

UNITED STATES PATENT OFFICE.

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TREATMENT OF STEEL, IRON, &c.

1,065,379.

Specification of Letters Patent.

Patented June 24, 1913.

No Drawing.

Application filed March 19, 1908. Serial No. 422,046.

To all whom it may concern:

Be it known that I, ADOLPH W. MACHLET, a citizen of the United States, residing in Elizabeth, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in the Treatment of Steel, Iron, &c., of which the following is a specification.

This invention relates to treating iron and steel articles, as well as articles of some other metals, in a manner to produce upon the articles a coating, skin, shell or finish.

In the preferred manner of treating iron or steel articles according to my invention or discovery, they are placed in a retort such as shown in U. S. Letters Patent No. 822,460 of June 5, 1906, or in my pending applications No. 292,626, filed Dec. 20, 1905, No. 318,679 filed May 25, 1906, or No. 318,678 filed May 25, 1906, and the retort is heated from 900 to 1800 degrees Fahrenheit, while a current of ammonia flows slowly through the retort. This operation may continue from a few minutes to several hours, while the said heat of the retort is maintained. After a sufficient duration of the ammonia treatment, I close the vent of the retort, and permit the retort to cool while the same remains filled with ammonia and contains the iron or steel articles. This prevents access of air or oxygen to the articles; although the invention is not limited to this particular method of preventing oxidization of the heated articles.

The articles when examined after cooling, are found to be provided with an integral alloyed skin, casing, shell or coating, which when unpolished has a dull silvery color, and is very compact and close-grained and hard, and is capable of taking a very high polish closely resembling polished silver. It is so hard that it is difficult to polish, and difficult or impossible to cut with an ordinary machinist's file. This coating is extremely reluctant to tarnish, corrode, or rust, or to oxidize; and under ordinary conditions may be regarded as practically proof against oxidization or rust, as for instance in indoor use, or where it is not unduly exposed to the elements.

Articles made according to my invention have been submitted to many tests at the same time with common steel untreated

screws and other articles; and while the latter rusted in the expected manner, the former showed no signs of rust or even oxidization. The invention is therefore of value in treating parts of machines and instruments, to prevent their rusting, and give them an attractive finish, and avoid the necessity of nickeling, silvering or otherwise plating or finishing them; while the hardness of the shell renders it desirable for certain wearing parts, cutlery, and in numerous other arts. This silvery casing is much harder than either cast iron or low-carbon steel. It is brittle, but owing to the presence of the softer metal beneath said shell, the brittleness is found unobjectionable in practice. It is magnetic. It is difficult or impossible to anneal said silvery casing by ordinary methods. It is not malleable when cold. It has a granular or granitic fracture of very fine grain. It may be acted upon by vitriol or muriatic acid in much the same manner as iron, but is very reluctant to yield to said acids. When red hot, said silvery casing is harder than tool steel at the same heat, and in many instances is too hard to be scratched with a file. If exposed to air when at a red heat, it oxidizes more rapidly than tool steel or iron at the same heat. These results may be obtained by treatment of Swedish iron or pure iron, or wrought iron, or low-carbon steel of different grades.

Articles finished according to this invention may be readily colored by heating in the manner of coloring steel articles; heating them to certain different degrees causing them to become straw, blue, brown, etc.

I continue the heating of cast iron two hours or more in the atmosphere of ammonia, and permit the iron articles to cool in the bath of ammonia. This produces upon the cast iron a hardened integral shell or casing, having substantially the same characteristics as already noted. With high-carbon or tool steel, the process should be substantially the same as with gray cast iron articles.

I offer the explanation, *de bene esse*, that by the foregoing operation, the iron is alloyed with ammonium to form a shell. The ammonium does not so readily penetrate the metal base at 900 degrees heat as at greater heats, nor is the shell or crust quite so hard

when formed at the lower temperatures as when formed at the higher temperatures.

It will be understood that in many cases, as for instance in incrusting small articles in bulk, it is preferable to rotate the retort during the operation of heating the articles in an atmosphere of the described gases, as set forth in said Letters Patent, so as to agitate the articles and expose them all over to the action of the gas, and cause every side of each article to come uppermost in turn. I also recommend the use of pure ammonia to which a plenum of hydrogen has been added ($\text{NH}_3 + \text{H}$), for incrusting the same with the hard alloy described; this making an alloy of ammonium (NH_4) with iron, or with the iron and the carbon that is already in the iron, or with the cementite (Fe_3C) that is in the iron article, or otherwise acting upon the article to produce a beneficial result.

Having thus described my invention, I claim:

1. The process of treating iron or steel, consisting in heating the metal in an atmosphere of ammonia.

2. The process of treating iron or steel, consisting in heating the metal to at least 900 degrees Fahrenheit and below the melting point in an atmosphere of ammonia.

3. The herein described process, consisting of exposing iron or steel articles when heated, to an atmosphere of ammonia.

4. The process of treating steel of either low or high carbon, consisting in exposing the same when heated above redness, to an atmosphere of ammonia alone.

5. The process of passing a current of ammonia slowly over iron or steel articles while the latter are maintained in a heated condition, to form the described shell or coating upon the articles.

6. The process of passing a current of ammonia slowly over iron or steel articles while the latter are maintained in a heated condition, and agitating the articles while heated and during the flow of such current, to form the described shell or coating upon the articles.

7. The process of passing a current of ammonia slowly over iron or steel articles while the latter are maintained in a heated condition, to form the described shell or coating upon the articles, and permitting the articles to cool without access of air thereto.

8. The process of heating cast-iron articles for at least two hours in an atmosphere of ammonia, and permitting the articles to cool in the bath of ammonia.

9. The process of heating cast-iron articles for at least two hours in an atmosphere of ammonia, agitating the articles while

heated in the ammonia, and permitting the articles to cool in the bath of ammonia.

10. The process of treating iron or steel, consisting in heating the article between 900 and 1800 degrees Fahrenheit while a current of ammonia flows slowly over the article, and maintaining the process until a crust is formed upon the article, which has a dull silvery color and is so hard that it is difficult to cut with a file, is capable of taking a very high polish closely resembling polished silver, and is reluctant to tarnish, corrode or rust.

11. The process of treating steel articles, consisting in exposing the same when heated above redness to an atmosphere of ammonia alone, and maintaining the heating and exposure until a crust is formed upon the articles, which has a dull silvery color and is so hard that it is difficult to cut with a file, is capable of taking a very high polish closely resembling polished silver, and is reluctant to tarnish, corrode or rust.

12. The process of treating steel articles, consisting in exposing the same when heated above redness to an atmosphere of ammonia alone, and maintaining the heating and exposure until a crust is formed upon the articles, which has a dull silvery color and is so hard that it is difficult to cut with a file, is capable of taking a very high polish closely resembling polished silver, and is reluctant to tarnish, corrode or rust, and permitting the articles to cool without access of air thereto.

13. The process of heating iron or steel articles above redness for at least two hours in an atmosphere of ammonia, causing fresh ammonia to flow over the articles when so heated, and permitting the articles to cool in the bath of ammonia.

14. The process of heating iron or steel articles above redness for at least two hours in an atmosphere of ammonia, causing fresh ammonia to flow over the articles when so heated, and permitting the articles to cool in the bath of ammonia, and agitating the articles during the heating thereof.

15. The process of placing iron and steel articles in a retort, heating the retort between 900 and 1800 degrees Fahrenheit, causing a current of ammonia to flow slowly through the retort while the articles are heated therein, continuing the operation for a period of from a few minutes to several hours while the heat of the retort is maintained.

16. The process of placing iron and steel articles in a retort, heating the retort between 900 and 1800 degrees Fahrenheit, causing a current of ammonia to flow slowly through the retort while the articles are heated therein, continuing the operation for

a period of from a few minutes to several hours while the heat of the retort is maintained, closing the vent of the retort and permitting the retort to cool while the same remains filled with ammonia and contains the iron and steel articles, whereby access of air or oxygen to the articles is prevented.

17. The process of heating iron or steel

articles until the articles are above redness, maintaining them at such heat, and causing ammonia to form the described crust on the articles.

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Witnesses:

SAMUEL R. OGDEN,
JOHN J. SCOTT.