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**Sanderson**

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[54] **RAZOR BLADES**

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[30] **Foreign Application Priority Data**

| | | |
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[51] **Int. Cl.** .......... **B26b 21/54**
[58] **Field of Search** .......... 117/132 CF, 71, 75 M; 148/16.6, 6.3; 30/346.54, 346.53

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[57] **ABSTRACT**

On a razor blade having at least one cutting edge there is provided a coating of a nitride of an alloy of chromium (as herein defined) and optionally a coating of an alloy of chromium (as herein defined). Preferably the outer coating is itself coated with a polymer which improves the shaving properties of the blade, for example polytetrafluoroethylene.

**13 Claims, No Drawings**

## RAZOR BLADES

This invention relates to razor blades and to methods for their production.

It is known to provide at least the cutting edge of a razor blade with a coating of certain materials in order to improve the shaving properties thereof, for example by increasing their resistance to wear. Materials which have been proposed include certain metals and alloys for example chromium, or chromium/platinum alloys and certain refractory materials such as chromium nitride or chromium oxide.

According to the present invention there is provided a razor blade having a discrete coating of nitride of an alloy of chromium (as herein defined) and if desired a discrete coating of an alloy of chromium (as herein defined) on and/or adjacent a cutting edge thereof.

As used herein the term "a discrete coating" means a coating of a material which is the same as or different from that of the basic blade and when of the same material as the basic blade, the coating is additional thereto. The basic blade is preferably of steel.

The chromium alloys which may be used include those of chromium with at least one element of Group VIII of the Periodic Table, for example iron, cobalt, nickel or a noble metal, i.e., ruthenium, rhodium, palladium, osmium, iridium or platinum, manganese, rhenium or two or more thereof. Some commercially available alloys may be used.

When iron, cobalt, nickel, or manganese are used in the nitrided chromium containing alloys, it is generally preferred that the alloy contains more than 12 percent by weight of chromium. In the case of the noble metals, also referred to as precious metals, and rhenium, the chromium preferably constitutes more than 50 atomic percent of the alloy.

As used herein, the term an "alloy of chromium" is meant to include alloys of chromium with one or more of the specific metals hereinbefore set forth for use in such alloys. Small quantities of at least one further alloying element, which may be either metallic or non-metallic, may be present in the alloy in an amount which does not significantly adversely affect the shaving properties of the razor blades of the invention, for example not more than 5 atomic percent. One non-metallic element which may be present, particularly in commercially available alloys, for example of iron, is carbon.

Particularly preferred chromium alloys are those alloys which are commonly referred to as stainless and these are generally stainless steels or stainless irons. Iron/chromium alloys which may be used should in general contain at least 12 percent by weight of chromium conveniently less than 30 percent by weight. A preferred class of iron/chromium alloys contain from 16 to 20 percent by weight of chromium with the balance being made up, for example, of from 6 to 12 percent by weight of nickel with the remainder being a major proportion of iron and possibly low concentrations of further alloying elements. One preferred alloy contains about 18 percent by weight of chromium and about 8 percent by weight of nickel with the balance iron and a low concentration of at least one further alloying element, for example carbon.



The term "an iron/chromium alloy" is used herein to refer generally to alloys containing both iron and chromium and it is intended to include alloys which contain one or more further alloying elements. In general, however, the iron and chromium should together form a major portion of the iron/chromium alloy (i.e. at least 50 percent preferably more than 70 percent by weight). The further alloying elements may be metallic or non-metallic. Metallic alloying elements may be selected, for example, from amongst the elements (other than iron) of Group VIII of the Periodic Table, e.g., cobalt, nickel, ruthenium, rhodium, palladium, osmium, iridium or platinum, or from amongst other metallic elements such as, for example, titanium, zirconium, vanadium, niobium, tantalum, molybdenum, tungsten or manganese.

The relative amounts of iron, chromium and, when present, one or more further alloying elements are preferably selected to provide alloys which are referred to in the metallurgical art as stainless. These alloys include stainless irons and stainless steels.

In general the chromium should be present in an amount of at least 12 percent by weight in the iron/chromium alloys. A preferred class of iron/chromium alloys for use in the present invention contains from 16 to 20 percent by weight of chromium. However, up to 30 percent by weight or even more chromium may be present.

As stated above, the iron/chromium alloys used in the present invention should generally contain a major proportion of iron and chromium. The other alloying elements, when present will then constitute less than 50 percent, preferably less than 30 percent by weight, of the alloy. Carbon is preferably present in only small amounts, e.g., 0.1 percent by weight of the alloy, especially when the chromium content of the alloy is low (i.e. less than about 14 percent).

A preferred class of iron/chromium alloys contains from 16 to 20 percent by weight of chromium with the balance being made up, for example, of from 6 to 12 percent by weight of nickel with the remainder being a major proportion of iron and possibly low concentrations of further alloying elements. One preferred alloy contains about 18 percent by weight of chromium and about 8 percent by weight of nickel with the balance iron and a low concentration of carbon.

Examples of iron/chromium alloys which may be used may be selected from the alloys listed in Table I below.

TABLE I

| Alloy Type | Chemical Composition, % | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Carbon | Silicon | Manganese | Nickel | Chromium | Molybdenum | | Others |
| 12% Chromium 0.10% Carbon max. | 0.10 max | 1.0 max | 1.0 max | 0.50 max | 11.5/14.0 | — | — | — |
| | 0.08 max | 0.80 max | 1.00 max | 0.50 max | 12.0/14.0 | — | — | — |
| 12% Chromium, 0.10% Carbon max. + Aluminium | 0.10 max | 1.0 max | 1.0 max | 0.50 max | 11.5/14.0 | — | — | Aluminium 0.10/0.30 |
| | 0.08 max | 0.08 max | 0.80 max | 0.50 max | 12.0/14.0 | — | — | 0.10/0.30 |

TABLE I—Continued

| Alloy Type | Chemical Composition, % | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Carbon | Silicon | Manganese | Nickel | Chromium | Molybdenum | Others | |
| 12% Chromium, 0.15% Carbon max. | 0.15 max | 1.0 max | 1.0 max | 1.0 max | 11.5/13.5 | — | — | — |
| | 0.09/0.15 | 0.80 max | 1.00 max | 1.00 max | 11.5/13.5 | — | — | — |
| 12% Chromium, 0.12%/0.40% Carbon | 0.12/0.40 | 1.0 max | 1.0 max | 1.0 max | 11.5/14.0 | — | — | — |
| | 0.14/0.20 | 0.80 max | 1.00 max | 1.00 max | 11.5/13.5 | — | — | — |
| | 0.20/0.28 | 0.80 max | 1.00 max | 1.00 max | 12.0/14.0 | — | — | — |
| | 0.28/0.36 | 0.80 max | 1.00 max | 1.00 max | 12.0/14.0 | — | — | — |
| 12% Chromium Free Cutting | 0.30 max | 1.0 max | 1.5 max | 1.0 max | 11.5/14.0 | 0.60 max | Sulphur S or Se | Selenium 0.15/0.30 |
| | 0.09/0.15 | 1.00 max | 1.50 max | 1.00 max | 11.5/13.5 | 0.60 max | 0.15/0.30 | — |
| | 0.09/0.15 | 1.00 max | 1.50 max | 1.00 max | 11.5/13.5 | 0.60 max | — | 0.15/0.30 |
| | 0.14/0.20 | 1.00 max | 1.50 max | 1.00 max | 11.5/13.5 | 0.60 max | 0.15/0.30 | — |
| | 0.20/0.28 | 1.00 max | 1.50 max | 1.00 max | 12.0/14.0 | 0.60 max | 0.15/0.30 | — |
| 17%Chromium | 0.12 max | 1.0 max | 1.0 max | 1.0 max | 14.0/18.0 | — | — | — |
| | 0.10 max | 0.80 max | 1.00 max | 0.50 max | 16.0/18.0 | — | — | — |
| 17% Chromium + Molybdenum | 0.12 max | 1.0 max | 1.0 max | 1.0 max | 14.0/18.0 | 0.80/1.5 | — | — |
| | 0.10 max | 0.80 max | 1.00 max | 0.50 max | 16.0/18.0 | 0.90/1.30 | | |
| 20% Chromium | 0.15 max | 1.0 max | 1.0 max | 1.0 max | 18.0/23.0 | — | — | — |
| | 0.1 max | 0.80 max | 1.00 max | 0.50 max | 18.0/22.0 | — | — | — |
| 17% Chromium, 2% Nickel | 0.20 max | 1.0 max | 1.0 max | 1.0/3.0 | 15.0/18.0 | — | — | — |
| | 0.12/0.20 | 0.80 max | 1.00 max | 2.00/3.00 | 15.0/18.0 | — | — | — |
| 17% Chromium, 2% Nickel Free Cutting | 0.20 max | 1.0 max | 1.50 max | 1.0/3.0 | 15.0/18.0 | 0.60 max | Sulphur 0.15/0.30 | — |
| | 0.12/0.20 | 1.00 max | 1.50 max | 2.00/3.00 | 15.0/18.0 | 0.60 max | 0.15/0.30 | — |
| 17%/7% Chromium-Nickel | 0.15 max | 1.0 max | 2.0 max | 6.0/8.0 | 16.0/18.0 | — | — | — |
| | 0.12 max | 0.20/1.00 | 0.50/2.00 | 6.0/8.0 | 16.0/18.0 | — | — | — |
| 18%/9% Chromium-Nickel, 0.15% Carbon max. | 0.15 max | 1.0 max | 2.0 max | 8.0/11.0 | 17.0/20.0 | | | |
| | 0.12 max | 0.20/1.00 | 0.50/2.00 | 8.0/11.0 | 17.0/19.0 | — | — | — |
| 18%/9% Chromium-Nickel Free Cutting | 0.15 max | 1.0 max | 2.0 max | 8.0/11.0 | 17.0/19.0 | 0.70 max | Sulphur S or Se 0.15/0.30 | Selenium 0.15/0.30 |
| | 0.12 max | 0.20/1.00 | 0.50/2.00 | 8.0/11.0 | 17.0/19.0 | 0.70 max | | — |
| | 0.12 max | 0.20/1.00 | 0.40/2.00 | 8.00/11.0 | 17.0/19.0 | 0.70 max | — | 0.15/0.30 |
| 18%/10% Chromium-Nickel, 0.09% Carbon max. | 0.09 max | 1.0 max | 2.0 max | 8.0/13.0 | 17.5/20.0 | — | — | — |
| | 0.03 max | 0.20/1.00 | 0.50/2.00 | 9.0/12.0 | 17.5/19.0 | — | — | — |
| | 0.06 max | 0.20/1.00 | 0.50/2.00 | 8.0/11.0 | 17.5/19.0 | — | — | — |
| | 0.06 max | 0.20/1.00 | 0.50/2.00 | 9.0/11.0 | 17.5/19.0 | — | — | — |
| 18%/12% Chromium-Nickel, 0.10% Carbon max. | 0.10 max | 1.0 max | 2.0 max | 10.0/13.0 | 17.0/19.5 | — | — | — |
| | 0.10 max | 0.20/1.00 | 0.50/2.00 | 11.0/13.0 | 17.0/19.0 | — | — | — |
| 18%/9% Chromium-Nickel, + Titanium, 0.12% Carbon max. | 0.12 max | 1.0 max | 2.0 max | 8.0/13.0 | 17.0/19.0 | — | Titanium 5C min. | — |
| | 0.08 max | 0.20/1.00 | 0.50/2.00 | 9.0/12.0 | 17.0/19.0 | — | 5C/0.70 | — |
| | 0.12 max | 0.20/1.00 | 0.50/2.00 | 8.0/11.0 | 17.0/19.0 | | 5C/0.90 | — |
| 18%/9% Chromium-Nickel, + Titanium, Free Cutting | 0.12 max | 1.0 max | 2.0 max | 8.0/11.0 | 17.0/19.0 | 0.70 max | 5C min | Sulphur 0.15/0.30 |
| | 0.12 max | 0.20/1.00 | 1.00/2.00 | 8.0/11.0 | 17.0/19.0 | 0.70 max | 5C/0.90 | 0.15/0.30 |
| 18%/9% Chromium-Nickel + Niobium,0.09% Carbon max. | 0.09 max | 1.0 max | 2.0 max | 8.0/13.0 | 17.0/19.0 | — | Niobium 10C min | — |
| | 0.08 max | 0.20/1.00 | 0.50/2.00 | 9.0/12.0 | 17.0/19.0 | — | 10C/1.00 | — |

TABLE I – Continued

| Alloy Type | Chemical Composition, % | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Carbon | Silicon | Manganese | Nickel | Chromium | Molybdenum | | Others |
| 17%/10% Chromium-Nickel, 1½% Molybdenum | 0.08 max | 1.0 max | 2.0 max | 9.0/12.0 | 16.5/18.5 | 1.25/2.0 | — | — |
| | 0.07 max | 0.20/1.00 | 0.50/2.00 | 9.0/11.0 | 16.5/18.5 | 1.25/1.75 | — | — |
| 17%/12% Chromium-Nickel, 2½% Molybdenum | 0.09 max | 1.0 max | 2.0 max | 10.0/15.0 | 16.0/18.5 | 2.0/3.0 | — | — |
| | 0.03 max | 0.20/1.00 | 0.50/2.00 | 11.0/14.0 | 16.5/18.5 | 2.25/3.00 | — | — |
| | 0.07 max | 0.20/1.00 | 0.50/2.00 | 10.0/13.0 | 16.5/18.5 | 2.25/3.00 | — | — |
| 18%/12% Chromium-Nickel, 3½% Molybdenum | 0.08 max | 1.0 max | 2.0 max | 11.0/15.0 | 17.0/20.0 | 3.0/4.0 | — | — |
| | 0.06 max | 0.20/1.00 | 0.50/2.00 | 12.0/15.0 | 17.5/19.5 | 3.0/4.0 | — | — |
| 17%/12% Chromium-Nickel, 2½% Molybdenum + Titanium | 0.08 max | 1.0 max | 2.0 max | 11.0/14.0 | 16.5/18.5 | 2.25/3.0 | Titanium 4C min. | — |
| | 0.08 max | 0.20/1.00 | 0.50/2.00 | 11.0/14.0 | 16.5/18.5 | 2.25/3.00 | 4C/0.60 | — |
| 17%/12% Chromium-Nickel, 2½% Molybdenum + Niobium | 0.08 max | 1.0 max | 2.0 max | 11.0/14.0 | 16.5/18.5 | 2.25/3.0 | Niobium 10C min. | — |
| | 0.08 max | 0.20/1.00 | 0.50/2.00 | 11.0/14.0 | 16.5/18.5 | 2.25/3.00 | 10C/1.00 | — |
| 23%/15% Chromium-Nickel | 0.15 max | 1.0 max | 2.0 max | 13.0/16.0 | 22.0/25.0 | — | — | — |
| | 0.15 max | 0.20/1.00 | 0.50/2.00 | 13.0/16.0 | 22.0/25.0 | — | — | — |
| 24%/18% Chromium-Nickel | 0.15 max | 1.0 max | 2.0 max | 16.0/19.0 | 23.0/26.0 | — | — | — |
| | 0.15 max | 0.20/1.00 | 0.50/2.00 | 16.0/19.0 | 23.0/26.0 | — | — | — |
| 23%/20% Chromium-Nickel | 0.15 max | 1.0 max | 2.0 max | 19.0/23.0 | 22.0/26.0 | — | — | — |
| | 0.15 max | 0.20/1.00 | 0.50/2.00 | 19.0/22.0 | 23.0/26.0 | — | — | — |
| Chromium-Silicon-XB | 0.70/0.90 | 1.5/2.5 | 1.0 max | 1.0/2.0 | 19.0/21.0 | — | — | — |
| | 0.75/0.85 | 1.75/2.25 | 0.30/0.75 | 1.20/1.70 | 19.0/21.0 | — | — | — |
| 14%/14% Chromium-Nickel, – Tungsten | 0.35/0.50 | 1.0/2.0 | 1.0 max | 13.0/15.0 | 13.0/15.0 | 0.70 max | Tungsten 2.0/3.0 | — |
| | 0.35/0.50 | 1.0/2.0 | 0.50/1.50 | 12.0/15.0 | 12.0/15.0 | — | 2.0/3.0 | — |
| | 0.37/0.47 | 1.00/2.00 | 0.50/1.00 | 13.0/15.0 | 13.0/15.0 | 0.40/0.70 | 2.20/3.00 | — |
| 21%/4% Chromium-Nickel, + Nitrogen | 0.45/0.60 | 0.80 max | 8.0/11.0 | 3.0/5.0 | 20.0/23.0 | — | Nitrogen 0.35/0.55 | Sulphur 0.10 max |
| | 0.48/0.58 | 0.25 max | 8.0/10.0 | 3.25/4.50 | 20.0/22.0 | — | 0.38/0.50 | 0.030 max |
| | 0.48/0.58 | 0.25 max | 8.0/10.0 | 3.25/4.50 | 20.0/22.0 | — | 0.38/0.50 | 0.030/0.080 |
| 21%/4% Chromium-Nickel, + Nitrogen + Niobium | 0.45/0.60 | 0.80 max | 8.0/11.0 | 3.0/5.0 | 20.0/23.0 | Niobium 2.0/3.0 | 0.35/0.55 | 0.10 max |
| | 0.48/0.58 | 0.45 max | 8.0/10.0 | 3.25/4.50 | 20.0/22.0 | 2.0/3.0 | 0.38/0.50 | 0.030 max |
| | 0.48/0.58 | 0.45 max | 8.0/10.0 | 3.25/4.50 | 20.0/22.0 | 2.0/3.0 | 0.38/0.50 | 0.030/0.080 |
| 21%/12% Chromium, – Nickel, + Nitrogen | 0.10/0.30 | 1.50 max | 2.0 max | 10.0/13.0 | 20.0/23.0 | — | 0.10/0.35 | 0.10 max |
| | 0.15/0.25 | 0.75/1.25 | 1.50 max | 10.5/12.5 | 20.0/22.0 | — | 0.15/0.30 | 0.030 max |

Other alloys which may be used include, for example a chromium/nickel alloy containing about 80 percent by weight of nickel (commonly referred to as Nichrome) and a chromium/cobalt/nickel alloy containing about 20 percent by weight of chromium, about 40 percent by weight of cobalt, about 15 percent by weight of nickel, about 7 percent by weight of molybdenum, about 2 percent by weight of manganese and about 0.15 percent by weight of carbon with the balance being iron (an alloy also known as Elgiloy). Chromium/platinum alloys may also be used.

The nitrided alloys of chromium may be selected from the nitrides of the alloys of chromium hereinbefore set forth.

Examples of chromium alloys which may be used in nitrided form include the iron/chromium alloys described above, for example in Table I.

The nitrogen content of such nitrided alloys may vary within wide limits. The term "nitride" is intended to embrace coatings over the range from a small amount of nitrogen in solid solution with the alloy metals up to any of the various compounds which may be formed between nitrogen and the alloy metals, e.g., $Cr_2N$, $Cr_3N_2$ and CrN. For example the composition may extend from 1 to 55 atomic percent nitrogen.

The nitride of the alloy of chromium may form either a single coating on a blade, preferably having an outermost covering of a polymer of copolymer which improves the shaving characteristics of the blade, or it may be one of a plurality of coatings. For example, the alloy of chromium may be present as a first coating on a razor blade base and the nitride of the alloy of chromium may be present as a coating upon the first coating.

Where a chromium alloy is used as a first coat of a dual coated blade it is believed to act as an edge strengthening coating. The second coating is generally chosen to provide a better substrate for adhesion of a subsequently applied polymer coating and/or to facilitate crystallisation of the polymer coating, upon deposition, in a manner which results in an improved polymer coating.

Two coatings other than a polymer or copolymer may be used and the outer of these two coatings is preferably a nitride of the alloy of chromium. The other coatings which are preferably other than a nitride of an alloy of chromium are preferably metallic, being either of a substantially pure metal (e.g. chromium) or an alloy thereof, for example an iron/chromium alloy as hereinbefore described. When an alloy coating is used, it is preferably the same alloy as that from which the nitride is derived. For example, the alloy may be an iron/chromium alloy of the type hereinbefore described and the nitride coating is then preferably derived from the same alloy. Similarly alloy and nitrided alloy coatings may be derived from chromium/platinum alloys.

The iron/chromium alloy coatings and the nitrided coatings may be produced by known methods. Ion-sputtering methods have been found convenient although vapour deposition methods may, if desired, be used.

In order to deposit a nitrided coating, a source of nitrogen is required to form the nitride and this may, for example be nitrogen alone or a gas containing nitrogen such as cracked ammonia or air. The gas composition can vary widely depending upon the alloy being deposited. For example, the nitrogen or other nitrogen-containing gas may be diluted with an inert gas such as argon, for example with up to 95 volume percent of argon.

Sputtering may be direct current or radio frequency sputtering and, in the latter case, sputtering may be direct from a chromium alloy or a nitride of a chromium alloy in an inert atmosphere as appropriate. A pressure of from 0.1 to 10 microns of mercury may in general be used to effect sputtering.

The chromium alloy coating and/or the nitride coating together with any further coating, other than the possible polymer or copolymer coating, should generally have a total thickness of not more than 500A and preferably from 50 to 450A, advantageously not more than 300A. When a plurality of coatings is used, each coating is preferably from 50 to 450A thick.

An outer polymer coating may be applied to the blade having a nitrided chromium alloy coating by known methods. Any of the conventional polymer coatings used to improve the properties of razor blades may be used, for example those comprising polytetrafluoroethylene or a copolymer of thiocarbonyl fluoride and tetrafluoroethylene.

In comparative shaving tests in which razor blades according to the invention were compared with conventional razor blades, the blades according to the invention were generally preferred since they were found to give a more comfortable shave from the first shave.

We claim:

**1.** A razor blade having at least one cutting edge carrying a discrete coating of a prereacted nitride of an alloy of chromium containing at least 12 percent by weight of chromium.

**2.** A razor blade as claimed in claim **1**, in which said nitride is a nitride of an iron/chromium alloy.

**3.** A razor blade as claimed in claim **1**, having at least one cutting edge carrying a plurality of coatings, the total thickness of the coatings being not more than 500A.

**4.** A razor blade as claimed in claim **1**, having a coating of an alloy of chromium below said nitride coating.

**5.** A razor blade as claimed in claim **4**, in which said nitride coating and said alloy coating are derived from the same alloy of chromium.

**6.** A razor blade as claimed in claim **4** in which both alloys of chromium are iron/chromium alloys.

**7.** A razor blade as claimed in claim **6**, in which the iron/chromium alloy contains from 16 to 20% by weight of chromium.

**8.** A razor blade as claimed in claim **7**, in which the iron/chromium alloy contains from 6 to 12 percent by weight of nickel.

**9.** A razor blade as claimed in claim **6**, in which the alloy contains about 18 percent by weight of chromium and about 8 percent by weight of nickel with the balance being a major proportion of iron and, optionally, one or more further alloying elements.

**10.** A razor blade as claimed in claim **6**, in which the iron/chromium alloy contains less than 0.1 percent by weight of carbon.

**11.** A razor blade as claimed in claim **1**, wherein a coating of a polymer which facilitates shaving with the blade is provided on said nitride coating.

**12.** A razor blade having a cutting edge, a first coating of an alloy of chromium on said cutting edge and a second coating of a prereacted nitride alloy of chromium containing at least 12 percent by weight of chromium on said coating of an alloy of chromium.

**13.** A razor blade as claimed in claim **12**, wherein each discrete coating is from 50 to 450A thick.

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