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UNITED STATES PATENT OFFICE.

PERCY A. E. ARMSTRONG, OF LOUDONVILLE, AND RALPH P. DE VRIES, OF NEWTONVILLE, NEW YORK, ASSIGNORS, BY DIRECT AND MESNE ASSIGNMENTS, TO LUDLUM STEEL COMPANY, OF WATERVLIET, NEW YORK, A CORPORATION OF NEW JERSEY.

TOUGH STABLE-SURFACE ALLOY STEEL.

No Drawing. Application filed February 1, 1921. Serial No. 441,641.

To all whom it may concern:

Be it known that we, PERCY A. E. ARMSTRONG, a subject of the King of Great Britain, and a resident of Loudonville, county of Albany, and State of New York, and RALPH P. DE VRIES, a citizen of the United States, and a resident of Newtonville, county of Albany, and State of New York, have invented a new and useful Tough Stable-Surface Alloy Steel, of which the following is a specification.

The invention relates to alloy steel. The alloy steel of the present invention has high surface stability, that is to say, has high resistance to agents tending to produce corroding, rusting, staining and the like, and also is markedly high in toughness and mechanical strength as indicated by ductility and impact tests, for example, making it particularly valuable for wrought metal articles which are to have high mechanical strength as well as highly stable surface characteristics.

The improved alloy steel contains principally iron, carbon, chromium, silicon and nickel, with more or less traces of manganese, phosphorus, etc., which are present in substantially all steels. With stable surface alloy steel containing principally iron, carbon, chromium and silicon as disclosed in Patent No. 1,322,511 of Nov. 25th, 1919, to said Armstrong, the addition of nickel is of relatively small importance so far as the stable surface characteristics of the alloy steel are concerned, though as is stated therein, some nickel can be added without substantial detriment to the stable surface qualities.

Where high mechanical strength and toughness are of importance as well as high surface stability, we substitute another metal of the iron group, preferably nickel, for part of the iron in the alloy of said Armstrong patent, thereby increasing the toughness of the alloy. Any tendency toward loss of surface stability produced by the substitution of nickel for part of the iron, such as results to some extent, for example, in respect to degree of resistance to rusting and to the action of strong nitric acid, is compensated where tough material is required by the increased toughness obtained. When the proportion of silicon is increased along with the substitution of nickel for a part of the iron tougher material can be obtained with practically no loss whatever of surface stability.

This can best be understood from the following example: An alloy steel containing carbon .5%, chromium 17%, silicon 2%, and the rest principally iron has better resistance to rusting than the same alloy with 15–25% of nickel and correspondingly less iron, but the toughness of the latter alloy is greater. With increase of the silicon to about 5% and without the nickel, an alloy is obtained of extremely high surface stability, but its physical properties are not so good as with the lower silicon. If 15–25% of nickel is incorporated in this last material in the place of a corresponding quantity of iron, giving an alloy containing carbon .5%, chromium 17%, silicon 5%, nickel 15–25%, and the remainder principally iron, the surface stability, while reduced as compared with the same material without the nickel, is about as good as with the alloy first-named in this paragraph, and the material is tough, and while comparatively hard to machine can nevertheless be machined with the use of the proper tools.

The carbon of the alloy steel should be from about .05% to about .50%. Where the carbon is high, nickel does not add substantially to the toughness of the alloy steel.

The silicon content of the alloy steel is from about .75% to about 6% and preferably from about 1.5% to about 4.5%. With less than .75% the stable surface effect of silicon is relatively inconsiderable and with silicon above about 6%, the desirable toughness is reduced.

The chromium may be from about 5% to about 25%.

The nickel may be from about 4% to about 30%, replacing a corresponding amount of iron.

Some examples of good alloy steel within the scope of our invention are given in the following table which is intended to serve only as affording an understanding of some of the alloy steels within the scope of the