Patented Mar. 13, 1934

1,950,549

UNITED STATES PATENT OFFICE

1,950,549

MANUFACTURING HARDENED ARTICLES

Adolf Fry and Roland Wasmuht, Essen, Germany, assignors to Fried. Krupp Aktiengesellschaft, Essen-on-the-Ruhr, Germany

No Drawing. Application June 19, 1931, Serial No. 545,617. In Germany July 16, 1930

8 Claims. (Cl. 148—16)

This invention relates to the manufacture of articles from nitride hardened iron and steel alloys. In such surface hardened articles it is often desired to impart to the core also considerable hardness especially when the articles have to be subjected to high pressures or to considerable impact stresses, for example in the case of matrices, toothed wheels, clutch couplings and ball and roller bearings where on account of the very high compression stresses there is a risk of the nitride hardened surface layer being pressed into the softer core material. It has already been proposed to use for the manufacture of such articles steel alloys which are both capable of being nitrided and resist tempering, that is alloys which are hard in the condition in which they are subjected to the nitriding process and do not lose their original hardness when they are heated to the nitriding temperature of about 500° C. which is equivalent to a tempering treatment. However when such alloys are used it is very difficult on account of the great hardness of the material to carry through the final working of the articles in the cold state before the nitriding.

The object of the present invention is to manufacture nitride hardened articles which have also great core hardness but which before the nitriding can be finally worked without difficulties in a soft state.

One method of proceeding in accordance with the invention is as follows: First a steel is manufactured which is capable of being nitride hardened and which contains in addition to elements such as aluminium, chromium, molybdenum, manganese and so forth which introduce the capacity for nitride hardening, also elements which can bring about precipitation hardening such, for example, as copper, beryllium, boron and titanium. This steel alloy or an article roughly worked therefrom is then cooled from high temperature in water, oil or air. The alloy is then soft and is finally worked. Next a nitriding process takes place at a temperature of between about 400 to 600° C. but preferably at about 500° C. and serves to increase the hardness of the surface layer of the article. The temperature used in the nitriding process, however, serves simultaneously to bring about a substantial increase in the hardness of the core as a result of a precipitation hardening action due to the presence of the copper, beryllium, boron, titanium or the like.

The process according to the invention may also be carried into effect by cooling the steel article from a temperature lying above its critical point and then tempering it at a temperature below the critical temperature but above the nitriding temperature, the article being cooled in air, oil or water from the tempering temperature. The article is then in a condition in which it may be worked, and in this condition it is subjected to nitride hardening whereupon as a result of its composition precipitation hardening simultaneously takes place.

The invention may also be carried into effect by making use of an alloy which can be nitrided and not bringing about precipitation hardening during the nitriding process but, by sufficiently quick cooling after the nitriding process from the nitriding or a somewhat lower temperature, holding a material in the alloy in supersaturated solution. Precipitation hardening is then brought about by tempering at a temperature below that of the nitriding or by allowing the material to remain for a long time at room temperature so that the hardness of the core is increased after the article has been nitride hardened. Examples of such materials which may be held in supersaturated solution are nitrogen and carbon.

What we claim and desire to secure by Letters Patent is:—

1. Process of making an article of a steel alloy having a hard core surrounded by a hard case, which comprises roughly shaping the article from a steel alloy containing one or more elements adapted to accelerate nitrogenization and one or more elements adapted to cause precipitation hardening at nitriding temperatures, cooling the article from a temperature below the melting point and above the nitriding temperature, further shaping the article, and then subjecting the same to a nitride hardening and precipitation hardening process.

2. Process of making an article of a steel alloy having a hard core surrounded by a hard case, which comprises roughly shaping the article from a steel alloy containing one or more elements adapted to accelerate nitrogenization and one or more elements adapted to cause precipitation hardening at a temperature below nitriding temperatures, cooling the article from a temperature below the melting point and above the nitriding temperature, further shaping the article, subjecting the article to a nitride hardening process, quickly cooling the article from a temperature not higher than the nitriding temperature, and tempering the article at a temperature below the nitriding temperature.

3. Process of making an article of a steel alloy having a hard core surrounded by a hard case, which comprises roughly shaping the article

from a steel alloy containing one or more elements adapted to accelerate nitrogenization and one or more elements adapted to cause precipitation hardening at room temperature, cooling the article from a temperature below the melting point and above the nitriding temperature, further shaping the article, subjecting the article to a nitride hardening process, quickly cooling the article from a temperature not higher than the nitriding temperature, and holding the article for a long time at room temperature.

4. Process of making an article of a steel alloy having a hard core surrounded by a hard case, which comprises roughly shaping the article from a steel alloy containing one or more elements adapted to accelerate nitrogenization and one or more elements adapted to cause precipitation hardening at nitriding temperatures, cooling the article from a temperature below the melting point and above the nitriding temperature, further shaping the article, and then simultaneously hardening the core and the surface by subjecting the article to a nitriding temperature in a nitrogen yielding atmosphere.

5. Process of making an article of a steel alloy having a hard core surrounded by a hard case, which comprises roughly shaping the article from a steel alloy containing one or more elements selected from the group consisting of aluminum, chromium, moybdenum, and manganese, and one or more elements selected from the group consisting of copper, beryllium, boron, and titanium, cooling the article from a temperature below the melting point and above the nitriding temperature, further shaping the article, and then simultaneously hardening the core and the surface by subjecting the article to a nitriding temperature in a nitrogen yielding atmosphere.

6. Process of making an article of a steel alloy having a hard core surrounded by a hard case, which comprises roughly shaping the article from a steel alloy containing one or more elements adapted to accelerate nitrogenization and one or more elements adapted to cause precipitation hardening at temperatures below nitriding temperatures, cooling the article from a temperature below the melting point and above the nitriding temperature, further shaping the article, subjecting the article to a nitride hardening process, and then subjecting it to a precipitation hardening process at a temperature below the nitriding temperature.

7. Process of making an article of a steel alloy having a hard core surrounded by a hard case, which comprises roughly shaping the article from a steel alloy containing one or more elements adapted to accelerate nitrogenization and one or more elements adapted to cause precipitation hardening at a temperature of about 400 to 600° C., cooling the article from a temperature below the melting point and above the nitriding temperature, further shaping the article, and then simultaneously hardening the core and the surface by subjecting the article to a temperature of about 400 to 600° C. in a nitrogen yielding atmosphere.

8. Process of making an article of a steel alloy having a hard core surrounded by a hard case, which comprises shaping the article from a steel alloy which has been cooled from a temperature below the melting point and above the nitriding temperature and which contains one or more elements adapted to accelerate nitrogenization and one or more elements adapted to cause precipitation hardening at nitriding temperatures, and then subjecting the article to a nitride hardening and precipitation hardening process.

ADOLF FRY.
ROLAND WASMUHT.