Patented Apr. 19, 1938

2,114,802

UNITED STATES PATENT OFFICE

2,114,802

NITRIDE HARDENED STEEL ARTICLE

Augustus B. Kinzel, Beechhurst, N. Y., assignor, by mesne assignments, to Union Carbide and Carbon Corporation, a corporation of New York

No Drawing. Application January 9, 1930, Serial No. 419,744

6 Claims. (Cl. 148—31)

My invention relates to chromium-silicon-manganese-zirconium articles having a nitride hardened wear-resistant case thereon.

Chromium-silicon-manganese steels are excellent for many purposes where great strength is desired. As a general rule, these steels have both high strength and exceptional ductility. For many uses, the production of articles having hard, wear-resistant nitrided cases is desired. Heretofore, aluminum has been added to steels to promote case-hardening by nitrification, but the addition of aluminum increases the difficulties of making the steel and may deleteriously affect the properties of the steel.

I have discovered that the presence of zirconium in the chromium-silicon-manganese-containing steels makes them especially susceptible to the production of hard, wear-resistant nitrided cases. The incorporation of zirconium, in contrast with the incorporation of aluminum, involves no considerable difficulty, and corresponding economies in the production of nitrided articles result.

The steels of my invention consist essentially of about 85% or more of iron, at least 0.3% chromium, at least 0.1% manganese, silicon and at least 0.05% zirconium; other nonessential elements may be present.

Steels are ordinarily deoxidized with silicon, a slight excess of the element being used for this purpose. The excess is usually such that analysis of the finished steel will show a silicon content somewhat below 0.3%. The steels of my invention preferably contain a larger content of silicon than is introduced in the usual deoxidation, as I have found that an increased silicon content assists the nitriding, and promotes the consistent production of hard, wear resistant cases.

The presence of some carbon is commercially unavoidable but not essential to the nitrification. It may be present up to about 0.9% in the alloys which contain relatively large amounts of chromium and manganese, without producing an undesirable brittleness or seriously affecting the presence of solid solutions of chromium and manganese. Carbon is usually present in amounts of about 0.10% to 0.3%.

It is not generally desirable to have more than about 10% of chromium. More than 3.5% of silicon is generally to be avoided. With more than 4% of manganese, segregation may occur. Larger amounts of manganese and silicon do not however destroy the nitriding properties of the steel.

Excellent results have been obtained by incorporating about 0.1% to 0.3% zirconium in the above described steel. More than 0.3% zirconium may be present; there being no maximum limit for zirconium except that which is imposed by the presence of the above described elements. Zirconium does not deleteriously affect the strength or ductility of the chromium-silicon-manganese steels, and may enhance these qualities. Strong, adherent, wear-resistant, hard cases may be produced on the above-described zirconium containing steels by nitrification. The coatings may be produced consistently and uniformly by heating the steels in the presence of nitriding agents, such as ammonia. Hard, wear-resistant coatings may advantageously be produced at low temperatures, such as 450° C. to 580° C. Good results are obtained when the aggregate of the chromium, silicon and manganese amounts to at least 1.25%; at least 0.05% zirconium being present.

The alloys referred to which contain zirconium have greater ductility and so called "shock resistance" in the condition existing after they are hot rolled and air-cooled than the steels which do not contain zirconium.

Steels containing 1% to 1.5% chromium, 1% to 1.25% manganese, 0.6% to 0.9% silicon, 0.1% to 0.3% zirconium and the remainder iron and impurities are examples of my invention. A forged article consisting of such a steel was given a nitrided case by heating for about 12 hours at about 450° C. in an atmosphere of ammonia. The nitride case consisted of a thin adherent skin of nitrogen-containing material having extreme wear-resistance and a hardness corresponding to about 1100 Brinell. The remainder of the article or core of alloy was not affected by the ammonia.

I claim:

1. An article of manufacture composed of steel having substantially the composition: 0.3% to 1.5% chromium, 0.3% to 0.9% silicon, 0.1% to 1.25% manganese, 0.05% to 0.3% zirconium, the remainder iron and incidental impurities; said article having a hard, nitrided surface layer.

2. An article of manufacture as defined in claim 1, wherein the combined percentages of chromium silicon, and manganese amount to at least 1.25%.

3. An article of manufacture composed of steel having substantially the composition: 1% to 1.5% chromium, 0.6% to 0.9% silicon, 1% to 1.25% manganese, 0.1% to 0.3% zirconium, the remainder iron and incidental impurities; said article having a hard, nitrided surface layer.

4. An article of manufacture composed of steel

having substantially the composition: 0.3% to 1.5% chromium, 0.3% to 0.9% silicon, 0.1% to 1.25% manganese, the combined content of chromium and silicon and manganese being at least 1.25%, 0.05% to 0.3% zirconium, the remainder iron and incidental impurities; said article having a hard, nitrided surface layer.

5. An article of manufacture composed of a nitride hardened steel alloy consisting of 0.05% to 0.3% zirconium, 0.1% to 4% manganese, 0.3% to 3.5% silicon, 1% to 10% chromium, and the remainder substantially iron.

6. An article of manufacture composed of a nitride hardened steel alloy consisting of 0.25% to 2% zirconium, 1% to 10% chromium, 0.1% to 4% manganese, 0.3% to 3.5% silicon, and the remainder substantially iron.

AUGUSTUS B. KINZEL.