

UNITED STATES PATENT OFFICE

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NITRIDING

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9 Claims. (Cl. 148—16)

My invention relates to the production of nitride cases on ferrous materials by heating the materials in the presence of nitriding agents, and it is the main object of my invention to intensify or accelerate the production of such cases.

Thin, hard, wear-resistant cases on ferrous alloys are useful as wearing surfaces for machine parts. The cases may be produced by nitriding, i. e., by heating the alloys in the presence of nitriding agents to temperatures below the nitride eutectoid temperature at about 600° C. In a nitriding gas, such as ammonia, a treatment of 12 to 20 hours is required to produce the cases, the treating time usually being longer when lower temperatures are used than when higher temperatures are used. The hard, wear-resistant cases are usually produced by heating in an atmosphere of ammonia to about 460° C. to 580° C., the treated alloy containing a promoting agent, such as aluminum or vanadium, which promotes the formation of the hard, wear-resistant coating at these temperatures. By far the most extensive use of my invention is in connection with the production of hard, wear-resistant coatings and the invention will be described with reference thereto.

It has been found that the action of nitriding agents is intensified when organic compounds containing nitrogen, and especially the closed carbon chain amino compounds, are present. For example, a nitride case of a given thickness can be produced in less time by heating steel in a mixture of ammonia and a closed carbon chain amine than by heating the steel under similar conditions in ammonia which does not contain the amine.

As illustrative of my invention, a specimen of ferrous alloy containing about 95.5% iron, 1% aluminum, and small amounts of phosphorus, sulphur, manganese, silicon, nickel, chromium, molybdenum and carbon was placed in a closed container. Ammonia was bubbled through aniline which was heated to a temperature just below its boiling point to increase its vapor pressure. The entrapped air in the container was displaced by the mixture of ammonia and aniline vapor, and the container and its contents were heated to 460° C. for 4 hours whilst a slow current of the gas mixture was passed into the container. A thin, uniform, wear-resistant case having a hardness corresponding to about 1000 Brinell was produced on the specimen. A similar hard, wear-resistant case was produced on another specimen of the same alloy by heating for 16 hours in ammonia but without the pres-

ence of aniline vapor. In a treatment in ammonia and without the aniline no appreciable hardness was produced by heating the alloy 4 hours at 460° C.

Beneficial results may be produced by the use of other closed carbon chain amines with nitriding agents, as for example poly-amine closed chain compounds, such as phenylenediamine, higher molecular weight closed chain amines such as oxnaphthylamine or other carbon compounds of the type R. M. in which R represents one or more aliphatic or closed carbon chain radicals and M represents one or more radicals composed of nitrogen or nitrogen and hydrogen linked to a carbon containing radical.

Any appreciable amount of the organic amino compound in conjunction with a nitriding agent is sufficient to produce acceleration. The preferred amount to be used with a given alloy under given conditions may be determined by experiment for each particular case but the invention is of course not restricted to the proportion which gives the maximum effect. Considerations of cost make it desirable not to use excessive amounts of the accelerator substance. The length of treatment for a given alloy at a given temperature may sometimes be regulated by the amount of accelerator which is introduced with the nitriding agent.

Although I have given only a few specific examples of accelerators and only one example of a nitriding agent, it is evident that other substances of the classes described may be used and modifications of the described method may be made without departing from my invention. Therefore, I do not wish to be understood as imposing limitations on my invention except such as are imposed by the prior art and by the annexed claims.

I claim:

1. The method of producing nitride cases on ferrous materials which comprises heating the material at nitriding temperatures below the eutectoid at about 600° C. in the presence of ammonia and at least one of the following: aniline, phenylene diamine, α -naphthylamine; the ammonia forming a predominating proportion of said medium.

2. Method of accelerating the production of nitride cases on ferrous materials by heating the materials in the presence of ammonia which comprises effecting said nitriding in the presence of an accelerating agent consisting of an aromatic primary amine chosen from the group comprising monamino and diamino phenyl and naphthyl

primary amines; said accelerating agent being present in materially less amount than the ammonia.

3. Method of accelerating the production of nitride cases on ferrous materials by heating the materials in the presence of ammonia which comprises effecting said nitriding in the presence of an accelerating agent consisting of an aromatic primary amine, chosen from the group comprising aniline, phenylene diamine, α -naphthylamine; said accelerating agent being present in materially less amount than the ammonia.

4. Nitriding medium comprising ammonia and an aromatic primary amine chosen from the group: monoamino and diamino phenyl and naphthyl primary amines; the ammonia forming a predominating proportion of said medium.

5. Nitriding medium comprising ammonia and at least one of the following: aniline, phenylene diamine, α -naphthylamine; the ammonia forming a preponderating proportion of said medium.

6. A gaseous nitriding medium consisting of ammonia and a minor proportion of aniline.

7. The method of producing nitride cases on ferrous materials which comprises passing a stream of ammonia in contact with an aromatic primary amine chosen from the group compris-

ing monoamino and diamino phenyl and naphthyl primary amines, whereby a mixture of ammonia and amine is formed, and heating the ferrous material at nitriding temperatures below the nitride eutectoid at about 600° C. in the presence of the mixture.

8. The method of producing nitride cases on ferrous materials which comprises passing a stream of ammonia in contact with an aromatic primary amine chosen from the group: aniline, phenylene diamine, α -naphthylamine; whereby a mixture of ammonia and amine is formed; and heating the ferrous material at nitriding temperatures below the nitride eutectoid at about 600° C. in the presence of the mixture.

9. The method of producing nitride cases on ferrous materials which comprises passing a stream of ammonia in contact with an aromatic primary amine chosen from the group: aniline, phenylene diamine, α -naphthylamine, which amine is at a temperature near its boiling point, whereby a mixture of ammonia and amine is formed; and heating the ferrous material at nitriding temperatures below the nitride eutectoid at about 600° C. in the presence of the mixture.

JOHN J. EGAN.

Certificate of Correction

Patent No. 1,965,798.

July 10, 1934.

JOHN J. EGAN

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, line 65, for "oxnaphthylamine" read *α -naphthylamine*; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 7th day of August, A. D. 1934.

[SEAL]

LESLIE FRAZER.
Acting Commissioner of Patents.

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primary amines; said accelerating agent being present in materially less amount than the ammonia.

3. Method of accelerating the production of nitride cases on ferrous materials by heating the materials in the presence of ammonia which comprises effecting said nitriding in the presence of an accelerating agent consisting of an aromatic primary amine, chosen from the group comprising aniline, phenylene diamine, α -naphthylamine; said accelerating agent being present in materially less amount than the ammonia.

4. Nitriding medium comprising ammonia and an aromatic primary amine chosen from the group: monoamino and diamino phenyl and naphthyl primary amines; the ammonia forming a predominating proportion of said medium.

5. Nitriding medium comprising ammonia and at least one of the following: aniline, phenylene diamine, α -naphthylamine; the ammonia forming a preponderating proportion of said medium.

6. A gaseous nitriding medium consisting of ammonia and a minor proportion of aniline.

7. The method of producing nitride cases on ferrous materials which comprises passing a stream of ammonia in contact with an aromatic primary amine chosen from the group compris-

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