454,214 | Dean | May 8, 1923 |
| 2,016,321 | Erdmann et al. | Oct. 8, 1935 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 415,846 | Great Britain | Sept. 6, 1934 |

OTHER REFERENCES

Condensed Chemical Dictionary, 4th ed., Reinhold Pub. Co., N. Y. (1950), p. 613 is pertinent.