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NITRIDING FERROUS ALLOYS

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My invention relates to the production of nitrided layers or cases on ferrous materials by heating the materials in gaseous nitrogen-containing substances and especially to the production of hard, wear-resistant cases. The object of my invention is to provide means for accelerating and intensifying the action of nitriding gases on ferrous materials so as to reduce the time required to produce a case of given hardness or thickness.

It is advantageous to produce the cases referred to by heating the objects to be cased for about 12 to 20 hours in the presence of ammonia at temperatures below the nitride eutectoid temperature of the steel. Accordingly, low temperatures, such as about 460° C. to 580° C. have been generally used. To produce these hard nitrogen-containing cases at low temperatures, at least a critical amount of an alloy promoting agent, such as aluminum or vanadium is contained in the alloy upon which the case is to be produced.

I have found that the action of gaseous nitriding agents is intensified by closely associating certain specially pre-nitrided alloy material with the surface to be hardened. The material is referred to herein as accelerator. Any form of the material may be used which will readily conform to the parts to be hardened and provide pores so as to allow access of the gas to the surface to be hardened. For example, metal in a state of subdivision, such as filings, powder, wire or wire gauze which can readily be made to conform to the surface of the object or present many points of contact therewith are preferred but other forms may be used.

The accelerator comprises a ferrous alloy containing at least one nitride promoting agent. For example a pre-nitrided ferrous alloy containing aluminum acts energetically as an accelerator for nitriding alloy steels which contain aluminum as the promoting agent. However, more than one nitride promoting agent may be present in the accelerator. For example, vanadium may be present in an aluminum containing accelerator, in which case the material is suitable as an accelerator for nitriding alloys containing either or both aluminum or vanadium as the promoting agent. In like manner, pre-nitrided ferrous alloys containing other nitride promoting agents act as accelerators. The best results have been obtained by using accelerators composed of alloys which contain the same nitride promoting agents as the alloys to be nitrided, but it is not always necessary that the same promoting agent shall be present in both the accelerator and the alloy to be nitrided.

The accelerator may be pre-nitrided by heating to critical temperatures in the presence of any nitriding agent, such as ammonia. In general, the critical temperature range is the same as that which may be used to produce hard, wear-resistant coatings on ferrous alloys containing nitride promoting alloy agents, the maximum temperature being known as the nitride eutectoid temperature. The maximum temperature of this range is about 580° C. and the minimum temperature is limited by the time of treatment and the atomic mobility of the reacting substances, approximately 400° C. being the practicable lower limit.

Accelerating material which is pre-nitrided at temperatures below the nitride eutectoid temperature may be used repeatedly. The acceleration produced by pre-nitrided material decreases as the temperature used for pre-nitriding is increased above the nitride eutectoid temperature. The nitride eutectoid temperature for the alloy of the accelerator is about the practicable maximum pre-nitriding temperature.

As illustrative of my invention, steel alloy filings composed of steel containing about 1% aluminum as a promoting agent were pre-nitrided by heating them at about 460° C. in an atmosphere of ammonia for 12 to 16 hours. A steel alloy article composed of steel containing about 1% aluminum as a promoting agent was embedded in the pre-nitrided steel filings in a closed container. The air in the container was displaced with ammonia and the contents were heated to 460° C. for 4 hours. The article was found to have a thin, hard, wear-resistant coating equal in hardness to the coatings produced by treating like articles for 16 hours at the

same temperature but without the use of the pre-nitrided alloy filings.

A second alloy article of the same composition was embedded in filings of the same alloy which had not been pre-nitrided. The article was heated to 460° C. for 4 hours in the presence of ammonia but no appreciable hardening of the surface of the article was produced.

A third article of the same composition was embedded in similar alloy filings which had been pre-nitrided at 700° C., a temperature higher than the nitride eutectoid temperature. No appreciable surface hardness was produced by heating in ammonia for 4 hours.

Instead of using the above described pre-nitrided material alone, it may be used in conjunction with inert substances and with other accelerators. Owing to the wide range of modification of which the invention is capable, applicant does not wish to be understood as limiting the invention to the modifications specifically described except as limitations are imposed by the prior art or as indicated in the appended claims.

I claim:

1. A nitriding accelerator comprising metallic subdivided material, said material being composed of ferrous alloy containing at least one nitride promoting agent and a nitrogenous substance of the same kind that is produced by nitriding a steel which contains at least one nitriding promoting agent, said accelerator being pre-nitrided at temperatures below the nitride eutectoid temperature thereof.

2. Method of accelerating the production of nitrided cases by the action of nitriding gases which comprises closely associating with the surface to be hardened pre-nitrided ferrous alloy containing at least one nitride promoting agent.

3. The method of producing a nitrided case on a ferrous alloy object containing a nitride promoting agent which comprises closely associating with the object a subdivided material comprising a pre-nitrided ferrous alloy containing at least one nitride promoting agent, and heating in the presence of a nitriding agent.

4. The method of producing a nitrided case on a ferrous alloy object containing a nitride promoting agent which comprises closely associating with the object a subdivided material comprising a pre-nitrided ferrous alloy containing at least one of the same nitride promoting agents as the object, and heating in the presence of a nitriding agent.

5. The method of producing a nitrided case on a ferrous alloy object containing a nitride promoting agent which comprises placing in contact with the object a subdivided material comprising a pre-nitrided ferrous alloy containing the same nitride promoting agent as the object, and heating in the presence of a nitriding agent.

6. The method of producing a hard nitrided case on a ferrous alloy object containing sufficient of a nitride promoting agent to produce a hard, adherent coating by heating in the presence of ammonia which comprises closely associating the object with a subdivided material comprising a pre-nitrided ferrous alloy containing one of the same nitride promoting agents as the object, and heating in the presence of a nitriding agent to temperatures of about 460° C. to 580° C.

7. A nitriding accelerator comprising nitrided metallic subdivided material which contains at least one nitride promoting agent of the group comprising aluminum and vanadium.

8. A nitriding accelerator comprising ferrous subdivided material which contains at least one nitride promoting agent of the group comprising aluminum and vanadium, said material being prenitrided at temperatures below the nitride eutectoid temperature thereof.

9. Method of accelerating the production of nitrided cases on ferrous materials by the action of nitriding gases which comprises closely associating with the surface to be hardened prenitrided ferrous subdivided material containing at least one nitride promoting agent of the group consisting of aluminum and vanadium.

10. Method of accelerating the production of nitrided cases on aluminum-containing ferrous materials by the action of ammonia at nitriding temperatures below about 580° C. which comprises closely associating with the surface to be hardened prenitrided steel alloy containing aluminum, said alloy being prenitrided at temperatures below the nitride eutectoid temperature thereof.

11. Method of accelerating the production of nitrided cases on vanadium-containing ferrous materials by the action of ammonia at nitriding temperatures below about 580° C. which comprises closely associating with the surface to be hardened prenitrided steel alloy containing vanadium, said alloy being prenitrided at temperatures below the nitride eutectoid temperature thereof.

12. Method of producing a nitrided case on a ferrous alloy object which comprises closely associating with the object a subdivided material comprising prenitrided ferrous material which contains at least one nitride promoting agent chosen from the group consisting of aluminum and vanadium, and heating at temperatures below about 580° C. in the presence of ammonia.

In testimony whereof, I affix my signature.

JOHN J. EGAN.