Patented July 14, 1942 2,289,443

UNITED STATES PATENT OFFICE

2,289,443

METHOD AND COMPOSITION FOR TREATING STEEL

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No Drawing. Application March 21, 1941, Serial No. 384,551

15 Claims. (Cl. 148—7)

The present invention relates to methods and compositions for treating steel, and more particularly to methods and compositions for obtaining a black surface upon the steel.

Among the objects of this invention are the provision of methods and compositions for surface-treating steel articles; the provision of methods and compositions for surface-treating steel articles to form a surface which is heat-resisting even at high temperatures; the provision of methods and compositions for obtaining a surface which is rust-resistant, and which yields without cracking to even sharp bending of the article; and the provision of methods and compositions for treating steel articles to obtain a uniform and pleasing black surface thereupon. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the ingredients and combinations of ingredients, the proportions thereof, steps and sequence of steps, and features of composition and manipulation, which will be exemplified in the products and methods hereinafter described, and the scope of the application of which will be indicated in the following claims.

Steel articles are strong and durable, but their surface characteristics are not all that could be desired. More pleasing colors are frequently wanted, and steel articles favor the formation of rust in the presence of water. It has become the practice therefore to coat the surface of such articles with various protective agents, and/or decorative means. While useful results have in general been obtained by such practices, they are impractical for certain applications, and in some cases the cost of application and/or subsequent treatment is excessive.

The present invention provides improved methods and compositions for imparting an attractive flexible black surface to steel articles, which surface is rust-resistant, and very tenaciously adherent to the steel article. Moreover, the coating is resistant to heat, and the coated article may be subject to temperature as high as red heat, or even higher, without deleteriously affecting the coating. Where lacquer or the like, for example, is employed, it is necessary to protect the steel article from even moderate heat, and the application of any temperature analogous to a red heat would quickly burn away the surface coating, usually leaving an unattractive carbon residue.

According to the present invention, a solution of a plurality of ingredients either in water, in an organic solvent, or in a combination of several such solvents, is formed. These ingredients comprise a lithium compound, a compound of an alkali metal other than lithium, and an alkali. For certain applications, it is preferable that an acid radical likewise be present although this is not essential. For most purposes, it is preferable that a single compound be employed to act in more than one capacity. Thus, the lithium compound may likewise contain an acid radical, while the compound of the other alkali metal may likewise be an alkali, or vice versa. For example, lithium acetate is both a lithium compound and contains an acid radical. It performs both functions in the compositions employed in the present invention. Similarly, sodium hydroxide is both a compound of an alkali metal other than lithium, and an alkali, and it performs the functions of both in the present invention.

Any soluble lithium compound may be employed. For example, lithium hydroxide, lithium nitrite, lithium acetate, or the like.

The compound of the alkali metal other than lithium may be, for example, sodium hydroxide. potassium hydroxide, sodium acetate, sodium nitrate, sodium nitrite, or the like.

The acid radical should preferably be one which breaks down, or which readily volatilizes. Among these may be mentioned the nitrates, the nitrites, the acetates, or the like. Hydroxides and cyanides may be employed, provided they are in relatively low concentrations, since they do not readily volatilize.

The alkali referred to above may be either a material which is alkaline in reaction, such as a hydroxide, or it may be an alkali former, such as an acetate, which forms an alkali at the temperature of reaction. Throughout the specification and claims it will be understood that alkali formers are included when alkalis or hydroxides are referred to.

As has been pointed out previously, more than one of these functions may be combined in the same chemical compound.

The solvent employed may be water or an organic solvent capable of dissolving a sufficient concentration of the active ingredients referred to. Methyl alcohol, ethyl alcohol, isopropyl alcohol and ethyl acetate, for example, may be employed either alone or in admixture with each other and/or with water. The preferred solvent is, however, a mixture of water and isopropyl alcohol.

For most purposes, it is preferable to add to

the solvent a small proportion of a wetting agent. This is especially true where the steel articles have not been de-greased. Wetting agents in general have a beneficial effect, but the preferred agent is a sulfonated ether, such as the compound marketed by Rohm and Haas Company under the name of "Triton 720." Only a relatively small proportion of the wetting agent need be present. It will be found that a proportion of approximately one-fifth or one-fourth of one per cent. is sufficient. Larger proportions are in general undesirable, while smaller proportions afford only partially improved results.

The following examples illustrate several of the possible compositions for treating steel in accordance with the present invention. They are exemplary only:

Example 1

Lithium hydroxide	g...	1.72
Sodium nitrate	g...	.15
Sodium acetate	g...	.22
Sodium nitrite	g...	.12
Water	ml...	60
Isopropyl alcohol	ml...	40
Sulfonated ether (Triton 720)	ml...	.2

Example 2

Sodium acetate	g...	.32
Lithium hydroxide	g...	2.1
Water	ml...	36
Isopropyl alcohol	ml...	64
Sulfonated ether	ml...	.21

Example 3

Sodium hydroxide	g...	.4
Lithium hydroxide	g...	2.0
Isopropyl alcohol	ml...	57.5
Water	ml...	42.5
Sulfonated ether	ml...	.25

Example 4

Lithium hydroxide	g...	.49
Sodium hydroxide	g...	.89
Water	ml...	50

Example 5

Lithium hydroxide	g...	2
Sodium hydrovide	g...	.49
Water	ml...	100

Example 6

	Grams
Sodium hydroxide	.4
Lithium hydroxide	2.0
Isopropyl alcohol	57.5
Water	42.5
Sulfonated ether	.25

Example 7

	Grams
Potassium hydroxide	.4
Lithium hydroxide	2.0
Isopropyl alcohol	57.5
Water	42.5
Sulfonated ether	.25

In general, it is preferred that the lithium compound or salt shall be in substantially greater concentration than the compound or salt of the other alkali metal.

It is likewise preferred that the concentration of ingredients dissolved in the solvent shall not exceed substantially five per cent. However, concentrations up to ten per cent., or even higher, may be employed under certain circumstances. The dissolved ingredients, however, should not be in sufficient concentration so that when the reaction with the steel is subsequently carried out an impervious surface layer of molten salts is formed. Such an impervious surface layer inhibits the reaction with the steel surface described subsequently.

The above solutions may be applied to the steel articles in any convenient manner. The articles may be dipped therein and withdrawn, leaving the solution adhering to the article, or the solution may be brushed or sprayed on the article, or, where steel sheets are being treated, the sheets may merely be passed between rolls which have been moistened with the solution. The only requirement is that the solution shall be relatively evenly distributed over and shall wet the surface of the article.

The solution having been applied to the surface of the article, the article is next heated to and maintained at a temperature sufficiently high to carry out the reaction of the solution with the steel. This temperature may be, for example, 800° F., although this figure is in no way critical. Lower temperatures may be employed, although in general a longer period of time is then required. The only essential factor is that the reaction between the solution and the steel surface shall proceed to form a uniform black surface.

It will be found that upon heating the steel article to, for example, 800° F. the solution reacts with the steel surface and a uniform jet-black surface is formed thereon. This surface is both rust-resistant and resistant to abrasion. Where a solution such as typified by Example 1 is employed, the finished article may be crimped or otherwise worked at will, and the surface will remain substantially intact.

Moreover, the finish remains black after the article has been heated to red heat, or even higher. The only result of such heating is to obtain under certain circumstances a slight darkening of the finish, due to further reaction of the steel with the coating ingredients. On the other hand, linseed oil base finishes, for example, would carburize and burn off long before an article coated with them reached red heat.

It is important that the entire surface of the steel article be wetted with the solution since only the wetted portions can react. Accordingly, where water alone is the solvent employed, it is preferable that the steel articles be de-greased to obtain a uniform and effective wetting of the surface.

The steel articles to be treated are preferably clean-finished, since the present treatment is not an effective method for removing scale or other impurities from the surface thereof.

Wetting agents in general may be employed to obtain improved wetting of the surface of the steel article. However, the wetting agent should not carburize, and preferably retains its wetting properties up to the point at which the solvent begins to evaporate.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in the above products and methods without departing from the scope of the invention, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. The method of treating steel which comprises applying to the surface of said steel a hydroxyl-containing solution comprising a lithium salt and the salt of an alkali metal other than lithium; any non-hydroxyl anions present being members of the class consisting of acetates, nitrates and nitrites; and heating the surface of the steel to a temperature of approximately 800° F. to react the steel and salts in the absence of a solvent.

2. The method of treating steel which comprises applying to the surface of said steel a solution comprising lithium hydroxide, sodium nitrate, sodium acetate, and sodium nitrite in a mixture of water and isopropyl alcohol, and heating the surface to a sufficiently high temperature to react the steel and solution.

3. The method of treating steel which comprises applying to the surface of said steel a solution comprising lithium hydroxide, sodium nitrate, sodium acetate, and sodium nitrite in a mixture of water, isopropyl alcohol and a sulfonated ether, and heating the surface to a sufficiently high temperature to react the steel and solution.

4. A solution for treating steel comprising lithium hydroxide, sodium nitrate, sodium acetate, and sodium nitrite in water and isopropyl alcohol.

5. A solution for treating steel comprising lithium hydroxide, sodium nitrate, sodium acetate, and sodium nitrite in water, isopropyl alcohol, and a sulfonated ether.

6. A solution for treating steel comprising lithium hydroxide, sodium nitrate, sodium acetate and sodium nitrite in water and isopropyl alcohol, the concentration of said salts being not substantially greater than ten per cent.

7. The method of treating steel which comprises applying to the surface of said steel a hydroxyl-containing solution comprising a lithium salt and the salt of an alkali metal other than lithium; any non-hydroxyl anions present being members of the class consisting of acetates, nitrates, and nitrites; said solution containing not over 10% of solid salts of which at least 4/10 of 1% and not over 2% is a lithium salt; the hydroxyl content being at least stoichiometrically equal to the lithium ion content; the content of the alkali metal other than lithium being equal in weight to at least 1/5 of the lithium salt and not over twice the lithium salt; and heating the surface of the steel to react the steel and salts is absence of a solvent.

8. The method of treating steel which comprises applying to the surface of said steel a hydroxyl-containing solution comprising a lithium salt and the salt of an alkali metal other than lithium; any non-hydroxyl anions present being members of the class consisting of acetates, nitrates, and nitrites; said solution containing not over 10% of solid salts of which at least 4/10 of 1% and not over 2% is a lithium salt; the hyhydroxyl content being at least stoichiometrically equal to the lithium ion content; the content of the alkali metal other than lithium being equal in weight to at least 1/5 of the lithium salt and not over twice the lithium salt; and heating the surface of the steel to react the steel and salts in absence of a solvent; said reaction being conducted at approximately 800° F.

9. The method of treating steel which comprises applying to the surface of said steel a hydroxyl-containing solution comprising a lithium salt and the salt of an alkali metal other than lithium; any non-hydroxyl anions present being acetates; said solution containing not over 10% of solid salts of which at least 4/10 of 1% and not over 2% is a lithium salt; the hydroxyl content being at least stoichiometrically equal to the lithium ion content; the content of the alkali metal other than lithium being equal in weight to at least 1/5 of the lithium salt and not over twice the lithium salt; and heating the surface of the steel to react the steel and salts in absence of a solvent; said reaction being conducted at approximately 800% F.

10. The method of treating steel which comprises applying to the surface of said steel a hydroxyl-containing solution comprising a lithium salt and the salt of an alkali metal other than lithium; any non-hydroxyl anions present being nitrates; said solution containing not over 10% of solid salts of which at least $\frac{4}{10}$ of 1% and not over 2% is a lithium salt; the hydroxyl content being at least stoichiometrically equal to the lithium ion content; the content of the alkali metal other than lithium being equal in weight to at least ⅕ of the lithium salt and not over twice the lithium salt; and heating the surface of the steel to react the steel and salts in absence of a solvent; said reaction being conducted at approximately 800° F.

11. The method of treating steel which comprises applying to the surface of said steel a hydroxyl-containing solution comprising a lithium salt and the salt of an alkali metal other than lithium; any non-hydroxyl anions present being nitrites; said solution containing not over 10% of solid salts of which at least $\frac{4}{10}$ of 1% and not over 2% is a lithium salt; the hydroxyl content being at least stoichiometrically equal to the lithium ion content; the content of the alkali metal other than lithium being equal in weight to at least ⅕ of the lithium salt and not over twice the lithium salt; and heating the surface of the steel to react the steel and salts in absence of a solvent, said reaction being conducted at approximately 800° F.

12. A solution for treating steel at an elevated reaction temperature in absence of a solvent; said solution comprising a hydroxyl-containing solution comprising a lithium salt and the salt of an alkali metal other than lithium; any non-hydroxyl anions present being members of the class consisting of acetates, nitrates, and nitrites; said solution containing not over 10% of solid salts of which at least $\frac{4}{10}$ of 1% and not over 2% is a lithium salt; the hydroxyl content being at least stoichiometrically equal to the lithium ion content; the content of the alkali metal other than lithium being equal in weight to at least ⅕ of the lithium salt and not over twice the lithium salt.

13. A solution for treating steel at an elevated reaction temperature in absence of a solvent; said solution comprising a hydroxyl-containing solution comprising a lithium salt and the salt of an alkali metal other than lithium; any non-hydroxyl anions present being acetates; said solution containing not over 10% of solid salts of which at least $\frac{4}{10}$ of 1% and not over 2% is a lithium salt; the hydroxyl content being at least stoichiometrically equal to the lithium ion content; the content of the alkali metal other than lithium being equal in weight to at least ⅕ of the lithium salt and not over twice the lithium salt.

14. A solution for treating steel at an elevated reaction temperature in absence of a solvent;

said solution comprising a hydroxyl-containing solution comprising a lithium salt and the salt of an alkali metal other than lithium; any non-hydroxyl anions present being nitrates; said solution containing not over 10% of solid salts of which at least $\frac{1}{10}$ of 1% and not over 2% is a lithium salt; the hydroxyl content being at least stoichiometrically equal to the lithium ion content; the content of the alkali metal other than lithium being equal in weight to at least ⅕ of the lithium salt and not over twice the lithium salt.

15. A solution for treating steel at an elevated reaction temperature in absence of a solvent; said solution comprising a hydroxyl-containing solution comprising a lithium salt and the salt of an alkali metal other than lithium; any non-hydroxyl anions present being nitrites; said solution containing not over 10% of solid salts of which at least $\frac{1}{10}$ of 1% and not over 2% is a lithium salt; the hydroxyl content being at least stoichiometrically equal to the lithium ion content; the content of the alkali metal other than lithium being equal in weight to at least ⅕ of the lithium salt and not over twice the lithium salt.

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